CUTTING-EDGE RESEARCH

LAB WORK
A close look at some of today’s most captivating psychology research labs
WHAT COULD BE MORE FASCINATING than psychological research, the vast array of studies that explore how we think, learn, love, work, emote and so much more? Each month in our “Lab Work” series, the APA Monitor on Psychology brings that research to life by shining a spotlight on a psychology lab, uncovering not only what these psychologists are studying, but how they are doing it. In this compilation of the series to date, we visit a lab working to understand the genesis of children’s emotions, one uncovering the roots of racial stereotyping, another exploring human creativity and many others. To read the latest installment of this series, go to www.apa.org/Monitor and search for “Lab Work.”

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COVER: NATALI_MIS/GETTY IMAGES
Studying children in the lab is hard enough. Designing novel experiments and recruiting high-risk kids from unstable backgrounds to participate in those experiments? “If you want to think of the most difficult kind of human research to do, we’ve pulled it all into one package,” says Seth Pollak, PhD, a professor of psychology at the University of Wisconsin–Madison.

Pollak launched his Child Emotion Research Lab in 1997, hoping to determine whether emotions are learned or innate. Over time, that interest evolved into two chief questions: What drives the emergence of emotions in children? And how do early life experiences affect the development of those emotions?

To get at those questions, some of Pollak’s projects focus on typical emotional development. But a fundamental angle of his research is how adverse experiences might influence that development. “At the beginning, we were narrowly focused on the effects of child abuse. Then we started looking at child neglect.”
The past couple of years, we’ve folded in children who aren’t maltreated, but are living in poverty,” Pollak explains. As his participant pool has broadened, he’s stayed true to a core mission, he says: “At the broad level, the lab has always been about using science to improve children’s well-being.”

FINDING THE SWEET SPOT

One important early line of research for Pollak was the Wisconsin International Adoption Project, which focused on children who spent time in orphanages abroad before being adopted by American families. Among the findings to come out of this long-term project, Pollak and his colleagues discovered that early neglect is associated with physical changes in the prefrontal cortex, which could explain cognitive deficits in neglected children (Child Development, 2013). They have also shown that early deprivation affects some developmental processes more than others. Postinstitutionalized children show deficits in areas such as visual memory, attention and inhibitory control, but not in abilities such as auditory processing, planning and rule acquisition (Child Development, 2010).

In a project launched more recently, Pollak collaborated with University of Wisconsin economist Barbara Wolfe, PhD, and their graduate students to study children living in poverty. They found that infants living in poverty had slower brain growth (PLOS, 2015) and that children from lower-income households showed structural brain differences that were associated with lower scores on cognitive and academic achievement tests (JAMA Pediatrics, 2015).

During those projects, the size of the lab’s portfolio grew significantly, hitting a peak around 2008 when Pollak was juggling multiple large grants from the National Institutes of Health, while managing eight or nine graduate students, several postdoctoral researchers, numerous paid research staff and 50 or 60 undergraduates. “It felt like a sign of success that the lab was being so productive, but I found myself really unhappy,” he says. “The lab got so big we had lab meetings in a large conference room. I didn’t really know people, and I couldn’t remember what they were working on.”

So, around six years ago, he began scaling back. These days he tries to maintain his lab with two or three grad students, a postdoctoral fellow or two, and around a dozen undergrads. “It’s big enough that there’s a diversity of ideas and room for debate, but we can really get to know each other,” he says. “I feel like this is my sweet spot.”

FOSTERING INDEPENDENCE

While Pollak now has more time to devote to each of his students, he still gives them plenty of space to figure things out on their own. Many (perhaps most) psychology labs are built on an apprenticeship model: The principal investigator has a large, ongoing project, and new students are each given their own slice of that project to work on. Pollak does things differently.

When graduate students start in his lab, they create their own projects from scratch. Instead of handing them a dataset, he helps them spend the first few months honing their interests. “I support them more like a consultant to help them get at the question they want to study,” he says. When he talks about his students’ experimental designs, his excitement is palpable. Giving students such freedom is a win-win, he says. “I’m pushed to delve into new literature and explore new methods, and it keeps me from getting locked into questions that fit my most familiar method. But the students are getting to see how you can take an inchoate idea and turn it into an empirically tractable project,” he says. “You can’t beat intrinsic motivation when the going gets tough.”

Pollak’s current PhD stu-
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students, Rista Plate and Brian Leitzke, and his postdoctoral researcher Madeline Harms, PhD, all say that the independence they’re given is the lab’s greatest strength—and biggest challenge. “It requires a lot of non-linear work to land on something that’s new and interesting, and you don’t always feel like you’re moving forward,” says Plate, who worked in Pollak’s lab as an undergrad and is now in her fifth year of graduate work. “But all of that movement is really in service of coming up with something unique that you can really feel ownership over.”

In Plate’s case, that something is a computer-based learning task in which kids search for hidden treasure. As they play, the children integrate feedback from the game with suggestions (sometimes helpful, sometimes not so much) from other people. Children from high-risk environments often receive unreliable emotional feedback from the adults in their lives, Plate says. Eventually, she hopes this research model will help explain how the children learn to process that feedback.

POWERED BY QUESTIONS

One downside to letting students and postdocs pave their own paths is that it can take longer to get projects off the ground—and to get papers published. “In a culture that requires a lot of papers, I think it’s harder. On the other hand, I think what they end up doing is a lot of what a new professor does setting up a lab,” Pollak says.

His students can also feel confident that they will be judged on their own merits, rather than those of their advisor. “No one who leaves our lab and goes on the job market is going to look like a cookie cutter of Seth,” Plate says.

The lab’s emphasis on independence has made the environment more cooperative, Pollak says. Because lab members all pursue different projects, there’s minimal competition among them, so they feel comfortable asking for help dealing with setbacks. “It’s a really supportive and collaborative culture,” Plate agrees.

One reason the independent model works may be that the lab isn’t wedded to any single question or method. Projects have ranged from basic mechanistic studies with fMRI to behavioral interventions. “This lab isn’t focused on a specific methodology. It’s focused on questions,” says Leitzke, a sixth-year graduate student investigating whether computer-based games can help children with a history of abuse learn to overcome perceptual biases to more accurately recognize emotions in people’s faces. “They are questions that we don’t know the answer to. But because they’re our own questions, it helps drive the passion.”

REACHING OUT

While research is the heart of Pollak’s lab, outreach is a fundamental piece of their work as well. Twelve years ago, when he began the international adoption project, he hired Barbara Roeber, a licensed social worker, as an outreach manager to help support the families involved in the study.

Roeber, who has a background in teaching children with emotional disabilities, recruits participants for research—a challenging task when those families often have trouble just meeting their basic needs. “We often have families come into the lab who have a great deal of stress, yet they’re doing us a service by volunteering their time to participate,” she says. So she connects them to social service agencies, community resources and mental health providers.

Pollak also makes a point to get out of the lab and spend time in the community. He regularly leads workshops and gives talks to schools, social workers, parent groups and family court judges. “I’ve always felt fortunate to have continuous NIH funding. Money from American taxpayers is supporting us, and I feel strongly that it’s important to get out there and tell them what we’re finding,” he says.

Ultimately, all of those efforts, outside the lab and within, are done in the service of helping kids. “To be successful in my lab you have to be a good scientist, but there’s no one in the lab that is just studying these kids to make a scientific name for themselves. Everyone genuinely is concerned about child welfare,” Pollak says. “What binds us together is the belief that behavioral science can be used to improve children’s lives.”

ADDITIONAL READING

Early Adversity and Learning: Implications for Typical and Atypical Behavioral Development
Hanson, J.L., et al., The Journal of Child Psychology and Psychiatry, 2017

Association of Child Poverty, Brain Development, and Academic Achievement
Hair, N.L., et al., JAMA Pediatrics, 2015

Neurodevelopmental Effects of Early Deprivation in Postinstitutionalized Children
Pollak, S.D., et al., Child Development, 2010

For direct links to the research cited in this article, visit our digital edition at www.apa.org/monitor/digital.
Pigeons have a storied history in psychology. Famed behaviorist B.F. Skinner, PhD, used pigeons to demonstrate his theory of operant conditioning. In the 1960s and 1970s, Harvard psychologist Richard Herrnstein, PhD, devised a classic set of experiments to show that pigeons could classify objects into categories, such as trees or people.

While that latter work was groundbreaking at the time, something about it bothered Edward Wasserman, PhD, a professor of experimental psychology at the University of Iowa. “We don’t form categories like ‘people versus non-people’ or ‘flower versus non-flower.’ That’s not how we carve up the world,” he says. “As clever as his work was, it didn’t capture what categorization is all about.”

So, Wasserman decided to take Herrnstein’s work further. He finished his PhD at Indiana University in 1972. After eight months as a postdoctoral fellow at the University of Sussex, he accepted a position at the University of Iowa and set up his Comparative Cognition Laboratory. He’s housed pigeons there ever since. In addition to
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categorization, he and his team have explored a range of other cognitive processes, including memory, judgment, task switching and visual processing, in pigeons, people and many other species. Pigeons, Wasserman has shown, can do a lot of what humans can do, including learning many new object categories simultaneously, selectively ignoring irrelevant information and learning to recognize human emotional expressions, even on unfamiliar faces (Journal of Vision, 2011).

Wasserman’s team currently includes a PhD research scientist, a part-time lab technician, two graduate students, five undergraduates and a rotating pool of collaborators all over the world. It’s a busy and productive group, says former student Fabian Soto, PhD, now an assistant professor of psychology at Florida International University (and recipient of the 2016 APA Award for Distinguished Scientific Early Career Contributions to Psychology). “We were running experiments day and night, and the range of topics was amazing,” he says.

Those topics have come a long way from the early days of animal research. “My theoretical inspirations are Pavlov and Skinner, but we want to know a good deal more about the basic mechanisms and principles” that control behavior and learning, Wasserman says. He was a physics major before pursuing psychology, so precise methodology comes naturally to him, he says. “What we’re doing isn’t rocket science—it’s way harder because we deal with living beings.”

**WORD LEARNING AND X-RAY VISION**

While the pigeon is a cornerstone of Wasserman’s work, he thinks of *Columba livia* as just one system by which to understand the basic building blocks of cognition. Raising many different species in one lab is impractical, however. In order to take a truly comparative approach, he’s collaborated with scientists around the world to incorporate research on bonobos, baboons, crows, parrots, dogs and more.

“I started off following the lone wolf model of scholarship. As I’ve gone deeper into the field, I’ve found we need teams of people working together to do really exciting work,” he says.

Those partnerships aren’t always easy. “It’s like dating. Some work out and some don’t. Some are flirtations that don’t amount to much. Long-distance relationships can be challenging,” he says. “But when they do work, they’re quite exciting.”

In 2016, Wasserman embarked on a major new collaboration when he and a team of investigators from the University of Iowa, the Ohio State University and University College, London, secured a five-year $5.77 million grant from the National Institute of Child Health and Human Development to study the development and neurobiology of categorization. The scientists will be exploring the processes that pigeons, rats and children of differing abilities use to categorize objects in their world. While Wasserman’s team will focus on the pigeon piece, his collaborators in London will undertake comparative work exploring the neural mechanisms of category learning in humans.

Leyre Castro, PhD, is helping to coordinate that project. Castro arrived from her native Spain for a one-year postdoc in Wasserman’s lab in 2004. When he offered her a permanent research scientist position, she stayed.

While Castro says the pigeons are a lot of fun, her motivations—like Wasserman’s—go deeper. “My main interest is in the pigeons as a model for learning more about cognition,” she says.

Psychologists who study human subjects don’t always fully appreciate how much can be learned from animal research, she adds. “We don’t do this because it’s cute or just for curiosity. The essence of how organisms learn and behave is the same. Things that seem really sophisticated, we see in the pigeon and we realize the mechanisms are much more basic than we may think.”

In one example, Wasserman and Castro presented pigeons with touchscreens featuring sets of images, such as stars and spirals. They showed that when learning to distinguish one set from another (as indicated by patterns of pecks on the screens), the birds—like humans—apply selective attention, essentially tuning out the irrelevant visual information. What’s more, the birds didn’t learn which pieces of information were relevant and then acquire the appropriate way to respond. Instead they seemed to learn which pieces of information were relevant simultaneously.
and steadily improved their ability to respond accurately, just as humans do (Journal of Experimental Psychology: Animal Learning and Cognition, 2014).

In another study, Wasserman and his colleagues showed that pigeons could learn to categorize objects into 16 human language categories simultaneously, as opposed to one category at a time. These results parallel findings of studies on word learning by human infants, suggesting pigeons use a process similar to the one that human babies employ as they acquire language. The results hint that human word learning might rely on more basic associative learning mechanisms than previously thought (Cognition, 2015). Such work could lead to improved methods of teaching words or other concepts to people, he says.

Other projects also angle toward applications outside the lab. For example, Wasserman, current PhD student Victor Navarro, and collaborators showed that pigeons could be trained to distinguish between healthy and cancerous tissues in X-rays. After around two weeks of training, the pigeons correctly identified signs of breast cancer 85 percent of the time, a level on par with that of human pathologists (PLOS ONE, 2015).

Wasserman suggests pigeons (or other animals) might be trained to serve as initial screeners before a person makes a final diagnosis, especially in developing countries where trained experts are in short supply. As far-fetched as that may sound, Wasserman has already heard from a group in South Africa who wondered if they might use pigeons to screen chest X-rays for tuberculosis. Perhaps more practically, the birds could be used to test image-enhancement techniques that could help human pathologists make more accurate diagnoses.

**GREAT TRAINING**

Despite the potential for downstream applications, animal cognition research in general doesn’t always command the respect it deserves, says Soto. “Funding for animal research is going down,” he says. That can make it hard to find jobs in the field after leaving the lab, unless graduates are willing to move into a different line of research. “You might have to reinvent yourself during your postdoc to be fundable,” he says.

Still, many lab graduates have continued in animal research, while others have moved into human cognition or other fields, such as neuroscience modeling in Soto’s case. “People come out of this lab and end up in really different places,” he says. Yet wherever they end up, their meticulous training in animal cognition provides a valuable foundation, he adds. “Working with animals you learn to study complex cognitive processes with a rigorous methodology that is not always possible in a human cognition lab.”

Soto also notes that there’s a great balance of enthusiasm and attention to detail in the lab. “Ed has the same excitement that young people have for science and for data, and that’s really contagious,” he says. And even after many decades of research, he remains open to new ideas, Soto adds. “He lets things go in the direction in which the data are telling you. He doesn’t have this five-year plan in which everything has to work in the way he thinks it should work. As long as the experiment makes sense, he supports you.”

Castro, whose role as research scientist involves a mix of helping with Wasserman’s larger projects and pursuing projects of her own, is similarly enthusiastic about the lab’s approach to science. “We live in this world where we have to publish, so you have to have some topics that are relatively safe,” she notes. “But he allows us to go beyond that, and try something that sounds crazy, or that we may not know exactly how it will work.”

Sometimes it can be hard to keep up with the sheer number and diversity of projects happening in the lab, says Navarro, a third-year PhD student. While that’s challenging, it’s also exciting to be in the midst of so much science. Wasserman has a knack for tackling intricate cognitive phenomena by dissecting them into manageable parts, says Navarro. “He has great experimental finesse and intuition.” It’s a talent Wasserman has polished over decades of doing hands-on science. “When I started as a grad student, I was told to do a project and given an empty room. The wood shop was the first place I went,” he says. “Now we have a beautifully equipped lab with touchscreen computers for every bird,” he adds. “We are able to ask questions we couldn’t even think of before.”

**ADDITIONAL READING**

Pigeons’ Tracking of Relevant Attributes in Categorization Learning

Pigeons Acquire Multiple Categories in Parallel via Associative Learning: A Parallel to Human Word Learning?

Pigeons (Columba livia) as Trainable Observers of Pathology and Radiology Breast Cancer Images
As smartphones, smart homes and other technology become more ubiquitous, it’s more important than ever for researchers and companies to focus on designing technology that older adults can use easily. That’s the aim of the Center for Research and Education on Aging and Technology Enhancement (CREATE), a multi-university collaboration aimed at developing technology and training programs to address the changes that come with age—such as decreased vision and working memory. “People have to be able to interact with technology to be able to function well independently,” says Sara Czaja, PhD, director of CREATE and a professor in the department of psychiatry and behavioral sciences at the University of Miami. “If [technology] is well designed and people are trained properly, then it has the potential to enhance quality of life.” CREATE began in 1999, when Czaja applied for a National Institutes of Health (NIH) grant with four colleagues who shared an interest in how human factors affect technology use among older adults: Joseph Sharit, PhD, of the University of Miami, Neil Charness, PhD, of Florida State...
University, and Wendy Rogers, PhD, and Arthur Fisk, PhD, then both at Georgia Tech. The researchers came from a variety of backgrounds—Sharit and Czaja's degrees are in industrial engineering, while Charness's, Rogers's and Fisk's are in psychology.

“We have similarities, but also differences in our backgrounds, experience and interests, which always strengthen a collaboration,” Czaja says.

The center is now in its 18th year (and fourth NIH grant cycle), and has produced more than 100 journal articles, 50 book chapters and a series of edited books on human factors and aging. The researchers have also worked with technology designers and developers in government and industry to get their findings out of the lab and to the public. For example, they worked with NIH's National Institute on Aging to help design a website with health information for adults older than 60.

**STRENGTH IN DIVERSITY**

Right now, the center’s primary project is designing and testing a software program called PRISM (Personal Reminder Information and Social Management) that helps older adults use the internet to boost their social connectivity, and improve their memory and other cognitive skills. The software provides streamlined access to email, calendar features, games and community resources, and offers training developed specifically for older adults who have minimal computer experience.

The CREATE researchers conducted extensive pilot testing with older adults as part of the design process, to refine both the software itself and the training protocol. They incorporated details including easy-to-read fonts, a consistent-looking and easy-to-navigate interface, and minimal distracting material on the screen.

This is the second iteration of PRISM: In a recent study, the researchers found that the first version boosted perceived social support, well-being and computer proficiency in a sample of 150 older adults at risk for social isolation, who used it for one year (*The Gerontologist*, advance online publication Feb. 15, 2017).

Now, the team is developing a tablet version of the software and testing it in diverse populations. At Florida State University, Charness's lab is testing it with rural residents; at Georgia Tech, Rogers's team is testing it with residents of senior housing communities, including low-income and minority residents; and at the University of Miami, Czaja is testing it with residents of an assisted living center.

In addition to this cross-site project, each of the principal investigators also runs his or her own research program under the center’s umbrella. For example, Wally Boot, PhD, an associate professor of psychology at Florida State University who joined as a principal investigator in 2008, studies how video games may help older adults improve their cognitive and memory skills. Czaja and Sharit have examined how well middle-aged and older adults are able to understand information from their personal electronic health records—like those accessible from a physician's office patient portal—and use the information to make medical decisions. And Wendy Rogers and her students are studying how older adults could use mobile health apps and activity trackers like Fitbits to increase physical activity.
AN EVOLVING MISSION

CREATE’s focus has evolved over time, Charness says. In the early 2000s, the research explored more basic questions, such as how to design a display screen to allow for easy navigation by older adults (they found the font should take up at least 2 degrees of the user’s visual angle), or whether older adults preferred to use a mouse or a light pen to navigate a computer screen (light pens were better, though they have now been replaced by touch-screen technology).

Now that many of those basic questions are answered, the team is working on how technology can address bigger issues, like how to reduce social isolation, increase physical activity and improve health. The work has also become more translational over time, moving from behavioral lab studies to randomized field trials in the community, Czaja says.

One constant, however, is the cohesion and interaction among the researchers. There are still five principal investigators: Fisk retired in 2013, Boot joined the team in 2008 and Katinka Dijkstra, PhD—now on the faculty at Erasmus University Rotterdam—was a PI from 2004 to 2009. The PIs hold four or five face-to-face meetings per year, plus monthly conference calls.

“We’re very friendly, interactive and we see each other all the time,” says Boot. “That just makes the experience more rewarding.”

Indeed, last year the center won the inaugural APA prize for interdisciplinary team research. Czaja describes the team as a “scientific family”—one that extends to students and former students, dozens of whom have passed through the researchers’ labs over the past two decades. Nineteen have received pilot research grants from the center, which also funds independent research projects by students and junior investigators from the undergraduate through postdoc level.

Richard Pak, PhD, now an associate professor of psychology at Clemson University, was a Georgia Tech graduate student and a member of CREATE from 1999 to 2005. He says the experience exposed him to a larger network of scientists. “The nice thing was that I was advised by my mentors, but I also had access to and frequent contacts with the other PIs, as well as their students. It was a great way to build a research community.”

FUTURE OF AGING

As today’s younger adults age, the center’s work may become even more relevant. Tomorrow’s older adults will likely be more familiar with technology than today’s seniors: 42 percent of Americans age 65 and older now own a smartphone, a 12 percent increase from two years ago, according to a 2017 Pew Research Center report. And nearly three-quarters—74 percent—of people age 50 to 64 own a smartphone.

“But what you’re going to find is that each generation, when they age into old age, is going to have similar problems [adapting to new technology],” Charness says. “It’s physiology: Vision declines, working memory capability declines.”

Despite those constraints, Czaja emphasizes that the center’s work shows that the stereotype of the “technophobic” older adult does not hold up to research scrutiny. “Older adults are not technophobic—we’ve trained people up to 98 years old to use a computer,” she says. “They are willing and interested in learning new technology, as long as they see the value of it, understand how it can be beneficial and how it can be used.”

Despite the stereotypes, older adults are not technophobic.
Most scientists would get excited to see topics related to their research on the evening news. For Keith Maddox, PhD, and his students, such news stories are all too frequent.

Maddox heads the Tufts University Social Cognition (TUSC) Lab, studying the social-cognitive underpinnings of stereotyping, prejudice and discrimination. Lately, many of his research topics have a ripped-from-the-headlines feel.

Last May, when two men were fatally stabbed on a train in Portland, Oregon, after intervening when a Muslim woman was being harassed, it called to mind Maddox’s research on confronting bias. While such an extreme outcome isn’t typical, the crime illustrated the importance of understanding how people perceive those who speak out against racism.

Similarly, in June, when basketball star LeBron James’s home was vandalized with a racist slur, it inspired conversations about the intersection of stereotypes based on race, fame and wealth—another area of active research for Maddox.

“A lot of people would have said that for people who have money, race doesn’t matter. The LeBron James anecdote suggests that’s not true,” Maddox says. Understanding how race interacts with other categories, such

The lab is exploring factors that motivate people to confront racial bias and how those who challenge bias are perceived.
as socioeconomic status or celebrity status, allows us to have more nuanced—and accurate—conversations about racism and prejudice, he adds.

**DECONSTRUCTING STEREOTYPES**

Maddox launched the TUSC Lab in 1997 and has funded his research mostly through department support and a series of small grants and fees he earns from speaking engagements and consulting on issues of racial bias and prejudice. “It’s a lot of rubber bands, but we hold it together,” he says.

Those funds typically support two or three graduate students and anywhere from five to 15 undergrads, depending on the semester and the projects on his lineup. Maddox and his students use an experimental approach to study the mental structures and processes underlying how people perceive and think about other people—often in interracial contexts.

One long-running focus of research is a phenomenon known as racial phenotypicality bias. Maddox and others have shown that black Americans with more Afrocentric features, such as darker skin, coarser hair and fuller lips, tend to be perceived more negatively and more stereotypically than are those with less typically Afrocentric features—even by members of their own racial group (Personality and Social Psychology Review, Vol. 8, No. 4, 2004).

Over the years, Maddox and his lab members have explored multiple variations on that theme. His graduate student Jennifer Perry, for instance, is studying how people allocate their attention toward others based on how typical they are of their race.

Other projects aim to understand the stereotypes we hold about people who don’t look like us. But Maddox’s team is interested in digging deeper than the broad black-white divide. He and student Lindsay Hinzman have been exploring how people conceptualize various subgroups of people from different racial groups (Journal of Experimental Social Psychology, Vol. 70, 2017). While most of us have preconceived notions about broad racial categories, the researchers have found we’re actually more likely to rely on stereotypes about subgroups, such as “black athletes” or “white businessmen,” when making judgments.

“The broader stereotypes we have about blacks are somewhat informative, but what actually gets used are your subgroup stereotypes about black women or black athletes,” Maddox explains. “Understanding the intersections of those categories can give us a more nuanced perspective.”

**REAL-WORLD RELEVANCE**

Maddox has always been interested in developing a theoretical account of the processes that underlie stereotyping and prejudice. That’s still an important theme of his research, though these days he’s often looking for links between theory and real-life situations. “It’s been a shift from trying to understand how stereotyping operates theoretically to understanding how it plays out in contexts that might have real-world relevance,” he says.

Some projects, for example, explore the factors that motivate people to confront racial bias and how those who do challenge bias are perceived by others.

In some circles, it can be touchy even to suggest that racial bias exists. “If you bring it up in an interracial context, it can challenge majority [white] people’s idea that the world is a fair place. It upsets the status quo,” he says. “As a result, black people who bring up the idea often experience backlash. There’s this idea they are ‘playing the race card,’” he says.

In a study with former student Jennifer R. Shultz, PhD, he found that white observers were more likely to exhibit backlash against people who made extreme claims of racial bias when the communicator was black rather than white. However, other factors influenced how a communicator was perceived, including the quality of his or her argument and the listener’s beliefs about meritocracy (Personality and Social Psychology Bulletin, Vol. 39, No. 3, 2013). In other words, there is still a lot to unpack in figuring out how best to confront racial bias.

But Maddox and his team are trying, one piece at a time. Recently, they’ve been exploring how anxiety can get in the way of having productive interracial dialogue.

Even well-meaning people who are concerned about racial justice can feel apprehensive about such conversations. That anxiety can cause people to become flustered or distracted or
display unintentional nonverbal behaviors that get in the way of productive conversation. And in some cases, it might prevent those important discussions from taking place at all.

In another study, Maddox, Schultz and collaborators recruited white participants to discuss race relations on campus. The participants were given the choice of talking to either a white or a black conversation partner. White participants were more likely to choose white conversation partners.

But in some cases, the researchers gave the participants instructions beforehand, letting them know that any anxiety they might be feeling was normal and that choosing to participate in interracial conversations might reduce future anxiety in similar situations. In those cases, white participants were more likely to choose to talk to black than to white partners (Translational Issues in Psychological Science, Vol. 1, No. 4, 2015).

By coding their nonverbal behavior, Maddox and Schultz found white participants overall were more engaged when choosing to talk to a black versus white conversation partner about race relations. But the intervention inspired them to push past their anxiety and choose a black partner when they might not have done so otherwise. “Just calling out the elephant in the room encouraged them to make the decision to talk to someone they might not normally talk to,” Maddox says. “It’s not that the intervention made them less anxious, but it encouraged them to make a choice we’d like to see more often in society.”

GOOD FOR A LAUGH
Maddox’s students often start out researching offshoots of his existing projects, such as those on racial phenotypicality bias or confronting bias. But as they hone their experimental skills, he urges them to take their research in new directions. “The goal is that by the time they’re done, they have something that belongs to them,” he says.

That’s how humor found its way into Maddox’s lab, courtesy of Alex Borgella, PhD, a 2017 graduate who is now a visiting assistant professor of psychology at Bates College. Borgella was interested in understanding the role humor plays in interracial relations—an area that was new
for Maddox, but one he encouraged Borgella to explore.

In his dissertation research, Borgella showed that when members of a stigmatized minority group use self-deprecating humor, it can help disarm people who might otherwise be uncomfortable with members of that group. Despite the possible interpersonal benefits, though, those jokes don’t seem to do much to change minds. “Deprecating humor might make majority group members feel more comfortable with that person individually, but they can still feel prejudice toward the person’s group,” Borgella explains.

Comedians often use racial humor to draw attention to serious topics, Borgella says. But it’s not clear whether jokes on late-night talk shows move the cause forward. “Race humor can bring these issues to the fore,” he says. Yet there’s more to learn about how to harness the power of a laugh for social good.

Third-year graduate student Chelsea Crittle has continued with some of the humor research, in addition to a project on confronting bias and another looking at life experiences at the intersection of race and gender. Like Crittle, many of Maddox’s students end up juggling multiple research projects. Those full research portfolios often lead to students collaborating with one another or with researchers in other labs.

“The culture of the Tufts social psychology program is extremely collaborative and supportive, and our lab also reflects that culture” says Perry. “We’re given a lot of freedom, so if you want to be collaborative, you need to go out and make those connections and propose projects and do it for yourself.” Maddox agrees he takes a relaxed approach to guiding students. He tends to give them space to pursue their own ideas on their own timelines. When asked to describe his strengths, he replies, “I tend to be fairly laid back.” What about his weaknesses? “I tend to be fairly laid back,” he laughs.

True, sometimes students ask him to give them deadlines to help them stay on track. But Maddox manages to be supportive and accessible without micromanaging, says Perry. “He recognizes that we are capable and allows us to be our own independent researchers.”

**Making a Difference**
Looking at a timely social issue from a social cognition angle can be challenging for everyone in the lab. “I understand the relevance of my research to very real social problems. At the same time, I see things like Philando Castile and Alton Sterling [black men who were fatally shot by police officers in 2016] and wonder, ‘How can my work make a real difference?’” says Crittle. “Sometimes it’s frustrating and sometimes it’s motivating. It depends on the day and the media coverage.”

Maddox also feels that tension. “I want to understand stereotyping and prejudice, but it’s not just that I want to know. I want to know in order to do something about it,” he says. Yet as a social scientist, he received little training in developing practical applications from his work. And his science training can make him hesitant to claim he has solutions. “The perspective of the scientist is that you have to leave room for doubt. You have to open your mind to the possibility that what you know now isn’t always true. That plays into the reticence of scientists to communicate what they know.”

Despite that hesitation, he forced himself out of his comfort zone by founding the Applied Diversity Science Initiative (ADSI) at Tufts. The program draws from research to develop and test programs and policies to promote diversity and inclusion. ADSI works with the School of Arts and Sciences and the School of Engineering, each of which has developed programs to bring more students from underrepresented groups to Tufts and to understand the challenges they face once they get there.

“It’s hard to move from what I’ve been trained to do to translate this to the real world. But I’m willing to make some mistakes as we learn and improve,” he says.

Despite the personal challenges and the steady stream of disheartening news coverage, Maddox is cautiously optimistic that society is taking steps toward racial justice. “There’s contention for sure, but there also seems to be more support for change. Like anything, it’s a conversation with ups and downs,” he says. “But if we’re not talking about it, we’re not making progress. I think it’s better that we’re talking.”

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**Additionnal Reading**

- **Confronting Bias Through Teaching**
  Crittle, C., & Maddox, K.B. Teaching of Psychology. 2017

- **Conceptual and Visual Representations of Racial Categories: Distinguishing Subtypes From Subgroups**
  Hinzman, L., & Maddox, K.B. Journal of Experimental Social Psychology. 2017

- **Reframing Anxiety to Encourage Interracial Interactions**
As teens cross the wobbly bridge from childhood to adulthood, they’re often expected to take on new responsibilities. Though they might not be thrilled about watching siblings or mopping the floor, there are benefits to helping their families, according to Andrew Fuligni, PhD, who heads the Adolescent Development Lab at the Semel Institute for Neuroscience and Human Behavior at the University of California, Los Angeles. In a series of studies, Fuligni has followed diverse samples of teens in the Los Angeles area, exploring such topics as adolescent identity, academic achievement, family relationships, psychological well-being and physical health. In one project, for instance, he explored the pros and cons of adolescents helping family members by providing emotional support, cooking and cleaning, watching siblings or helping parents at their jobs.

Those helping roles were sometimes challenging for kids, Fuligni found. Adolescents with more family responsibilities often reported feeling burdened by their duties. Yet they also reported more happiness and positivity on a daily basis than teenagers who had fewer jobs to do at home (Developmental Psychology, Vol. 45, No. 4, 2009).

“Helping was challenging at
Lab Work

times, but also highly meaningful," he says.

Yet the particulars differed for families from different cultural and ethnic backgrounds. Boys and girls from Asian and Latino backgrounds were more likely than those from European backgrounds to lend a hand at home and to place higher value on familial obligations, he found.

Exploring how cultural and ethnic differences affect adolescent development is a key theme in Fuligni’s research. But his broader goal is to understand the processes that affect health and well-being for all adolescents.

Adolescence is often thought of as a time of challenges and risks. But Fuligni sees young people as having more to offer—and he’s committed to understanding what makes them thrive. “Ultimately, it comes down to figuring out the extent to which adolescents feel like they have a place in the world, that they have an ability to contribute and the implications of that ability for their health and well-being,” he says.

DIVERSITY AND DIARIES

Fuligni earned his PhD in developmental psychology at the University of Michigan. His first academic position was at New York University, where he conducted the foundational work that would form the basis of his current research.

In 2001, after seven years at New York University, Fuligni moved his lab to UCLA because of the collaborative opportunities that exist within the psychology department and across the institution, he says.

“I’m trying to connect what’s going on outside the body with what’s going on inside, whether that’s neuroscience or the biological bases of health,” he explains. “It clearly requires interdisciplinary work to make that happen, and we have a remarkable community of folks here that are very willing to collaborate.”

That willingness to join forces is evident in his lab, where many of his students are involved in research projects that extend to other labs on campus. Fuligni typically has four to six graduate students at a time, and about half have a second co-advisor in another lab. The lab roster usually includes one postdoctoral researcher as well, plus three to five undergrads. Those lab members all work together to tackle the large, detailed longitudinal studies that are Fuligni’s forte.

The Adolescent Development Lab focuses on immigrant families or children from diverse ethnic and cultural backgrounds. His commitment to diversity is twofold. First, he says, it’s important to help policymakers and practitioners understand the experiences of children from those backgrounds. Second, investigating a diverse sample of families gives a more complete picture of the central developmental processes at play in all children as they make the transition to adulthood.

“In every study, we have diverse backgrounds. A lot of times it makes a difference [to the outcome]; sometimes it doesn’t. But I believe that looking at a diverse population is necessary for really understanding these normative processes,” he says.

In one longitudinal study funded by the National Institute of Child Health and Human Development (NICHD), for example, Fuligni and his collaborators are following adolescents from Asian, Latin American and European backgrounds. The researchers use a daily diary method to collect extensive information from adolescents about their daily activities, moods, stress levels, sleep habits and relationships with family and friends. The researchers also collect blood samples, allowing Fuligni and his team to track both short- and long-term changes in stress hormones, inflammation and other biological markers of health.

The project is ongoing, but several findings have emerged from the study’s first wave. Fuligni and his colleagues have found that as early as the high school years, there’s a connection between sleep patterns and inflammatory processes (Psychosomatic Medicine, Vol. 78, No. 6, 2016). “The extent to which kids fluctuate in the amount of sleep they get each night was predictive of higher levels of inflammation,” he says. “That’s consistent with emerging findings that it’s not just the amount of sleep you get, but the variability in sleep behavior that gets under your skin.”

The team also found that adolescents who reported a higher frequency of unfair treatment and discrimination had greater levels of the stress-related hormone cortisol across

That brain activity could help to explain another of Telzer and Fuligni’s findings: Mexican-American adolescents who placed more value on family obligations had lower rates of substance use than their peers. Yet in families with a lot of parent-child conflict, kids who reported providing more family assistance had higher rates of substance use. In other words, family values can be protective, but could turn risky in certain contexts (Journal of Youth and Adolescence, Vol. 43, No. 2, 2014).

At the time Telzer was beginning her graduate work, around 2006, developmental neuroimaging was an emerging field, she says. But when Telzer proposed the idea to Fuligni, she
found a receptive audience.

“Whenever I said I was interested in culture, development and neurobiology, most people looked at me like I was crazy. When I talked to Andrew about it, he was excited,” she says. Fuligni hadn’t yet done any fMRI work in his own lab, but he helped Telzer pull together an interdisciplinary team to make it happen.

Fuligni takes care to expose his students to the gamut of research experiences. “All of my projects involve extensive involvement of students and trainees, from design and data collection to analysis and writing papers,” he says.

And there are often a lot of data to collect. The lab is usually engaged in two or three active data collection efforts at a time, while the researchers also analyze reams of data from previous projects.

“Everyone makes the whole project move along and everyone contributes to the entire project,” he says. Still, he makes a point to let students carve out their own niche. “When it comes time to write up papers, we have discussions about what each student wants to focus on and where it makes sense for him or her to take the lead.”

Joanna Kim, a current PhD student, joined the lab in the middle of the NICHD-funded longitudinal family health study. When it came time for the next wave of data collection, she says, Fuligni gave her a chance to add some new items to the daily diary checklists for participants. “The core research questions and methodology were already established, but he opened it up and gave us opportunities to chime in,” she says.

KIDS IN A CANDY STORE
Perhaps because he’s used to juggling many large projects at a time, Fuligni has a reputation for being flexible, which shows in his approach to meeting students where they are. “He communicates and finds out how best to work with each student’s individual style,” says Jessica Chiang, PhD, a lab graduate who now works as a postdoctoral researcher at Northwestern University. “For some, that means giving more autonomy early on, while for others it means providing more frequent guidance.”

That guidance can be particularly important as new lab members get up to speed on the projects’ moving parts—and the sophisticated analyses that those large data sets require. “There is an overwhelming wealth of information to be gained from these datasets. It took a while to gain knowledge on all the different tasks, questionnaires and collection protocols,” says Evelyn Mercado, PhD, a postdoc in the lab who is studying how the family environment affects mental health in adolescence. “It has been an analytical challenge, but also rewarding, to learn how to best capture the growth these families are experiencing,” she says.

Analyses from the lab’s longitudinal studies often require the statistical framework known as multi-level modeling, which allows the researchers to evaluate multiple, hierarchically organized variables such as individuals within families over time. Even seasoned researchers with a background in that framework can find it daunting to figure out how best to make use of such a rich dataset, Mercado and Kim agree.

Yet that challenge can be stimulating, Kim adds. “It’s hard because there are so many variables at your disposal. Should I look at family conflict? Support? Autonomy? Sleep? It can feel like being a kid in a candy store, and you have to decide what you can prune away to get at a cohesive question.”

Fortunately, Fuligni has fostered a culture in which his lab members are eager to jump in to help new arrivals learn the ropes. Established students often spend time helping newer students familiarize themselves with the datasets and analyses. Fuligni also helps connect lab members with similar interests. “The culture in the lab is one of collaboration rather than competition,” Chiang says.

Fuligni is understandably proud of that congenial culture. “It’s incredibly gratifying to see the willingness of older students to engage with younger students to teach them the skills and analytical techniques,” he says.

That openness extends to Fuligni himself, who is always willing to listen to new ideas from students and collaborators. “It’s important as a scientist to continue to change and learn and develop. You want to follow where the science is going and also keep yourself interested—and really exciting work is often driven by my students,” he says.
When a magician pulls a rabbit out of a hat, or knows exactly which card you secretly plucked from a deck, how curious are you to know how she managed the trick? For many people, the answer is “very.” Some people are even willing to risk a mild electric shock to find out, as psychologist Kou Murayama, PhD, and his colleagues learned in a recent experiment. Using fMRI scans, the team found that people who showed more activity in the striatum—part of the brain’s reward network—were more likely to risk the electric shock to find out how the magic trick worked. In some ways, that’s not a surprise. Humans have long understood the powerful pull of curiosity—in proverb and myth, curiosity kills the cat and curious Pandora unleashes evil into the world. But “intrinsic motivation”—which includes curiosity, as well as the desire to learn and to try challenging new things—is understudied in psychology, says Murayama, who heads the Motivation Science Lab at the University of Reading in the United Kingdom.

Now he and his students are working to change that, by using fMRI, behavioral experiments, longitudinal studies

THE SEDUCTIVE POWER OF CURIOSITY

The Motivation Science Lab at the University of Reading explores how our need to know drives human behavior

BY LEA WINERMAN
and computational modeling to explore such questions as how curiosity drives behavior, what it looks like in the brain and how it interacts with extrinsic motivators, such as money or other tangible rewards.

The hope is that such basic knowledge might someday lead to interventions to increase intrinsic motivation in schools, workplaces and other settings, Murayama says. But to understand how to increase motivation, he says, “we need to first understand what it is and what the mechanisms are.”

**A YEARNING TO KNOW**

Murayama’s lab is relatively young. He earned his PhD from the University of Tokyo in 2006 and joined the faculty at the University of Reading only four years ago, after a series of postdocs. But the lab is in expansion mode, and his work is gaining notice.

In 2016, he won APA’s $25,000 F.J. McGuigan Early Career Investigator Research Grant on Understanding the Human Mind. This year, he earned his first two major research grants as the sole principal investigator, totaling £1.3 million ($1.7 million), from the Leverhulme Trust, a U.K. research charity foundation. The grants will allow him to nearly triple the size of his team.

Together, Murayama and his students are weaving diverse lines of study into the lab’s research program. One focus is using behavioral and neuroimaging experiments to explore intrinsic and extrinsic motivation and how the two kinds of motivation can interact with each other.

For example, postdoc Johnny Lau, PhD, is working with Murayama on the magic trick study. In it, participants in an fMRI scanner view either a picture of a tempting food (a tangible external motivator), or a short video of a magic trick performed by a professional magician. Then the researchers show the participants a “wheel of fortune” that can be spun for the chance to win the food or an explanation of the trick. However, participants are told that if they lose, they will get a mild electric shock. In preliminary results, Lau and Murayama have found that food and curiosity excite the same reward areas of participants’ brains, in the striatum. And, in both cases, people who showed more activity in those reward areas were more likely to choose to risk the electric shock.

“If you’re familiar with the story of Pandora’s box, that’s what this is,” Lau says. “It’s about the seductive power of curiosity.”

**RESEARCH FOCI**

The Motivation Science Lab is exploring:

1. What is curiosity; what drives people to learn and try new things?
2. How do “intrinsic” and “extrinsic” motivation interact to influence behavior?
3. How well do people understand what motivates them?
4. Can students become more motivated by spending time with motivated peers?
Murayama has also found that people are not very good at estimating or understanding what will motivate them (what he calls “metamotivational capacity”)—they underestimate intrinsic motivation and overestimate the sway of external rewards. Classic research from the 1960s and 1970s on the “undermining effect” found that extrinsic rewards are often not, in fact, effective motivators and that offering rewards can even undermine people’s intrinsic motivation to do a task. But Murayama’s results suggest that laypeople don’t understand this.

In one study, for example, Murayama asked participants how much they believed that they would enjoy a seemingly boring task (e.g., putting words in alphabetical order), and then asked them to rate their actual enjoyment afterward. He found that people underestimated how much they would enjoy the dull work.

“They found a way to make it more interesting,” Murayama says. “People have a good capacity to create enjoyment out of even a boring task.”

However, when the researchers then introduced an external motivator—offering people cash to complete the task—participants overestimated how much more they would enjoy it.

“They thought that because they were getting money, they should enjoy it,” Murayama says. “But the actual enjoyment was not that high.”

In another line of research, Murayama and graduate student Greta Fastrich are studying what inspires people to attempt difficult tasks. “Why do people go mountaineering?” Murayama asks. “People want to climb challenging mountains, even though it is difficult and they run the risk of losing their life. When we look into the [psychology] literature, there are not many studies that attempt to explain why.”

To try to begin to answer this question, Murayama and Fastrich are asking people to answer vocabulary questions. Participants can choose the level of difficulty of the vocabulary words. In preliminary results, Fastrich has found that when participants are offered cash rewards for correct answers, the participants, not surprisingly, prefer easier questions. But when no cash is offered, participants prefer the challenge of more difficult questions. Next, Fastrich plans to do the experiment again, this time combining computational modeling and fMRI scans to investigate the underlying neural correlates of challenge-seeking behavior.

In another line of research at the lab, graduate student Laura Burgess is working on a longitudinal study designed to measure “motivation contagion,” or whether students can become inspired by spending time with more motivated peers. “If you see a friend who likes mathematics, do you start to like mathematics more, too?” Murayama asks. To find out, the researchers (in collaboration with the charity organization BrainCanDo) aim to recruit about 100 girls from a local boarding school and will follow them for one school year. The researchers will gather behavioral and fMRI measures of the girls’ intrinsic motivation to learn, then follow them and their friendship networks to see if girls who spend more time together become more alike in their levels of motivation and brain functioning.

**ONE QUESTION, MANY METHODS**

Murayama’s students say he is interested in multidisciplinary research methods—including neuroimaging, behavioral experiments, longitudinal studies, computational modeling and analyzing large-scale data sets—allows them the freedom to expand their own knowledge. “One of the reasons I really appreciate working with Kou is that his knowledge allows me to use and learn different techniques,” Fastrich says.

Such diverse studies can be challenging to organize, Burgess says. For the motivation contagion study, for example, she will administer multiple rounds of questionnaires to more than 100 students, plus schedule time for fMRI scans for all of them.

“Luckily, the support I get here is amazing,” she says. “Kou has always got time to meet, even if he doesn’t really.”

For his part, Murayama hopes that examining the question of motivation from many angles will lead to a better understanding of how different types of motivation drive human behavior. But he knows it is a long-term project. “It’s a big question: What is motivation?” he says. “I don’t think I can answer it in the next 20 or 30 years.”
Middle school students file into the computer lab and take their seats at the monitors. As they work through the math problems on the screen, they receive immediate feedback about their performance. Students who excel are given a harder set of problems to work through, while those who are struggling practice more basic math skills.

Meanwhile, their teacher observes her class through a pair of mixed-reality glasses that show icons hovering over the students’ heads. Some icons indicate the students are doing well on the lesson. Others suggest the students are having trouble but are likely to arrive at the right answer. Some icons reveal that the student is stuck. It’s not a dream scene but a real-life pilot project led by Vincent Aleven, PhD, a researcher in human-computer interaction at Carnegie Mellon University and a member of CMU’s LearnLab.

LearnLab’s mission is to create educational technologies that help students learn, while also serving as a platform through which to study the cognitive principles and mechanisms of learning in real classrooms. Despite its name, LearnLab uses rigorous methodology to study learning in real classrooms.

The LearnLab at Carnegie Mellon University takes a high-tech approach to understanding and improving learning.

BY KIRSTEN WEIR
human learning. In most LearnLab projects, both of those things are happening at once. Students might be learning algebra or Chinese with computer-based tutoring systems, for instance, while at the same time those systems embed experiments and collect data on what factors influence learning.

The interdisciplinary project draws collaborators from fields including psychology, computer science and human-computer interaction. It’s a sizable undertaking, with 10 faculty members—each with a set of graduate students—plus postdoctoral researchers, research assistants and programmers.

Though LearnLab is big, it’s goal is even bigger, says lab director and cognitive psychologist Ken Koedinger, PhD, a professor of human-computer interaction and psychology. “We’re really striving to be a model for every school or university by applying psychological research to what it does.”

REAL-WORLD RESEARCH
LearnLab got its start as the Pittsburgh Science of Learning Center, one of three national learning science centers funded by the National Science Foundation in 2004. A joint program of CMU and the University of Pittsburgh, the Pittsburgh learning center—also directed by Koedinger—was an interdisciplinary program focused on advancing a practical science of student learning.

When NSF funding for the program ended in 2014, the Pittsburgh center shut down, along with the official partnership between CMU and the University of Pittsburgh. But Koedinger and his colleagues decided to keep the mission alive. LearnLab receives funding through grants and through CMU’s Simon Initiative, a program that takes a cross-disciplinary approach to measurably improving student learning outcomes.

Despite its name, a standout feature of LearnLab is that it takes the research into real-world middle school, high school and college classrooms, rather than conducting experiments in a lab. That approach allows for longer studies with students engaged in genuine academic learning. And from a practical point of view, it means researchers can spend less time recruiting and scheduling lab participants, and more time working with students in schools.

“The central idea is to study learning in real learning environments, but with the same kind of methodological rigor that we have historically incorporated into psychology labs,” says Koedinger.

LearnLab isn’t the only group studying learning in an applied setting, but it takes a unique approach, says Paulo Carvalho, PhD, a postdoctoral researcher at LearnLab since 2016. “Many times, when people do applied research, they do a different kind of experiment than they would do in a laboratory. Here it’s the same materials, the same approach, we just do it in collaboration with teachers and schools, instead of in a lab with participants.”

Straddling the line between applied science and basic, theory-oriented research on learning can be challenging at times, says Rony Patel, PhD, a former psychology graduate student of Koedinger’s who now works at Google.

“Sometimes people on the educational side thought we were too theoretical, and people on the theoretical side thought we were too practical. We had to figure out how to negotiate that space,” he says. “But what I liked about LearnLab was that I was in actual schools getting actual feedback from teachers, administrators and other stakeholders in the education fields, in addition to education researchers.”

SHAKING THINGS UP
With so many scientists and students from a variety of departments, it’s no surprise that LearnLab covers a lot of research territory.

One recurring theme is the development of intelligent tutoring programs, which grew out of cognition research by CMU psychologist John R. Anderson, PhD. Intelligent tutors are computer-based learning systems that provide immediate and customized instruction and feedback to students as they work through a series of problems.

Such systems don’t replace teachers, but are used in classrooms alongside face-to-face instruction, Koedinger says. Think of them as interactive textbooks that provide students opportunities to test their developing knowledge, practice new skills and get personalized instruction in response to...
vision to develop an intelligent tutoring system that watched 4- to 8-year-olds as they played a game that involved predicting and explaining what makes block towers fall on a simulated earthquake table.

To test the potential added benefit of doing hands-on science, Yannier developed a computer version of the game where kids watched videos of towers from the earthquake table. Compared with students engaged in computer-based inquiry, those who observed real-life demonstrations learned more, both about physics principles and building sturdier towers (ACM Transactions on Computer-Human Interaction, Vol. 23, No. 4, 2016).

“The kids learn almost five times more from the 3-D physical interaction than they do from the exactly analogous flat screen interaction. And it’s more fun! They’re super excited about it,” Koedinger says.

Other LearnLab projects have begun to look beyond student learning to explore better ways to support teachers, such as Aleven’s project to provide teachers with real-time feedback about student performance through mixed-reality glasses. “Software can give different students different sets of problems, and I’d argue that’s a good thing. But it’s not without its challenges for teachers,” he says.

Providing teachers with real-time insight into their students’ thinking allows them to focus their attention where it’s needed. “Students who ask for help aren’t always the ones who need it the most,” Aleven says. “Time moves fast in a classroom, lots...
of things are happening, and it’s important to give the teacher the highlights.”

**DRIVEN BY DATA AND COLLABORATION**

Computational modeling and data analysis is another key element of LearnLab’s mission. The lab oversees DataShop, a central repository for the data collected from educational software. Those data are freely available to researchers around the world and integrated into all the work being done in LearnLab.

“It’s an incredible resource to have just lying around. We sometimes call it the Large Hadron Collider of Learning because it’s like having a particle accelerator for educational data mining,” says Erik Harpstead, PhD, who completed his dissertation in human-computer interaction in Aleven’s lab in 2017 and now works as a systems scientist at CMU. “If someone has an interesting idea, they can pull some data sets to explore it without having to set up a whole study.”

That data repository allows researchers to continuously refine their models and interventions, says Carvalho. “We go to the old data to look for patterns before starting new research. It’s about closing the loop: creating models, applying data, seeing the results and then going back to the model,” he says. “It’s going full circle to create better and better interventions.”

Carvalho, for instance, has been combing through previously collected data to compare the benefits of reading course materials versus working through activities or exercises in online courses. In a phenomenon he calls the “doer effect,” students who engage in more activities have better grades than those who spend more time reading. “We see the doer effect in pretty much every data set we could find,” he says.

If access to reams of data is one of LearnLab’s highlights, its embrace of interdisciplinary collaboration is another, says Amy Ogan, PhD, an educational technologist and LearnLab faculty member who received her doctorate in the department under Aleven in 2011. Ogan studies the social context of the use of educational technologies, such as how students engage with educational software when their home language and the language of instruction differ. Though her background is in computer science, such research requires partnerships with psychology, she says. People with technical know-how frequently turn to psychologists for theory, and those with psychology training know who to ask for help if they need to build a system to test their ideas, she says.

**ADDITIONAL READING**

- **Data Mining and Education**

- **Instructional Complexity and the Science to Constrain It**
  Koedinger, K.R., Booth, J.L., & Klahr, D. Science, November 2013

- **The Knowledge-Learning-Instruction Framework: Bridging the Science-Practice Chasm to Enhance Robust Student Learning**

- **International Handbook of Metacognition and Learning Technologies**
  Azvedo, R. & Aleven, V. (Eds.), 2013

“Having people with all of these backgrounds lets us push things to a level we might not be able to otherwise.”

To foster those connections, graduate students in LearnLab are required to do an interdisciplinary project with another student outside their field. It’s a welcoming environment to both students and faculty members who are interested in getting involved, says Harpstead. “There’s a core team of LearnLab researchers. But if you’re a student in an affiliate department or someone who is only peripherally involved, it’s really easy to walk up and say, ‘Can I work on something like this?’ There’s a kind of flexibility to bring people in from project to project.”

Those partnerships have been fruitful. LearnLab has improved student learning by improving educational technologies, and educational companies, such as Pearson and Kaplan, have adopted evidence-based practices from the lab’s research. The lab has also launched startup companies that are putting intelligent tutoring systems into schools.

The research coming out of LearnLab is often highly technical, requiring a deep understanding of cognitive principles and complex data analysis. But ultimately, the work is less about the educational systems and more about the people using them, Ogan says. “We think a lot about students and how to support them through personalization of their learning experience. That’s the big connecting thread running through LearnLab.”

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In addition to exploring student learning, LearnLab is looking at better ways to support teachers, such as one project that provides teachers with real-time feedback.
TREATING THE EFFECTS OF LGBT STIGMA

The Esteem Program at the Yale School of Public Health is building and testing much-needed interventions for lesbian, gay, bisexual and transgender people

BY TORI DEANGELIS

Last fall’s election of openly transgender Danica Roem to the Virginia Senate was another step forward for the rights of lesbian, gay, bisexual and transgender (LGBT) people in the United States. But despite such successes, many LGBT people continue to struggle with harassment and other forms of social stigma, which research shows is associated with mental health problems. The LGBT population has far higher rates of depression, anxiety, substance use and suicide than their heterosexual and cisgender counterparts.

And unfortunately, evidence-based mental health interventions for LGBT people have been virtually nonexistent, says clinical psychologist John Pachankis, PhD, who heads the Esteem Program at Yale University’s School of Public Health. “There has been this tragic lack in science, where we’ve taken much longer than we should have to create and deliver interventions that can reduce these mental health disparities,” he says.

Pachankis, who earned his doctorate from the State University of New York at Stony Brook in 2008, says this work began to grip him as a graduate student, when he was providing...
therapy to gay and bisexual men in New York. “There was no clear guidance on how to support these men in some of the unique difficulties they were going through,” he recalls.

To try to address that gap, Pachankis and his lab combine psychological and public health approaches to learn about and address the stigma-related mental health issues that they are finding among people in their studies. The lab—which has dual locations in New Haven, Connecticut, and New York City—includes about 15 team members who are a mix of postdoctoral fellows, graduate students and undergraduates working in public health, psychology or both.

The group’s largest project is developing and studying ESTEEM (Effective Skills to Empower Effective Men), an evidence-based intervention for young gay and bisexual men at risk for HIV infection.

In addition, the lab is examining the intersection of physical health, mental health and stigma among lesbian and bisexual women, LGBT people in underserved areas and transgender women in prison.

Most of the lab’s work is funded by a grant from the National Institute of Mental Health (NIMH); other projects are funded by Yale’s Fund for Lesbian and Gay Studies, Yale faculty incentive funding, and smaller grants from NIMH and the Fogarty International Center at the National Institutes of Health.

SEXUAL MINORITY MEN

The rationale behind ESTEEM is to address ways that internalized stigma and homophobia may cause sexual minority men to think, act and feel in ways that undermine their physical and mental health. If a gay man is experiencing significant levels of stigma-related unconscious shame, for example, he might be tempted to mask the pain by having compulsive sex, drinking too much or overworking.

To tackle participants’ issues in these areas, Pachankis and colleagues have developed a 10-session treatment derived from the unified protocol for treating anxiety, depression and other mood disorders developed by Boston University psychologist David Barlow, PhD, and adapted to this group’s stigma-based stress. Through the intervention, therapists help participants identify minority stress experiences—instances of being rejected based on their sexual orientation, for example—and track their cognitive, affective and behavioral reactions to this stress. The providers then help the men build healthy counter-thoughts and behaviors, such as learning to attribute their distress to minority stress rather than to personal failure, and become more assertive and self-affirming.

The intervention involves screening for depression and anxiety disorders and substance abuse, lengthy clinical interviews that identify areas to target, the intervention itself and periodic outcome assessments for a year after treatment. The team also measures HIV-risk behaviors and sense of self-worth.

The team’s pilot project showed that the intervention was successful in reducing depression, alcohol overuse, having sex without condoms and sexual compulsivity (Journal of Clinical and Consulting Psychology, Vol. 83, No. 5, 2015).

Now, together with a research team at the University of Miami headed by Steven A. Safren, PhD, several members of Pachankis’ team are halfway through a five-year randomized controlled trial comparing how 250 men in New York and Miami fare after receiving...
ESTEEM, community treatment as usual, or brief HIV testing and counseling.

In another research effort, the lab has found that sexual minority men experience stigma-related stress from members of their own communities—for example, scrutiny based on appearance, financial status, sexual desirability and other external features. In surveys and experimental studies, postdoctoral fellow Charles Burton, PhD, and Pachankis are showing that this within-community stress is as likely to cause mental health problems as other forms of minority stress. The two are now looking into how this phenomenon might influence men’s depression and sexual risk-taking behavior. “It’s important work,” says Burton, “because most clinicians are not aware of the emotional and physical health significance of a community that, for many sexual minority clients, is both a source of support and stress.”

ADDRESSING LESBIAN AND TRANSGENDER NEEDS

Other team members are looking into ways that stigma may affect the mental health and health behavior of sexual minority women and transgender individuals.

Erin McConocha, a public health master’s student in the school’s social and behavioral sciences program, is using Pachankis’ basic study design to develop a therapy program for sexual minority women called EQuIP—Empowering Queer Identities in Psychotherapy. To develop the intervention, she is interviewing 20 sexual minority women about their experiences with stigma, depression, suicidality and alcohol overuse, and getting input from 10 psychologists across the country who McConocha has identified as expert clinicians based on their scholarly publications and professional reputations in working with sexual minority women. Like Pachankis, she is drawing themes from those interviews to inform the intervention, and she and the team will also use Barlow’s unified protocol as a starting point.

Meanwhile, team member and epidemiologist Jaclyn White Hughto, has been focusing on a particularly vulnerable segment of the LGBT community: transgender women in
prison. Her dissertation, now in press, combines qualitative and quantitative work to assess and intervene in this population's health care. Her first step was to interview transgender women about their health care experiences while incarcerated.

Next, she and a former member of the lab, Kirsty Clark, now earning her doctorate at the University of California, Los Angeles, talked with correctional health-care providers to gain their perspectives on caring for these patients. Based on that work, White Hughto then adapted an educational intervention to improve correctional providers' cultural and clinical competency in providing transgender care, and in 2016, she and Clark trained 100 providers in the model. At a three-month follow-up, White Hughto documented that providers had improved significantly in their willingness and ability to provide such care. Now she is eager to assess the impact of the training on both providers and inmates.

She also wants to develop online training video segments of transgender inmates.

“We know that these online trainings can be very dry when you have to read through a lot of content,” she says. “So, having something visual and engaging is one of my goals.”

**INTERVENING WITH THE UNDERSERVED**

LGBT individuals in low-resource and rural settings tend to face greater stigma and be more closeted than those in urban areas, and team members want to intervene there, too. In a project funded by NIH's Fogarty International Center, Pachankis and social psychologist Corina Lelutiu-Weinberger, PhD, of Rutgers University, are conducting a pilot study of a mobile therapy intervention delivered to about 60 young gay and bisexual men in Romania—one of the few Eastern European countries where the rate of new HIV/AIDS cases among this population is increasing. Therapists provide real-time LGBT-affirmative motivational and cognitive-behavioral therapy via smartphones and other mobile devices. The devices can also be used to track mood, alcohol use and risky sexual behavior, and those results can be used in therapy discussions. In a related project funded by NIMH, the team is also training 180 therapists to deliver LGBT-affirmative mental and behavioral health care across Romania, including in small towns.

“The idea behind providing therapist training as well as the mobile intervention is to ensure there is adequate support on the ground to continue the mobile treatment once the grant is finished,” Pachankis says.

In a similar type of study in the United States, members of Pachankis' team are working with partners at East Tennessee State University in Johnson City, Tennessee, and the College of the Holy Cross in Worcester, Massachusetts, to deliver low-cost writing interventions to rural LGBT youth. One intervention instructs participants to advise a person being discriminated against based on their sexual orientation; the other encourages them to write about the most stressful experiences they’ve faced due to their status.

These interventions “have been shown to be effective in reducing mental health concerns and to some extent risk behavior, so we want to see how they work among LGBT young adults in rural Appalachia and other high-stigma places,” says the lab's senior research assistant, T.J. Sullivan, who has worked in Pachankis' lab for two years and is now applying to psychology doctoral programs.

For his part, Pachankis is heartened by his team's progress toward his long-standing goal of improving LGBT health and mental health through evidence-based interventions. But he’s also interested in a broader aim: He’d like to use psychological research to create a more valid picture of LGBT mental health, a topic that’s been muddied over the years by politics and such harmful interventions as conversion therapy. Even well-meaning research of the past, such as Evelyn Hooker’s studies in the 1950s arguing that LGBT people’s psychological profiles are indistinguishable from those of straight people, need an update, he says.

“We now know, for example, that LGBT people are more affected by mental health problems than heterosexuals, but it’s because of stigma-related stress,” Pachankis says. “We’re finally in a position, historically, where we can use high-quality science to arrive at a more accurate truth about LGBT people’s lives, and how their unique experiences shape their mental health.”

**ADDITIONAL READING**

Most of us use the wrong word or misspeak from time to time, saying “squirrel” when we mean “chipmunk,” swapping sounds to utter “Yew Nork” instead of “New York” or calling a partner by a child’s name. Such slipups are more than just a quirk of human language, says Nazbanou “Bonnie” Nozari, PhD, a cognitive psychologist and assistant professor of neurology at the Johns Hopkins University School of Medicine. They’re also valuable tools for understanding the normal processes of speech.

“We have the ability not only to produce language, but to catch our errors when we make them. How do we detect those errors, apply corrections to them and prevent them from coming up again?” she asks.

Nozari aims to answer those questions as founder and head of the four-year-old Language Production and Executive Control Lab at Johns Hopkins University, where she studies the cognitive processes that monitor and control speech. The cognitive control of language production is surprisingly understudied, Nozari says. “My hope is that my work will help return language to those who have lost it.”
WHEN SPEECH MISFIRES
One branch of Nozari’s research focuses on how we catch ourselves when we misspeak. Traditionally, researchers believed that the brain mechanisms involved in understanding language (the comprehension system) were responsible for recognizing and correcting slips of the tongue. While Nozari acknowledges the role of comprehension in detecting speech errors, her work suggests the brain mechanisms involved in generating speech (the language production system) play a key role in the process. She and her colleagues showed black-and-white drawings of objects to people who suffered from aphasia, or language impairment, after a stroke. The researchers recorded whether the participants named the objects incorrectly and, if so, whether they caught and corrected their mistakes. They found that each participant’s ability to detect errors in his or her speech was better predicted by that person’s language production skills, as opposed to his or her comprehension skills (Cognitive Psychology, Vol. 63, No. 1, 2011).

“There is no doubt that some part of self-monitoring happens through comprehension, but there are internal mechanisms within the production system itself that actually help catch and repair its own errors,” she says.

More recently, she and her colleague Rick Hanley, at the University of Essex in England, extended that theory to children. The research team tested 5- to 8-year-olds with the “moving animals” task, in which the children watched cartoons featuring nine familiar types of animals and described the events to the experimenter. Older children were better than younger children at catching and correcting their own semantic errors, such as calling a dog a cat.

Nozari, Hanley and their team also measured the maturity of each child’s language production system using a separate picture-naming task that required the child to identify the objects in a series of black-and-white drawings. By tallying the kids’ semantic errors (those related to meaning) and phonological errors (those related to sound), the researchers were able to estimate the strength of each child’s language production system using computational modeling. In particular, they showed that this strength was a key predictor in how well the children detected their errors in the moving animals task. This finding mirrored what Nozari and her colleagues found in individuals with aphasia, adding support to the theory that the language production system has its own built-in ability to catch verbal slipups, in children as well as adults (Journal of Experimental Child Psychology, Vol. 142, No. 1, 2016).

A WOLF IN SHEEP’S CLOTHING
Nozari received a medical degree from the Tehran University of Medical Sciences in her native Iran in 2005, then went to London to study people with Alzheimer’s disease. In a routine screening test for dementia, one of her research participants was shown a picture of a sheep and asked to name the object. First, he said “wolf.” He tried again: “steep.” Then, “sleep.”

“I was fascinated that these were not just random errors,” Nozari recalls. “‘Wolf’ is related to ‘sheep’ in meaning, ‘steep’ is related in sound, and ‘sleep’ in both meaning and sound. I was blown away by this phenomenon, and I started reading all about language.”

In 2014, she joined the faculty at Johns Hopkins, where she studies language production. In particular, she hopes her research will lead to new ways to restore language to those who have lost it. “One of the most rewarding parts of my job is working with participants with brain damage,” she says. “There is nothing more inspiring than seeing the effort and hard work they put into regaining lost function after a stroke.”

Much of Nozari’s research involves participants recruited from the Snyder Center for Aphasia Life Enhancement, an aphasia support and community center in Baltimore. In one project with those participants, she and her colleagues took a fresh look at how to reteach words to people after a stroke. Traditionally, these patients are taught words organized in semantic themes—learning fruits in one session, animal names in another. But all of us, with or without aphasia, are more inclined to mix up words that are similar to one another, Nozari says. “If you make a slip of the tongue, you’re more likely to confuse a fruit with another fruit than you are to confuse a
fruit with an animal.” Nozari predicted that language therapy arranged by semantic themes might actually be less effective than therapy that retaught words in semantically unrelated blocks.

To test that idea, she and her colleagues performed a small pilot study with two people who had post-stroke aphasia. Each participated in six training sessions to relern object names, with the words arranged within semantic groups (such as a block of fruit names) or in semantically unrelated groups. While grouping words by theme helped one participant remember them better in the short term, both participants had better long-term retention of the words they learned in unrelated groups. Nozari and her colleagues presented the results at the 2017 annual meeting of the Academy of Aphasia.

The findings could also have implications for second-language education. In one study being prepared for publication, Nozari and former graduate student Bonnie Breining, PhD, and their Johns Hopkins colleague Brenda Rapp, PhD, taught neurotypical adults an artificial language. They showed that participants were better at learning new labels for objects if they were trained in semantically unrelated blocks.

More recently, Nozari and her lab manager Jessa Sahl are completing a version of the language training experiment among Baltimore schoolchildren. Sahl taught 7- and 8-year-olds French vocabulary words, arranged in related or unrelated blocks, for several weeks. She revisited the students to test their recall of the words three weeks and six weeks later.

So far, the results suggest that children, too, learn words better when taught in unrelated groupings, Nozari says.

“It’s harder to learn something when it is presented along with similar things. Sometimes difficulty in learning can be a good thing because you put more effort into learning. But difficulty is undesirable if you cannot overcome it at the time of learning.”

While these findings are preliminary, Nozari hopes such research could point to ways to improve language instruction, leading to better learning outcomes for both students and people with language deficits.

BECOMING A MENTOR
Nozari’s appointment is in the medical school’s neurolinguistics, which doesn’t have a dedicated PhD program. Though she typically hosts a postdoctoral fellow and occasionally co-mentors graduate students from the department of cognitive science, most of her team includes undergraduates and paid research assistants, who typically have bachelor’s or master’s degrees. She pays those assistants with help from both internal university funding and grants from sources such as the National Science Foundation and the National Institutes of Health.

Nozari embraces a direct approach to helping her students set deadlines and establish schedules. “It’s often hard for young students to get a grip on how to manage their time, while still doing quality work,” she says.

When it comes to her mentees’ research interests, though, she’s relatively hands off. “I really believe students have to choose their direction,” she says. “I can give them some help, I can nudge them, but ultimately they have to come up with what they want to do, or they will not have vested interest in the research,” she says.

While most of Nozari’s work to date has focused on spoken language, she’s excited about the many possible directions her research can go. In the last couple of years, she’s collaborated with colleagues such as Rapp who have expertise in other modalities of language production, such as written language. Svetlana Pinet, PhD, a post-doctoral fellow in the lab, has a background studying the cognitive mechanisms at play when people type words rather than speak them. “Our backgrounds all touch on language production, so we can all understand each other and contribute,” says research assistant Chris Hepner. “But it’s a diverse enough group that we can bring different perspectives to the table.”

Going forward, Nozari hopes her team’s work will encourage other psychologists and scientists to see human language in a new light. “There has sometimes been a tendency to view language as so special that it is somehow disconnected from the rest of cognition,” she says. “The goal of a number of psycholinguists, including myself, is to situate language within the broader picture of cognition.”
Next time you dream up what to cook for dinner, remember to buy everything on your mental grocery list and then resist buying a candy bar at the checkout (despite your rumbling stomach), take a moment to praise your executive function. Also known as executive control, this group of mental processes gives you the power to plan, remember, focus, multitask and keep your impulses in check.

But we’re not born with a full toolbox of executive function skills. Children develop and improve these abilities over time—and Sandra Wiebe, PhD, aims to find out precisely how that happens.

Wiebe heads the Alberta Brain & Cognitive Development Lab in the psychology department at the University of Alberta in Edmonton, Alberta, Canada. There, she uses behavioral studies and tools such as electroencephalography (EEG) to understand how young children develop the ability to regulate their thoughts, actions and emotions.

The preschool years are a critical period for the development of executive function. From ages 3 to 5, kids develop a deeper understanding of self, their language skills blossom and they become more adept at working toward a goal.
a deeper understanding of self, their language skills blossom and they become more adept at working toward a goal. There’s much to learn about how those skills take shape during this incredible period of rapid learning and brain development, Wiebe says. Understanding these processes can ultimately lead to better ways to help children develop the executive function skills that are so important for success in school and beyond. “I want to understand the factors that influence the development of executive function, and the implications of that development for children’s lives,” Wiebe says.

**STRUCTURAL SURPRISE**

Wiebe earned a PhD in child psychology at the University of Minnesota Twin Cities in 2003. Her first academic position took her to the University of Nebraska–Lincoln, where she worked as a research assistant professor until she relocated to her native Canada in 2009 for a tenure-track position at the University of Alberta.

One trajectory of her current research stems from a surprising finding she and her colleagues made while she was in Nebraska. The most widely accepted model of executive function describes it as composed of three distinct pieces: Working memory allows you to hold information in mind to inform your behavior, inhibitory control allows you to tune out irrelevant or distracting information and set shifting provides the mental flexibility to switch from one activity or task to another. But while studying executive function in preschool-age kids, Wiebe and her colleagues uncovered evidence that clashed with that three-part model.

The researchers tested 2- to 6-year-old children on a series of 10 cognitive tasks. In a test of working memory, for example, the children opened boxes to look for a hidden reward. The boxes were shuffled between trials, so the kids had to remember which boxes they had previously opened. In a test of inhibitory control, the children were told to freeze like a statue for 75 seconds while the examiner tried to distract them by coughing or dropping a pencil. After collecting data from the battery of tests, the researchers used an established statistical method known as confirmatory factor analysis to compare the results using different models of executive function. They found that inhibition and working memory always seemed to go hand in hand in the children, rather than operating independently of one another as they do in adults (Developmental Psychology, Vol. 44, No. 2, 2008). “Rather than being two clearly separate factors, they seemed to be more of a unitary construct in young children,” Wiebe says. “This wasn’t at all what we were expecting to find.”

In a follow-up study, Wiebe and her colleagues focused on children who had just turned 3, the age when executive function skills begin to emerge. They found additional evidence that working memory and inhibition operate as a single intertwined construct (Journal of Experimental Child Psychology, Vol. 108, No. 3, 2011).

There’s no doubt that executive function becomes more efficient as children develop, Wiebe notes. But her work suggests the development of executive function isn’t just about efficiency. Rather, the very structure of executive function appears to undergo dramatic change during the preschool years, crystallizing into three distinct components sometime after early childhood.

**SORTING SEASHELLS**

Wiebe is continuing to study how the structure of executive function changes in childhood. In a current study, she’s tracking 4- to 7-year-olds over the course of a year to see whether the components of executive function remain stable over time. She’s also collecting measures of their math and reading abilities to assess how executive function might affect academic performance. “There’s a lot of evidence that executive function is especially important for learning math concepts,” she says.

Meanwhile, she’s also taking a closer look at set shifting, the third component of executive function. “One thing that very young kids struggle with is switching between different rules,” Wiebe says.

She and her doctoral student Sarah Elke designed a project to study how children shift their focus from one task to another. Specifically, they wanted to understand what prompts kids to engage the cognitive controls they’ll need to complete a task.
“If they know they’re going to have to switch rules, do they prepare for that cognitive challenge in advance? Or do they just respond to things as they happen?” Wiebe asks.

To find out, she and Elke decided to compare task switching in two groups of children on either side of a major childhood milestone: 4- and 5-year-olds who hadn’t yet started school, and 7- and 8-year-olds who had already made the transition.

Elke and Wiebe devised a computer game that required the kids to sort seashells and starfish. When a gray dolphin appeared on the screen ahead of the sorting task, it was a cue that the kids should plan to sort the shells and starfish by shape. When a multihued octopus popped up, they were to sort the objects by color instead.

The researchers used EEG to measure event-related potentials (ERPs), small voltage changes generated in the brain in response to cognitive or sensory events. The results, Elke says, were another surprise. “We were expecting to see differences in ERPs between the younger kids and the older kids, but we didn’t see any big differences,” she says. Older kids were faster and more accurate at the sorting task, but ERP measures showed that even the 4-year-olds could initiate cognitive control ahead of when they’d need to use it (Developmental Cognitive Neuroscience, Vol. 26, No. 1, 2017).

The findings suggest that kids in both age groups use the same underlying cognitive control processes, and that the system matures and improves with age, Wiebe says. To her, a key takeaway from the study is that even before kindergarten, children can engage in some impressive mental machinations.

“Four- and 5-year-olds have more advanced cognitive capabilities than we might have thought,” Wiebe says.

PLAYING SPIDER-MAN
Although it can be quite a feat to convince a 4-year-old to wear an electrode-studded EEG cap for the research, the technique is useful because of its sensitivity, Wiebe says. “Sometimes you can see differences at the brain level that you can’t see at the behavioral level.”

Still, the tool takes practice, Elke says. If you want pristine EEG data, you need to convince your participants to sit perfectly still. When you’re working with squirming preschoolers, noisy data
are inevitable. Yet Elke credits the kids with helping her hone her data-analysis skills. “Instead of relying on the participants to give you clean data, you have to rely on your own abilities and work with what you’ve got,” she says.

Though capturing the data from the children can be challenging, other aspects of the research are highly rewarding, Elke says.

“Everything you do has to have a fun atmosphere. You have to convince the kids they’ll look like Spider-Man to get them to put the EEG hat on.” And the difficulties have given her a deeper appreciation of the participants, she adds. “It’s made me more aware of what we’re asking of our research participants, and made me more empathetic and grateful to them.”

Elke is one of four graduate students working in Wiebe’s lab, along with a long list of undergraduate honor students and volunteers. Funding for the lab’s basic operating costs comes from the Natural Sciences and Engineering Research Council of Canada. In addition, the lab receives a variety of foundation grants to support individual projects.

Wiebe’s academic home is in the psychology department, but she is also a member of the university’s interdisciplinary Neuroscience and Mental Health Institute, which brings together scientists from fields such as cell biology, psychiatry, genetics and nursing. That involvement is well-suited to Wiebe’s interest in collaboration and fresh ideas.

EXERCISE AND COGNITION
In a recent example of that collaborative spirit, Wiebe has been teaming up with Valerie Carson, PhD, an associate professor of kinesiology, sport and recreation at the University of Alberta. Together with Wiebe’s graduate student Aishah Abdul Rahman, they are studying how children’s physical activity affects their cognitive development. They started with a review of the existing research on the topic (Journal of Science and Medicine in Sport, Vol. 19, No. 7, 2016). While they found evidence to suggest exercise in early childhood had a positive effect on cognitive development, only seven studies met their criteria for inclusion in the review, and of those, six used questionable methodology.

“There’s a real lack of research looking at physical activity and cognition in early childhood,” Abdul Rahman says. Studies of older children, adolescents and adults more clearly suggest a link between physical activity and improved cognitive performance, she adds. But early childhood “has been sort of neglected.”

To help address that gap, they recruited 100 children ages 2.5 to 4 and tested them on skills related to working memory, inhibitory control and language development. Parents reported the types of activities the kids participated in, and for a full week the children wore a device to measure their physical activity during waking hours. In this first wave of the study, the researchers didn’t find any evidence that the kids’ activity influenced their working memory or inhibitory control. They did, however, find that more physically active kids scored better on vocabulary tests (Mental Health and Physical Activity, Vol. 13, No. 1, 2017).

The researchers repeated the tests with the same children six and 12 months later, and they are now analyzing those data. Abdul Rahman is also analyzing EEG data they collected while the children completed the cognitive tests in the lab. “We hope to see how things change together,” Wiebe says. “If kids become more active or more sedentary, does that parallel changes in their cognitive abilities?”

FURTHER READING
Neural Correlates of Response Inhibition in Early Childhood: Evidence From a Go/No-Go Task

Proactive Control in Early and Middle Childhood: An ERP Study
Elke, S., & Wiebe, S.A. Developmental Cognitive Neuroscience, 2017

Associations of Subjectively and Objectively Measured Sedentary Behavior and Physical Activity With Cognitive Development in the Early Years
Carson, V., et al. Mental Health and Physical Activity, 2017

Separating the Fish From the Sharks: A Longitudinal Study of Preschool Response Inhibition

BACK TO BASICS
Depending on their findings, Wiebe says a next step could be an intervention study to discover how children’s cognitive abilities change if they start spending more time moving and less time zoning out in front of the television or computer screen.

While Wiebe is open to possible interventions and applications of her work, she remains committed to answering the big, fundamental questions about the nature of executive function. That commitment sets her apart from many other researchers in this field, says doctoral student Daphne Vrantsidis.

“A lot of people study the neurological basis of executive function, or study how executive function is exhibited in certain situations,” she says. “I was interested in working with Dr. Wiebe because she is answering basic questions about what executive function is.”

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How many times have you heard the statements “I’m just not very creative” or “He always thinks outside the box”? People often think of creativity as a trait—a static quality that a lucky few possess and others do not.

But creativity is not only a trait, it’s also a state, points out Adam Green, PhD, an associate professor of psychology at Georgetown University. The same person can be more creative, or less so, depending on the hour of the day, the task at hand or simply whether he or she wants to put in extra effort. Green and his colleagues have even found that if you simply ask people to think more creatively, they’re often able to do so. Now, they are seeking to understand what’s happening in the brain when those “creative juices start flowing”—and whether researchers can tap that knowledge to help people maximize their creative potential.

Green does this work as head of the university’s Laboratory for Relational Cognition, which he founded in 2010 after completing a PhD in cognitive neuroscience at Dartmouth and a postdoctoral fellowship at Yale. He and his students study many aspects of relational thinking—how the human brain makes connections among seemingly...
unrelated concepts. In recent years, though, they’ve focused increasingly on creativity. At first glance, the two might not seem closely related, but in fact, Green says, relational thinking and analogy-making are key aspects of creativity. For example, when physicist Niels Bohr first depicted the atom as a miniature solar system in 1913, it was both a creative analogy and a brilliant scientific innovation.

Studying creativity is particularly timely, Green believes. “Creative intelligence is increasingly important now—and into the future—because many other aspects of human intelligence are done very well by computers,” he says. “If you had a phenomenal memory 200 years ago, that alone would make you intelligent. But today, being an idea generator is what distinguishes the smartest folks.”

CREATIVE CONNECTIONS
In his lab, Green measures creativity by looking at the “semantic distance” between the words in an analogy—that is, how closely the words are related in meaning. Semantic distance is complicated to compute—it’s done by computers analyzing vast amounts of English texts to see how words are related to one another. But, Green points out, the idea is relatively intuitive. The words in the analogy “Nose is to scent as tongue is to taste” are not very semantically distant, and so the analogy is not particularly creative. The words in “Nose is to scent as antenna is to signal,” on the other hand, are more semantically distant, and thus the analogy is more creative.

In a series of studies over the past decade—funded by the National Science Foundation and the John Templeton Foundation, among others—Green and his colleagues have used fMRI to explore what happens in the brain when people try to make and recognize creative analogies. In one study, they found that when people work with analogies, the process activates a part of the brain called the frontopolar cortex. Green has focused his research on this area ever since (Brain Research, Vol. 1096, No. 1, 2006).

Concurrently, he’s explored the idea of creativity as a state rather than a trait, and whether it’s possible to increase people’s creativity level. In one study, Green and his colleagues showed participants a series of analogies—some valid, with a true relationship between the words (e.g., “nose” is to “scent” as “antenna” is to “signal”) and some invalid, with no relationship between the words (e.g., “nose” is to “scent” as “eyelash” is to “mascara”). Then, they asked the participants to identify the valid ones. In some trials, the participants were cued to “think creatively” about the analogies, while in others, they were not. The researchers found that when asked to think creatively, participants were more likely to recognize more creative, semantically distant valid analogies (Intelligence, Vol. 40, No. 6, 2012).

More recently, Green has used fMRI to look at what happens in the frontopolar cortex when people consciously bump up their effort to be creative. In one study, he asked people to create as many analogies as possible using a set of words in a word grid. He found that when people were cued to think creatively on the analogy-making task, brain activity in the frontopolar cortex increased compared with when they did the same task but were not asked to think creatively. What’s more, participants whose frontopolar cortex activity increased the most between the two trials also showed the most improvement in making creative analogies (Human Brain Mapping, Vol. 36, No. 3, 2015).

And in a study that might seem like science fiction, Green and his colleagues have shown that they can make people more creative by using electromagnetic stimulation (transcranial direct current stimulation, or tDCS) to excite a targeted area of the frontopolar cortex. They asked 31 participants to think creatively while working on two tasks. One was the analogy-making task in which they had to create analogies from a word grid; in the other, they were shown a cue word and given a short time to think of as many other words as possible related to it.

Half the participants received tDCS stimulation while they performed the tasks; the other half wore a sham electrode helmet but did not receive any stimulation. The researchers found that, on average, participants who received tDCS produced more creative analogies, and thought of more semantically distant words related to the cue word, than did the non-tDCS participants (Cerebral
The research is fascinating, but Green cautions that it is also early—consumers should not expect to see a scientifically valid tDCS-based “creativity-enhancing machine” on the market any time soon, he says. But that hasn’t stopped some commercial companies from trying to capitalize on the broader idea that tDCS can enhance human cognition. A growing field of research has linked it to attention, working memory and other aspects of cognition, as well as creativity. Now, commercial companies are marketing tDCS headset systems to video-game players who want to improve their performance and other consumers who are looking for a cognitive boost. But the companies doing so are getting ahead of the science.

“It worries me a lot, because to do tDCS well, there’s a lot of modeling of where the electrical current is going in the different tissues in the head. And without that, it’s almost impossible to know that you’re doing what you think you’re doing.”

MENTORING STUDENTS
Green and his students have begun extending their creativity research in several new directions. Graduate student Rich Daker and undergraduate Rob Cortes, for example, are exploring “creativity anxiety”—the idea that some people feel that they are not good at being creative and that this anxiety may affect their performance. The three have developed a scale to measure creativity anxiety and plan to use it in future research.

Another grad student, Adam Weinberger, is looking at creativity in groups of people. “In the real world, many creative things are done with other people, not in a little bubble,” Weinberger says. In a pilot study, he’s observing groups of three to four people as they work on creative tasks, and he’s looking at how the personalities and communication styles of individual group members affect the group’s success.

Undergraduate Paola Mendez, meanwhile, is examining having a growth versus fixed mindset—how much people believe that their intelligence and other basic traits are maliable versus inflexible—affects performance on creativity tasks.

Ideally, students spend about half of their time working on their own ideas and projects and half contributing to larger, ongoing research. “It’s a good mix. I’ve benefited incredibly from the ideas that have come from students,” Green says. “I think that every lab does.”

He also tries to stay personally involved in all work going on in the lab. Right now, the lab includes one postdoc, three graduate students and five undergraduate research assistants, as well as a lab manager and a research coordinator. “A huge lab has never been for me—the appeal for me is about really knowing what people are doing and getting directly involved in all the projects,” he says.

The lab’s work also extends beyond creativity to other topics under the umbrella of “relational cognition”—how people connect different pieces of information and learn to reason, and to form new concepts and ideas. For instance, lab members are conducting two large interdisciplinary studies in which they are following high school students taking a year-long geoscience course that focuses on developing spatial thinking skills.

They’re using fMRI and cognitive tests to assess how the class affected the students’ broader spatial and reasoning abilities.

In another line of research, the lab members are looking at an international sample of participants—from the United States and Afghanistan—to study how performance on basic tests of cognition and perception correlates with religious belief.

They’ve found some intriguing—though preliminary—evidence that in both cultures, people who are more likely to implicitly or subconsciously recognize patterns in tests of basic pattern recognition are also more likely to believe in an “interventionist” God.

If those research subjects seem far-flung, they are. Green says he feels lucky he’s been able to follow his interests where they lead.

“I always expected I would narrow my focus down, but so far I haven’t had to,” he says. “If pressed, it might be harder to say what relational cognition isn’t rather than what it is.”

In addition to work within his lab, Green is a co-founder of the Society for the Neuroscience of Creativity (SfNC), which held its fourth annual convention in March. SfNC seeks to foster research on how creative thinking works by joining the energies of researchers, educators and industry innovators. For more on the society’s work, visit www.sfn.org.
Today, it’s well accepted that chronic stress can affect a person’s physical health in all sorts of ways. But more than three decades ago, when psychologist Christine Dunkel Schetter, PhD, joined the faculty at the University of California, Los Angeles (UCLA), the connection between stress processes and physiology was significantly fuzzier. In the intervening years, she has helped bring that picture into focus.

Among her most important findings: The stress and anxiety that women experience while they are pregnant—or even before conceiving—can affect their health and the health of their future children, leading to problems including low birth weight, earlier delivery and postpartum depression.

And although it has taken a while for that message to spread from the psychology lab to the clinic, physicians are finally recognizing the importance of managing stress during pregnancy, Dunkel Schetter says. “When I started this, there was great skepticism. Now, I am invited to give talks at pediatric and OB-GYN forums,” she says.

THE CONSEQUENCES OF STRESS DURING PREGNANCY

At this UCLA lab, researchers explore the ways stress and social support influence the health of mothers and their babies, before and after birth

BY KIRSTEN WEIR

In one study, researchers found that women who reported depressive symptoms after a birth were more likely to have greater stress later.
“It’s so exciting that this has become accepted in medicine.”

A CAREER-CHANGING COLLABORATION

Dunkel Schetter’s career began with a broad interest in the link between social relationships and health, which she studied as a PhD student at Northwestern University and as a postdoctoral fellow at the University of California, Berkeley.

When Dunkel Schetter moved to the psychology department at UCLA in 1983, Susan Scrimshaw, PhD, then a medical anthropologist in UCLA’s School of Public Health, invited her to collaborate on a study exploring stress in pregnancy and its effect on preterm birth. It was the beginning of a body of research that has extended to this day. “That completely transformed my work,” she says.

With Scrimshaw, then-student Marci Lobel, PhD, now at Stony Brook University in Stony Brook, New York, and other colleagues, Dunkel Schetter followed 130 socioeconomically disadvantaged women, mostly Latina- or African-American, from pregnancy through the postpartum period. Through a series of in-depth interviews with each participant, they found that prenatal stress predicted lower birth weight and earlier delivery, after controlling for traditional medical risk factors (Health Psychology, Vol. 11, No. 1, 1992).

Though some previous research had hinted at the connection, Dunkel Schetter says, this was the first prospective study to demonstrate the effect with greater methodological rigor. “Almost immediately, more collaborators and grants started coming to me. There was a deluge of interest,” she says.

Despite that attention, it took a while for the medical community to embrace the findings. So, Dunkel Schetter replicated and extended those results in a series of substantial, long-term studies funded largely by the National Institute of Child Health and Human Development (NICHD). In time, her research helped the medical community come to understand how stress in pregnancy can affect the health of mothers and their babies and has led to assessments of prenatal stress and anxiety in some clinical settings.

BEFORE AND AFTER

Since that first pioneering project, Dunkel Schetter and her colleagues at the UCLA Stress Processes and Pregnancy Lab have conducted numerous studies with expectant mothers, often with large networks of collaborators from fields including public health, medicine, nursing and sociology. In one major undertaking, she participated in the NICHD’s Community Child Health Research Network (CCHN), a multisite project investigating how stress and resilience influence pregnancy outcomes and child health. Beginning in 2008, the researchers followed more than 2,000 families. They conducted interviews with mothers and fathers about their psychosocial experiences and measured health biomarkers such as body mass index, cholesterol levels and levels of cortisol, one hormone involved in regulating stress responses.

In one study from that project, Dunkel Schetter; Darby Saxbe, PhD, at the University of Southern California; and colleagues found that women who reported high levels of physical and emotional aggression from their partners in the first year of their children’s lives had cortisol patterns indicative of chronic stress. Interestingly, those women and their male partners were also more likely to display matching cortisol patterns, suggesting that the men who behaved aggressively were also experiencing chronic stress at levels that could affect their physical and psychological health (Psychoneuroendocrinology, Vol. 62, No. 1, 2015).

After the initial five-year CCHN study concluded, Dunkel Schetter and her colleagues continued following a subset of the women—many of whom went on to have additional children. That’s an exciting development because it allows the researchers to explore how psychosocial factors that were in place before pregnancy might influence birth outcomes. “We have information on the women’s biology, medical background and psychosocial factors from before they even conceived their children,” she says.

She and her collaborators are just starting to work with that rich data set, but they’ve already made important findings. In a study led by Dunkel Schetter’s former graduate student

RESEARCH FOCI

The Stress Processes and Pregnancy Lab at UCLA is exploring:

1. Stress processes in pregnancy
2. Social support processes and their influence on health
3. Socioeconomic and ethnic disparities in maternal and child health

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Christine Guardino, PhD, now at Dickinson College in Carlisle, Pennsylvania, the researchers found women who had cortisol patterns associated with greater stress before they became pregnant went on to have children with lower birth weights (*Health Psychology*, Vol. 35, No. 6, 2016).

In another study of the women who went on to have second pregnancies, Dunkel Schetter and colleagues examined various stressors as well as the women’s perception of their own stress. They found that women who reported more depressive symptoms after the birth of one child were at risk for greater stress in the months and years that followed, and those stressors, in turn, increased the likelihood of depressive symptoms in the next postpartum period (*Clinical Psychological Science*, Vol. 4, No. 5, 2016).

Together, such findings indicate that the stress women experience even before conceiving a child is associated with poorer health for the women in pregnancy and beyond, and for their future children. “To help mothers, we have to start even before pregnancy,” Dunkel Schetter says.

This year, she launched a randomized controlled pilot study with collaborators at UCLA and the University of California, San Francisco. The researchers are working with doulas in Oakland, California, to provide web-based cognitive-behavioral therapy to pregnant women who are high in anxiety or depression. Initially, they’ll compare 50 women who receive the treatment with 50 who receive care as usual. Eventually, they plan to expand the trial to a second site. “It’s complicated work to get into the right settings to screen women and find a way to make it convenient for a busy pregnant woman,” she says. “It’s a big project, but it’s an exciting one.”

**EMBRACING DIVERSITY**

While much of Dunkel Schetter’s previous work focused on women’s lives leading up to their pregnancies and giving birth, a new project examines how stress, depression and relationship factors during pregnancy affect the health of the children after they’re born. In 2013, she and Mary Coussons-Read, PhD, at the University of Colorado, Colorado Springs, launched the Healthy Babies Before Birth (HB3) study, also funded by NICHD. They are wrapping up data collection this year. The project follows women in Los Angeles and Denver beginning in the first trimester of pregnancy. Researchers continue to interview the mothers and collect biosamples to measure stress markers and inflammatory activity in both mothers and their babies up to 12 months after birth.

“What’s new with this study is that now we’re able to look at how these various factors during pregnancy are predictive of inflammation, infant health and developmental outcomes,” says Isabel Ramos, a graduate student who is helping to interview mothers and collect blood and saliva samples.

Ramos hopes to use the data to better understand how psychological symptoms in pregnancy affect health outcomes. In one analysis, she’s exploring the link between pregnancy anxiety and preterm birth, and how corticotropin-releasing hormone (CRH), the levels of which increase during pregnancy, is involved in that pathway. In another study, she’s investigating whether CRH levels during pregnancy predict postpartum depression.

Ramos has a particular interest in Latina mothers and plans to do some analyses by ethnic group to look for ethnic- and culture-specific patterns. “Often in health psychology, ethnicity is something that’s controlled for in the analyses,” she says. “I feel lucky to have these large data sets where we have a big enough sample size to really look at these ethnic effects.”

Indeed, much of Dunkel Schetter’s work embraces diverse populations, often from disadvantaged backgrounds. That was one of the factors that drew postdoctoral researcher Kharah Ross, PhD, to the lab.

In a line of research she’s started since joining the lab three years ago, Ross is exploring the
interactive effects of race/ethnicity and socioeconomic status on pregnancy physiology and risk factors for preterm birth. “A lot of people look at race/ethnicity and socioeconomic status as separate predictors, with the assumption that gains in socioeconomic status are equally beneficial across populations and contexts. But that might not always be the case,” Ross says. “There’s some evidence that gains in education and income might not always benefit black individuals to the same extent as white individuals. I want to understand whether the same effect appears in pregnancy physiology, and how that affects the way we think about health disparities during pregnancy.”

HIGH EXPECTATIONS
While research on stress and pregnancy is the centerpiece of the Dunkel Schetter lab, her interests continue to incorporate her early work on relationships and health. Her research has covered topics such as social relationships and adjustment to cancer; psychological adjustment to other health conditions, such as HIV and infertility; and social support in middle-aged couples.

To help juggle these projects, she typically has two postdocs and two to four graduate students who work primarily with her. And, because the health psychology program at UCLA requires graduate students to have two advisors, she often works with three or four additional graduate students whose primary research is done with another faculty member.

The double-advisor arrangement was first tested by Dunkel Schetter and her UCLA psychology colleague Shelley Taylor, PhD, as part of a National Institutes of Health training grant. It was so successful that when UCLA’s health psychology PhD program was founded, it continued the model. “Our students develop a relationship to a second mentor and gain a second set of perspectives,” Dunkel Schetter says.

Thanks to that model, Dunkel Schetter’s lab often welcomes students from a variety of areas, including social, clinical and quantitative psychology. The resulting mix of backgrounds is extremely helpful during regular lab meetings where members share what they’re working on and solicit feedback from one another, she says. “It’s great to have those perspectives when we talk about each other’s work and provide feedback.”

Dunkel Schetter admits that feedback isn’t always easy to swallow. “I think some people might characterize us as sort of ruthless, but our lab meetings are always thought-provoking and lead to better, more rigorous work,” she says. Students say they appreciate the emphasis Dunkel Schetter puts on scientific precision. “She does have high expectations for us, but she is always in the loop and available to guide us every step of the way,” Ramos says.

“There’s a lot of focus on putting out high-quality work, and we’re always challenged to grow and develop,” adds Ross. “There’s no laurel-resting.”

MENTOR OF MENTORS
In Dunkel Schetter’s case, there isn’t much resting, period. In addition to her research portfolio, she’s involved with the UCLA Healthy Campus Initiative, an effort to enhance healthy lifestyle choices at the university. With her psychology department colleague Theodore Robles, PhD, Dunkel Schetter is helping to design an “Engage Well” component of the project to improve social relationships on campus, with the goal of improving health and well-being among staff and students.

Dunkel Schetter also holds a part-time position as associate vice chancellor for faculty development for all of UCLA. In that role, she mentors junior faculty and runs programs to help her colleagues succeed.

Whether she’s helping junior faculty or her students, Dunkel Schetter takes pride in helping others learn, grow and identify their passions and talents. “Being a mentor is what I do,” she says. “There’s a lot of camaraderie, a lot of friendship, a lot of collaboration in my lab, but I’m not looking to create little versions of me. Everyone becomes a unique researcher.”

She is also passionate about health psychology and enjoys helping her field of research grow. “Not only do I know most of the psychologists working on maternal and child health, more than half of them were my students,” she says. “I continue to want to see the science get sharper and better, and to be applied in clinical settings and in policy.”

FURTHER READING

Resilience in the Context of Chronic Stress and Health in Adults
Dunkel Schetter, C., & Dolbier, C. Social and Personality Psychology Compass, 2011

Shedding Light on the Mechanisms Underlying Health Disparities Through Community Participatory Methods

Explaining Racial and Ethnic Inequalities in Postpartum Allostatic Load: Results From a Multisite Study of Low to Middle Income Women

Moving Research on Health and Close Relationships Forward—A Challenge and an Obligation
Dunkel Schetter, C. American Psychologist, 2017