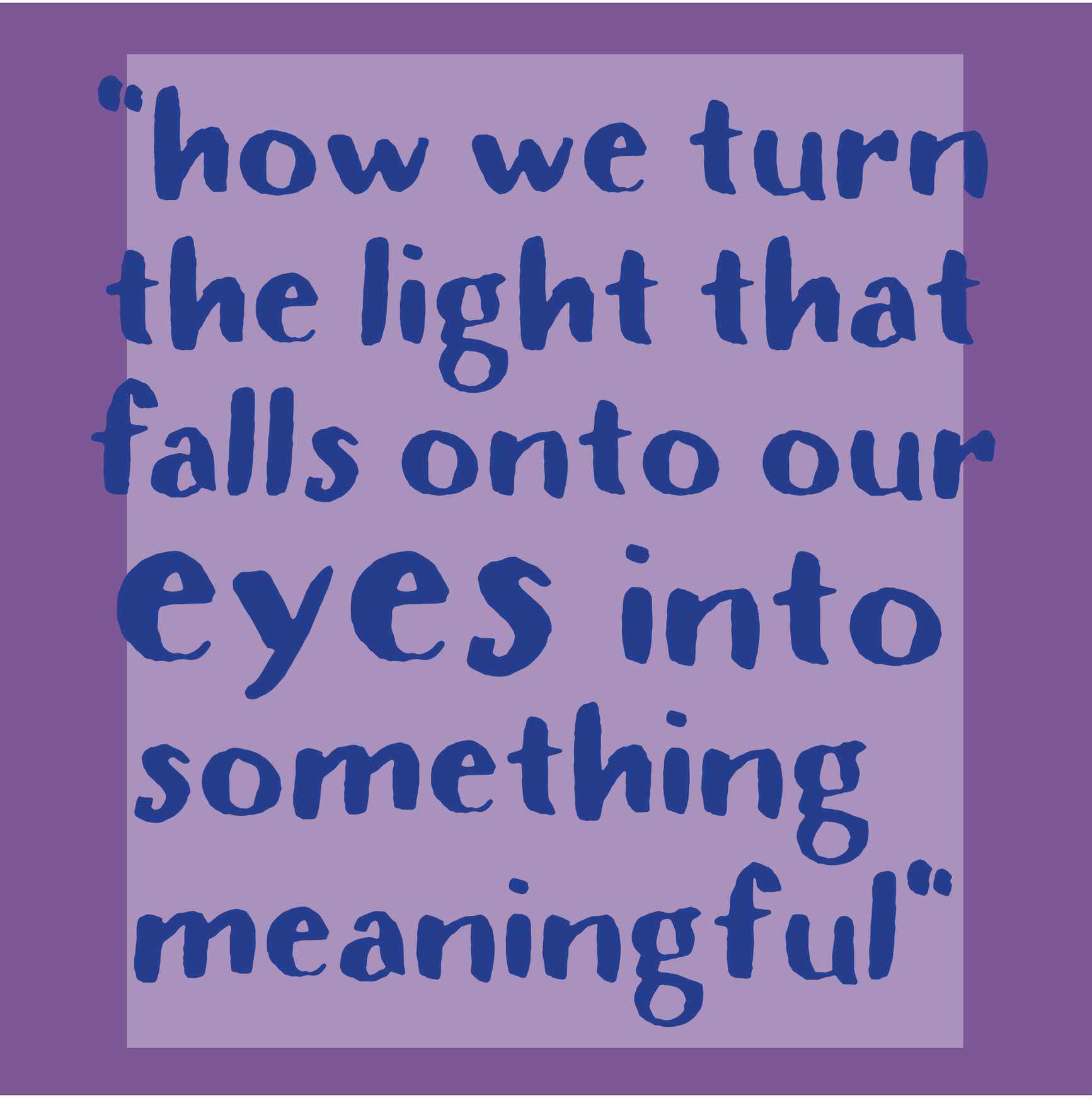

"how we turn
the light that
falls onto our
eyes into
something
meaningful"

TO THE LETTER

A DOUBLE TAKE ON READING

BY KRISTIN BUNDY

As you read this, your brain is moving from one word to the next at a rate of 100–250 milliseconds per word, using context clues to make sense of the clusters of letters that formulate sentences. In essence, you're reading these words at a gist level. But if I pint a word that doesn't fit the context (e.g., pint versus print—see that difference?), your brain catches up a word or two later and says, *Hold on, that wasn't right.* You'll backtrack to make sense of it—a process called true-word recognition, or individuation.

This concept of reading as a two-phase process, first published by Pitt researchers in *Proceedings of the National Academy of Sciences* in July, is a new way of thinking about this uniquely human brain process. And it may help put to rest a 150-year-old debate about how the brain reads.

In the 1800s, neurologists had two possible explanations for what happens as we read and say the words in our heads. Either the brain converts the visual information of letters into sound, recognizing whole written words based only on these phonological representations, or there is a dedicated visual word center in our noggins.

As neuroimaging became more refined, researchers homed in on a brain region called the left mid-fusiform gyrus. Controversy ensued. One camp said that the brain area translates all visual information (words and objects) into their auditory form, while another camp insisted there's a brain region solely dedicated to words.

The Pitt group (which included psychology, neurosurgery, and neuroscience faculty) had the rare opportunity to stimulate the left mid-fusiform gyrus itself and record the results.

"It's a unique and amazing experience to be able to record directly from the human brain," says Avniel Ghuman, PhD and assistant professor of neurological surgery, who was the senior investigator of the study. Four study volunteers—each of whom had drug-resistant epilepsy and had chosen to have brain electrodes implanted to aid in managing their symptoms—elected to participate in the study, Ghuman says, adding thanks for their kindness and generosity.

During the procedure, scientists applied pain-free electrical current to the left mid-fusiform gyrus as patients described letters, words, and objects on the screen in front of them. Each patient experienced word-specific disruptions—that is, they misnamed letters and words. Sometimes they mistook letters to be other letters entirely; sometimes they envisioned fragments of words floating around the only word on the screen. Interestingly, however, they could still name objects and faces fairly normally.

Stimulating the left mid-fusiform gyrus "disrupted word processing in a very orthographic, letter- and word-specific manner," says Ghuman.

"We clearly induced severely disordered reading, and certainly this word-form area has been shown to be abnormal in individuals with [certain] reading disorders." (How similar the disordered reading he saw in the study is to acquired or developmental reading disorders remains to be seen, he adds.)

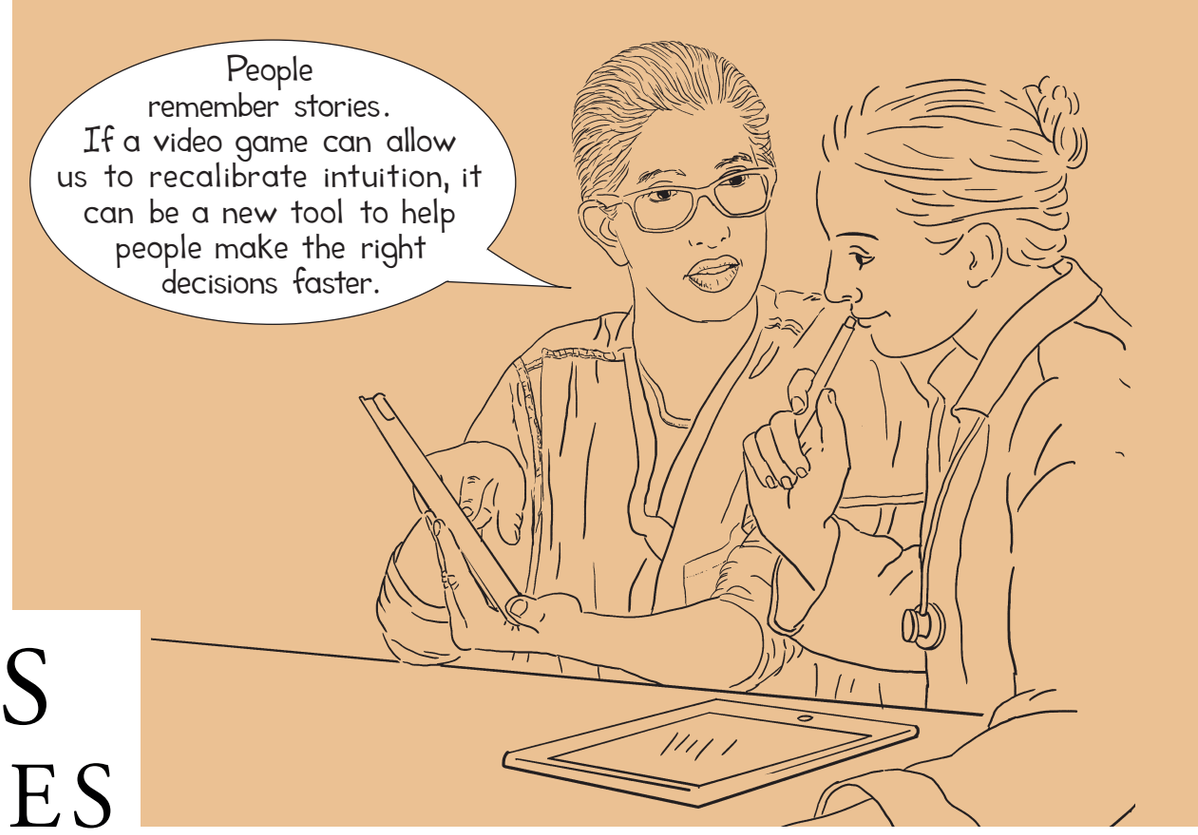
In another part of the study, volunteers simply read while the Pitt team recorded electrophysiological activity from the left mid-fusiform gyrus. Using machine-learning algorithms to analyze the activity, the researchers were able to discern what word a patient was reading at a given moment and track the process with unprecedented precision. From their analysis, two distinct phases of reading emerged: gist level in the first 100–250 milliseconds, followed by true-word recognition around 300–500 milliseconds.

"The idea that there's dynamic shift—that a single area can be involved in multiple stages of processing—is a different way of thinking," Ghuman says.

"The fact that you can see one area of the brain involved in early gist-level processing and later individuation processing suggests something way more nuanced than the classic view of the brain acting in an assembly line, [where] one part of the brain does its job and passes it on."

The investigators' evidence suggests that the left mid-fusiform gyrus is the visual information center for words and that its connectivity to other language areas of the brain is also important for reading. It's a cooperative exchange of information among different areas that makes reading possible. Or, as Ghuman puts it, "how we turn the light that falls onto our eyes into something meaningful." ■

TYPOGRAPHY: ELENA GIALAMAS CERRI



PAUL BRITTENHAM

PLAY, DOCTOR

BY MICHELE D. BAUM

SERIOUS GAMES

In critical care medicine, the difference between life and death often hinges on physicians' split-second decisions. For Deepika Mohan, an MD, MPH assistant professor of critical care medicine and surgery, the most important question isn't which decisions are made, but why.

"Most efforts to reduce physician error begin with the idea that decisions reflect knowledge, attitudes, and external constraints," she says. "I argue that intuition often forms the basis of physician decision-making—particularly in critical cases like trauma triage, sepsis, and stroke."

Mohan believes games may be able to sharpen physician judgment. Her study uses a video game, *Night Shift*, developed by Pittsburgh-based Schell Games, which simulates situations a physician may expect to encounter during a typical night in the emergency department—spiced up with a few curveballs and a narrative hook. *Night Shift*'s design is based on behavioral science principles about how people learn.

In October 2016, Mohan sat in a booth at the American College of Emergency Physicians (ACEP) scientific assembly in Las Vegas to recruit attendees to take part in a randomized, controlled trial on her new game. Participants were given iPads and asked to play either *Night Shift* or complete an educational module. Each then undertook a separate online task to determine the degree to which game-play or the educational module could influence decision-making.

"We were recruiting about 30 to 40 physicians an hour. Then someone sent out a tweet at 1:15, and by 1:30 we were swamped," says Mohan. "At 2:30, the conference organizer came up and said people thronging the booth and blocking traffic were creating a fire hazard. She said if we couldn't get it under control she was going to have to shut us down."

In all, 368 ACEP attendees took part, with 80 percent completing both parts of Mohan's study.

"The good news is that the game did, in fact, change practice," says Mohan, adding that the team saw "significant improvement" in performance on the virtual simulation compared to those who did an educational module. "The bad news is there are still some kinks to be worked out—bugs we discovered in the game and some other tweaking we need to do."

The team learned that games are potentially effective tools to change behavior, says Mohan. "That's something no one has really shown [in critical care], so that's pretty exciting. We're part of the way there but haven't hit the home run yet."

Mohan's study is funded by a five-year, $2.3 million National Institutes of Health Director's New Innovator Award, one of 41 conferred in 2015 to support "unusually creative new investigators with highly innovative research ideas" early in their careers. ■

Adapted from the School of Medicine's 2016 annual report.

ON THE NIGHT SHIFT

Those who play Deepika Mohan's serious game, *Night Shift*, enter the world of the imaginary Andy Jordan—an emergency medicine physician who has some problems.

Jordan's beloved grandfather, grief-stricken by his wife's death and incommunicado for several years, has mysteriously disappeared. Now Jordan—living at Grandad's and working as a new attending at the local hospital—needs answers—especially after finding that cryptic I'M NOT DEAD message in the attic.

This intrigue surrounds Jordan as he attempts to settle into his demanding new job. He has to learn the ropes quickly to efficiently interact with hospital staff, evaluate his patients, write clear orders, and make proper diagnoses and treatment decisions—if and when the cranky computer system cooperates. That old fellow in exam room 101 (Benjamin, nice, knows Grandad and may have information to help find him) isn't looking too good. Ben fell off his bike and is complaining of neck pain, with tingling and numbness in one hand.

Better order an X-ray and CT, and maybe a CBC and chemistry profile to be on the safe side. Hang on—someone just came in with a gunshot wound to the abdomen. Think fast, Dr. J.!



GETTY IMAGES

Pitt surgeons are adopting an approach to surgery that throws out some time-honored practices and gets patients moving again sooner.

OVERTURNING PROTOCOL

SURGEONS CHALLENGE THEIR OWN DOGMA

BY JENNY BLAIR

Picture a post-op surgical patient, and you might envision someone bleary, bedridden, fasting, on opioids, and tethered to tubes and catheters. But it doesn't have to be that way. As it turns out, some long-held surgical practices like restricted diets or IV pain medications actually have little basis in evidence—and often stress patients needlessly.

At Pitt, a set of research-tested protocols called enhanced recovery after surgery (ERAS, pronounced ee-rass) is overturning such practices, getting patients to eat, walk, feel better, and go home much sooner.

"I'd call it challenging dogma where there was no science," says surgery chair Timothy Billiar (Fel '90, Res '92).

Surgery and general anesthesia are physically demanding for patients. So ERAS holds that they should optimize their health beforehand. Through this protocol, they get help quitting smoking, losing weight, and building physical stamina before the operation.

"The stress of two hours of anesthesia is the same as the stress of running a 5K race at a high speed," says Pitt anesthesiology professor Stephen Esper (MD '07), a cardiothoracic anesthesiologist who codirects ERAS with assistant professor of surgery Jennifer Holder-Murray, a colorectal surgeon. The pair are spearheading the effort to institute ERAS across UPMC. "Why would you train for a race, but [not] train for your surgery?" asks Esper.

Patients' mental health, too, is something ERAS practitioners work to optimize, in part so they feel empowered to work toward recovery and in part because depression after major surgery can worsen outcomes. It's also important to provide patients with psychological support after frightening diagnoses, like cancer, and if they have substance-abuse problems.

Typically, the night before surgery, patients are told to fast in order to prevent vomiting during breathing-tube placement. But in ERAS, patients can take clear liquids like Gatorade and oral medications as late as two hours before surgery. This seems to do no harm during intubation, and the metabolic tank-up can reduce post-op insulin resistance and inflammation, as well as vomiting.

During surgery, fewer opioids are used, and IV fluids are carefully optimized to meet physiologic goals and avoid both dehydration and fluid backup into the lungs.

And after surgery, patients can drink liquids as soon as they wake up, then take oral medications and solid foods within 24 hours. Abdominal surgeons have long been taught to keep post-op patients from eating until the gut "wakes up." But studies have shown that's not only unnecessary, it's also hard on the metabolism. Rather than the traditional emphasis on pain control via bowel-slowing opioids, ERAS emphasizes using a variety of different pain medications, such as acetaminophen or ketamine.

Reducing IVs helps with another key ERAS goal: moving. Patients need to get out of bed soon after surgery. Lying around can delay bowel function and lead to metabolic problems or even blood clots.

These changes work. Studies of ERAS in colorectal and pancreatic procedures at UPMC found that patients go home at least two days sooner, and they suffer fewer complications—outcomes consistent with what other U.S. hospitals are experiencing. And, most important, those early discharges don't lead to more readmissions.

Danish surgeons developed ERAS in the 1990s; the approach has slowly made inroads in the United States. Since 2015, ERAS has been adopted in colorectal, pancreatic, gynecological, and gynecological oncology surgeries at six UPMC hospitals, and Billiar says its use will be expanded here. Keeping tabs on how ERAS is carried out is key, Billiar says: "It's really easy to slip back into old habits.

"You have to really get people to change their mind-set. When they do, they almost uniformly realize their patients are happier, [and] . . . the vast majority actually do pretty well. [Surgeons] almost always become rapid converts." ■