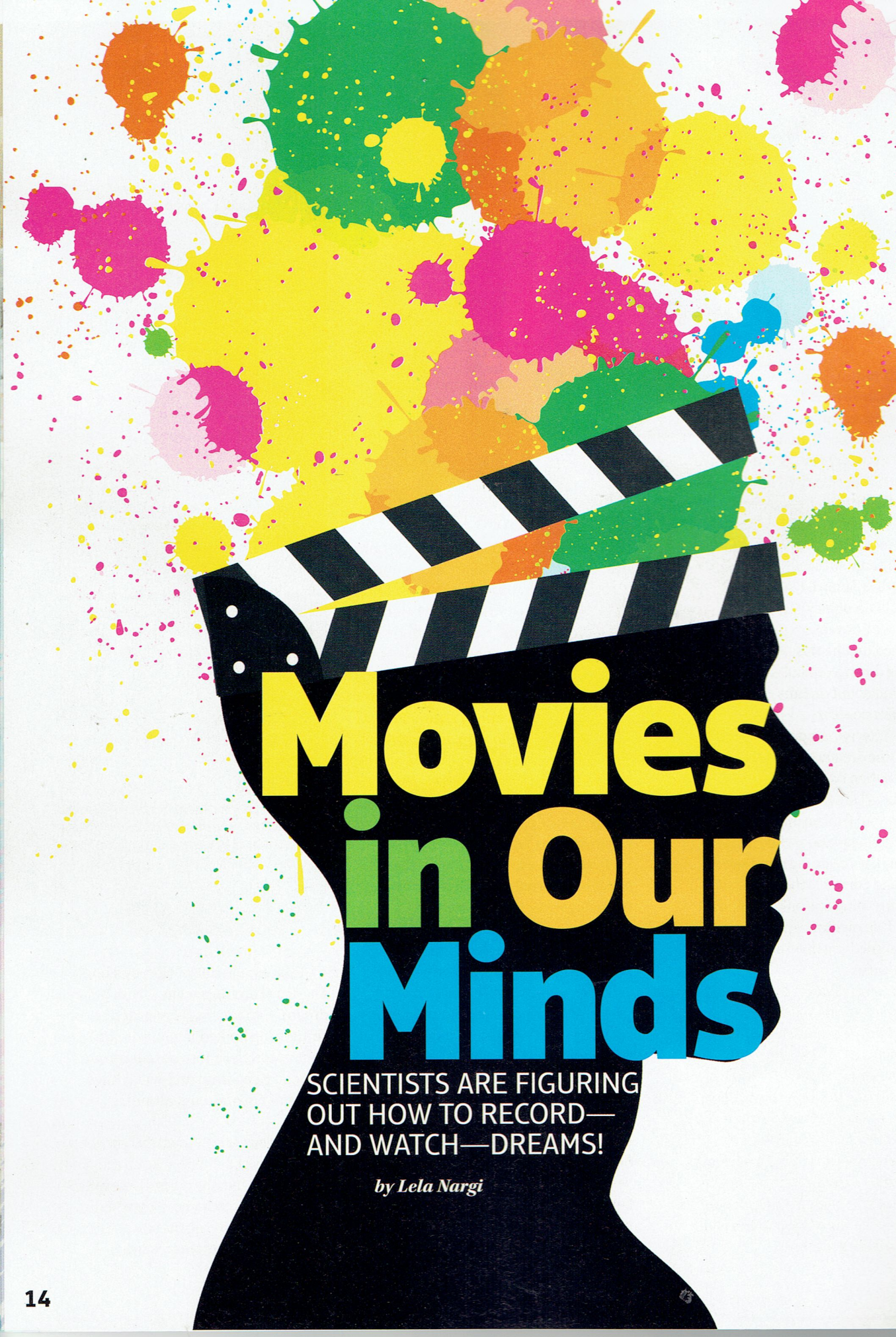


Movies in Our Minds

SCIENTISTS ARE FIGURING OUT HOW TO RECORD—AND WATCH—DREAMS!

by Lela Nargi

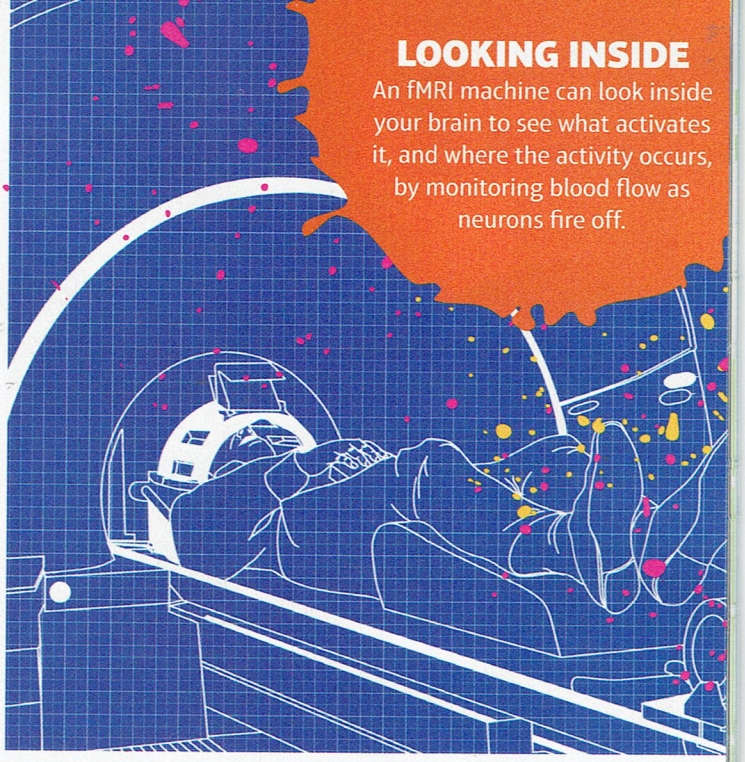
We have dreams every night. Exciting dreams. Scary dreams. Dreams about winning giant trophies and discovering we've got superpowers. Then we wake up. And right away, we forget the amazing moving pictures we saw behind our eyelids as we slept.

But what if we could record our dreams right out of our brains, and sit down to watch them later? Teams of scientists around the world are making that possible.

Pass the popcorn!

What Dreams Are Made For

The average 16-year-old has spent seven years sleeping and almost one full year dreaming. But opinions about what purpose this serves have been changing for thousands of years. Ancient Greeks believed that dreams were messages from the gods, whose meanings only priests could interpret. In nineteenth-century Austria, the psychoanalyst Sigmund Freud thought that dreams were clues to experiences we'd forgotten and to wishes we wanted to come true.



LOOKING INSIDE
An fMRI machine can look inside your brain to see what activates it, and where the activity occurs, by monitoring blood flow as neurons fire off.

Today, some neuroscientists think that dreams may help us work through problems we had during the day. And also pare down, then lock in, what we remember. (You saw this happening to core memories in the movie *Inside Out*.)

A lot of neuroscientists wonder if our dreaming thoughts are linked to our waking thoughts. Before reseachers made videos of dreams, a bunch of them were trying to show how *awake* and *asleep* fit together.

Decoding Our Brains

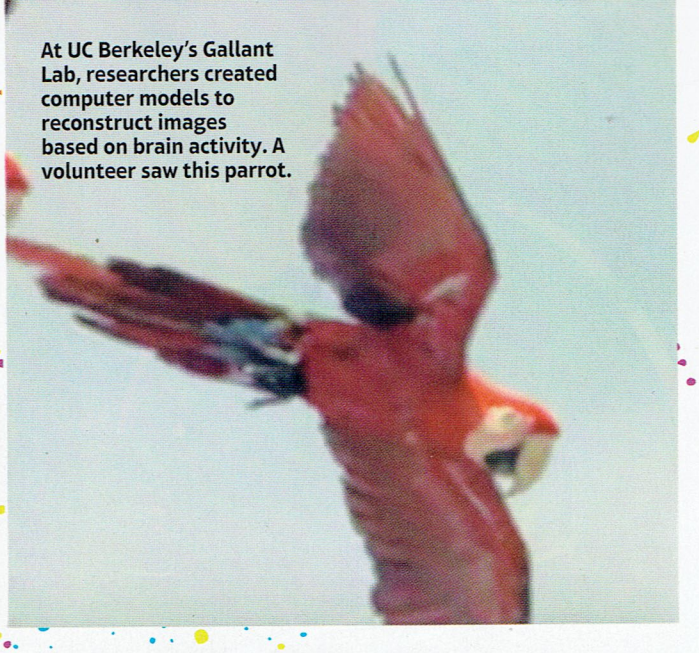
At the Gallant Lab at the University of California, Berkeley, Jack Gallant has been figuring out how brains process the things we see and hear. Like an explorer charting a new land's mountains and rivers and forests, Gallant has been mapping brains.

To do this, he put (awake) volunteers in an fMRI machine. He played a radio show or a movie while the volunteers listened or watched. The fMRI data revealed patterns of neurons firing in the volunteers' brains. Then Gallant organized that activity into categories: which groups of neurons fired when volunteers saw images of *people*, for example.

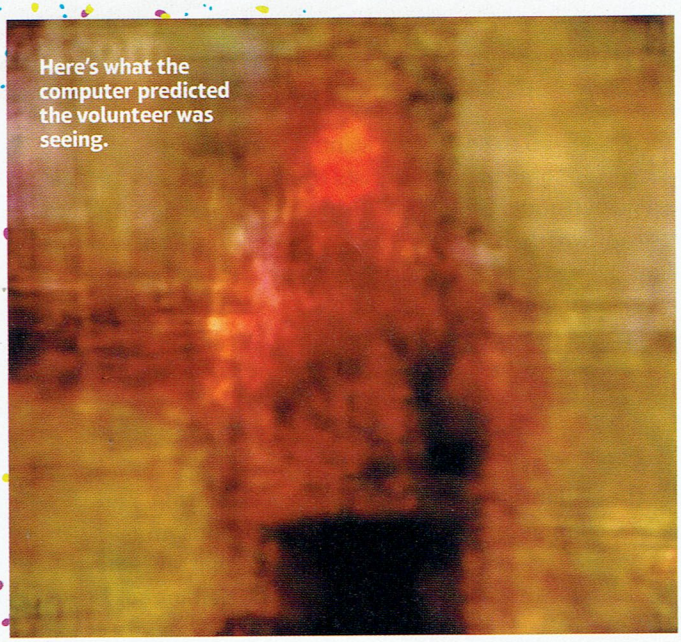
Would those same neurons also fire in sleeping volunteers?

Florian Mormann at the University of Bonn in Germany tested that out. He had volunteers memorize a story about Bart Simpson and former U.S. vice president Al Gore. He recorded their brain activity while they did it. Then he let them fall sleep. He recorded their brain activity again. What did he discover?

Neuroscientist Moran Cerf explained the results in a TED Talk he gave in 2016: while the volunteers slept, their brains replayed the story. As this happened, they fired the same neurons in the same order, sequence, and timing as



At UC Berkeley's Gallant Lab, researchers created computer models to reconstruct images based on brain activity. A volunteer saw this parrot.



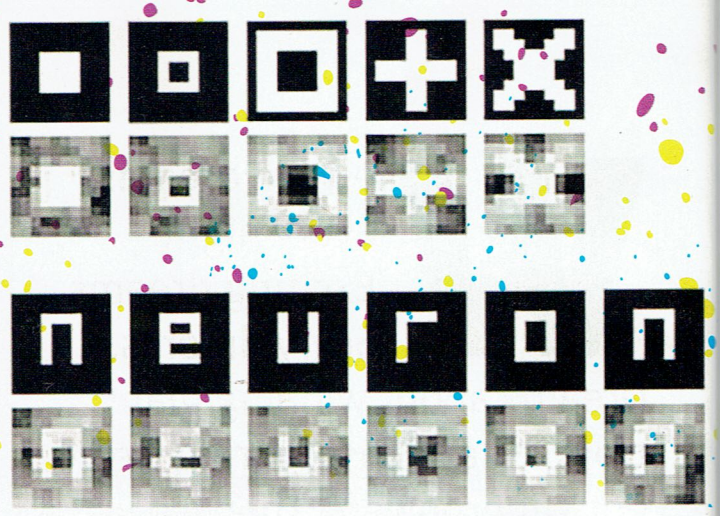
Here's what the computer predicted the volunteer was seeing.

when they were memorizing the story. Said Cerf, "Maybe in [the volunteer's dreaming] mind Al Gore is holding a balloon and Bart Simpson is blue. But something about the content is preserved, and we can decode it."

Can you imagine the researchers' work as a movie montage? Scientists were assembling the materials they needed to make movies of the images we see in our minds.

Put It All Together and What Does It Spell? M * O * V * I * E !

Jack Gallant made the first breakthrough in 2011. In that study, he stuck awake volunteers inside an fMRI. He showed them some movie trailers. He fed the fMRI readings into a computer that figured out *which* images the volunteers were seeing triggered *what* activity in their brains. Then he took more fMRI recordings while the subjects watched a totally new set of videos. The



In Kyoto, Japan, a team of scientists analyzed brain scans taken while subjects viewed black and white images. The goal was to replicate the pattern or word based on activity in subjects' heads. Here, the replicated images are below the real images. Sure, they're blurry, but they're also mind reading in action.

computer had to recreate those new videos with only the brain activity data to work from. The computer sifted through thousands of YouTube clips, looking for images that matched the volunteers' brain activity. It made those clips into a movie. You can actually watch it! Many of the images are recognizable.

Yukiyasu Kamitani at Kyoto University in Japan took it to the next dreamy level in 2014. His volunteers fell asleep in an fMRI. After three hours, Kamitani's team woke them up and asked them what they'd dreamed. The team searched for pictures that were like the images the volunteers had seen as they slept: of cars, dwellings, men, and women. They "taught" these pictures to a computer program and let the volunteers fall asleep again. This time, the program tried to match their sleeping-brain activity with the assembled pictures. It got pretty good at this. The images the computer chose for the video it made matched up with volunteers' reported dreams about 60 percent of the time.

Mormann's lab team is recording the dreams of volunteers too. But their methods are a lot more drastic than Kamitani's. Using a technique called single neuron decoding, they stick electrodes *inside* the brains of people who've had surgery for other reasons. This technique makes a huge difference in what researchers are able to view from dreams.

According to Cerf, Kamitani's fMRI method is like "looking at a football stadium from two kilometers above it. You could see a person, an object, a landmark—the big picture in low resolution." With Mormann's procedure, though, it's "like going down to 10 feet above the stadium and being able to see the goalkeeper, the ball, your mom and dad sitting in the stands, all in high resolution."

The movies that emerge from these studies won't be winning any awards. But they're forever changing what we know about our brains and the dreams they conjure.

Ever since she was a little girl, **Lela Nargi** has had dreams that she could fly. Luckily for her safety and the safety of everyone who knows her, she's never tried to figure out if she could fly in her waking life too.