Researchers pinpoint where the brain unites our eyes' double vision

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If you have two working eyes, you are live streaming two images of the world into your brain. Your brain combines the two to produce a view of the world that appears as though you had a single eye—like the Cyclops from Greek mythology.

And that's a good thing, as the combination of the two images makes for a much more useful impression of the world. With one eye shut, catching a ball or parking a car become far more difficult.

"If you're reaching out with your hand, you want to aim not at where things appear to be, but where they are," says Bas Rokers, psychology professor at the University of Wisconsin-Madison. "Two eyes are giving you two images that don't by themselves tell you where things are relative to your hand. It's the integrated information that tells you where things are."

Using prisms and an advanced brain scanner, Rokers and collaborators at Utrecht University in the Netherlands have found the point in the human brain—very early in image processing in the visual cortex—in which the transformation to a cyclopean view of the world takes place.

Their work, published recently in the journal *Current Biology*, may aid in the treatment of vision problems like amblyopia, or lazy eye.

"We're not necessarily interested in what activity stimuli produce on our sensory organs while we're using them," Rokers says. "We're interested in what they tell us about where things are in the world. This transformation to cyclopean vision is central to figuring that out."

According to Rokers, a group of neurons in the visual cortex called the striate cortex, or V1, is handling two sets of pictures from our eyes—one view each from the left eye and the right eye. Move one step down the line to an area called V2, part of the extrastriate cortex, and the neurons have largely shifted to a single picture. The research clears up unsettled questions as to what purpose V2 serves in visual processing.

The researchers tucked people in functional MRI machines, and had them peer into a prismatic device that showed each eye a different image. For example, the left eye would see a vertical black bar slightly to the right of center, while the right eye saw the bar slightly to the left of center.

"The brain processes the two presented images like it would with any normal pair of images, and perceives them as a single bar in the center of the field of vision, but shifted slightly backwards in depth," Rokers says.

Because the MRI results are sharp enough to discern the different brain activity signatures for each vertical bar, the researchers could compare brain activity when the bars were presented to each eye separately or both eyes together.

"What we show is that in V1, that activity goes with the presented location—some neurons see the left eye image, some the right eye image," Rokers says. "But in V2, the activity matches the perceived, centered location. V2 is working with the combined, cyclopean image."

The researchers plan to shift their attention to finer layers of V1, as well as to an area called V3, with an eye toward figuring out where the brain brings depth and object shape into focus. Rokers expects that a better understanding of the way images are processed will help with ongoing research into disorders like lazy eye. In amblyopia, the most common cause of vision problems among children around the world, the brain learns to favor the images of a stronger eye over those from one that is weaker or misaligned.

"Now that we know where to look in amblyopia, we can focus on these brain regions and see if the representation has shifted toward the dominant eye," Rokers says. "And we could get a sense of how successful we've been in treating amblyopia if we see activity in V2 shift back toward a cyclopean representation."

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