

'Mind reading' brain scans reveal secrets of human vision

May 19 2011, By Dan Stober



Researchers were able to determine that study participants were looking at this street scene even when the participants were only looking at the outline. Credit: Fei-Fei Li

Researchers call it mind reading. One at a time, they show a volunteer – who's resting in an MRI scanner – a series of photos of beaches, city streets, forests, highways, mountains and offices. The subject looks at the photos, but says nothing.

The researchers, however, can usually tell which photo the volunteer is

watching at any given moment, aided by sophisticated software that interprets the signals coming from the scan. They glean clues not only by noting what part of the [brain](#) is especially active, but also by analyzing the patterns created by the firing neurons. They call it decoding.

Now, psychologists and computer scientists at Stanford, Ohio State University and the University of Illinois at Urbana–Champaign have taken [mind reading](#) a step further, with potential impact on how both computers and the visually impaired make sense of the world they see.

The researchers, including Stanford computer scientist Fei-Fei Li, removed almost all of the detail from the color photographs, leaving only sparse line drawings of the assorted scenes. When they ran the experiment again with just the outlines, the researchers were still able to read the minds of the participants – with as much accuracy as before.

The research was focused on the parahippocampal place area, a region of the brain that plays an important role in recognition of scenes such as rooms, landscapes and city streets.

The results demonstrate that outlines play a crucial role in how the human eye and mind interpret what is seen. The bare outlines of the photos shown to the participants seemingly offered the brain almost as many clues as the original photo. This "impoverished" signal sent to the brain was enough, Li said.



The drawing of a dog as part of the Nazca Lines geoglyphs, Peru, ca. 700-200 B.C. suggests the power of outlines throughout time. Credit: Steve Taylor / Creative Commons

The significance of the work? "By noting what is driving the brain, you will be learning the way the brain works," Li said, "why certain cues are more important than other cues."

"Mind reading" could prove helpful in assessing patients in comas. "Inferring what people are seeing is clinically important," Li said.

The power of outlines seems backed up by history and common experience. As the authors wrote in their research paper, published in the *Proceedings of the National Academy of Sciences*, early cave dwellers drew outline figures on the walls of their homes; Chinese calligraphy revolves around lines and strokes; and children draw outlines as they attempt to describe the world unfolding before them.

"The representations in our brain for categorizing these scenes seem to be a bit more abstract than some may have thought – we don't need

features such as texture and color to tell a beach from a street scene," said Dirk Bernhardt-Walther, a psychologist at Ohio State University who was a member of the research team.

Even when the software made errors reading the black-and-white line drawing of, for example, the beach, the mistakes closely resembled the mistakes made with the color photo of the beach, underscoring the conclusion that line drawings stimulate the mind in almost the same way as color photographs.

As researchers began removing parts of the line drawings piece by piece before showing them to the participants, they learned that the longer contours created by the lines, which formed the structure of the scene, were the most important.

"Lines capture really important structure, and you can find evidence of that in the brain," Li said.

Provided by Stanford University

Citation: 'Mind reading' brain scans reveal secrets of human vision (2011, May 19) retrieved 26 June 2024 from <https://medicalxpress.com/news/2011-05-mind-brain-scans-reveal-secrets.html>

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