# The brain performs visual search near optimally

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In the wild, mammals survive because they can see and evade predators lurking in the shadowy bushes.

That ability translates to the human world. Transportation Security Administration screeners can pick out dangerous objects in an image of our messy and stuffed suitcases. We get out of the house every morning because we find our car keys on that cluttered shelf next to the door.

This ability to recognize target objects surrounded by distracters is one of the remarkable functions of our nervous system.

"Visual search is an important task for the brain. Surprisingly, even in a complex task like detecting an object in a scene with distracters, we find that people's performance is near optimal. That means that the brain manages to do the best possible job given the available information," said Dr. Wei Ji Ma, assistant professor of neuroscience at Baylor College of Medicine. A report on research by him and colleagues from other institutions appears online in the journal Nature Neuroscience.

Recognizing the target is more than figuring out each individual object.

"Target detection involves integrating information from multiple locations," said Ma. "Many objects might look like the target for which you are searching. It is a cognitive judgment as well as a visual one."

One factor that must be taken into account is reliability of the

information.

"We study that in particular," said Ma. "If you are a detective, you weight different pieces of information based on the reliability of the source. Similarly, the brain has to weight different pieces of visual information."

In his study, he and his colleagues used computer screens to show subjects sets of lines that might or might not contain a line oriented in a particular way. To manipulate reliability, they randomly varied the contrast of each line, making the target easier or more difficult to detect. Each screen was shown for only a fraction of a second, making the search task very difficult.

"We found that even in this complex task, people came close to being optimal in detecting the target," he said. "That means that humans can in a split second integrate information across space while taking into account the reliability of that information. That is important in our daily lives."

The task was deliberately made very hard so that people made mistakes, he said, but their answers were as good as they could be given the noise that is inherent to visual observations.

In the second part of their study, they determined that this ability might rely on groups (populations) of neurons that respond differently to different line orientations. Using such populations, they were able to construct a neural network that could weight information by the appropriate reliability.

They simulated this task on the computer and reproduced the behavior of human subjects, giving credence to their argument that the task requires populations of neurons.

"The visual system is automatically and subconsciously doing complex tasks," said Ma. "People see objects and how they relate to one another. We don't just see with our eyes. We see with our brains. Our eyes are the camera, but the process of interpreting the image in our brains is seeing."

The next question is when does a visual task become so complex that the human brain fails to be optimal?

**More information:** *Nature Neuroscience*: http://www.nature.com/neuro/index.html

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