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Searching for tumors or handguns can be like looking for food

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If past experience makes you think there's going to be one more cashew at the bottom of the bowl, you're likely to search through those mixed nuts a little longer.

But what keeps the attention of a radiologist who sees just 70 suspicious lesions in 1,000 mammograms or a baggage screener who hasn't found a handgun in more than a year?

The answer, according to biological theory and a laboratory study conducted by Duke University psychologists, may be to make those professional searchers believe there are more targets to be found.

"In the real world, most of the time you don't have to find absolutely everything," said post-doctoral researcher Matthew S. Cain. Consequently, we tend to search for something until our experience tells us the payoffs are declining.

But baggage screeners and radiologists are expected to find absolutely everything, which research by this group says is a real long shot. In earlier work, they found that humans visually searching for things can miss targets that only appear rarely, and will often miss items after finding a first target, even if there are more to be found.

In a laboratory experiment that taps into the biological theory of foraging behavior, the Duke group found that the shortcomings in our visual searching abilities may be rooted in the evolutionary past.

Test subjects were presented with a series of screens and told to pick out a particular shape among many similar shapes. Some subjects were given an environment where there would be lots of targets to find; others had slimmer pickings. Feedback after each screen showed them what they had missed.

"The basic pattern is very clear," said Cain, a post-doctoral researcher at Brown University who did this work in the Duke Visual Cognition Lab. "Searchers who had found that there could be a lot of targets stayed on task longer. Searchers who had fewer targets to find gave up on a given screen sooner."

The experiment also tested the research group's earlier findings on "satisfaction of search," in which people are unlikely to see a second target after they've found a first one. Again, the people with fewer targets to find were more likely to quit searching after one hit; those with higher-frequency targets stayed on task longer.

The study, which appeared online Aug. 6 in *Psychological Science*, was supported by the Army Research Office and the Department of Homeland Security. Cain and Stephen Mitroff, a Duke professor of psychology & neuroscience, are part of a regional research collaborative in North Carolina's Research Triangle known as the Institute for Homeland Security Solutions. They are currently working with Transportation Security Administration (TSA) baggage screening officials at Raleigh-Durham International Airport to study real-world expert visual searching.

The researchers say that for crucial searching tasks like airport security and cancer screening, the effectiveness of screeners could be improved by making them think there are more targets to be found.

In fact, through a program known as "threat image projection," the TSA

is already doing this by digitally inserting phantom images of contraband into the images seen by baggage screeners to increase the hit rate and improve attention, Cain said.

Now the Duke team knows why this works. It seems to come from something called "foraging theory" in biology. It's well studied in nature that a foraging creature decides at some point that the patch of food it is working on is no richer than the surrounding environment, and moves on to find something better.

Foraging theory has been supported by field studies on birds, primates, insects and rodents and even in creatures that don't have real brains, such as plants, said Michael Platt, director of the Duke Institute for Brain Sciences and Center for Cognitive Neuroscience. He and his colleagues Ben Hayden, now at the University of Rochester, and John Pearson helped this team apply the foraging model to their work on visual searches. (A study by Platt last year found the areas of a monkey's brain that apparently govern this foraging behavior).

"This study endorses the idea that the brains of a wide array of animals, including humans, evolved to solve foraging problems in similar ways -- whether foraging for food, mates or visual information," Platt said. "What's really fascinating is the implication that our brains are specialized to search in specific ways, and that these biases may have real-world consequences for medicine or national security."

"Applying animal foraging theory to human searches can open new doors for how to improve performance," said Mitroff, who co-authored the study and directs the Duke Visual Cognition Lab. "The key to reducing errors in difficult searches, such as those done by radiologists and airport security officers, is to understand where things go wrong. These new findings suggest we may be able to make searchers better by simply adjusting their expectations."

More information: "A Bayesian optimal foraging model of human visual search," Matthew S. Cain, Edward Vul, Kait Clark, Stephen R. Mitroff. *Psychological Science*, Aug. 6, 2012 online. DOI: 10.1177/0956797612440460

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