FEATURE

Sights unseen

Research on a phenomenon known as inattentional blindness suggests that unless we pay close attention, we can miss even the most conspicuous events.

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Picture this: a teen-ager, cruising down a familiar highway, keeping a conscientious eye on the speedometer, the rear view mirror, the oncoming traffic. Too late, he notices a deer standing in the road. He slams on the brakes but can't avoid striking the animal.

Later, the teen insists to his skeptical parents that his eyes were on the road--he was paying attention to his driving. He just never saw the deer.

Why are the boy's parents skeptical? Because intuitively, people believe that as long as our eyes are open, we are seeing. Even as we recognize that the brain does a lot of processing behind the scenes, we expect that at least salient objects--a large animal in our path, for example--will capture our attention.

Just as people intuitively believe that seeing is a matter only of opening one's eyes, cognitive scientists also once assumed that visual perception is like a videotape--that the mind records what the eyes take in. But increasingly, studies of visual perception have demonstrated how startlingly little people see when we're not paying attention, a phenomenon known as "inattentional blindness."

"This research is showing us something that we didn't think was the case--that we can fail to perceive very major things going on right in front of our eyes," remarks cognitive psychologist Brian Scholl, PhD, of Yale University. "In contrast with a lot of research on visual perception, these studies are truly surprising for both scientists and laypeople because they're so at odds with how we assumed vision worked."

Inattentional blindness is one of two perceptual phenomena that have begun to change scientists' view of visual perception, from one of a videotape to something far less precise. Beginning in the 1970s researchers began to recognize a phenomenon called "change blindness," finding that people often fail to detect change in their visual field, as long as the change occurs during an eye movement or when people's view is otherwise interrupted. Such findings have spurred debates about how--and indeed, whether--the brain stores and integrates visual information.

Research on inattentional blindness has come to the fore more recently. That work, showing people's inability to detect unexpected objects to which we aren't paying attention, raises other questions: How much visual input can the mind encode, consciously and unconsciously? What brings some visual objects to conscious awareness, while others remain unnoticed? What is the fate of information that is perceived only unconsciously?

The answers to such questions, as they emerge, are likely to have ramifications both theoretically, for scientists' understanding of how the visual system works, and practically, for human performance in areas such as aviation and driving.

Perception and attention

The term inattentional blindness entered the psychology lexicon in 1998 when psychologists Arien Mack, PhD, of the New School for Social Research, and the late Irvin Rock, PhD, of the University of California, Berkeley, published the book, "Inattentional Blindness," describing a series of experiments on the phenomenon. In Mack and Rock's standard procedure, they presented a small cross briefly on a computer screen for each of several experimental trials and asked participants to judge which arm of the cross was longer. After several trials, an unexpected object, such as a brightly colored rectangle, appeared on the screen along with the cross.

Mack and Rock reported that participants--busy paying attention to the cross--often failed to notice the unexpected object, even when it had appeared in the center of their field of vision. When participants' attention was not diverted by the cross, they easily noticed such objects.

Following these initial findings, Mack and Rock discovered that participants were more likely to notice their own names or a happy face than stimuli that were not as meaningful to them--for example, another name or an upside-down face.

Finally, the team found that even though participants did not detect the presence of unattended words that were presented on a computer screen, such stimuli nonetheless exerted an implicit influence on participants' later performance on a word-completion task.

"I came away from our studies convinced that there's no conscious perception without attention," Mack says. She adds that the findings also led her to suspect that the brain undertakes considerable perceptual processing outside of conscious awareness before attention is engaged and that objects or events that are personally meaningful are most likely to capture people's attention.

Explosion of interest

Mack and Rock's findings soon captured others' imaginations, and research on inattentional blindness has proliferated quickly.

In 1999, Harvard University psychologists Daniel Simons, PhD, and Christopher Chabris, PhD, extended Mack and Rock's results using a "selective looking" procedure introduced in the 1970s by Ulric Neisser, PhD, of Cornell University, and colleagues.

In a replication of Neisser's study, Simons and Chabris showed participants a film of two basketball teams, one wearing black shirts and the other wearing white. These displays were created such that all of the actors were partially transparent and thus could simultaneously occupy the same locations.

The researchers instructed participants to count how many times a basketball passed between members of one team, ignoring the other team. Just as Neisser had found two decades earlier, many participants didn't notice a woman who walked through the scene carrying an open umbrella, even though the woman was present for several seconds.

Although Neisser's original findings were striking, they stimulated little further research--perhaps in part because the results were difficult to incorporate into the mainstream science of the time, suggests Ron Rensink, PhD, a psychologist and computer scientist at the University of British Columbia.

"Back then, there was still a strong belief that we built up a visual representation of all the objects around us and held it in a big buffer," Rensink notes. "Neisser's work flew in the face of that--people didn't quite know what to do with it. There seemed to be a general reluctance to pursue it."

Two decades later, Simons and Chabris's replication has received a more welcome reception. The team has now extended the original findings by showing that inattentional blindness also occurs in more natural displays, in which all of the actors are fully visible and opaque. Across a range of conditions, more than 25 percent of observers missed a fully visible and opaque "umbrella woman."

In a particularly dramatic demonstration of the inattentional blindness effect, half of the observers failed to notice a person wearing a gorilla suit who walked into the middle of the

basketball game, stopped to face the camera, thumped its chest and walked off the screen--spending a total of nine seconds on screen.

Simons and Chabris's work also hinted that inattentional blindness may depend on the similarity between unexpected and attended objects: Participants were more likely to notice a gorilla, whose fur was black, when they were attending to the basketball team in black shirts than when they were attending to the team in white shirts.

Recently, Steven Most, a graduate student working with Simons, along with colleagues Chabris and Scholl, confirmed that similarity effect in experiments using stimuli presented on computer displays instead of in a basketball game. That research was published in the January issue of *Psychological Science* (Vol. 12, No. 1).

In the same article, the group also reported that about a third of people exhibit inattentional blindness even to objects that are distinctive in color, shape or path of motion. In one experiment, for example, the researchers presented white and black circles and squares moving against a gray background. Participants were instructed to attend to the black objects and ignore the white, or vice versa. After several trials, a red cross unexpectedly appeared and traveled across the display, remaining on the computer screen for five seconds.

The results of the experiment showed that even though the cross was distinctive from the black and white objects both in color and shape, about a third of participants nonetheless missed it. That suggests, Simons argues, that at any given time, people may be attentionally tuned to certain perceptual dimensions, such as brightness or shape.

"We feel like we've got all the details of the things going on around us," he observes. "But my bet is that most of the time people are really focused on one goal at a time."

Inattentional amnesia?

Demonstrations of inattentional blindness are compelling largely because of the scope of their implications, say researchers.

"At some level, I think every serious person in psychology has always believed that we don't consciously perceive everything that happens to us," Chabris comments. "The shocking thing was that you could show that so little is being perceived."

Some psychologists have questioned, however, whether inattentional blindness indeed reflects a failure of perception or instead represents limitations in memory--a kind of inattentional amnesia. Jeremy Wolfe, PhD, a psychologist at the Harvard University Medical School, and others have argued that it may be that people consciously perceive unattended objects but quickly forget them.

In one recent set of studies, Pennsylvania State University cognitive psychologist Cathleen Moore, PhD, and Johns Hopkins University colleague Howard Egeth, PhD, showed that although they are not consciously recalled, unattended patterns of dots can influence how people perceive objects to which they are paying attention. These results suggest that attention is critical not for engaging perceptual processing but rather for encoding the products of those processes into short term memory, so that they can be reported, contend Moore and Egeth.

Simons and his colleagues, however, are skeptical that people could notice but so quickly forget unexpected, salient objects that--as in their "umbrella woman" and gorilla experiments--are visible for up to nine seconds. Instead, they suggest, Moore and Egeth's findings highlight the role that unconscious processes likely play in perception.

"One conclusion of the inattentional blindness work has been that we see far less of our world than we think we do," says Simons. "Moore and Egeth's work shows that we consciously see far less of our world than we think we do. We might well encode much of our visual world without awareness."

Unanswered questions

Amid the flurry of inattentional blindness experiments now under way, many questions remain unanswered. At a practical level, several investigators have probed the effects of inattentional blindness--and its close relative, change blindness--on real-world behavior and performance.

For example, aviation psychologist Christopher Wickens, PhD, at the University of Illinois at Urbana Champaign, has examined how pilots in flight simulators perform while using head-up displays--equipment that projects information such as airspeed and altitude onto the windshield. The research has shown that when experimenters put something unexpected but important in pilots' field of vision, such as an airplane on the runway, pilots often miss such objects.

"Because pilots have such an incredibly high visual attention load, the issues of what causes breakdowns in attentional allocation become critically important," Wickens notes. "Now we know that just superimposing images on a head-up display does not guarantee that events both on the display and in the world beyond the aircraft will always be detected."

At a more theoretical level, some researchers have begun to investigate whether people vary in their susceptibility to inattentional blindness. As Harvard's Simons explains, "From experiments with only one critical trial, we can't tell whether everybody experiences inattentional blindness about 30 percent of the time or 30 percent of people are characteristically inattentionally blind."

Several laboratories have begun to explore whether individual differences can contribute to rates of inattentional blindness. For example, Harvard's Most and cognitive psychologist Andrew Conway, PhD, of the University of Illinois at Chicago, are testing whether factors such as working memory capacity are associated with inattentional blindness. Likewise, Mack and a student are exploring whether people who score higher on intelligence tests are less susceptible to inattentional blindness.

Finally, some researchers have moved beyond vision to examine whether attention's critical role in perception extends to other senses.

Mack and her colleagues, for example, have begun to study the role of attention in hearing and touch. Early results suggest that inattentional blindness is actually part of a more general sensory phenomenon, says Mack. Indeed, she believes, "That's what makes it so interesting."

Further Reading

- Mack, A., & Rock, I. (1998). Inattentional Blindness. Cambridge, MA: MIT Press.
- The online journal Psyche's special section on inattentional blindness can be found on the Internet at http://psyche.cs.monash.edu (http://psyche.cs.monash.edu/) .
- Daniel Simons's Web site, with demonstrations of videos and computer displays used in his group's work, can be found at www.wjh.harvard.edu/~viscog/lab/demos.html (http://www.wjh.harvard.edu/~viscog/lab/demos.html) .

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