Pay Attention

Concentration affects how we detect and perceive objects and scenes

To a neuroscientist, the trouble with cocktail parties is not that we do not love cocktails or parties (many neuroscientists do). Instead what we call "the cocktail party problem" is the mystery of how anyone can have a conversation at a cocktail party at all.

Consider a typical scene: You have a dozen or more lubricated and temporarily uninhibited adults telling loud, improbable stories at increasing volumes. Interlocutors guffaw and slap backs. Given the decibel level, it is a minor neural miracle that any one of these revelers can hear and parse one word from any other.



BY STEPHEN L. MACKNIK AND SUSANA MARTINEZ-CONDE

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Because your attentional system cannot absorb an entire image at once, it is easy to miss the differences between these pictures, a phenomenon known as change blindness.

SPOT THE DIFFERENCE SOLUTION:
From left: mountain peak, red shoes, blue scarf, missing glass

GALLERY STOCK; SEAN McCABE (*Macknik and Martinez-Conde*)

The alcohol does not help, but it is not the main source of difficulties. The cocktail party problem is that there is just too much going on at once: How can our brain filter out the noise to focus on the wanted information?

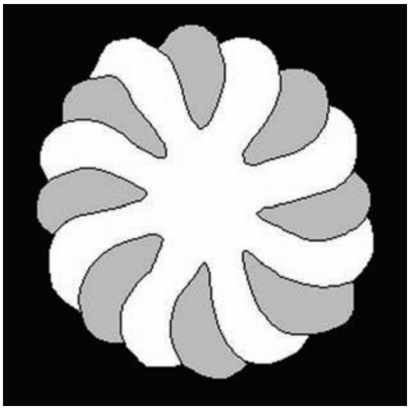
This problem is a central one for perceptual neuroscience—and not just during cocktail parties. The entire world we live in is quite literally too much to take in. Yet the brain does gather all of this information somehow and sorts it in real time, usually seamlessly and correctly. Whereas the physical reality consists of comparable amounts of signal and noise for many of the sounds and sights around you, your perception is that the conversation or object that interests you remains in clear focus.

So how does the brain accomplish this feat? One critical component is that our neural circuits simplify the problem by actively ignoring—suppressing—anything that is not task-relevant. Our brain picks its battles. It stomps out irrelevant information so that the good stuff has a better chance of rising to awareness. This process, colloquially called attention, is how the brain sorts the wheat from the chaff.

In collaboration with the laboratories of neuroscientists Jose-Manuel Alonso of the SUNY College of Optometry and Harvey Swadlow of the University of Connecticut, we discovered the initial circuits that mediate attention in the primary visual cortex of the brain. To do this, we observed neurons in this area, some of which encourage activity in their fellow brain cells, so-called excitatory neurons, and others that tamp down activity, known as inhibitory neurons. We compared the activity in brain cells that process specific areas of visual space with that of other visual cells that are unaffected by changes in our gaze and attention. This comparison revealed that when someone attends to a specific spatial location, the inhibitory neurons take action, suppressing the activity in the brain cells that process other visual regions. In short, the brain depends on these inhibitory neurons to enable focus.

Even more interesting, the harder you concentrate, the greater the suppression. One fundamental role of cognition is to select what your brain goes on to process. It does that, at least in part, by blocking irrelevant information.

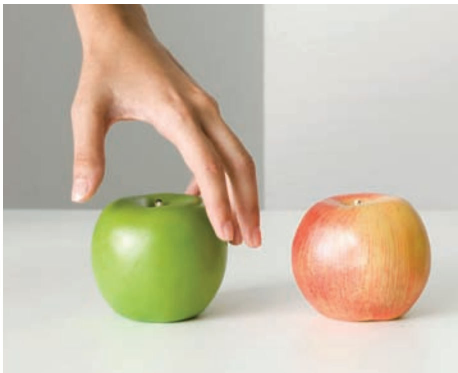
But that is not attention's only role. As the neural activity associated with attention travels down throughout our visual system's circuits, it can also affect how we perceive and interpret the shapes of objects. The illusions in this article illustrate some of the numerous perceptual consequences of our brain's attentional circuits. **M**



ALTERED STATES

In the illustration at the left, does the image depict a white octopus hugging a gray rock or a gray octopus hugging a white rock? You can see it either way. In 2013 neuroscientist Peter U. Tse of Dartmouth College and his colleagues included this example in a collection of illusions shaped by attention. The researchers hypothesized that our attentional systems influence the way our perceptual systems parse ambiguous objects to help us determine the interpretation most adequate for the task at hand.

PICK AND CHOOSE



Imagine you could pick one of the two apples at the right. Let's say you snatched that green Granny Smith—would you believe that someone might dupe you into thinking you had picked the red Honeycrisp? It may sound unlikely, but researchers at Lund University in Sweden have studied the phenomenon of choice blindness in-depth. Their work reveals that we can indeed be deceived into thinking we made a different choice—and even justify our nondecisions.

In 2013 they asked people to share their voting intentions in a survey. By using a secretly rigged survey tablet, they swapped their respondents' answers with people from the opposite political camp. Surprisingly, when the researchers showed participants their "answers," 92 percent of people endorsed and accepted the altered viewpoints. Many participants would then extensively confabulate on why they made their (swapped) choice, suggesting that much of the rationale we concoct for our everyday decisions may be rooted in self-deception.

THE RADIOLOGIST'S OVERSIGHT

One typical task for a radiologist is to count cancerous white nodules in a patient's lungs and differentiate them from similar (but elongated) white blood vessels. In 2012 neuroscientist Jeremy M. Wolfe and his colleagues at Brigham and Women's Hospital in Boston presented this image (*left*), along with many others, to specialists and untrained observers and asked each subject to tally up cancerous nodules in it. But their real question was whether participants would spot the 800-pound gorilla in the radiology suite. That's right—there is a gorilla in the image, although you may have missed it. All the untrained observers, and an astounding 83 percent of the trained radiologists, failed to see the gorilla during an experiment conducted with similar scans. Cognitive scientists call this a demonstration of inattentional blindness. So were the radiologists unobservant? Did their brain fail them? Not at all. The specific task was to characterize white nodules in the images, not black gorillas. The attention system did what it was supposed to do and suppressed the irrelevant distractors.

FROM "HOW ATTENTION CAN ALTER APPEARANCES," BY PETER U. TSE ET AL., IN *HANDBOOK OF EXPERIMENTAL PHENOMENOLOGY: VISUAL PERCEPTION OF SHAPE, SPACE AND APPEARANCE*. EDITED BY LILIANA ALBERTAZZI. WILEY, 2013 (*octopus*); GETTY IMAGES (*apples*); FROM "THE INVISIBLE GORILLA STRIKES AGAIN: SUSTAINED INATTENTIONAL BLINDNESS IN EXPERT OBSERVERS," BY TRAFTON DREW, MELISSA L-H. VÕ AND JEREMY M. WOLFE, IN *PSYCHOLOGICAL SCIENCE*, VOL. 24, NO. 9; SEPTEMBER 2013 (*scan*)

ALARMINGLY, ONLY 35 PERCENT OF SUBJECTS NOTICED THE BEATINGS IN A NIGHTTIME **EXPERIMENT BY CHABRIS AND SIMONS.**

WOULD YOU IGNORE A BRUTAL ASSAULT?

One night in 1995 a group of Boston police officers brutally beat an undercover officer—a case of mistaken identity—during the chase of a suspect in a shooting. Another police officer, Kenny Conley, ran right by the violence while in pursuit of the real suspect. Conley later claimed that he never saw any of the beating, even though he had been just feet away. Prosecutors and jurors, assuming that Conley was lying to protect his guilty comrades, convicted him and sentenced him to jail for 34 months on charges of perjury and obstruction of justice. But could Conley have been telling the truth?

To find out, cognitive scientists Christopher Chabris of Union College, Daniel Simons of the University of Illinois at Urbana-Champaign and their colleagues conducted staged street beatings to determine if naive volunteers could miss them (*as shown in image at right*). But first they gave the experimental subjects a different task: to pursue a runner and count the number of times that he touched his head. Alarmingly, only 35 percent of subjects noticed the beatings when Chabris and Simons tested their subjects at night. Deeper study revealed that the more closely subjects attended to the runner, the more likely they were to miss the beating. This was also a case of inattentional blindness. So Conley might indeed have missed the beating of his fellow officer, despite having been in the midst of the attack.

THE HAND IS MORE ATTENTION GRABBING THAN THE EYE

Illusions of attention are central to magic performance, which we have discussed in our book *Sleights of Mind.* After all, sleight of hand often depends on the magician's ability to manipulate where and for how long we focus our attention. But are a magician's hands or eyes more likely to draw the attention of the spectator? We tested this by showing videos to participants of magic tricks by famous Las Vegas magicians Mac King, a headliner at Harrah's, and Teller, of Penn and Teller fame. The magicians' gaze did not affect the observers' behavior strongly—although it might in other routines. Instead spectators usually directed their attention to the magicians' hands. This is not altogether surprising from a neurophysiological perspective: our visual system contains some neurons that respond preferentially to hands, and hand motions can be an important part of social communication.

FROM "YOU DO NOT TALK ABOUT FIGHT CLUB IF YOU DO NOT NOTICE FIGHT CLUB: INATTENTIONAL BLINDNESS FOR A SIMULATED REAL-WORLD ASSAULT," BY CHRISTOPHER F. CHABRIS ET AL., IN *I-PERCEPTION*, VOL. 2, NO. 2; 2011 (*assault*); ISTOCKPHOTO (*magician*)

FURTHER READING

- **Task Difficulty Modulates the Activity of Specific Neuronal Populations in Primary Visual Cortex.** Yao Chen et al. in *Nature Neuroscience,* Vol. 11, No. 8, pages 974–982; August 2008.
- **You Do Not Talk about Fight Club If You Do Not Notice Fight Club: Inattentional Blindness for a Simulated Real-World Assault.** Christopher F. Chabris, Adam Weinberger, Matthew Fontaine and Daniel J. Simons in *i-Perception,* Vol. 2, No. 2, pages 150–153; 2011.
- **Perceptual Elements in Penn & Teller's "Cups and Balls" Magic Trick.** Hector Rieiro, Susana Martinez-Conde and Stephen L. Macknik in *PeerJ,* Vol. 1, Article No. e19; February 12, 2013.
- **The Invisible Gorilla Strikes Again: Sustained Inattentional Blindness in Expert Observers.** Trafton Drew, Melissa L.-H. Võ and Jeremy M. Wolfe in *Psychological Science,* Vol. 24, No. 9, pages 1848–1853; September 2013.
- **How Attention Can Alter Appearances.** Peter U. Tse et al. in *Handbook of Experimental Phenomenology: Visual Perception of Shape, Space and Appearance.* Edited by Liliana Albertazzi. Wiley, 2013.