

Mismatched Sound and Vision

When sounds and images get mismatched in the mind, a person's perceptions fall prey to maddening illusions and reality is turned on its head. One day, while watching an old episode of *Law & Order: Criminal Intent*, Carl Zimmer noticed that the actors' voices lagged a fraction of a second behind the movement of their mouths. At first, he would watch the characters speak. Then, he would switch to listening to them, and then back to watching them. Thanks to this moment of disorientation, Zimmer was confronted with one of the most crucial tricks that the human brain uses to make sense of the world: combining input from all five senses into a single, coherent experience, updated many times a second in virtually real time. But, the brain's techniques of combining the senses are not perfect, which can cause people to experience a variety of illusions (such as audio and video that is out of sync).

In the mid-1900s, neuroscientists launched their first efforts to map out the brain's sensory pathways. They identified different regions of the brain that became active for each sense, and separate systems of neurons handled information from each different sense. After each system had produced a sophisticated representation of the world, the brain combined these perceptions into one experience of reality. However, later scientists began to discover that the brain sometimes. One illusion, known as the McGurk Effect (named after its discoverer, Harry McGurk, a developmental psychologist at the University of Surrey in England), had a video with people repeatedly saying "ga," and audio of people repeatedly saying "ba" in sync with the video. But, when watching the video, many people were confident that the person was saying "da." With their eyes closed, the people heard "ba," but the addition of video allowed the illusion to form, causing the people to hear "da" once again. Today, psychologist Ladan Shams from the University of California in Los Angeles has been able to create an illusion by displaying a flash paired with a varying number of corresponding beeps. If Shams delivered a flash with a pair of beeps, participants were more likely to say that two flashes were seen. These illusions provide evidence about the brain's strategy of combining multiple senses into one piece of information.

Michael Beauchamp and Audrey Nath, neuroscientists at the University of Texas Health Science Center at Houston, have pinpointed one of the crucial nodes where information from the senses meets. When delivering short magnetic pulses (that briefly shut down different parts of the brain) to a strip of the brain near the ear, which is a region known as the superior temporal sulcus, the McGurk Effect was diminished. In a follow-up study, Beauchamp and Nath scanned people's brains with functional magnetic resonance imaging (fMRI) as McGurk videos of mismatched sound and vision were played. It was found that the left superior temporal sulcus became more active in people who experienced the illusion and remained less active in those who didn't. This evidence suggests that when the illusion occurs, it is because the superior temporal sulcus discounts some of the signal coming from one sensory region of the brain in favor of others.

Sight and sound are not the only senses that are mingled in the brain. Touch can affect what people see or hear. A person's very understanding of their own body can be informed by pressure, stretching, and movement. Together, the body's senses work together to allow a person

to control their own body. In 1998, Matthew Botvinick and Jonathan Cohen, two psychologists from the University of Pittsburgh, found that they could make people feel as if a rubber hand were really their own. This was done by putting a rubber hand in front of their subjects and having them put their real hand behind a screen. When the scientists simultaneously brushed the real hand and the fake hand, people reported that the rubber hand felt as if it were part of their own body and that they even felt it being brushed. In 2008, neuroscientist Valeria Petkova of the Karolinska Institute in Sweden performed a similar experiment, but with an entire mannequin. Once again, during the experiment, the synchronized acts of brushing made participants feel as if the mannequin's body were their own. Following the experiment, they redesigned it so that the volunteers would lie in an fMRI scanner that recorded their brain activity. Once the participants felt that the mannequin's body was their own, the same brain regions became active as when they actually looked down at their own bodies. These tricks that are used to integrate the senses take time to develop. In the future, the ability to manipulate the senses may be beneficial, and may also be able to help some people rewire their sense of reality for the common good.

I. Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis. Enduring Understanding 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.

II. Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes. Enduring Understanding 3.E: Transmission of information results in changes within and between biological systems.