# Beyond the Five Senses

## Telepathy, echolocation, and the future of perception

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The world we experience is not the real world. It's a mental construction, filtered through our physical senses. Which raises the question: How would our world change if we had new and different senses? Could they expand our universe?

Technology has long been used to help people who have lost, or were born without, one of the five primary senses. More recently, researchers in the emerging field of "sensory enhancement" have begun developing tools to give people additional senses—ones that imitate those of other animals, or that add capabilities nature never imagined. Here's how such devices could work, and how they might change what it means to be human.

### 1 | Hearing Pictures

For decades, some deaf people have worn cochlear implants, which use electrode arrays to stimulate the auditory nerve inside the ear. Researchers are working on other technologies that could restore sight or touch to those who lack it. For the blind, cameras could trigger electrodes on the retina, on the optic nerve, or in the brain. For the paralyzed or people with prosthetic limbs, pressure pads on real or robotic hands could send touch feedback to the brain or to nerves in the arm.

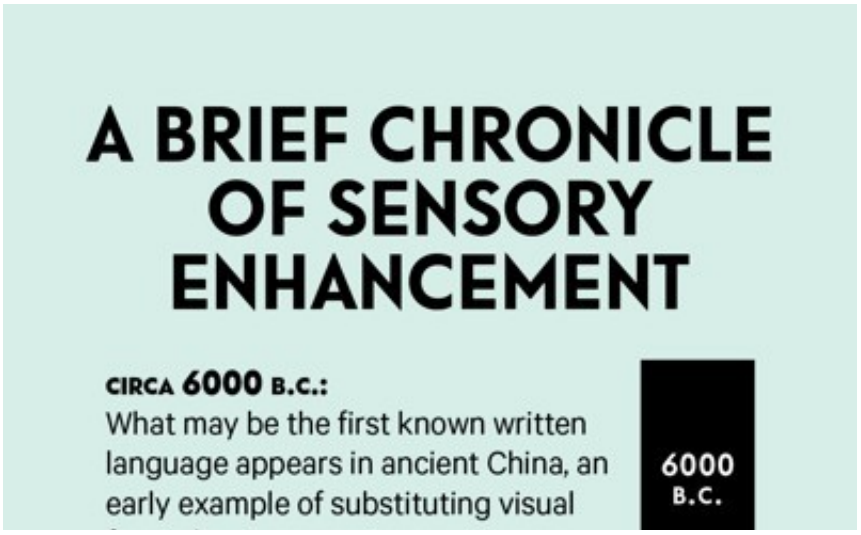
Autistic people might even gain a stronger social sense. Last year, MIT researchers revealed the EQ-Radio, a device that bounces signals off people to

detect their heart rate and breathing patterns. A yet-to-be-invented device might infer a target's mood from those data and convey it to an autistic user—or anyone who wants to improve their emotional intuition.

We can also substitute one sense for another. The brain is surprisingly adept at taking advantage of any pertinent information it receives, and can be trained to, for instance, "hear" images or "feel" sound. For the blind, a device called the BrainPort V100 connects a camera on a pair of glasses to a grid of electrodes on a person's tongue. At first the effect just feels like tiny bubbles, but eventually users can learn to read stronger points of stimulation as bright pixels and weaker points as dark ones, and can form a mental picture.

Somewhat similarly, a Dutch device called the vOICe ("Oh I see!") uses a camera to create a soundscape that the vision-impaired wearer hears through headphones. To the uninitiated it sounds like bursts of static, but with training, people can discern images. Every second or so, the sound pans from left to right, using frequency to indicate an object's height (the taller the object, the higher the pitch) and volume to indicate its brightness.

For the deaf, David Eagleman, a neuroscientist at Stanford University, has developed a vest that turns sound into a pattern of vibrations on the torso. With practice, people can learn to use it to interpret speech and other sounds.



for auditory perception.

**1888:**
The first contact lenses, which were made of glass, are manufactured by a Swiss physician.

1850

**1960:**
The Smell-O-Vision, a system designed to add odors to the movie-theater experience, is deployed for the film *Scent of Mystery*.

**1972:**
Patients, mostly children and veterans, begin receiving the first cochlear implants.

1965

**1992:**
Peter Meijer, a Dutch engineer, develops the vOICe, a device that can convert images into sound.

**2013:**
Researchers in Singapore develop a digital lollipop that can simulate different tastes.

**2015:**
The FDA approves the BrainPort V100, a device that allows blind people to "see" with their tongue.

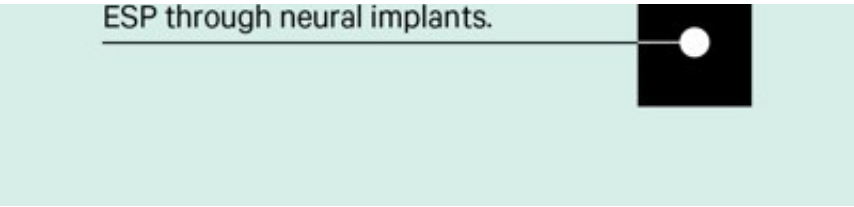
2014

2017

PREDICTIONS

**2100:**
People will gain the "sixth sense" of

2100




Hulton Archive / Getty; The Hearing Aid Museum; Peter Meijer / seeingwithsound.com

## 2 | Borrowing From Nature

Scientists are also exploring ways to add senses found elsewhere in the animal kingdom. For instance, a handheld device called the Bottlenose, built by amateur biohackers, uses ultrasound to detect the distance of objects, then vibrates the user's finger at different frequencies, giving him or her echolocation. Other devices provide the navigational sense of migratory birds: A company called feelSpace sells the naviBelt, a belt that points you in your desired direction by vibrating on your waist. Another company, Cyborg Nest, sells the North Sense, a device you can attach to your chest that vibrates when pointing north.

In the future, cochlear implants could be tuned to pick up really low frequencies, such as those used by elephants, or really high ones, such as those used by dolphins. Bionic eyes could be built to allow humans to see ultraviolet rays (as butterflies, reindeer, dogs, and other animals can) and infrared light (as certain snakes, fish, and mosquitoes can).

Some researchers think we may eventually install a port in our brains that would allow us to swap in different sensors when we need them. "Maybe there's a Swiss Army Knife of sensors that you carry with you," says Rajesh P. N. Rao, the director of the National Science Foundation's Center for Sensorimotor Neural Engineering. You might rely on a distance sensor when climbing a mountain, then plug in night vision after dark.

## 3 | Sensing Moonquakes

We might also gain senses that no other animal has. The vibrating vest Eagleman created can be programmed to receive any input, not just sound. He says it could be used to monitor the stock market, or sentiment on Twitter, or the pitch and yaw of a drone, or one's own vital signs. You could of course display these things on a computer screen, but our brains can't attend to lots of visual details at once, Eagleman says. The body, on the other hand, is used to monitoring dozens of muscles just to keep us balanced, so would be more adept at handling multidimensional inputs.

A cortical implant could also theoretically take in just about any type of information, which the brain could process as a new sense. "You can do whatever you want," says Neil Harbisson, a "cyborg artist" who's originally from Spain. "You can design a unique sense that is related to your interests or to your curiosity."

Harbisson was born seeing in gray scale. In 2004, he had an antenna surgically attached to his skull. The antenna has a camera at the end and vibrates at different frequencies, turning colors into sound. (He can also use the antenna to take phone calls and listen to music.) He plans to implant a band around his head with a warm spot that orbits every 24 hours, giving him a temporal organ. His friend and collaborator Moon Ribas has a wireless chip in her arm that vibrates when earthquakes occur anywhere in the world, giving her a seismic sense. She hopes to put vibrating implants in her feet that convey moonquakes.

But Bernd Fritzsch, a neuroscientist at the University of Iowa, cautions that for every patch of neural real estate we dedicate to interpreting a new sense, we leave fewer neurons for processing the others. So with each sense we add, we're also taking something away.

## 4 | Literal Groupthink

Perhaps we'll even achieve that so-called sixth sense: ESP. Kevin Warwick, an engineer at Coventry University, in the U.K., wirelessly connected an electrode in his arm to one in his wife's arm, so that wherever they were, they could feel when the other flexed a hand. Eagleman wants to take that idea one step further and wirelessly connect heart and sweat monitors on his wife and himself so they can sense each other's moods.

Research by Rao shows that people can send yes/no messages telepathically: An EEG senses brain activity in the sender and another device applies magnetic pulses to the brain of the receiver. Eventually, we might have brain implants connected wirelessly. "This kind of communication might get over some of the limitations of language," Rao says. It could help people share sensations or express thoughts that are hard to put into words, and enhance collaboration. "I think that will completely change how we are as humans," Warwick says. "Telepathy is the future." Indeed, Elon Musk recently started a company called Neuralink focused on connecting brains to computers; he says it could someday enable computer-mediated telepathy.

Exactly how all this tinkering will change us remains to be seen. Harbisson says that gaining animals' senses "would allow us to connect with nature and to other species in a more profound way." But if shared senses connect us to other species, might sensation inequality pull people apart by creating new categories of haves and have-nots? We already struggle to agree on what's real and what's fake; that problem seems likely to get worse as technology creates new means of perception. "Society is stretched like an elastic band," Warwick says. Radical sensory enhancement for some could stretch it even more. "The question is, does the elastic band break?"