Neuroscientists challenge long-held understanding of the sense of touch

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Credit: Rice University

Different types of nerves and skin receptors work in concert to produce sensations of touch, University of Chicago neuroscientists argue in a review article published Sept. 22, 2014, in the journal *Trends in Neurosciences*. Their assertion challenges a long-held principle in the field—that separate groups of nerves and receptors are responsible for distinct components of touch, like texture or shape. They hope to change the way somatosensory neuroscience is taught and how the science of touch is studied.

Sliman Bensmaia, PhD, assistant professor of organismal biology and anatomy at the University of Chicago, and Hannes Saal, PhD, a postdoctoral scholar in Bensmaia's lab, reviewed more than 100 research studies on the physiological basis of touch published over the past 57 years. They argue that evidence once thought to show that different groups of receptors and nerves, or afferents, were responsible for conveying information about separate components of touch to the brain actually demonstrates that these afferents work together to produce the complex sensation.

"Any time you touch an object, all of these afferents are active together," Bensmaia said. "They each convey information about all aspects of an object, whether it's the shape, the texture, or its motion across the skin."

Three different types of afferents convey information about touch to the brain: slowly adapting type 1 (SA1), rapidly adapting (RA) and Pacinian (PC). According to the traditional view, SA1 afferents are responsible for communicating information about shape and texture of objects, RA afferents help sense motion and grip control, and PC afferents detect vibrations.

In the past, Bensmaia said, this classification system has been supported by experiments using mechanical devices to elicit one or more of these specific components of touch. For example, responses to texture are often generated using a rotating, cylindrical drum covered with a Braille-like pattern of raised dots. Study subjects would place a finger on the drum as it rotated, and scientists recorded the neural responses.

Such experiments showed that SA1 afferents responded very strongly to this artificial stimulus, and RA and PC afferents did not, thus the association of SA1s with texture. However, in experiments in which subjects moved a finger across sandpaper—the quintessential example of the type of textures we encounter in the real world—SA1 afferents did not respond at all.

Bensmaia also pointed out discrepancies in the predominant thinking about how we discern shape. Perception of shapes has generally been tested using devices with raised or embossed letters to test a subject's ability to interpret text by touch. These experiments also showed that such inputs produced a strong SA1 response, so they were implicated in perception of shape as well.

In the 1980s, however, researchers developed a device meant to help blind people read by generating vibrating patterns in the shape of letters on an array of pins. While the device was not a commercial success, people were able to use it to detect letter shapes and read, although experiments showed that it activated RA and PC afferents, not the supposedly shape-detecting SA1s.

Bensmaia said such experiments show how devices created to generate artificial stimuli focusing on individual components of the sense of touch can result in misleading findings. Some types of afferents are better than others at detecting texture or shape, for example, but all of them respond in their own way and contribute to the overall sensation.

"To get a good picture of how stimulus information is being conveyed in these afferent populations, you have to look at a diverse set of stimuli that spans the range of what you might feel in everyday tactile experience," he said.

Instead of thinking of individual groups of afferents working separately to process different components of the sense of touch, Bensmaia said we should think of all of them working in concert, much like individual musicians in a band to create its overall sound. Each musician contributes in his or her own way. Emphasizing one instrument or removing another can change the character of a song, but no single sound is responsible for the entire performance.

Adopting this new way of thinking will have far-reaching implications for both the study of the sense of touch and the design of future research, Bensmaia said.

"I think it's going to change neuroscience textbooks, and by extension it's going to change the way somatosensory neuroscience is taught. It's really the starting point for everything."

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