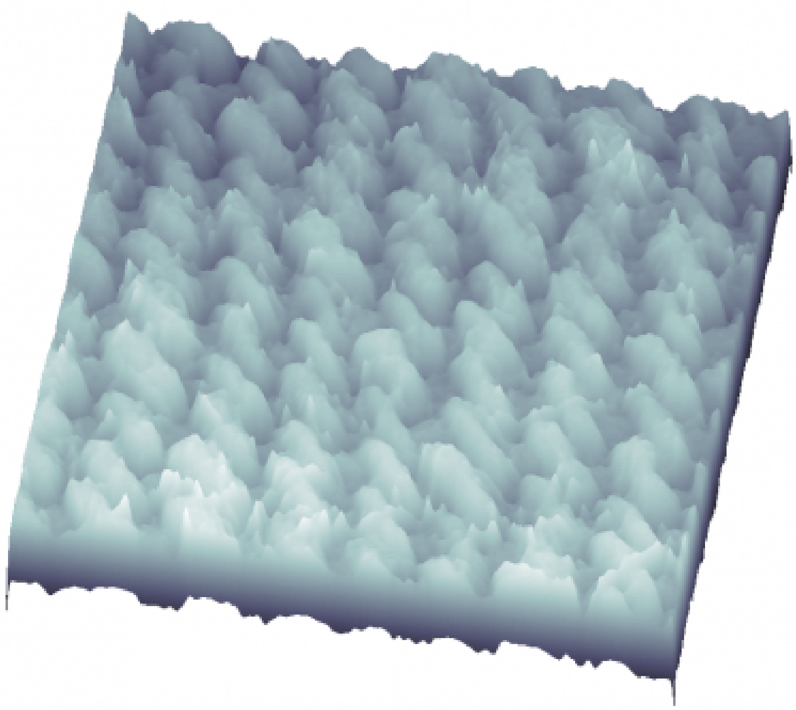
Skin receptors convey sensation of texture through vibrations

September 30 2013



This is a laser microscope image of denim. When we run our fingers along a surface, variations in the surface produce vibrations in the skin which are conveyed as information about texture to the brain. Credit: Bensmaia/University of Chicago

New research shows that humans distinguish the difference between fine textures, such as silk or satin, through vibrations, which are picked up by two separate sets of nerve receptors in the skin and relayed to the brain.

Previous research has shown that coarse textures, such as Braille dot patterns, are encoded by receptors that are densely packed into the primate fingertip. The spatial layout of responses of these receptors corresponds to the spatial layout of surface features of a texture. However, most natural textures are too fine to be perceived in this manner. A new study published early online in the *Proceedings of the National Academy of Sciences* shows, for the first time, that two other sets of receptors convey information about fine textures by responding to the high-frequency vibrations produced in the skin as it is scanned across a surface.

"Coarse textures are reflected in the spatial pattern of responses by one set of receptors, but that's only a small part of the story," said the study's senior author, Sliman Bensmaia, PhD, assistant professor in the Department of Organismal Biology and Anatomy at the University of Chicago. "Most of what we consider to be natural textures are represented in temporal patterns of activation in the other two groups of receptors."

The majority of studies investigating the neural basis of texture perception have used coarse materials, such as gratings and Braille patterns, which activate a set of receptors in the skin called slowly adapting type 1 (SA1) afferents.

In the experiments performed in this study, Bensmaia and his colleagues used a drum covered with strips of such coarse textures, along with several materials with finer textures, such as sandpaper, fabrics and plastics. The drum then ran the textures across the fingertips of Rhesus macaques, whose somatosensory system is similar to humans, while the researchers recorded the neuronal responses.

While the coarse textures produced the familiar SA1 response, the SA1 afferents did not fire at all for the majority of the finer textures. Instead, two sets of afferents that have not been implicated previously in texture sensation, rapidly adapting (RA) and Pacinian (PC) fibers, responded in a temporal pattern that followed the vibrations produced in the skin by scanning the surface.

"If you relied on SA1 afferents alone for texture perception, you would not be able to discriminate most textures. You couldn't tell silk from satin, or denim from felt and corduroy," Bensmaia said.

Until now, rapidly adapting afferents were primarily thought to play a role in detecting when an object was slipping from a grasp. Pacininan afferents were thought to detect vibrations such as those felt after striking something with a hammer.

In addition to ascribing to these receptors a new role in touch, the study highlights that touch employs two modes of operation: One based on spatial patterns of activation, the other on temporal patterns. These two modes coexist and interact.

The research has important implications for the field of neuroprosthetics, which seeks to develop devices that can substitute for a motor, sensory or cognitive functions that might have been damaged through injury or disease. To produce realistic tactile sensations, both modes must be engaged. This is true whether the goal is to elicit texture percepts or any other kind of artificial tactile sensation.

"What we've shown here is that all three sets of afferents contribute to texture perception," Bensmaia said. "In fact, signals from all three populations are integrated to culminate in any kind of tactile perception."

More information: Spatial and temporal codes mediate the tactile perception of natural textures, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1305509110

Provided by University of Chicago Medical Center