Tactile perception: The “comb illusion”

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Abstract

At first, I was underwhelmed by this one. But what it does is demonstrate the existence of stretch receptors in our system for the sensation of touch. Running an object (like a stick, or a pen) along the fine teeth of a comb, causes successive teeth of the comb to deflect laterally.

Keywords

Cognitive Neuroscience (Subfield)

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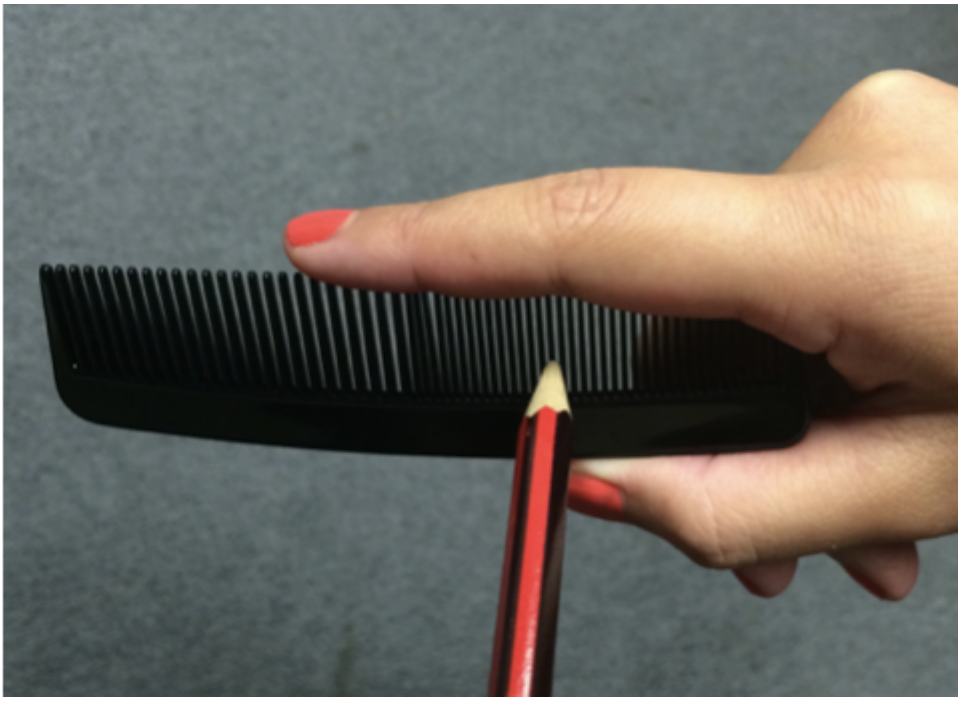
At first, I was underwhelmed by this one. But what it does is demonstrate the existence of stretch receptors in our system for the sensation of touch.

Running an object (like a stick, or a pen) along the fine teeth of a comb, causes successive teeth of the comb to deflect laterally. There is no appreciable up-and-down component to the teeth's movement, just the side-to-side movement.



If you place your finger along the top of a comb's teeth and close your eyes while you stroke the teeth with the stick, you'll feel something running along your finger. I wouldn't call this much of an illusion, so I didn't think much of it at first. But Hayward & Cruz-Hernández (2000) pointed out that from this phenomenon, we can conclude your finger is able to sense lateral force, essentially *skin* stretch, not just indentation of the skin. The brain interprets the successive stretch signals as an object running down the finger. That stretch *alone* can result in these percepts is interesting.

There are several sorts of touch receptors in the skin. Most detect vibration or indentation. Stretch is detected by a rather distinct class, the Ruffini corpuscles, which are the specialized endings of nerves that carry the corpuscles' signal to the spinal cord.

Now run the stick along the comb without your finger on top. Look carefully at the comb's teeth. If you drag the stick along with some force, you'll be able to see the teeth move a bit. But try running the stick along with very little force, at an acute angle so the side of the stick barely touches the comb, and runs smoothly. Make it nearly parallel to the plane of the comb, so it's smooth enough that you don't get the clicking sound and bump-bump vibration from successive teeth that occurs if the stick protrudes between the teeth. I noticed that when doing this, the deflection of the teeth is so small that looking directly at the ends of the teeth, I can't see the deflection.

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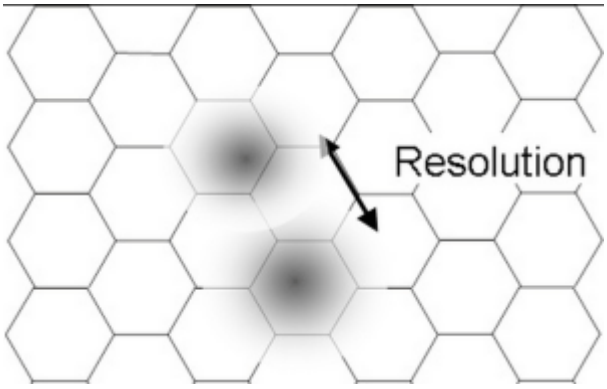
Yet if you put your finger again atop the comb, you should still have the sensation of something running along your finger. Hayward & Cruz-Hernández (2000) suggest that here the teeth move only by microns, and perhaps they are right, as we ought to be able to see even a few microns of deflection when we look closely at the comb. Indeed, I suspect that the teeth may be moving less than a micron.

This shows how extraordinarily sensitive our sense of touch is- more spatially acute than vision. But note that the exquisite sensitivity of touch here comes from an ability that has no direct analogy in vision. In vision, when we think about spatial sensitivity, we think of acuity,



Spatial resolution in vision is limited by receptor spacing. Image: Gerald Westheimer.

which is limited by receptor spacing (although hyperacuity makes it a bit more complicated than that). Vision has nothing like touch’s stretch receptors, which here are not limited by spatial spacing, but rather by the minimum force the Ruffini corpuscles can register.

Touch can also best visual acuity in another way. Receptors sensitive to ultra-high-frequency *vibration* allow us to discriminate a rough surface from a smooth one even when the roughness is created by features much smaller than a micrometer. For that phenomenon, I created a picture to put the spatial scales involved into perspective. I might explain it more another time.

Reference

V. Hayward, M. Cruz-Hernandez, Tactile display device using distributed lateral skin stretch, in: *Proceedings of the Haptic Interfaces for Virtual Environment and Teleoperator Systems Symposium*, Vol. DSC-69-2, ASME, 2000, pp. 1309–1314.