Link between light touch and Merkel cells solves 100-year mystery

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Light touch - the sense that lets musicians find the right notes on a keyboard, a seamstress revel in the feel of cool silk, the artisan feel a curve in material and the blind read Braille - truly depends on the activity of Merkel cells usually found in crescent-shaped clusters in the skin, said researchers from Baylor College of Medicine and colleagues in a report that appears in the current issue of the journal *Science*.

"Human, primates and any animal that relies on hands for dexterity use their Merkel cells to feel texture and shape," said Dr. Ellen Lumpkin, assistant professor of neuroscience, molecular physiology and biophysics and molecular and human genetics at BCM and a senior author of the report. "Merkel cells are not like pain fibers. They exist in special areas of the skin to feel light touch. We have a lot of them on our fingertips and also on our lips."

However, while many scientists thought Merkel cells were key elements of light touch, they could never directly prove the link. The topic has been debated for more than 100 years, since the cell were first described in 1875 by German scientist Friedrich Sigmund Merkel (for whom they are named).

In cooperation with Dr. Huda Zoghbi (another senior author), Lumpkin, first author Dr. Stephen Maricich (now of Case Western Reserve University in Cleveland, Ohio), and colleagues generated mice that lacked a gene called Atoh1 in some areas of the body and, as a result, had no Merkel cells in skin located below the head. Experiments on these mice directly demonstrate the link between Merkel cells and touch in way that can be seen and heard.

That is probably the most significant thing about the paper, said Marichich. While Merkel himself first postulated the link between the cells and light touch, "this is the first direct evidence," said Maricich, who plans to continue working with the cells, determining the progenitor cells from which they arise and determining how they relate to human disease.

A decade ago, Zoghbi, Dr. Hugo Bellen and other BCM researchers identified Atoh1 (also called Math1), and were the first to show it affects hearing and proprioperception - the sensing of where parts of one's body are in space. (See figures 1 and 2)

Zoghbi is professor of pediatrics, molecular and human genetics, neurology and neuroscience at BCM and is also a Howard Hughes Medical Institute investigator.

"To our knowledge, Atoh1 is the first gene shown to be necessary for the specification of Merkel cells," the authors noted in their paper.

To further prove their point, the researchers used special equipment to record tiny electrical impulses that touch elicits from neurons in the skin. (See videos 1 and 2. Listen to audio recordings 1 and 2.) In mice that lacked Merkel cells, the skin was missing touch receptors with high spatial resolution (the hallmark of Merkel cells), but was still innervated by other touch-sensitive neurons.

While Merkel cells are probably not involved in proprioperception, Merkel cells and hair cells (the sensory cells of the ear) "allow you to manipulate objects with high spatial resolution and discrimination of sound. That's what I think is beautiful about Atoh1, the Merkel cell and the hair cell," said Lumpkin.

"These cells are the first way our body interacts with the outside world," she said. "Both hair cells and Merkel cells tell us what and when at the finest level we humans relate to our environment."

A decade ago, Lumpkin chose to study Merkel cells at the same time that Zoghbi and Bellen first

announced their discovery that Atoh1 (Math1) is necessary for inner ear hair cells. She recognized that the two fields would someday have importance for one another.

Merkel cells are not limited to fingertips or lips, where tactile sensitivity is highest. They are also found in hairier parts of human skin as well as on the bodies of all vertebrates, from fish to primates.

In mice and other nocturnal animals, Merkel cells in the body might be important for maneuvering in the dark. Lumpkin and Maricich plan to use the mice lacking Merkel cells to directly test this possibility.

This is another important component of the Atoh1 network that helps people realize where they are in space, said Zoghbi. While the specific activity of Merkel cells permit light touch and the "what and when" of activity, "Atoh1-dependent neurons are processing that information," she said.

Lumpkin sees the finding as a stepping stone to even more basic answers.

"Bigger than that, we don't know how any mammalian touch receptor works," she said. "What genes allow them to function as light or painful touch receptors? This project gives us the experimental handle with which to start to dissect the genetic basis of touch."

Source: Baylor College of Medicine (news : web)