Scientists determine how body differentiates between a scorch and a scratch

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You can tell without looking whether you've been stuck by a pin or burnt by a match. But how? In research that overturns conventional wisdom, a team of scientists from the California Institute of Technology and the University of California, San Francisco (UCSF), have shown that this sensory discrimination begins in the skin at the very earliest stages of neuronal information processing, with different populations of sensory neurons--called nociceptors--responding to different kinds of painful stimuli.

Their findings were published this week in the early online edition of the Proceedings of the National Academy of Sciences (PNAS).

"Conventional wisdom was that the nociceptive neurons in the skin can't tell the difference between heat and mechanical pain, like a pin prick," says David Anderson, Seymour Benzer Professor of Biology, a Howard Hughes Medical Institute (HHMI) Investigator, and one of the paper's lead authors. "The idea was that the skin is a dumb sensor of anything unpleasant, and that higher brain areas disentangle one pain modality from another, to tell you if you've been scorched or scratched."

This conventional wisdom came from recording the electrical responses of nociceptive neurons, where it was shown that these neurons are capable of sensing pretty much every kind of painful stimulus--from pin pricks to heat to cold. But this, Anderson notes, was not sufficient to understand the control of pain-avoidance behavior. "We were asking the cells what the cells can sense, not asking the animal what the cells can sense," he explained.

And so Anderson and coprincipal investigator Allan Basbaum, chair of the Department of Anatomy at UCSF, decided to ask the animal. To do so, they created a genetically engineered mouse in which specific populations of pain-sensing neurons can be selectively destroyed. They were then able to see if the mouse continued to respond to different types of stimuli by pulling its paw away when exposed to a relatively gentle heat source or poked with a nylon fishing line.

What the researchers found was that, when they killed off a certain population of nociceptor neurons, the mice stopped responding to being poked, but still responded to heat. Conversely, when the researchers injected a toxin to destroy a different population of neurons, the mice stopped responding to heat, but their sense of poke remained intact.

"This tells us that the fibers that mediate the response to being poked are neither necessary nor sufficient for a behavioral response to heat," Anderson explains, "and vice versa for the fibers that mediate the response to heat."

In addition, Anderson notes, neither of these two classes of sensory neurons seem to be required for responding to a painful cold stimulus, like dry ice. Research into pinpointing that population of cells is ongoing.

"This tells us that the discernment of different types of painful stimuli doesn't happen only in the brain--it starts in the skin, which is therefore much smarter than we thought," says Anderson. "That's a pretty heretical point of view."

It's also a potentially useful point of view, as Anderson points out. "If doctors want to repair or replace damaged nerve fibers in conditions such as diabetic neuropathy," he explains, "they need to make sure they're replacing the right kind of nerve fibers."

More information: "Distinct subsets of unmyelinated primary sensory fibers mediate behavioral responses to noxious thermal and mechanical stimuli," *PNAS*.

Source: California Institute of Technology (news : web)

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