Identification of a stretch sensitive mechanoreceptor that detects slip

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Animals use touch to guide and inform movement, including the avoidance of slip during navigation and object manipulation. Here, we develop a slip assay and find that glabrous skin tactile feedback is essential for maintaining non-slipping contact with an angled ramp in mice. To identify populations of mechanoreceptors that underlie the avoidance of slip, we optogenetically mapped A-fiber neurons that innervate glabrous skin and discovered an uncharacterized population of neurons with large (1mm^2) receptive fields. These neurons correspond to a class of mechanoreceptors that respond to innocuous tangential forces that stretch the skin. We generated a *Ptgfr*^{CreER} line to selectively label these neurons and find that they innervate the skin with large terminal fields that occasionally span multiple digits. Surprisingly, Ptgfr$^+$ neuron terminals in glabrous skin are free nerve endings that penetrate the epidermis of the skin, an anatomical feature that is often associated with nociceptors capable of signaling damaging stimuli. Optogenetic activation of Ptgfr$^+$ neurons failed to elicit nocifensive responses, but instead triggered grasping movements similar to gripping reflexes that counteract object slip in a state-dependent manner. Mice that conditionally lack the mechanically gated ion channel Piezo2 in Ptgfr$^+$ mechanoreceptors show slip avoidance deficits and altered motor strategies for handling objects. Finally, we find that endings with similar anatomy are present in human glabrous skin. We propose that Ptgfr$^+$ mechanoreceptors provide tactile feedback crucial for the avoidance of slip and thus support motor strategies that rely on the simple dynamics of stable contacts to navigate and manipulate the world.