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SENSORY SYSTEMS

Sensational organization in the dorsal horn

The spinal cord dorsal horn serves as the first relay station for incoming somatosensory information. Evidence for extensive information processing at early stages of neural pathways in other sensory modalities, such as vision, has prompted a re-evaluation of the role of the dorsal horn in somatosensation; however, the neural mechanisms that might mediate information processing in this region have been unclear. Ginty and colleagues have therefore undertaken a detailed dissection of the molecular, functional and organizational properties of the neurons that comprise this important sensory processing area.

Innocuous touch is conveyed to the CNS via specialized sensory neurons, the low-threshold mechanoreceptors (LTMRs). The authors characterized the mouse LTMR-recipient zone (LTMR-RZ) as the region of the dorsal horn that received inputs from Aβ-, Aδ- and C-LTMRs, assessed through genetic labelling. Further characterization of the LTMR-RZ revealed the presence of large numbers of locally projecting interneurons that might contribute to the processing of sensory information in this region.

The LTMR-RZ interneurons displayed a broad range of morphological and physiological properties, prompting the authors to consider whether they could be classified into distinct subtypes. By screening publicly available atlases of gene expression they identified genes expressed within the LTMR-RZ but not in surrounding parts of the spinal cord and used these genes to generate transgenic mouse lines that enabled fluorescent labelling and/or recombinase-mediated manipulation of subsets of LTMR-RZ neurons. By combining assessment of gene expression with analysis of the morphological and physiological properties of the labelled cells, the authors identified 11 interneuron subtypes (7 excitatory and 4 inhibitory) within the LTMR-RZ.

To investigate the importance of LTMR-RZ interneurons in somatosensory processing, the authors used an intersectional genetic strategy to express tetanus toxin in large cohorts of excitatory or inhibitory LTMR-RZ interneurons. In a texture-specific novel-object recognition task, the mice in which these subsets of interneurons were silenced exhibited impaired texture discrimination and reduced hairy skin sensitivity, confirming the importance of these interneurons in tactile perception.

Next, the authors sought to dissect the synaptic organization of the LTMR-RZ by creating transgenic mice that enabled the visualization of synapses that are made by each of the genetically defined classes of interneuron, as well as of synapses that are formed by different subtypes of LTMR. This showed that LTMR-RZ interneurons receive converging synaptic input from diverse subtypes of LTMR, with each interneuron subtype exhibiting unique combinations of LTMR inputs. The LTMR-RZ interneurons also received substantial input from other locally projecting neurons and cortical projection neurons.

The authors' analysis further revealed that all subtypes of LTMR-RZ interneuron form local axodendritic (feedforward inhibitory) synapses, whereas only a subset of the inhibitory interneurons forms axoaxonic synapses on the presynaptic terminals of LTMRs. Furthermore, the ascending postsynaptic dorsal column (PSDC) neurons receive most of their synaptic input from LTMR-RZ interneurons, a subset of inputs from Aβ-LTMRs and few, if any, inputs from Aδ- and C-LTMRs. Thus, the innocuous-touch information that leaves the dorsal horn via PSDC neurons is first funnelled through a complex system of highly interconnected interneuron subtypes.

These findings suggest that LTMR-RZ interneurons are well positioned to receive and integrate converging input from different types of LTMR and descending modulatory cortical inputs to shape the sensory information that is conveyed to higher brain regions to enable tactile perception.

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> “LTMR-RZ interneurons are well positioned to receive and integrate converging input from different types of LTMR and descending modulatory cortical inputs”

ORIGINAL ARTICLE Abraira, V. E. *et al.* The cellular and synaptic architecture of the mechanosensory dorsal horn. Cell **168**, 295–310 (2016)