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A new mechanism for somatosensory information processing by descending noradrenergic pathway via spinal dorsal horn astrocytes

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The spinal dorsal horn (SDH) receives somatosensory inputs from the periphery and descending pain modulatory inputs from several brain regions including the locus coeruleus (LC). Recent progress has been made in understanding neuronal circuits in the SDH, but the role of astrocytes, one type of glial cells, in somatosensory information processing and behavior under physiological conditions is entirely unknown. Here, by establishing a method to monitor SDH astrocytic activities using an *in vivo* Ca^{2+} imaging technique, we revealed that superficial SDH astrocytes were activated following noxious stimulation by intraplantar capsaicin injection and that the astrocytic responses required activation of a_{1A}-adrenergic receptors (a_{1A}-AR) through descending noradrenergic signaling from the LC. Pharmacological inhibition of LC–SDH noradrenergic pathway and selective knockdown of a_{1A}-AR in superficial SDH astrocytes prevented capsaicin-induced pain hypersensitivity to light mechanical stimulation. Moreover, pharmacological activation of a_1-AR in superficial SDH astrocytes was sufficient to induce mechanical pain hypersensitivity. Our findings demonstrate for the first time the potential ability of superficial SDH astrocytes to modulate mechanosensory behavior as a non-neuronal gate for the descending noradrenergic pathway from the brain.