Plantar cutaneous afferent responses to behaviorally relevant forces

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Abstract

The foot sole is the primary interface between the body and environment, carrying information about the surface upon which we are standing and contributing to balance and gait. Existing research into the responses of tactile afferents at the foot sole has used carefully controlled low-amplitude stimuli to identify afferent firing thresholds and characterise response properties. However, such stimuli are not reflective of those experienced by the foot sole during everyday behaviour, limiting the generalisability of current experimental results to real-world behaviour. To fill this gap, we presented load profiles comparable to those experienced during gait, with forces of up to 35 N/cm2, and recorded afferent responses using microneurography. We found that greater forces and slower rates of loading influence afferent classes to different extents: slowly adapting afferents exhibit greater firing rates to high force-low derivative stimuli, whereas fast adapting afferents respond more to low force-high derivative stimuli. We then use a computational model of foot sole cutaneous afferents to replicate experimental firing rates observed during microneurography. Using this new knowledge, we simulate tactile responses in response to spatiotemporal pressure patterns during gait. Combining experimental and computational methods affords the opportunity to provide new-found insight into the role that tactile feedback plays during natural behaviours, such as standing balance and gait.

Keywords: Gait, Touch, Computational modelling, Microneurography

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