Mechanical, neural and perceptual aspects of tactile transparency

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Abstract

A material has tactile transparency when it comes between the skin and an external stimulus, but we can still feel the external stimulus. We experience this frequently in our daily lives, for example with clothing. However, materials with tactile transparency change how the external stimuli feel, which is particularly apparent when wearing gloves. We have conducted multiple experiments studying tactile transparency, using a 40 microns thin plastic film attached to the skin. Specifically, we measured changes in mechanical skin displacement, neural- and perceptual thresholds and perceived intensity when applying force-controlled mechanical indentation.

Optical coherence tomography showed that the plastic film reduced the vertical displacement required to achieve the same force from the mechanical indenter. Microneurography showed that the film increased force thresholds for C-tactile fibers, while slowly adapting mechanoreceptor thresholds were unaffected. Psychophysical experiments showed that the film caused an increase in detection thresholds and a reduction in perceived intensity.

We have shown that even with an extremely thin film, tactile transparency has measurable mechanical, neural and perceptual consequences. Our measurements suggest that this is because the film reduces skin displacement of force-controlled indentation. The psychophysical results indicate that these small effects are functionally meaningful. Particularly interesting is that CT afferents were more sensitive to this effect than SA afferents, suggesting a possible role for CTs in force perception. If thresholds and perceived intensity depend on the overall quantity of peripheral inputs, reduced CT input could explain our results. However, other afferent types not tested might also play this role.

Keywords: tactile transparency, indentation, microneurography, psychophysics, skin mechanics

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