Effect of Surface Textures on Tactile Perception. A numerical model for friction-induced mechanoreceptor stimulation with application to the tactile perception of topical films.

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Abstract

Through contact of our fingers against the objects and surfaces around us, mechanical stimuli propagate to the sites of our tactile mechanoreceptors. Through changing the material, geometric and interfacial properties of these countersurfaces, it can be possible for product designers to modulate the elicited mechanical stimuli in order to deliver more functional and desirable sensations to consumers. In this investigation, a numerical, two-dimensional, viscoelastic, hyperelastic, multilayered, microscale finite element model representing finger skin was compressed and translated against a variety of rigid sinusoidal surface textures. A parametric study was conducted in which the wavelength and amplitude of these surface textures were systematically and independently varied whilst the strain energy density at the high spatial resolution (Type 1) Merkel and Meissner receptors within the finger model was recorded. It was found that when surface wavelengths were commensurate (similarly sized, but not necessarily identical) to that of the fingerprint, elevated and highly oscillatory strain energy density signals were experienced at each of the receptor sites. Furthermore, in these scenarios, increases in surface amplitude further elevated the strain energy density reported at each site. The stain energy density signals propagating to the receptor sites were substantially attenuated when the finger skin model was compressed against surfaces whose wavelengths did not approximate the fingerprint wavelength. These results may be used in conjunction with perceptive data to develop surfaces and in particular modify the skin's surface to elicit or tune specific targeted sensations amongst consumers in cosmetics and dermatology.

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