Material-texture confounds in haptic perception: Exploring a potential metameric relationship between surface roughness and material elasticity

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Abstract

Perceptual metamers result from the inability of our sensory apparatus to resolve the entirety of the physical properties of objects, leading to confounds, where different physical stimuli can be perceived to be identical. Here we will present data exploring the interdependent relationship between surface roughness and material elasticity in determining the perceived roughness and softness of textured, elastic surfaces. Everyday-life encountered surfaces are often self-affine, exhibiting fractal properties over many different length scales. However, research focusing on perceived surface roughness has typically used simple stimulus material (e.g., sandpapers or periodic gratings). Furthermore, in everyday surface interactions, changes in surface characteristics are frequently accompanied by alterations in material properties. Despite this, the joint influence of these parameters on haptic surface and material perception has been investigated very little. Here we use a database of 49 stochastically-rough silicone rubber samples, resembling natural textures in some of their features, without compromising on the control needed for haptic experiments. The samples are varied systematically in their statistical microscale roughness (Hurst exponent) and elasticity (shore hardness). We employ a 2AFC-discrimination procedure, embedded in a non-parametric Bayesian inference framework, to determine the probability of any given sample in our stimulus space as being perceived as rougher or softer. Our hypothesis posits that if both cues – surface roughness and material elasticity – influence the perceptual outcome (roughness or softness), there should be perceptual regions where A) one cue dominates the other and B) the two cues provide confounding percepts (metamers).

Keywords: roughness, elasticity, material & texture perception, self, affine, metamer, perceptual confound

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