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Rapid Sensing of Material Affordances

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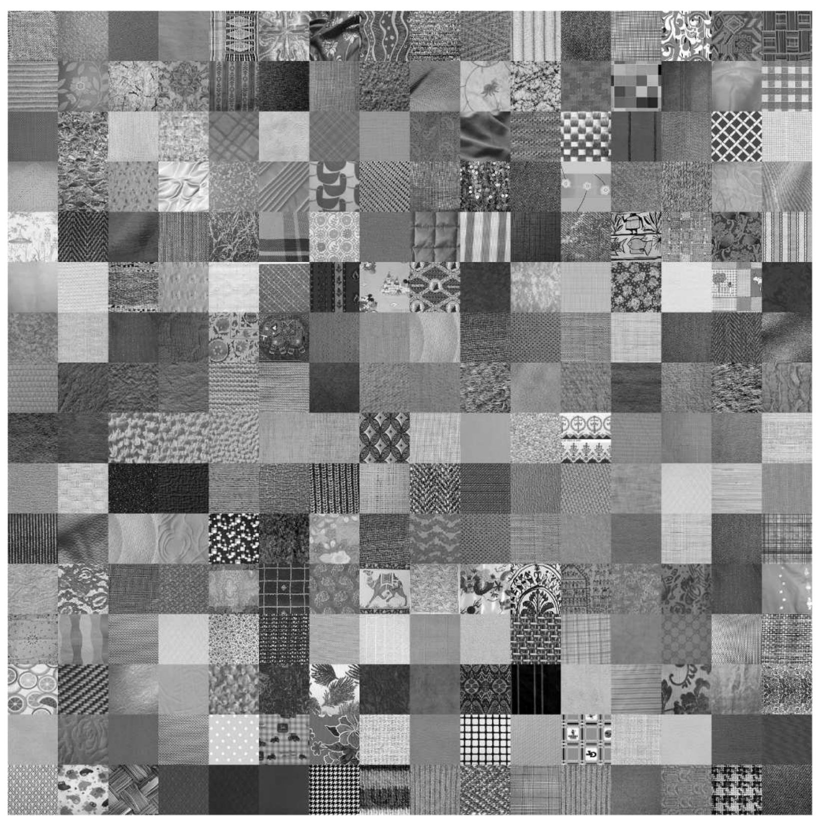
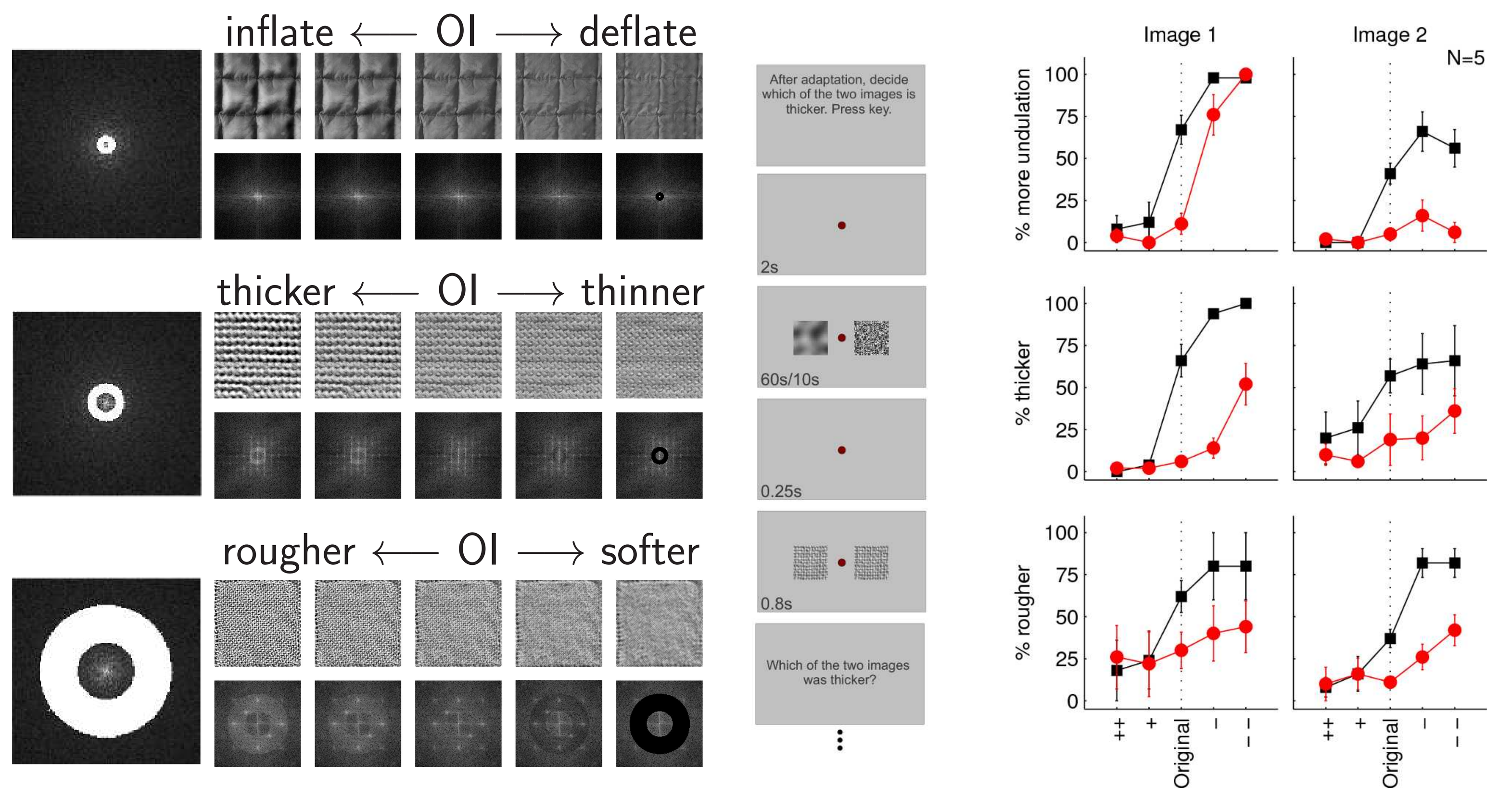
Introduction

Material perception may be as important as object perception for successful interactions with the environment. Possibly the most important facet of visual material identification is to infer properties from the available information that can provide predictions for the appearance of the material in other states, for effects of the material on other sensory modalities, for the calibration of motor actions, and most importantly for potential uses, i.e. affordances. Here, we present exploratory results relating the perception of material properties to information present in photographs of the materials.



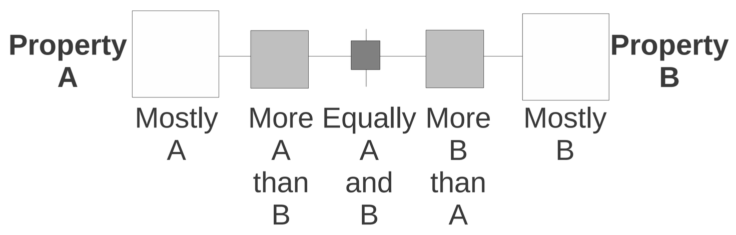
Material manipulation and adaptation



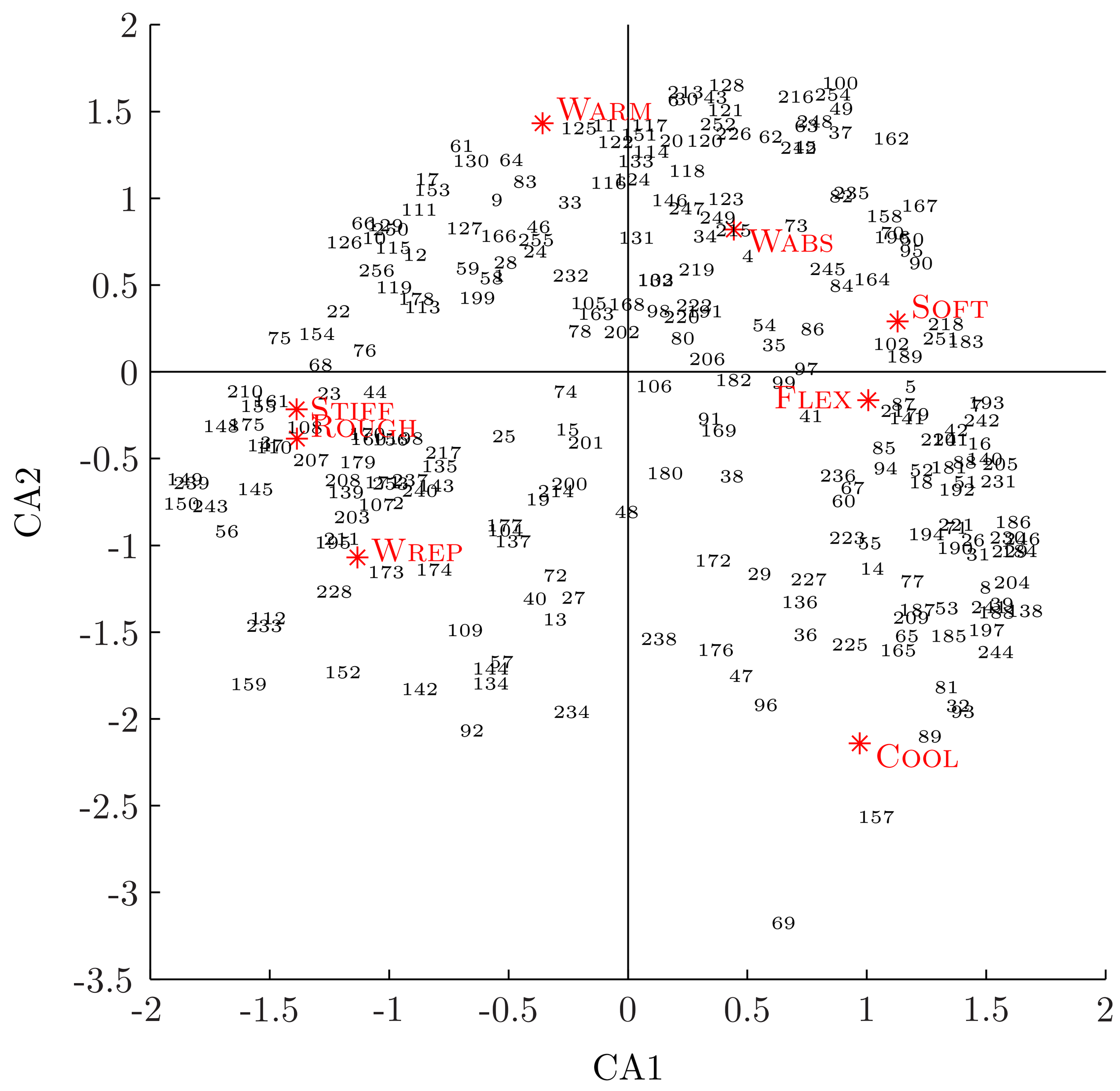
Affordance classification

261 uncalibrated color images of fabrics (150×150 pixels; 3.5°) were presented on a monitor against a black background. Observers were asked to rate each image separately on four bipolar property dimensions using a five step scale. To guide observers in inferring each property, we presented them with a question aimed at potential uses of the material.

Properties	Questions
soft — rough	If you felt this material on your skin would it feel soft or rough?
flexible — stiff	If you folded or draped this material would it be stiff or flexible?
water-absorbent — water-repellent	Would you use this material to repel water or would you use it to absorb water?
warm — cool	Would clothes made of this material keep you warm or cool?



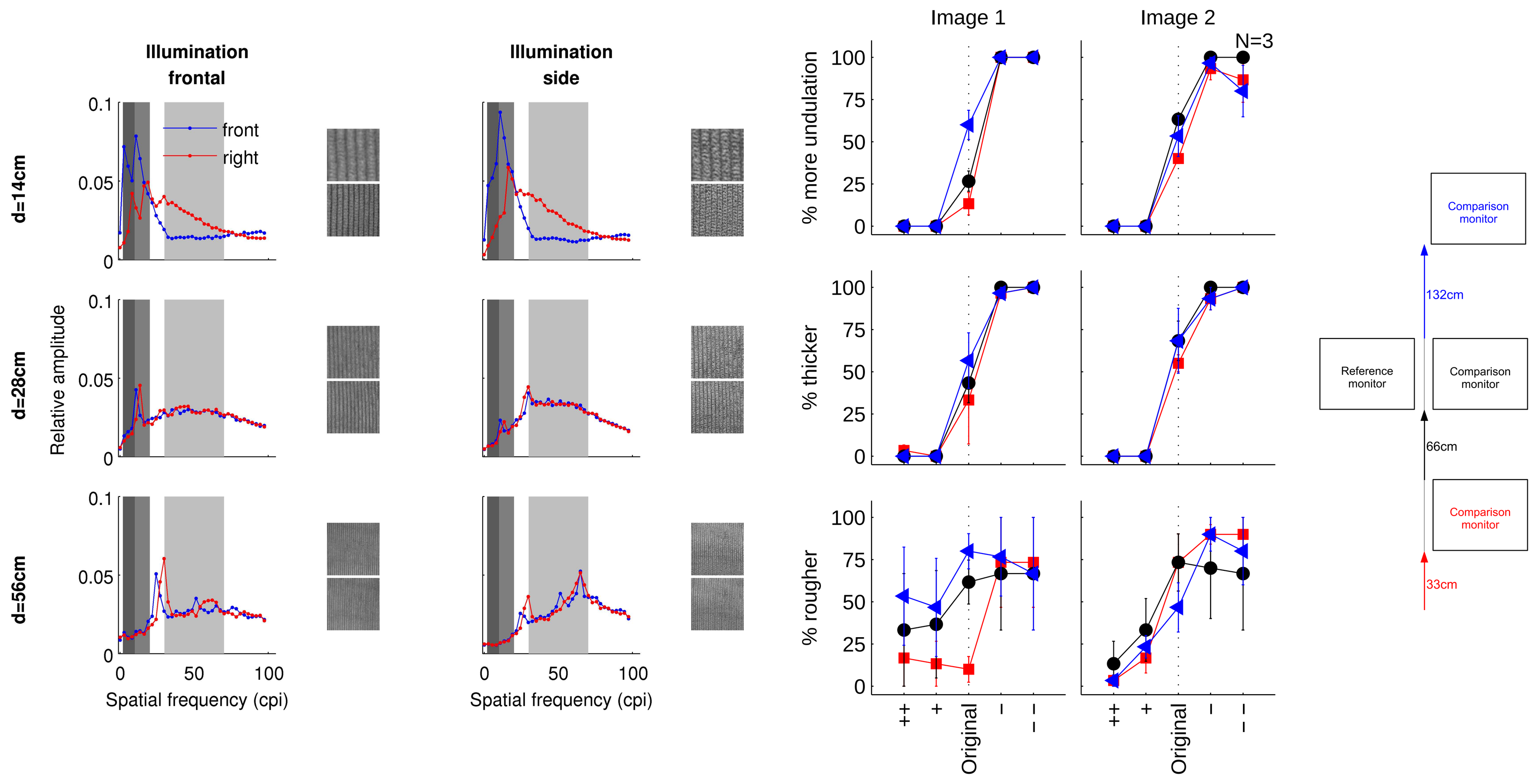
The experiment was repeated twice on separate days. For data analyses, only images that have been rated consistently in the two sessions by at least five observers were used. Correspondence analysis was used to identify a reduced set of orthogonal dimensions on which the eight properties and 256 images can be represented.



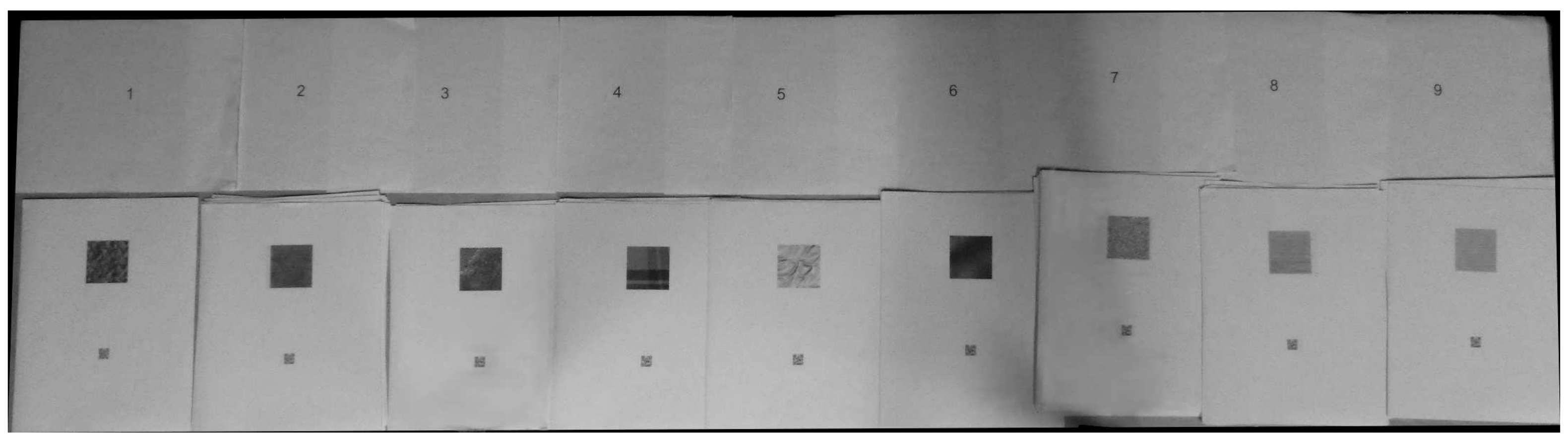
Pose – Illumination – Distance

Using images from the KTH-TIPS database (Fritz, M., Hayman, E.,Caputo, B., and Eklundh, J.-O. (2004). The KTH-TIPS database. Available at www.nada.kth.se/cvap/databases/kth-tips), we analyzed the effects of changes in pose (frontal vs slanted to the right), illumination (top vs right), and distance (14, 28, and 56cm) on the amplitude distribution across bands of spatial frequencies. We found that the changes in material appearance are closely reflected in the frequency-band signatures.

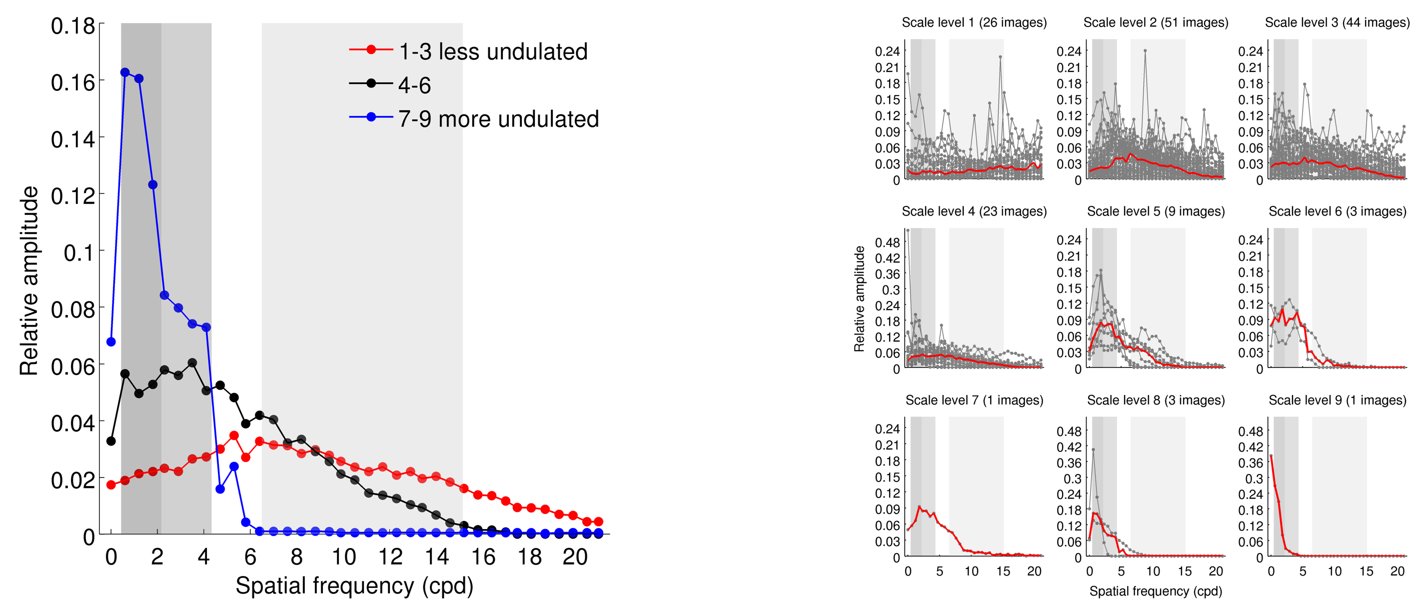
Viewing distance was varied by using two CRTs. The reference monitor was placed at 66cm, while the comparison monitor was placed at 33, 66, or 132cm. The original stimulus was displayed on the comparison monitor, while either the original or one of four manipulated versions of the original image was shown on the reference monitor. The observers indicated which of the images of a fabric displayed on the two monitors appeared as being more undulated, thicker, or rougher, respectively.



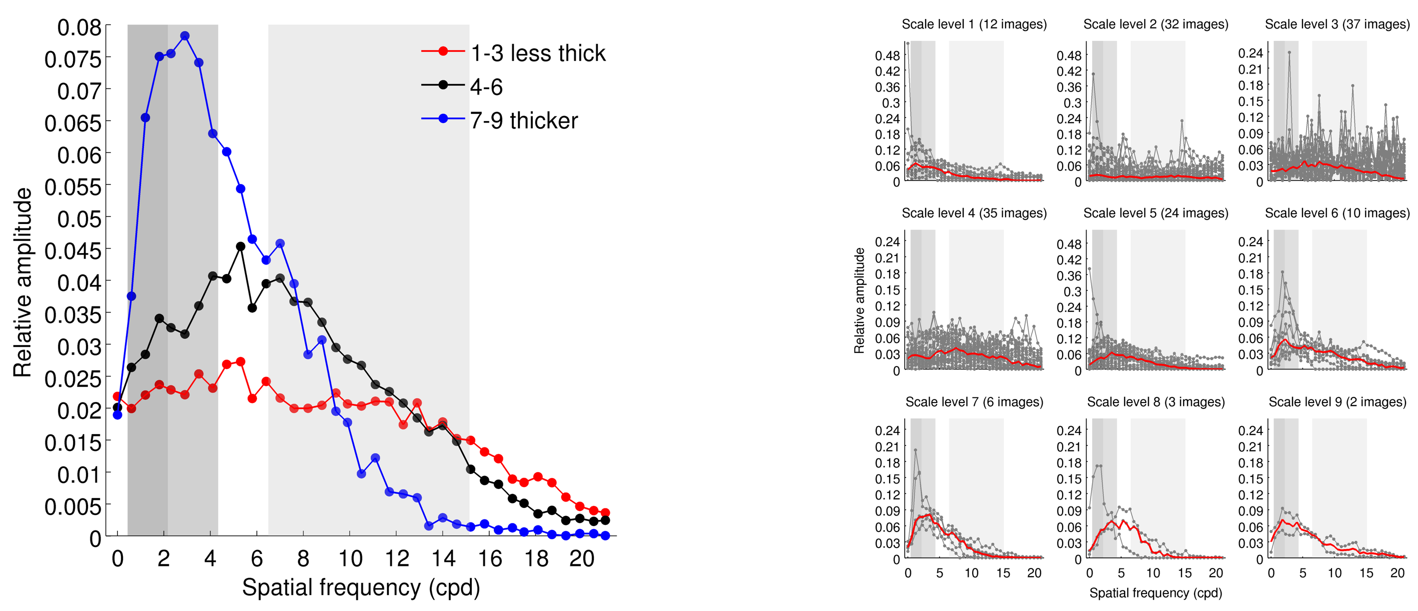
Material ranking



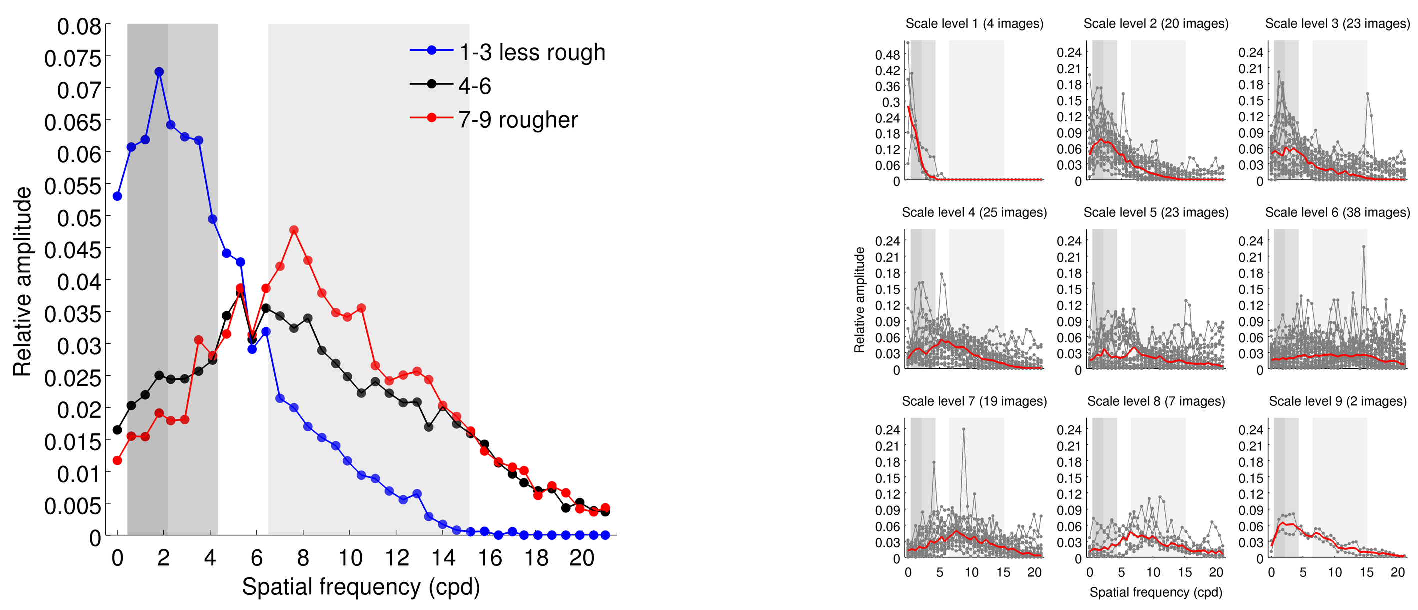
Undulation



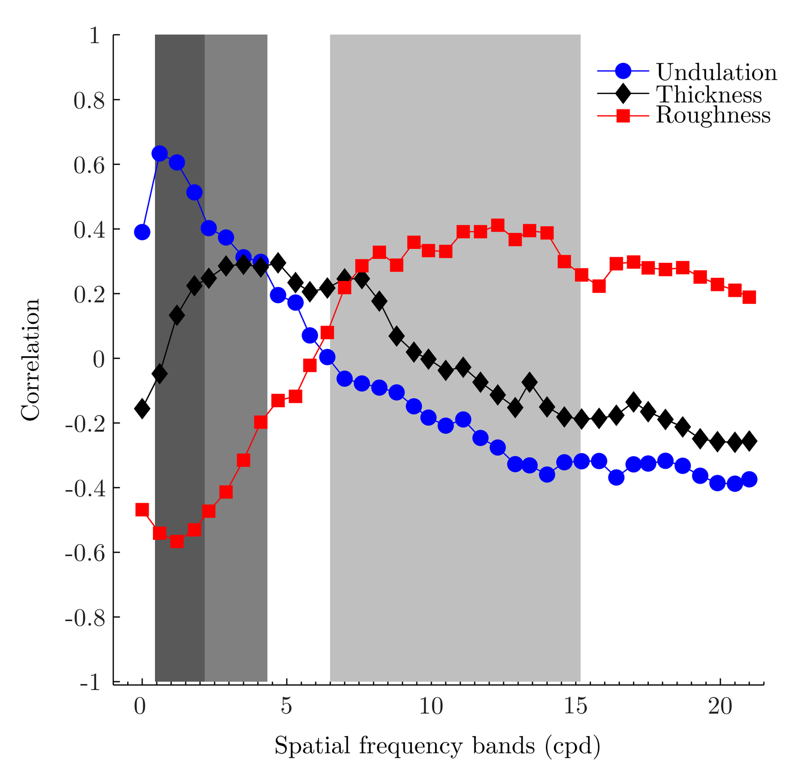
Thickness



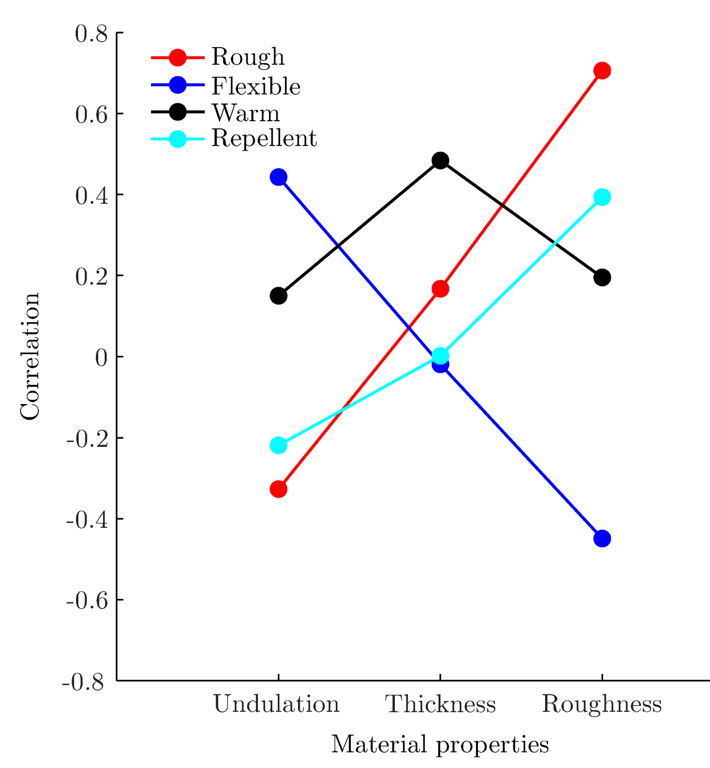
Roughness



Ranking and frequency



Ranking and affordances



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