Visual perception 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.

Methods

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.

Property ratings

Soft Rough Flexible Stiff

W.-absorbent W.-repellent Warm Cool

Consistency of the ratings across repetitions

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Experimental results

From the ratings, both groups of closely associated properties as well as mutually exclusive properties seem to emerge. One associated group is formed by the properties soft, flexible, and water-absorbent, whereas soft, stiff, and water-repellent have no overlapping ratings. 88% of the fabrics that have been rated as cool were also rated as flexible. A large proportion of the fabrics rated as flexible can be characterized by the presence of folds. With respect to the property cool the presence and shape of folds might have served as an indicator for the thinness of a fabric.

Spectral analysis of material properties

To identify visual cues underlying the complex inferences about affordances, we chose sets of images from opposite ends of bipolar dimensions, that were otherwise similar, and identified four frequency bands which when increased or decreased in energy lead to appearance changes that seem to be correlated to some of the material properties.

Phase exchange

Water-absorbent → Water-repellent

Water- absorbent

Water-repellent

Associate properties

Soft & Flexible

Rough & Stiff

Water-absorbent & Warm

Water-repellent & Rough

Flexible & Cool

Frequency band: 53 – 68 cpi

thinner ← Original image → thinner

shiny ← Original image → matte

Experimental setup

261 color images were presented from opposite ends of bipolar dimensions using a five step scale. Fourier analyses were performed on gray-scale versions of these images.

Associate properties

Soft & Flexible

Rough & Stiff

Water-absorbent & Warm

Water-repellent & Rough

Flexible & Cool

Frequency band: 53 – 68 cpi

thinner ← Original image → thinner

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