Joint online inference of material properties and object shape

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Abstract

Humans remarkably can perceive 3D surfaces that are literally invisible – when their shapes are implied through dynamic physical interaction with various materials (liquid, granular, elastic). To study this ability and its interaction with perception of material properties, we produced videos simulating unfamiliar non-rigid or non-solid materials interacting with differently shaped rigid objects and containers. Crucially, videos rendered only the materials, while the rigids remained invisible. Observers correctly identified the underlying surface shape from two alternatives in most, but not all cases; observers also simultaneously inferred the internal properties of the material and identified a matching sample from how it interacted with novel surfaces. In fact, judgments about materials were comparable to when observers saw fully visible renderings of all objects in the scenes. Our results highlight the role of an internal physics model in the joint perception of shape and material properties, and in the loop of perception more generally.

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