PSYCHORHEOLOGY: TOWARD UNDERSTANDING HOW WE EXPERIENCE VISCOUS AND VISCOELASTIC MATERIALS

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ABSTRACT

Physical properties of materials with which we interact are perceived by combining information gathered with our senses. Properties like "thickness" (viscosity) and "firmness" (elasticity) can be experienced using different senses, e.g., vision and/or touch. We perceive feedback from different modalities during material deformation, e.g., resistance to force, appearance, shape, and motion; however, it is unclear how these measurable properties map to perceptions while driving our behavior and decision-making.

When discriminating differences in the viscosity of *Newtonian liquids* in a two-alternative forced choice (2AFC) task, the observers' sensitivity to changes in viscosity depends on the modality of perception as well as the magnitude of viscosity itself. Furthermore, we found that fluid transparency and opaqueness influenced the visual judgments of thickness. This appearance bias was reduced when observers were able to combine information from vision and touch, but the bias increased when their performance accuracy was negatively affected by mood. Overall, combining information from vision and touch improved discrimination in certain ranges of viscosity but not others. This behavior was well reproduced by a sensory cue combination model with normalization which weighs information from each modality based on its reliability.

When discriminating differences in firmness of six model *viscoelastic* materials (hand therapy putties) in a 2AFC task where both samples are identical, subjects exhibited a strikingly wide range of probing behavior where 70% of the variance is described by creep time, stress rate, and stress. Furthermore, we observe a bias toward whichever sample was probed for a longer total time. In a 2AFC task where all six samples were compared against each other, subjects were unexpectedly accurate when discriminating samples whose linear viscoelastic and traditionally measured nonlinear (LAOS) moduli and viscosities vary by small amounts that are significantly less than the just noticeable difference thresholds for both elastic solids and viscous liquids. This suggests that the material properties that subjects are using to make their determinations are likely not these traditionally measured properties, but rather transient rheological properties which can be readily measured by transient recovery rheology.