The effect of texture element size, density, luminance, and motion coherence on long-range object grouping

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Abstract

The human visual system assigns boundary edges to adjacent objects based on both local and long-range features, including element size, density, luminance, and motion coherence (Kaplan, 1969; Yonas, Craton, & Thompson, 1987). It is an open question, however, exactly how long-range interactions are combined to provide relative depth orderings in the absence of *local information* around the object boundary. This study explores the effectiveness of long-range interactions between moving elements and edges in providing a stable perceptual relative depth ordering using two sparsely textured, uniform, moving surface displays when local information is either absent or ambiguous.

Previous relative depth studies have used displays where two object's textures abut one another at the object boundary. Separate studies have additionally shown that border ownership cells can use this local information to assign the boundary edge to one of the two objects based on the texture coherence of this location information. Our study instead investigates how identical, but sparsely spaced, texture elements can spread an ordinal depth signal over long distances, both across visual space and brain regions.

In order to appropriately assign depth relations to adjacent objects the visual system must extract occlusion cues even when there are few or no such cues at the object boundary. In this study, we designed a few psychophysical experiments to determine (1) whether occlusion cues can have long visual range and (2) the relative importance of each of these individual features for long-range grouping in depth in the case when local relative depth information and occlusion cues are ambiguous or non-existent. We use this relative depth ordering data to constrain a model that groups objects in depth based on the individual feature coherence, size, and density and also determine the weight of each feature in depth ordering. We also investigate the implication of the results in the way that the visual system assigns border ownership.

Our preliminary study shows that by setting a luminance based edge and having visual elements on either side with different spatial and temporal properties, namely, different velocity and texture element size, a perceptual bias toward one of the side to own the edge emerges. This encouraging result strongly suggests that by systematic variation of sparse visual cues within each uniform surface, clear figure–ground, and border–ownership signals can be subjectively accomplished.

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