Quantifying boundary extension in scenes

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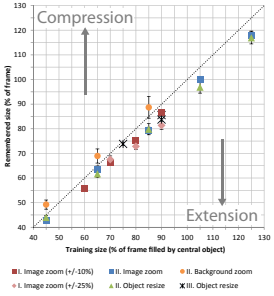
Background

- After viewing a picture of a scene, people remember having seen a wider-angle view than was originally presented (Intraub & Richardson, 1989)
- Similar "spatial compression" effects occur in other paradigms with non-scene stimuli: eg, localization of briefly-presented targets (Sheth & Shimojo, 2001), line length judgment (Sneider & Ehrlich, 1978), multiple object tracking (Liverence & Scholl, 2011)
- Our goal: quantify the magnitude of the boundary extension effect to determine what portion of the effect can be explained by low-level perceptual processes

Overview of results

Amount of boundary extension / compression across all conditions



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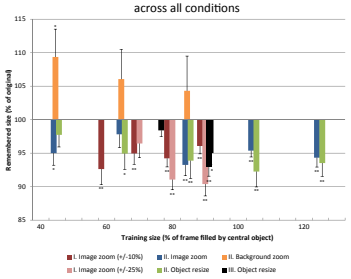


I. Effect of training and test zoom

Stimuli: 12 photos of natural scenes with a central object/region, shown at a single zoom level (zoom levels were defined by the size of the central object):

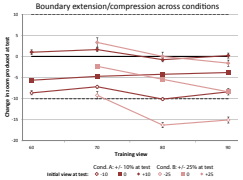
Experiment I training conditions

Task:

- All experiments were run on Amazon Mechanical Turk, 12 participants / condition
- Memory phase: Images were shown for 3 seconds each and participants were asked to memorize details.
- Memory test: Each image was shown again and participants used the arrow keys to zoom in/out to the original view. At test, 1/3 of images appeared at original zoom, 1/3 zoomed out (-10% or -25%), and1/3 zoomed in (+10 or +25%).

Results:

Closer initial and more extreme testing views produce more extension (in pixels), but as a % of original size, the extension was consistent across training and test conditions (images were remembered at ~ 94% of original size).



II. Size of central object or size of background elements?

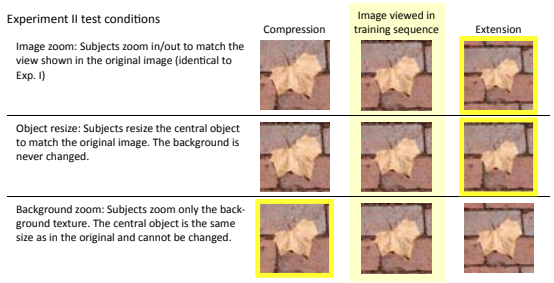
Stimuli: 12 photos of objects on flat, textured surfaces, at a single zoom level:

Experiment II training conditions

Task:

Similar to Exp. I, but at test participants were asked to manipulate one of the following (all conditions used +/-10% zoom at test):

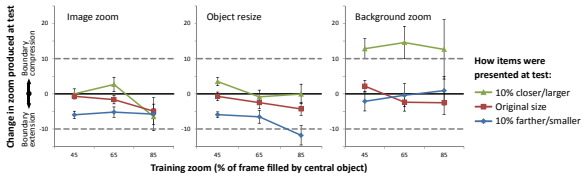
Experiment II test conditions



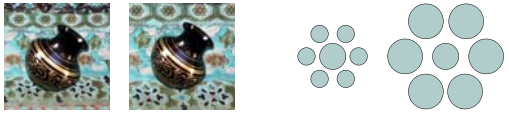
Results:

- No significant difference between image zoom and object resize conditions: people chose views in which the central object was 95% or 94% of original size, respectively
- Background zoom showed the opposite effect: background details were increased to 105% of their original size

Amount of boundary extension/compression across test conditions in Exp. II



A possible explanation for the background manipulation results: people move the background closer because this makes the central object appear smaller, as in the Ebblinghaus illusion.

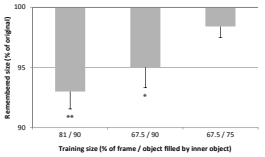


III. Object size or distance to nearest boundary?

Stimuli: 12 photos of object pairs in which a supporting object forms a boundary for the central object (based on Gottesman & Intraub, 2003). Participants saw images in one of three conditions:

Experiment III training conditions

Boundary extension in Exp. III



Task:

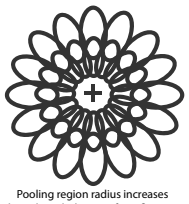
Similar to Exp. II object resize condition; only the central object was resized.

Results:

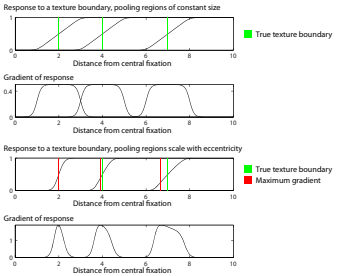
- Significant extension of object boundaries in 2 of the 3 conditions
- The amount of extension varies with both object size and distance to nearest boundary

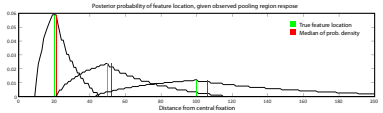
Discussion

- The amount of boundary extension was fairly consistent across a variety of stimuli and testing conditions: participants chose views in which central objects were about 94-95% of their original size
- The effect may not be entirely due to extrapolation of scene details outside the boundary of the view: people do not add background details when manipulating the background separately, and boundary extension can be obtained at object boundaries as well as view boundaries
- Pooling of features over peripheral locations may introduce asymmetries in the way images are processed and perceived



Pooling region radius increases linearly with distance from fixation





Because location uncertainty increases with eccentricity the median of the probability density for feature location shifts outward. The gradient between two texture regions shifts inward. The magnitude of these distortions depends on pooling region scaling but is proportional to eccentricity.