Boundary Extension: Replicating the Perceived Distance Effect and Re-Examining the Coding of Object Counts

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Introduction

What is Boundary Extension?

Boundary extension is something people's minds do when they look at pictures of objects. Instead of seeing and remembering the picture exactly as it looks, people extend the borders and fill in parts beyond the edges of the image that are not actually there (Intraub & Richardson, 1989).

Look at the house (A). When people are asked to draw it, they add unseen parts to the picture around the border (B) not in the original picture.

(**A**) what they saw   (**B**) what they thought they saw

Photo Credit: Bainbridge and Baker (2020) Figure 1, Panel A

Background

Boundary extension is a well replicated effect.

Bainbridge and Baker (2020) found that pictures that are <u>zoomed in closer</u> and <u>contain fewer central objects</u> show greater boundary extension, but these features often occur together in natural images and were not tested separately.

Researchers agree that subjective distance affects boundary extension, but researchers disagree on how the number of objects in an image affects boundary extension (e.g., Hale, Brown, and McDune, 2016).

Photo Credit: Bainbridge and Baker (2020) ggl images

Question & Hypothesis

Research Question: How do subjective distance and number of objects each affect the size of the boundary extension effect?

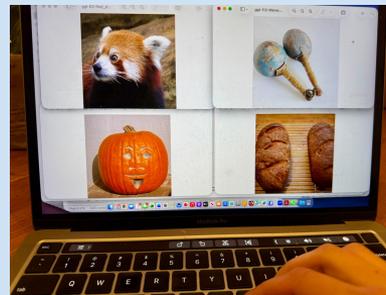**H1: Subjective Distance Hypothesis (most researchers agree):**
If a picture's subjective distance increases, then the boundary extension will decrease because the picture already appears zoomed out, so people are less likely to extend the image and fill in beyond the borders. (see also Hubbard, 2025)

H2: Number of Objects Hypothesis (conflicting theories):
If the number of objects in a picture changes, then the size of the boundary extension will change because having more objects in a scene may change how people focus their attention when viewing a picture. Prior research disagrees on the direction of the effect.

Method

- Secondary coding and analysis of 500 natural images of objects from Bainbridge and Baker (2020), publicly available on OSF.

- Independent variables:
  - *Subjective distance (extreme close up to far away)*
  - *Number of objects (recoded as 1, 2, 3, 4, 5+)*

- Dependent variable:
  - *Boundary transformation scores* (-1 to +1)

Recoding the number of objects; photo taken by student researcher

- Recoding of object counts for this study:
  - "Number of objects" was coded based on the number of objects a human would perceive at a glance and compared to GPT-5.2 counts.

Coding Challenge

| Counting Method	1	2	3	4	5+
Original	306	103	32	19	40
Human	50	94	69	50	237
GPT-5.2	148	114	67	19	152

This chart was made in excel by the student researcher

Counting the number of objects in naturally occurring images is not straightforward. How would you code the number of objects in these photos?

Photo Credit: Bainbridge and Baker (2020) ggl images

Results & Discussion

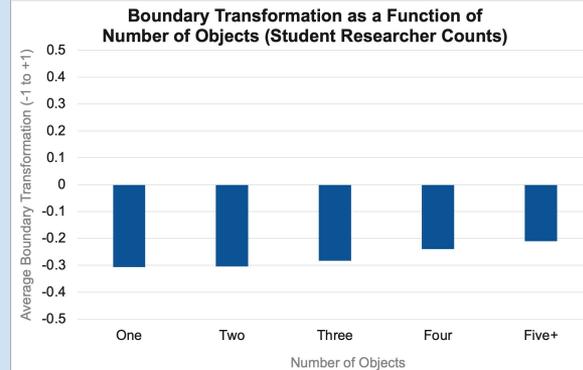**Boundary Transformation as a Function of Subjective Distance**
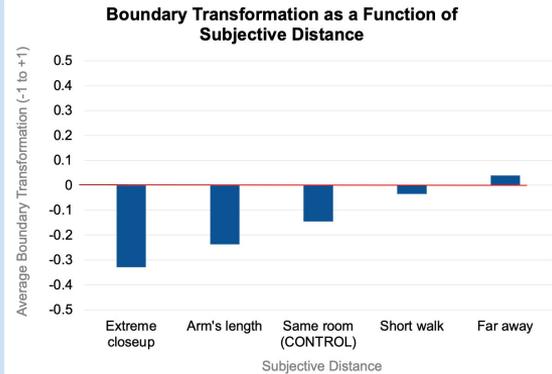
As the subjective distance increases the average boundary transformation score increases.

More negative values in the boundary transformation score indicates greater boundary extension.

Red line indicates the picture was seen as the same as original.

This graph was made in Excel by the student researcher.

Boundary Transformation as a Function of Number of Objects (Student Researcher Counts)

As the number of objects increases the average boundary transformation score increases.

More negative values in the boundary transformation score indicates greater boundary extension.

This graph was made in Excel by the student researcher.

Closer distance → More boundary extension
Result held when # of objs was held constant

Fewer objects → More boundary extension
Result didn't hold when distance was held constant

Conclusion & Implications

Main Finding
Subjective distance was a stronger predictor of boundary extension than the number of objects in natural images.

Key Insight
Counting the number of objects in natural images is not straightforward.

Application
Boundary extension helps explain why people do not remember things exactly as they are.
It may affect decisions in the world and explain why eyewitness testimony is not reliable.

Future Work
Experimentally manipulate distance and number of objects independently to test causal effects.

Key References

Bainbridge, Wilma A., and Chris I. Baker. "Boundaries Extend and Contract in Scene Memory Depending on Image Properties." Current Biology 30.3 (2020): 537-543.

Hale, Ralph G., James M. Brown, and Benjamin A. McDunn. "Increasing Task Demand by Obstructing Object Recognition Increases Boundary Extension." Psychonomic Bulletin & Review 23.5 (2016): 1497-1503.

Hubbard, Timothy L. "Setting the Scene for Boundary Extension: Methods, Findings, Connections, and Theories." Psychonomic Bulletin & Review 32.1 (2025): 97-138.

Intraub, Helene, and Michael Richardson. "Wide-angle Memories of Close-up Scenes." Journal of Experimental Psychology: Learning, Memory, and Cognition 15.2 (1989): 179.