Normative Representation of Objects and Scenes:
Evidence from predictable biases in visual perception and memory

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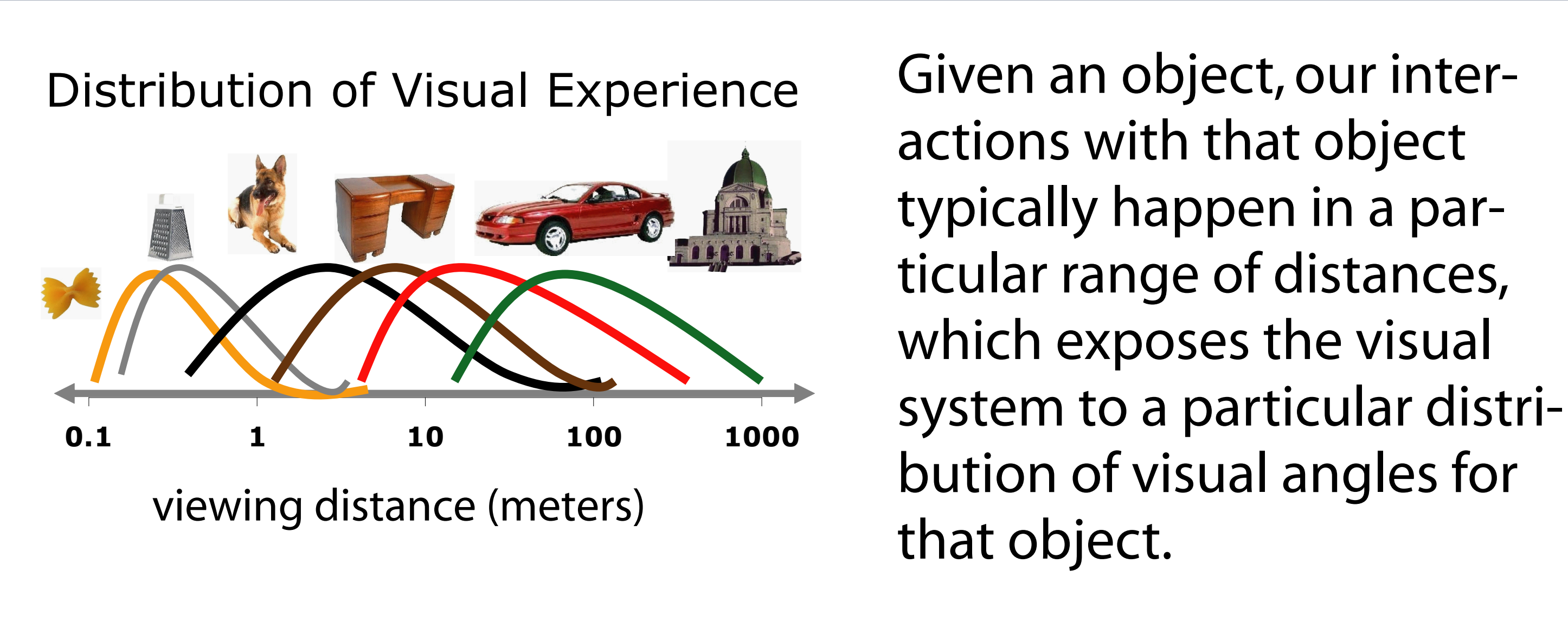
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Introduction

You can stand at any distance to an object in the world, so the object can appear at any visual size.

Question: Is there a canonical visual size for perception and representation of objects and scenes?

There are two motivations for positing a canonical or "normative" visual size:

(1) perceptual resolution limits exist across the visual field
(2) experience with objects and scenes is statistically constrained

Distribution of Visual Experience

0.1 1 10 100 1000
viewing distance (meters)

Given an object, our interactions with that object typically happen in a particular range of distances, which exposes the visual system to a particular distribution of visual angles for that object.

too far   too close   just right?

Long-Term Memory

Question: Is memory influenced by the norm in a suprise test for visual size?

OBJECTS   SCENES

Method: "You will be tested on your memory for these objects." No instruction about what kind of test.

banana ... cow ... violin
5 sec 1 sec 5 sec 1 sec 5 sec ...
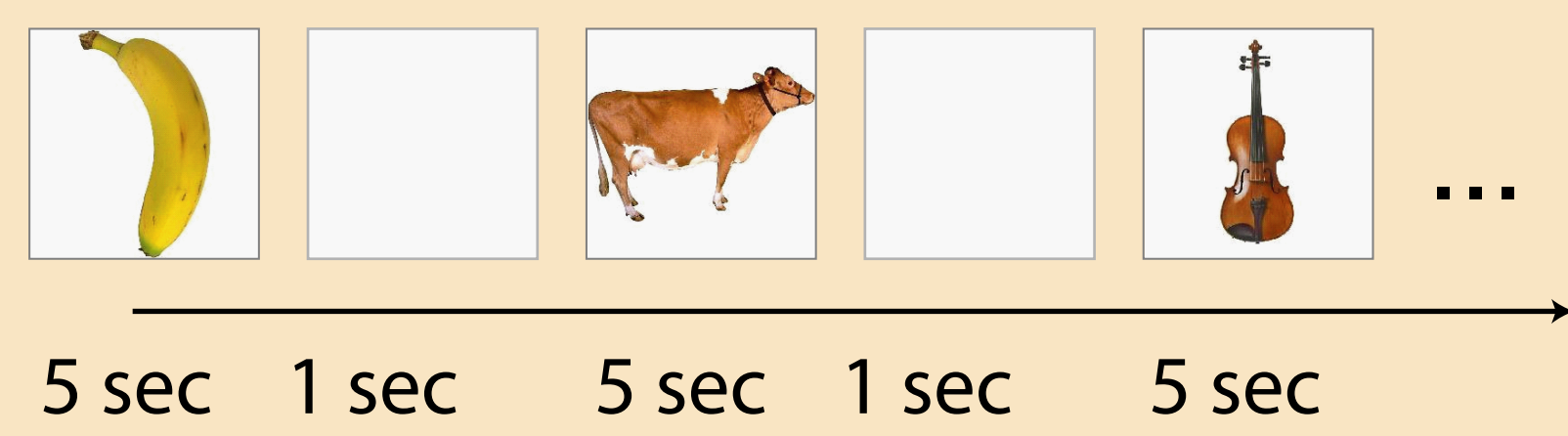
presentation phase: 20 objects presented, 10 too close and 10 too far, relative to the normative size from experiment 1
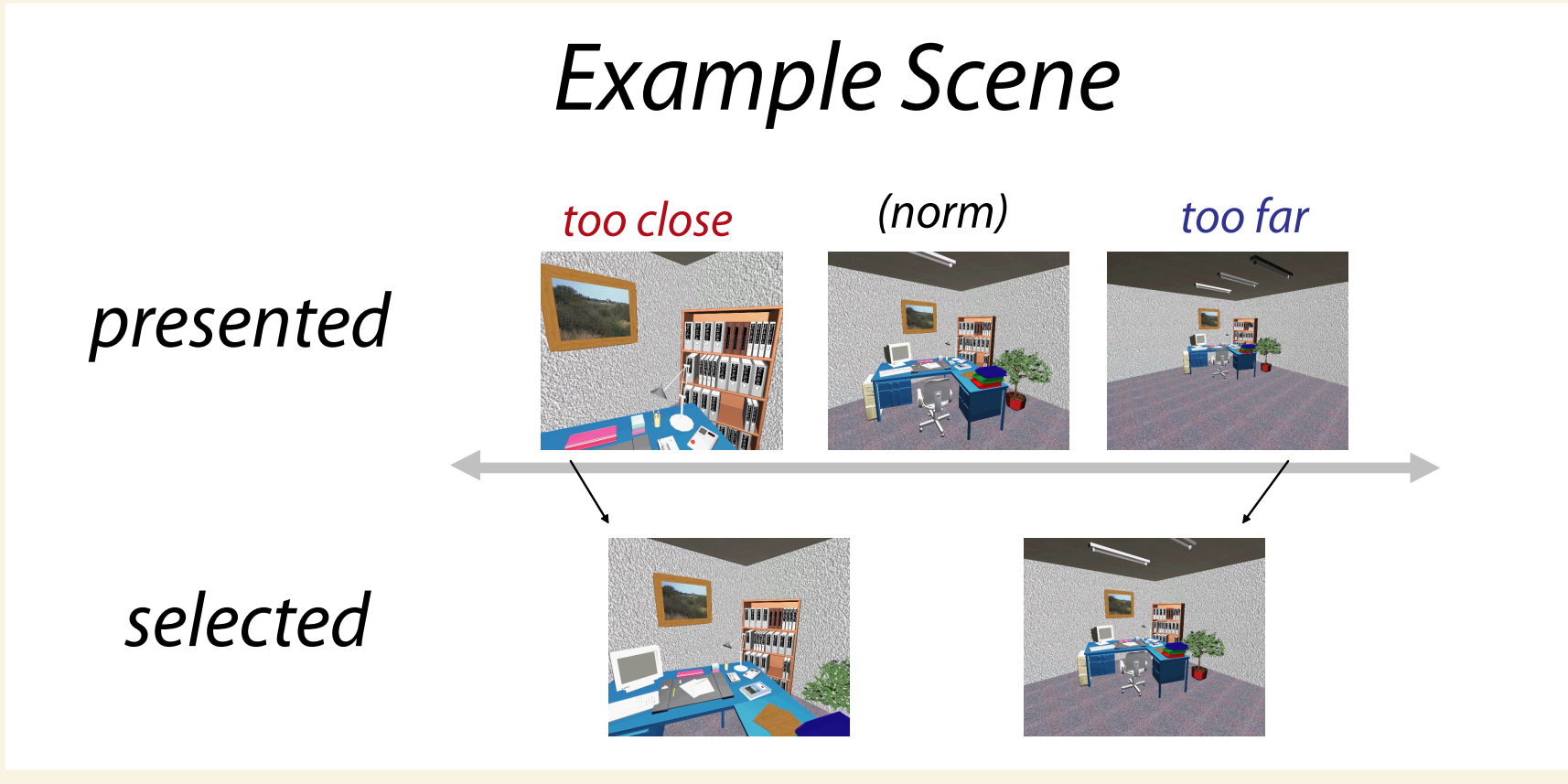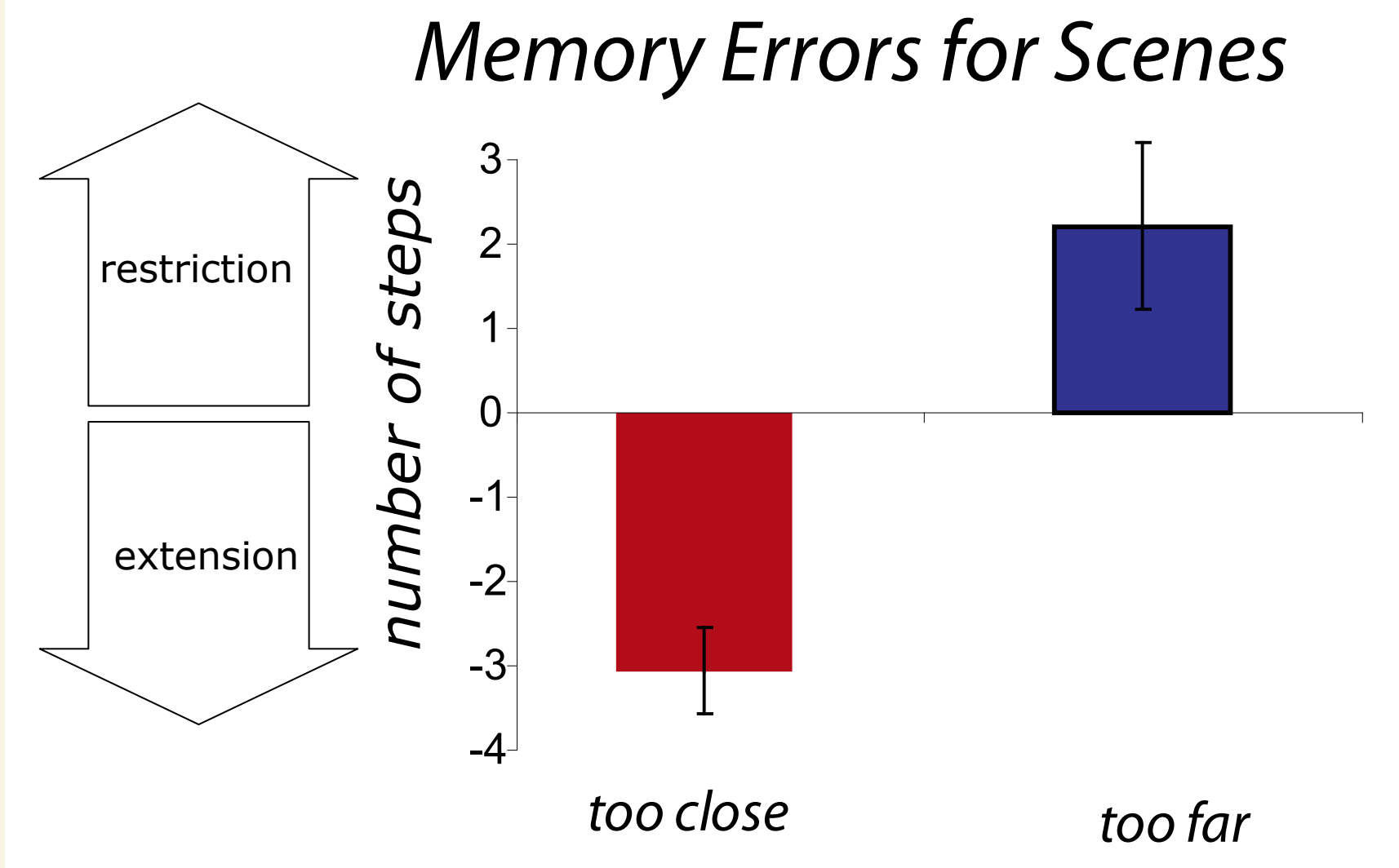
test phase: resize each object to match the size at presentation

Predictions:
Memory errors will be systematically biased towards the normative size

	too close	too far
presented		
selected		

Contraction (negative)   **Expansion (positive)**

Memory Errors for Objects
expand / contract
number of steps
too close   too far

Memory Errors for Scenes
restriction / extension
number of steps
3
too close   too far

Example Object
too close (norm) too far
presented
selected

Example Scene
too close (norm) too far
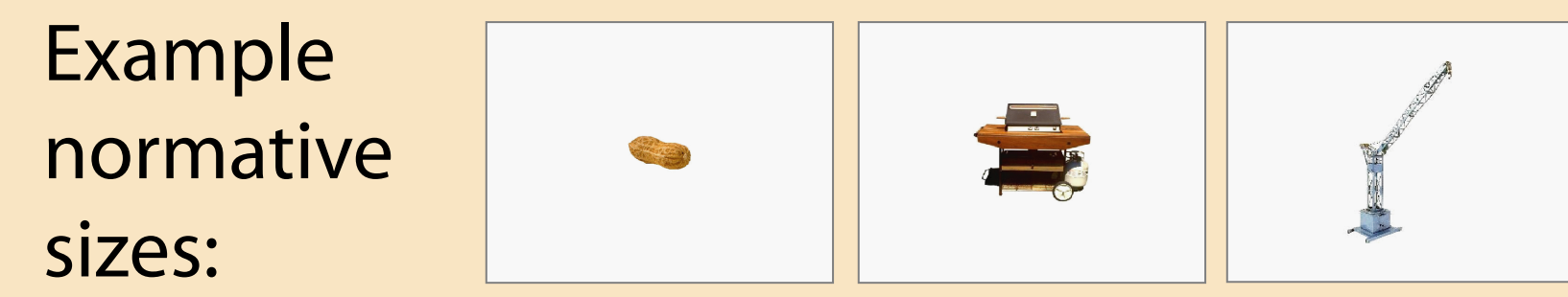presented
selected
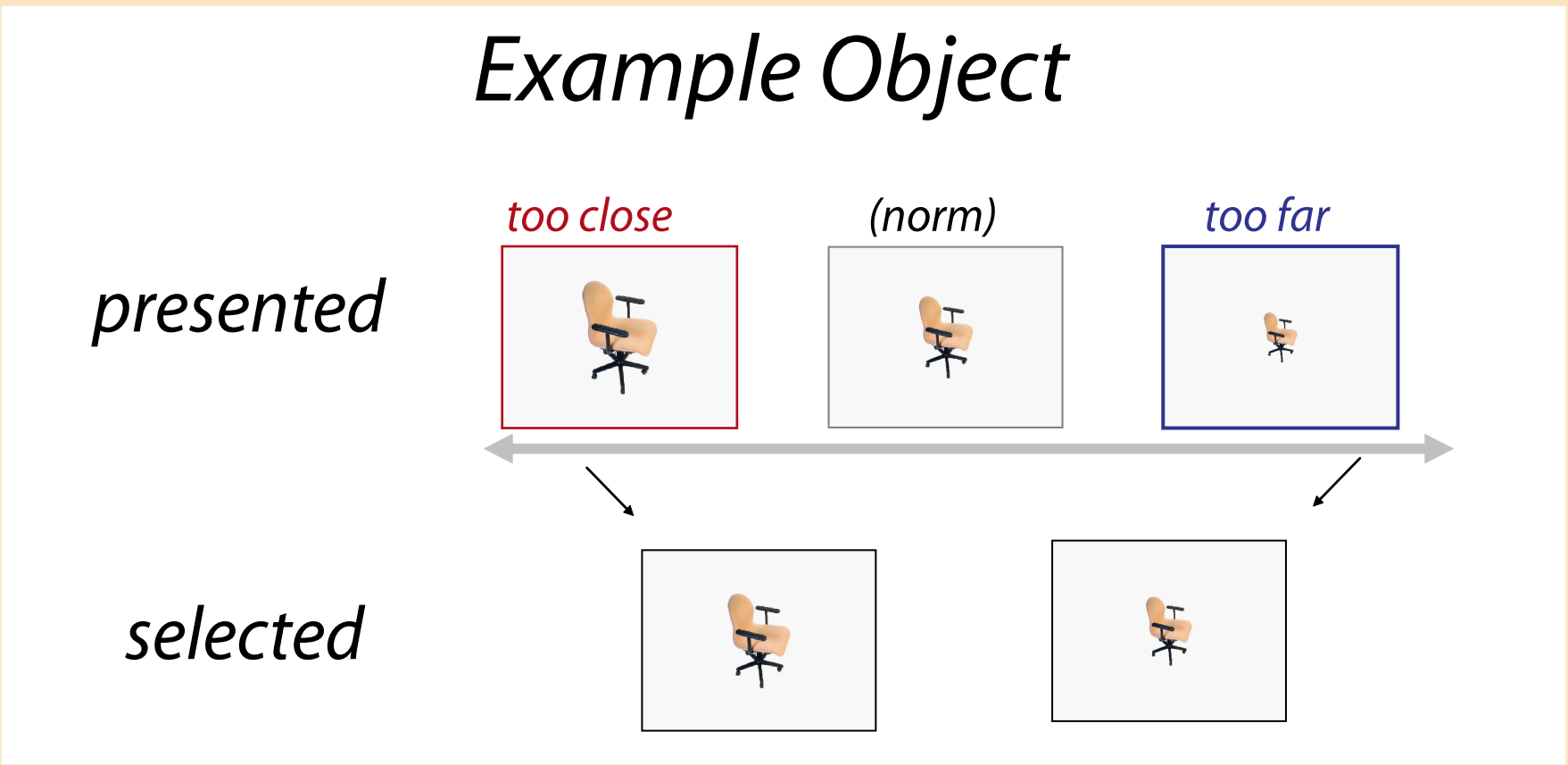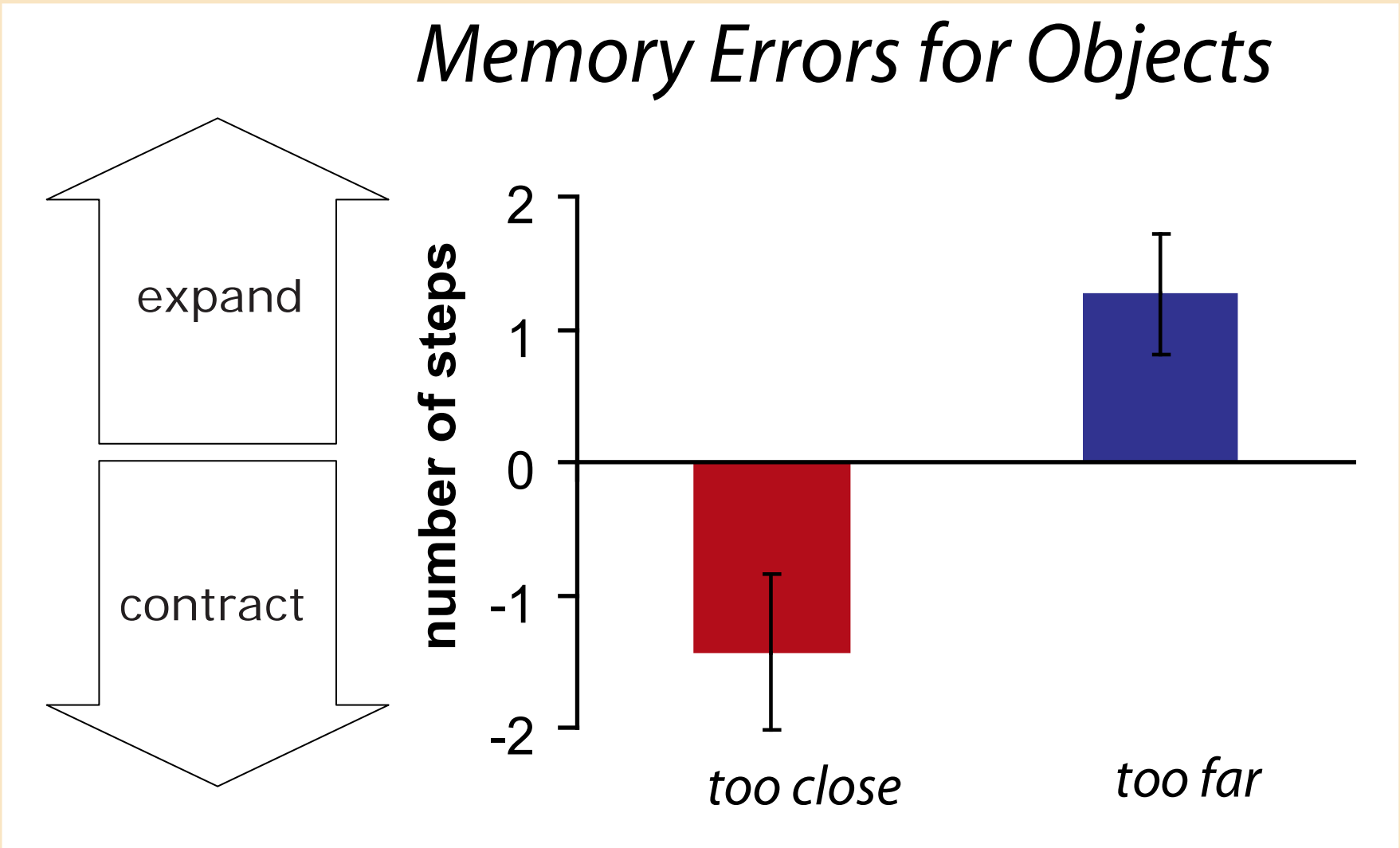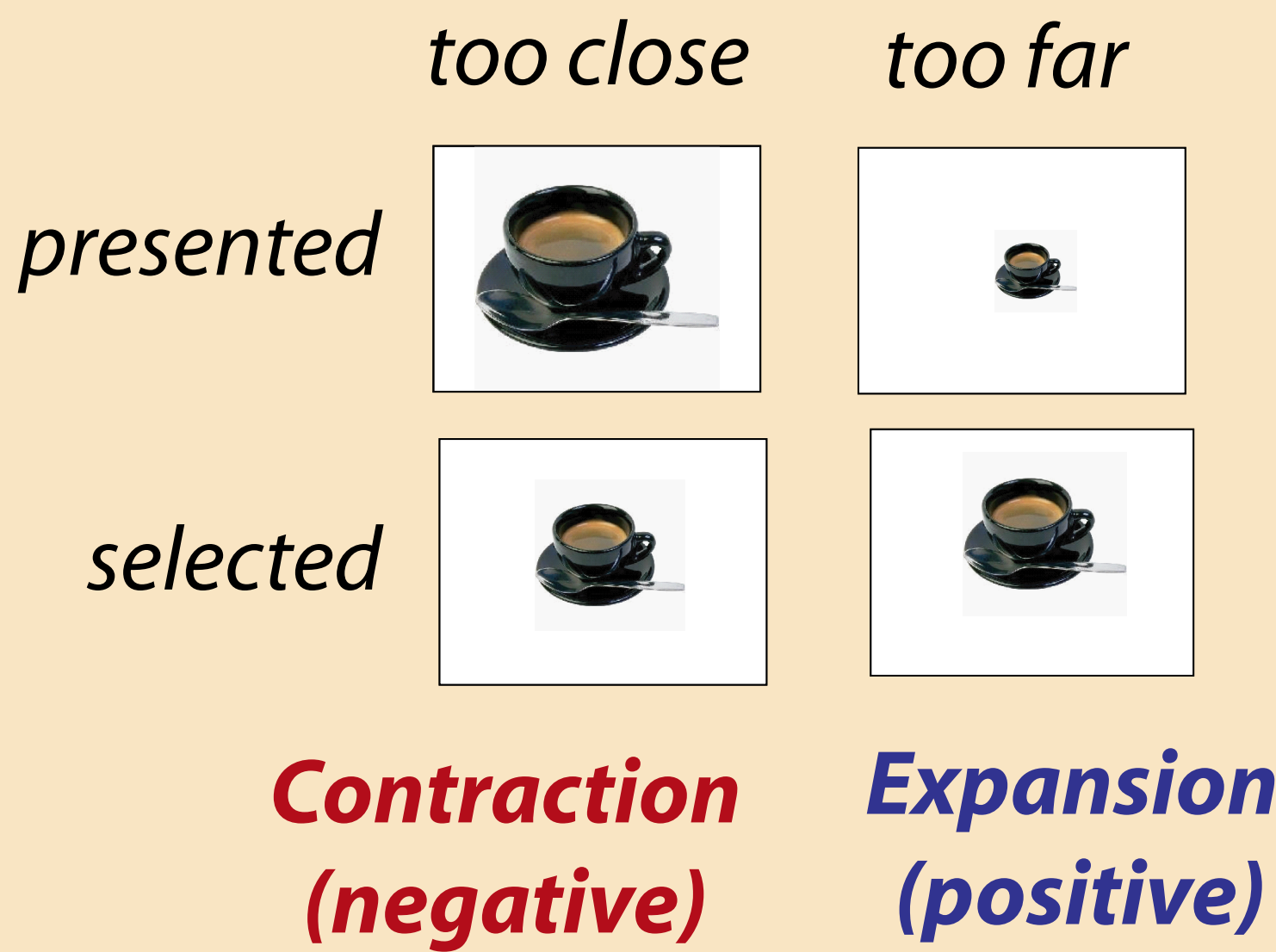
Existence of a Perceptual Norm

OBJECTS

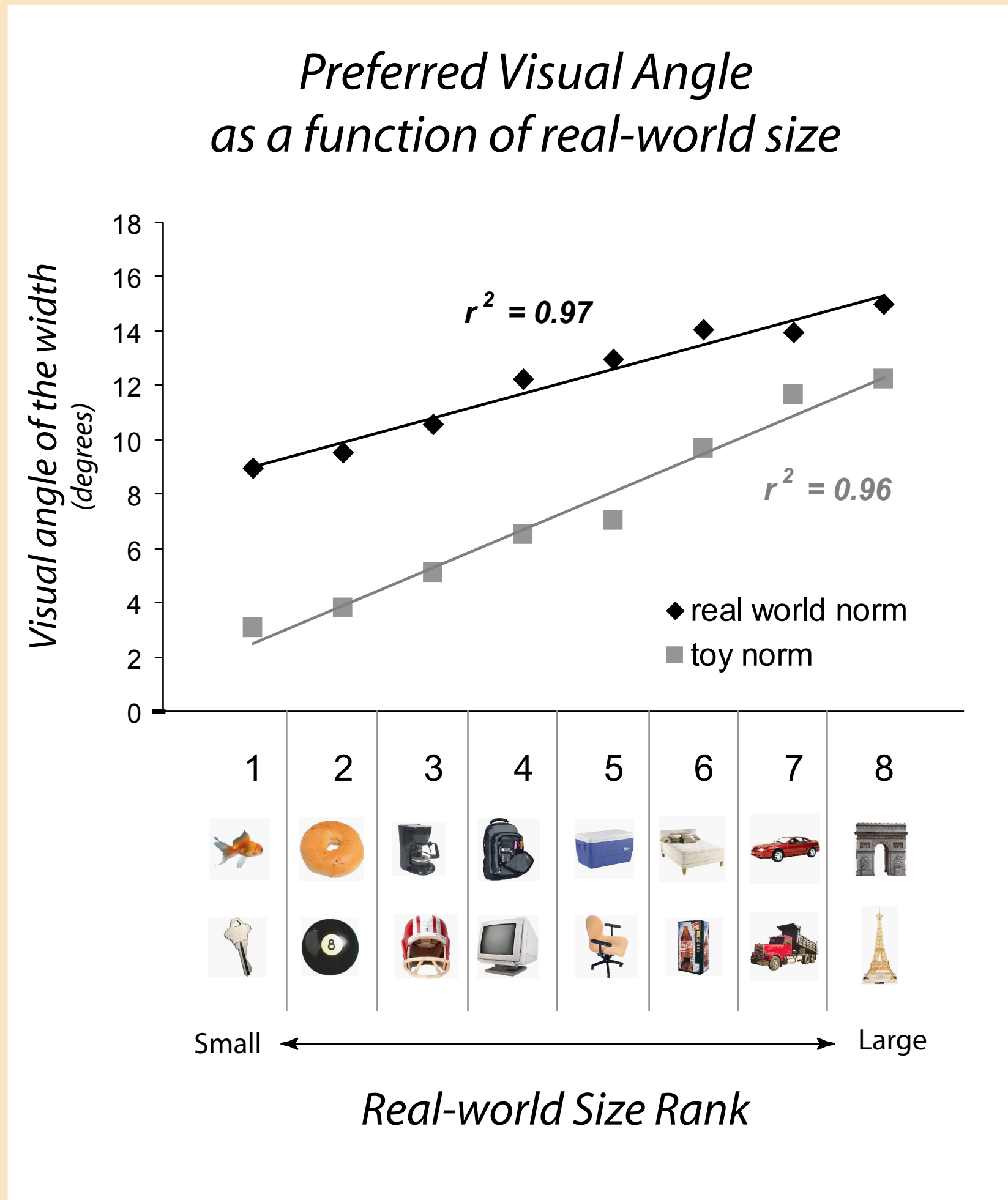**Question: Do observers prefer a consistent visual size for each object?**

Task: Rescale the objects on the monitor until they are in the "intuitively right place" to see them.

Answer: Yes. Inter-rater reliability R = 0.9, p<0.05

Example normative sizes:

Question: What happens to the preferred size when observers think these objects are toys?

Answer: Normative size is 5 degrees smaller, on average. Inter-rater reliability R = 0.89, p<0.05)

Preferred Visual Angle as a function of real-world size

$r^2 = 0.97$
$r^2 = 0.96$

Visual angle of the width (degree)
18 16 14 12 10 8 6 4 2

real world norm
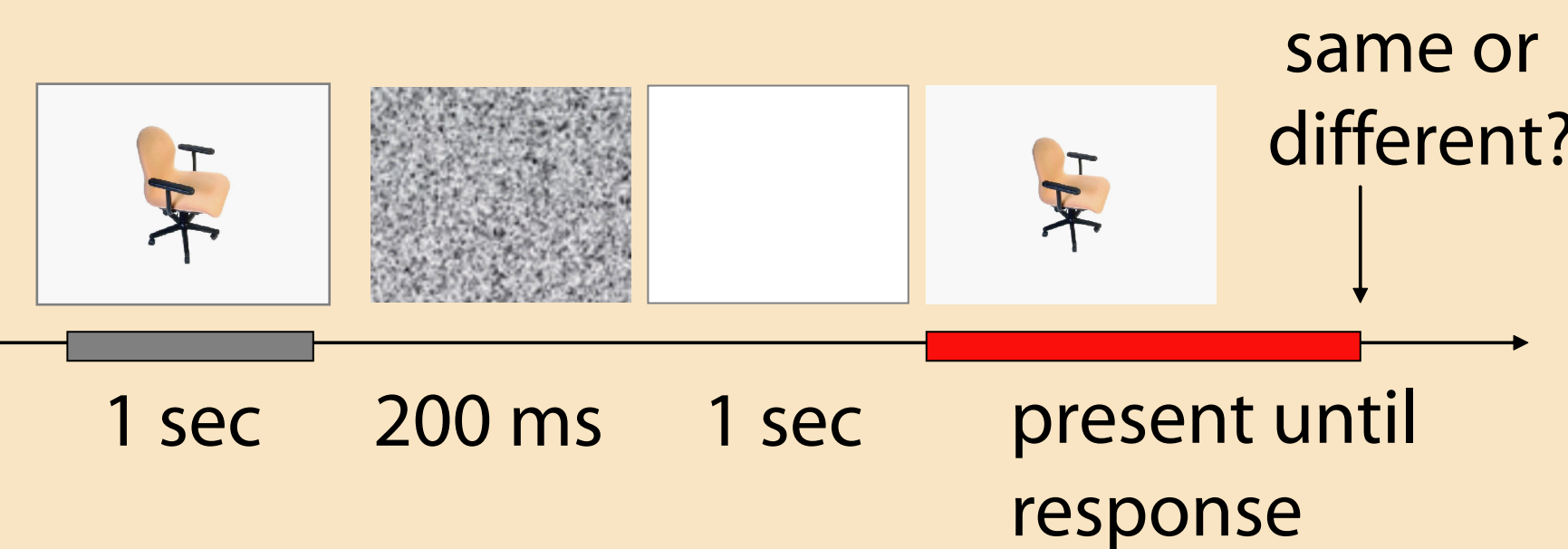toy norm

Real-world Size Rank
1 2 3 4 5 6 7 8
Small ← → Large

Results:

1) People are consistent when they select the preferred visual angle to view an object.

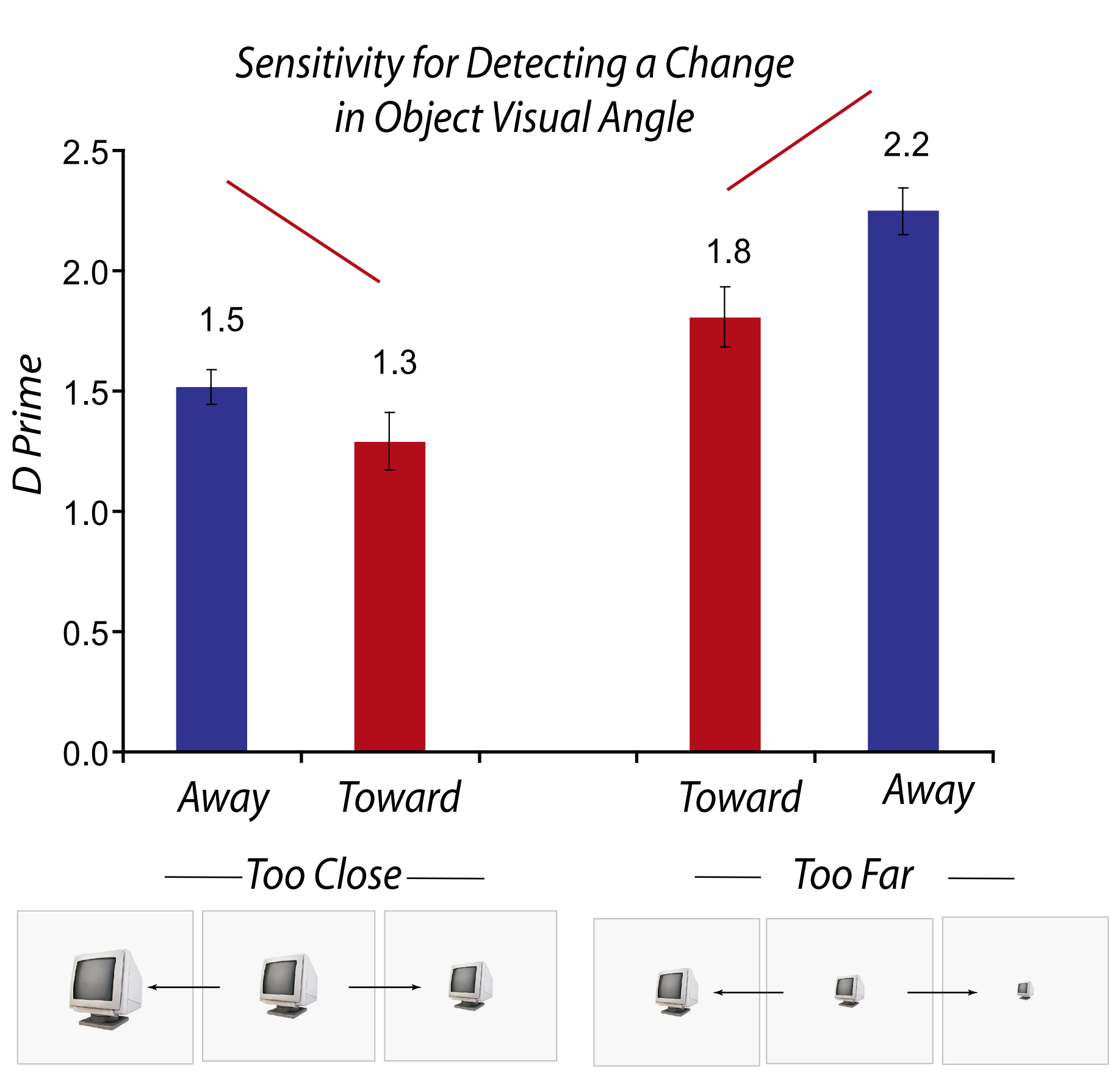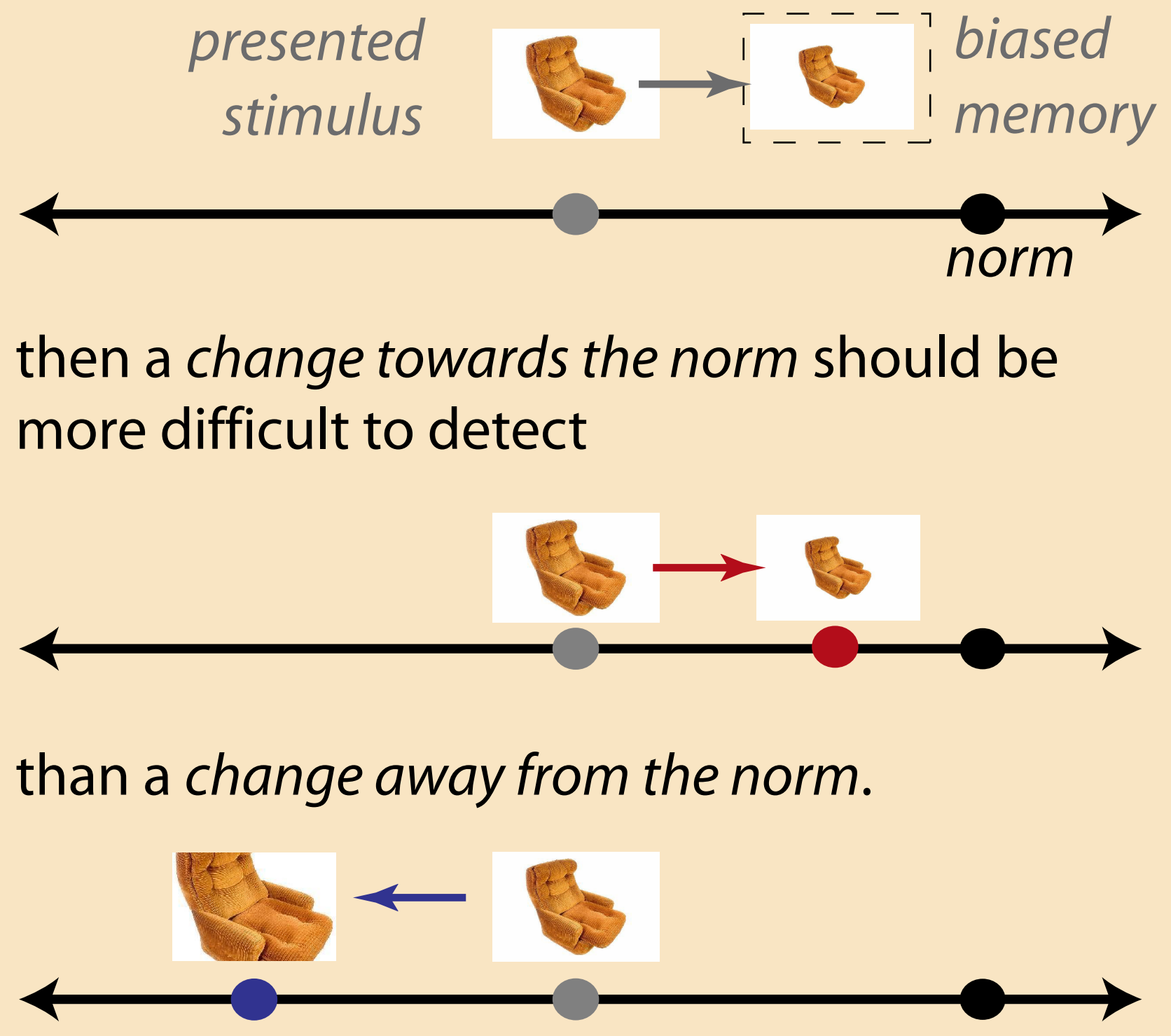2) The conceptual size of the object influences the preferred visual angle

SCENES

Question: Do observers prefer a consistent viewing distance for each scene?

Task: Walk forwards and backwards through the scene until you are in the "intuitively right place" to see it.

Answer: Yes. Inter-rater reliability R = 0.9, p<0.05

Example normative size

Possible range of viewing distances

Too close ←→ Too Far

Short-Term Memory

Question: Does this bias occur when explicitly attending to size?

OBJECTS   SCENES

Method:
Change Detection Paradigm.
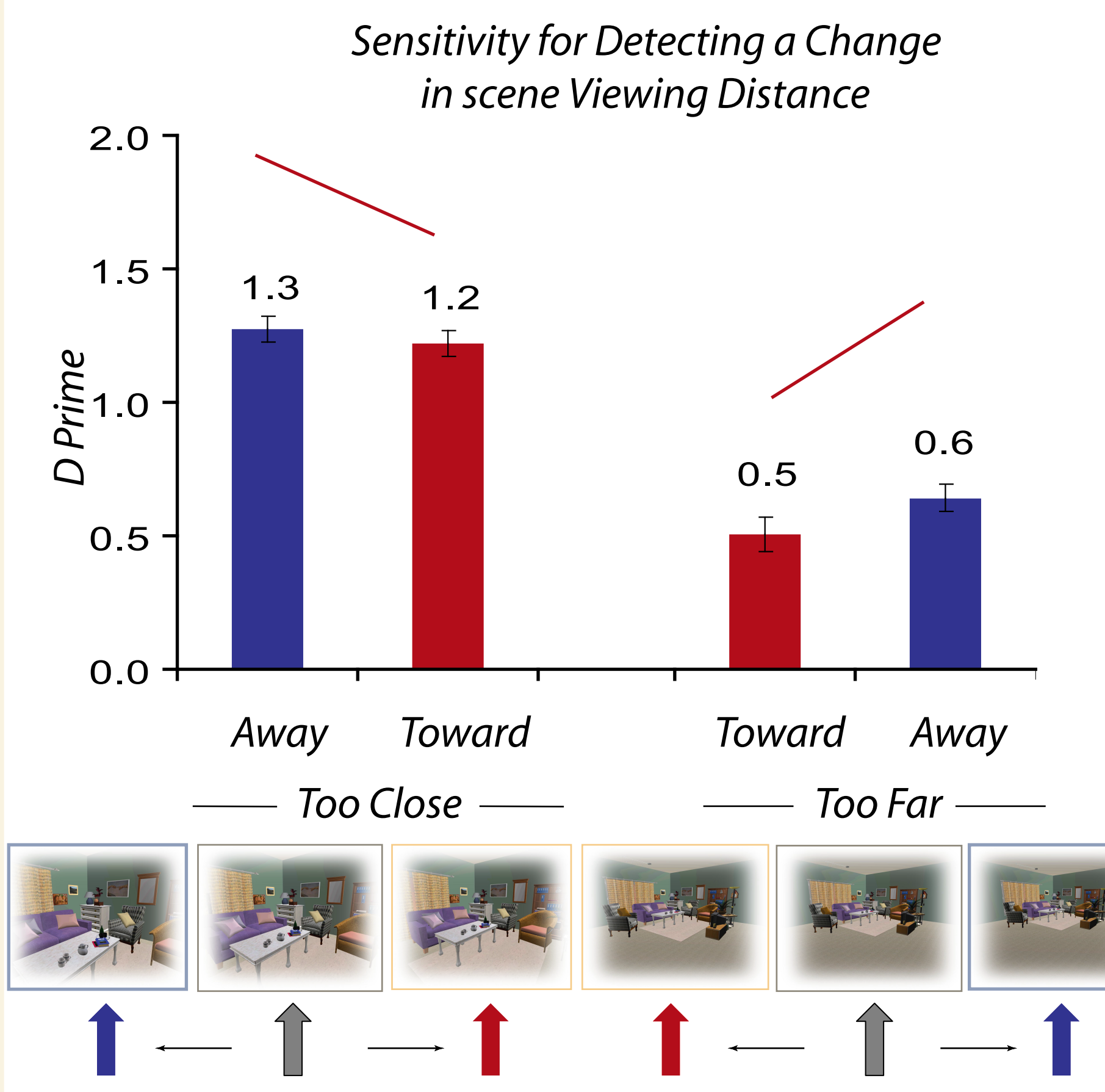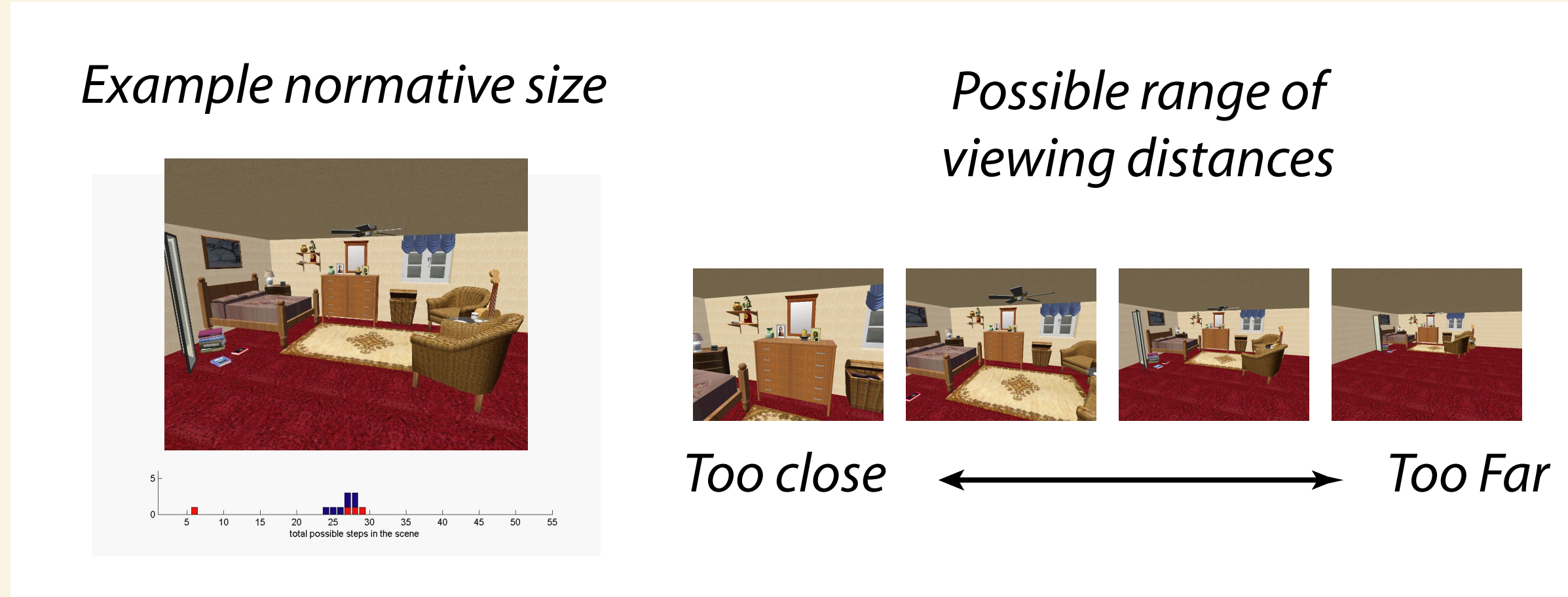The object size can change towards or away from the norm.

1 sec 200 ms 1 sec present until response
same or different?

Predictions:
If memory for the first object is biased towards the norm

presented stimulus → biased memory
norm

then a *change towards the norm* should be more difficult to detect

than a *change away from the norm.*

Sensitivity for Detecting a Change in Object Visual Angle
D Prime
2.5 2.0 1.5 1.0 0.5

1.5 1.3   1.8 2.2
Away Toward   Toward Away
—Too Close—   —Too Far—

Sensitivity for Detecting a Change in scene Viewing Distance
D Prime
2.0 1.5 1.0 0.5

1.3 1.2   0.5 0.6
Away Toward   Toward Away
—Too Close—   —Too Far—

Summary and Conclusions

(1) *Perception is implicitly sensitive to a normative visual size for objects and a normative viewing distance for scenes.*

(2) *Long-Term and short-term memory are predictably biased towards the normative size for objects and the normative viewing distance for scenes.*

(3) *The size you conceive objects to be in the world anchors your perception and subsequent memory of them.*