Semantic influences on episodic memory distortions

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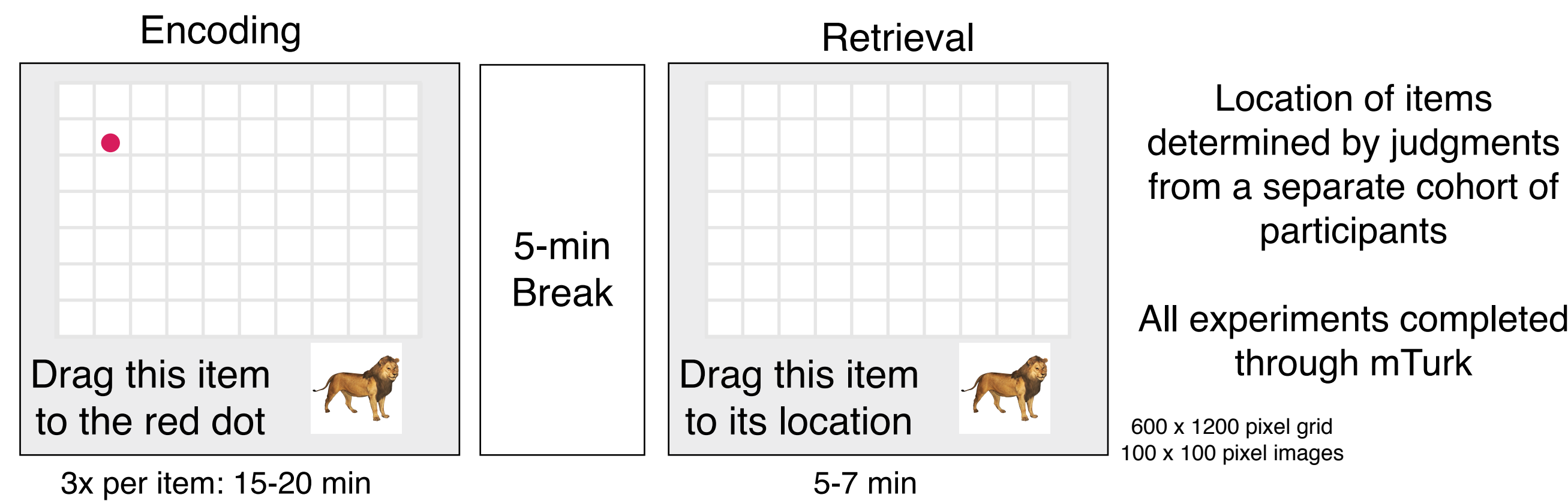
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Introduction

Existing semantic knowledge changes how we learn new information by facilitating encoding of related items[1-2] and accelerating their cortical representation[3]. However, prior knowledge can also distort new encoding, resulting in false memories or confabulation[4-5].
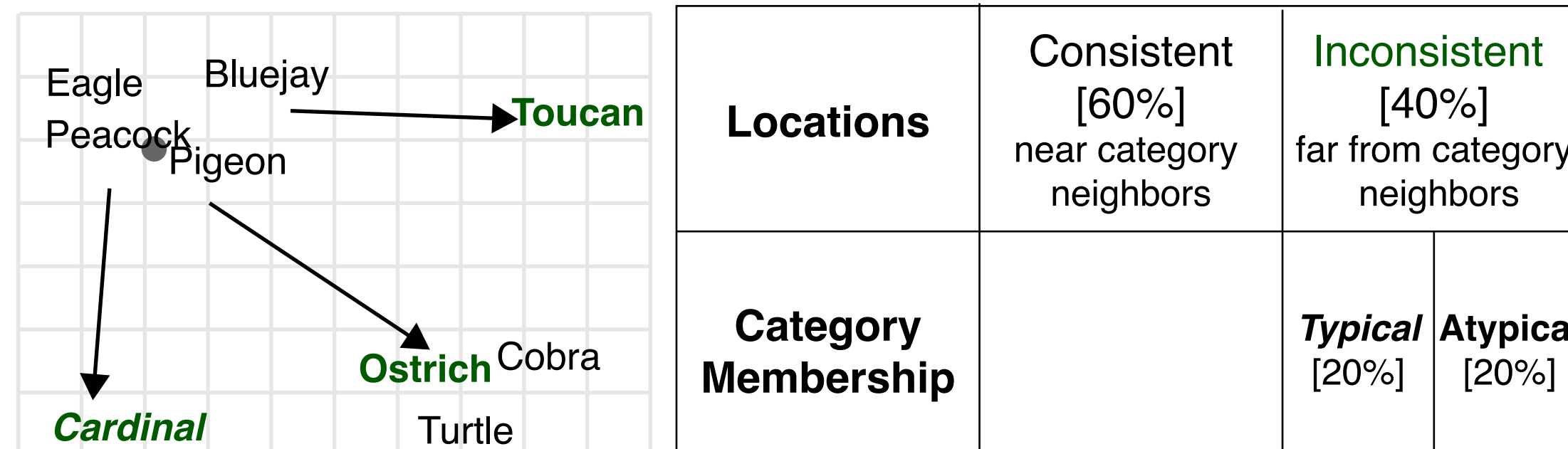
Leveraging the organization of semantic memory may help to understand when new memories are facilitated or distorted. For instance, typical category members are thought to be more strongly associated with members of the same category, resulting in faster categorization, more efficient recognition, etc[6].

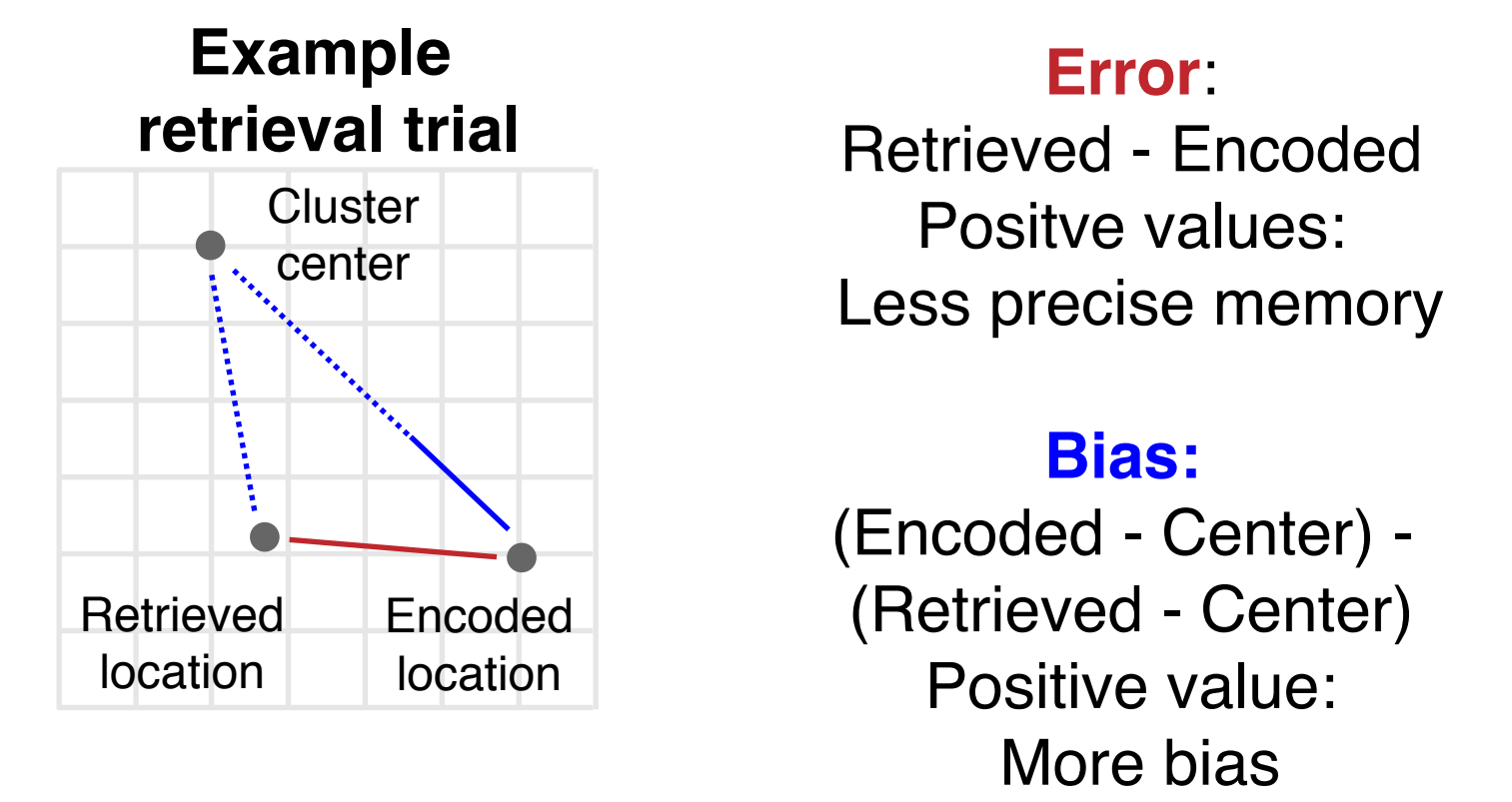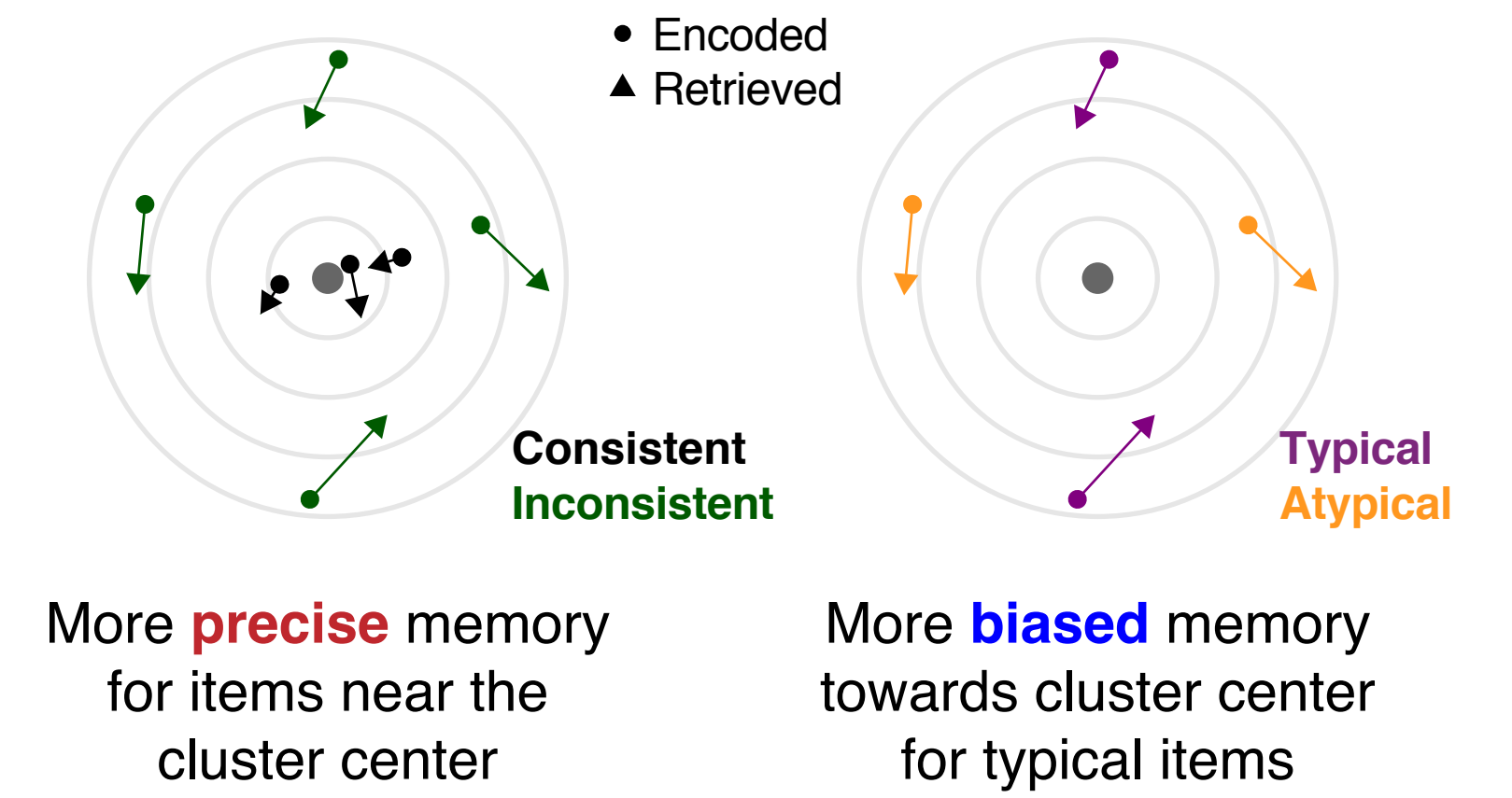**How does category typicality influence the precision and distortion of new episodic memories?**

Design

Encoding — Drag this item to the red dot
5-min Break
Retrieval — Drag this item to its location

3x per item: 15-20 min | 5-7 min

Location of items determined by judgments from a separate cohort of participants

All experiments completed through mTurk

600 x 1200 pixel grid
100 x 100 pixel images

Conditions

Eagle, Bluejay, Peacock, Pigeon, **Toucan**, **Ostrich**, Cobra, **Cardinal**, Turtle

Locations	Consistent [60%] near category neighbors	Inconsistent [40%] far from category neighbors
Category Membership		Typical [20%] Atypical [20%]

Analysis

Example retrieval trial
Cluster center, Retrieved location, Encoded location

Error: Retrieved − Encoded
Positive values: Less precise memory

Bias: (Encoded − Center) − (Retrieved − Center)
Positive value: More bias

Predictions

● Encoded ▲ Retrieved

Consistent / Inconsistent
More **precise** memory for items near the cluster center

Typical / Atypical
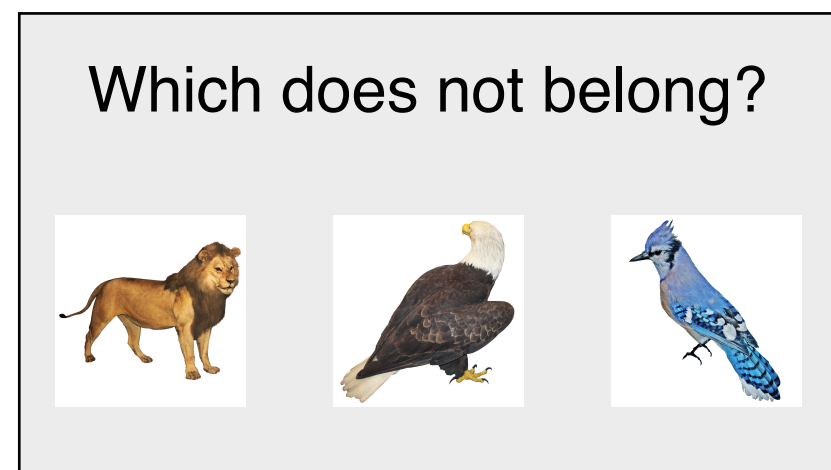More **biased** memory towards cluster center for typical items

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Experiment 1

Is memory more precise when the locations of the items relate to category membership? Are typical items more biased towards category neighbors than atypical items?
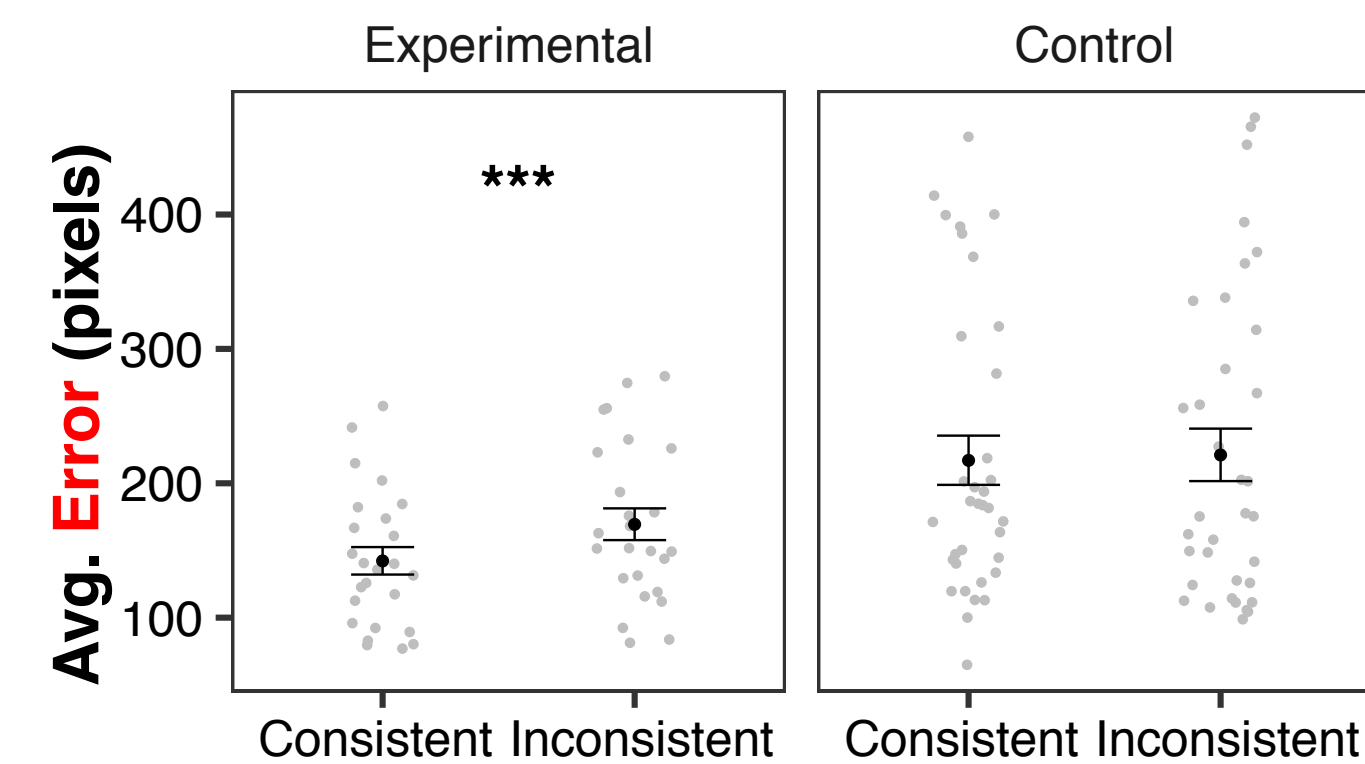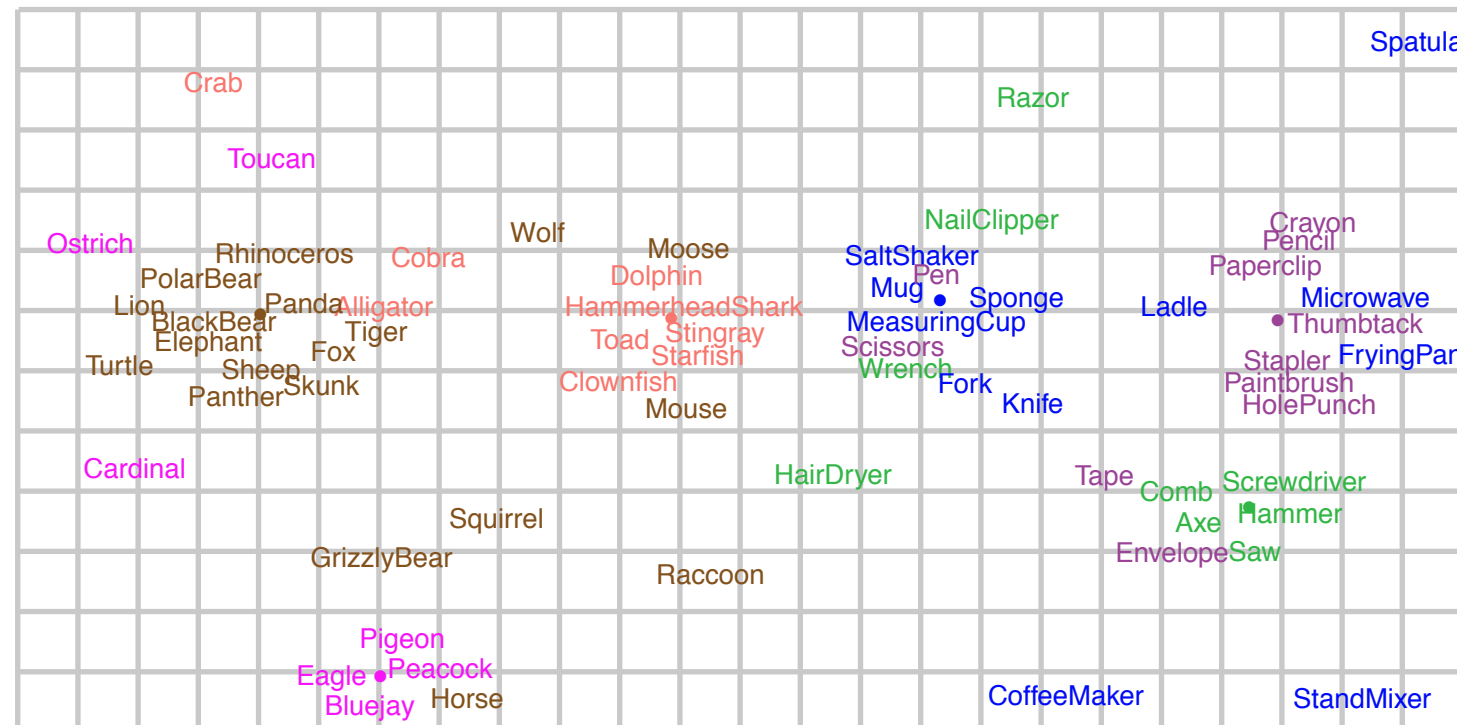
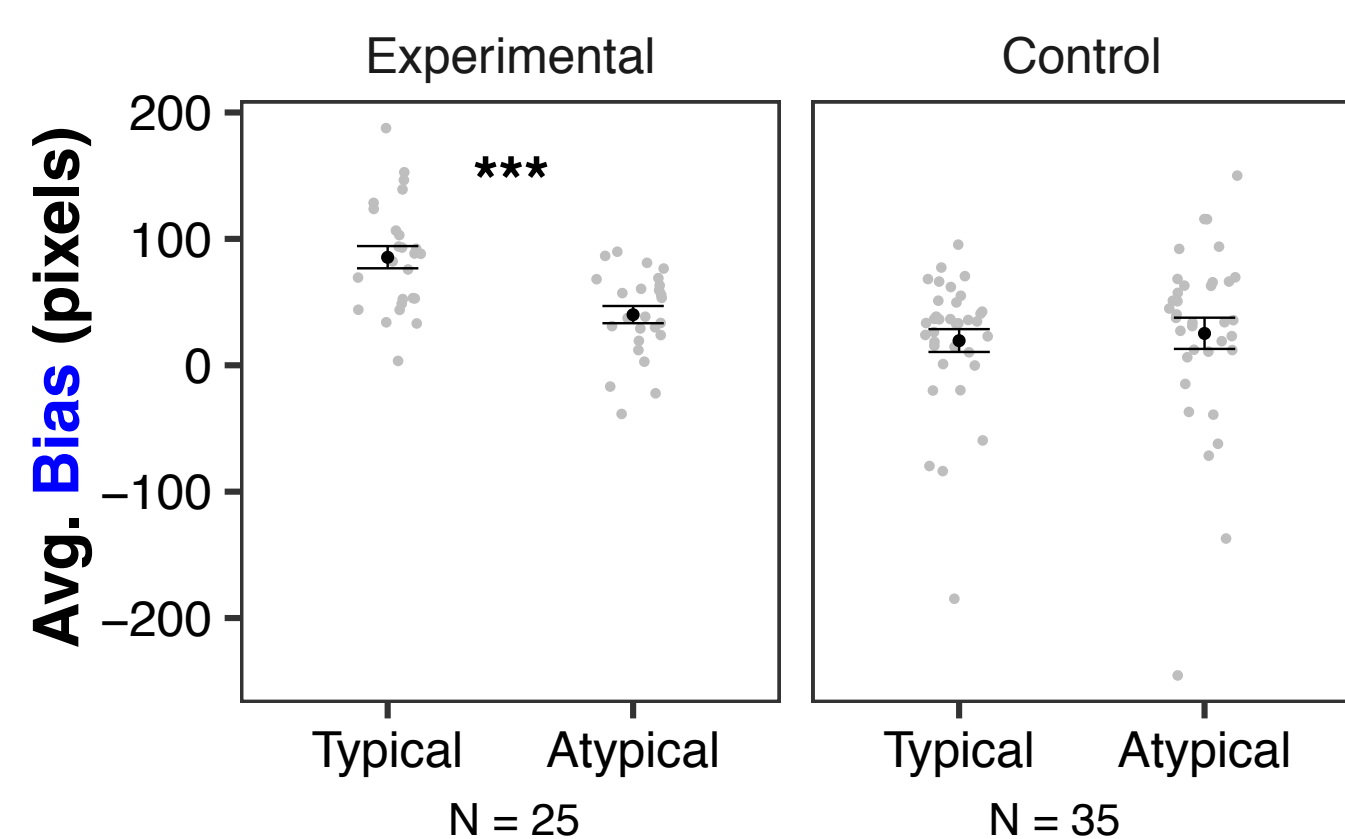**Semantic judgments**
Which does not belong?
2620 trials per super-ordinate category
N = 21

3 animal categories: birds, mammals, sea (35 images)
3 objects categories: kitchen, office, tools (35 images)

Item locations (Expts. 1 and 4)
Colors indicate category membership, dots indicate center of each category cluster
Control group: images shuffled across locations, within super-ordinate category

Experimental *** | Control
Avg. Error (pixels) — Consistent / Inconsistent

Memory is more precise for items located near category neighbors.

Experimental *** | Control
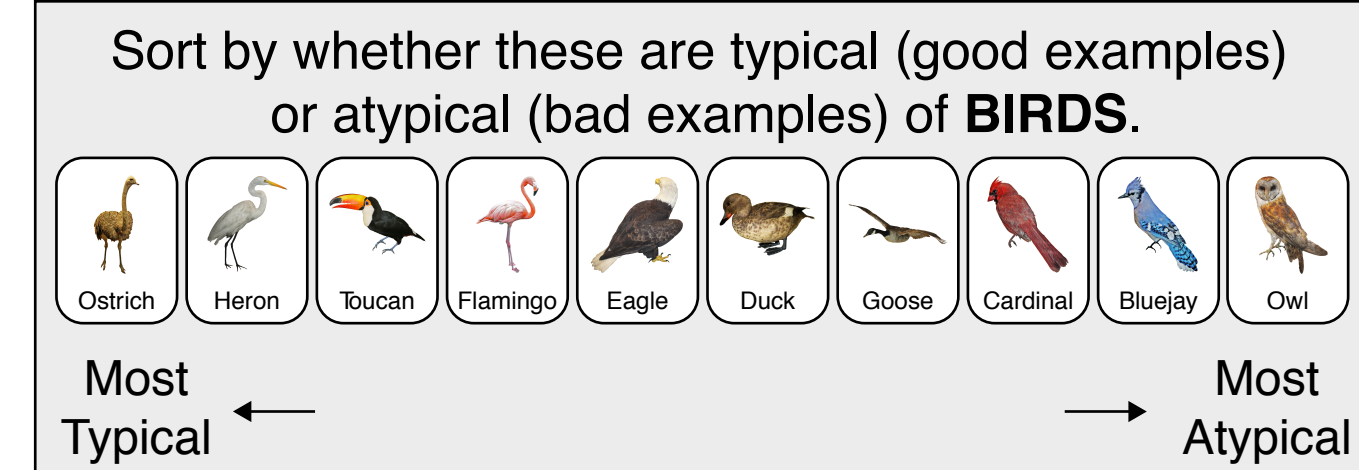Avg. Bias (pixels) — Typical / Atypical
N = 25 | N = 35

Memory for typical category members is more biased toward category neighbors, relative to atypical members.

Experiment 2

The categories in Expt 1 were data-driven. Can we replicate Expt 1 with more validated category membership[7-8] and a uniform distribution of encoding locations?
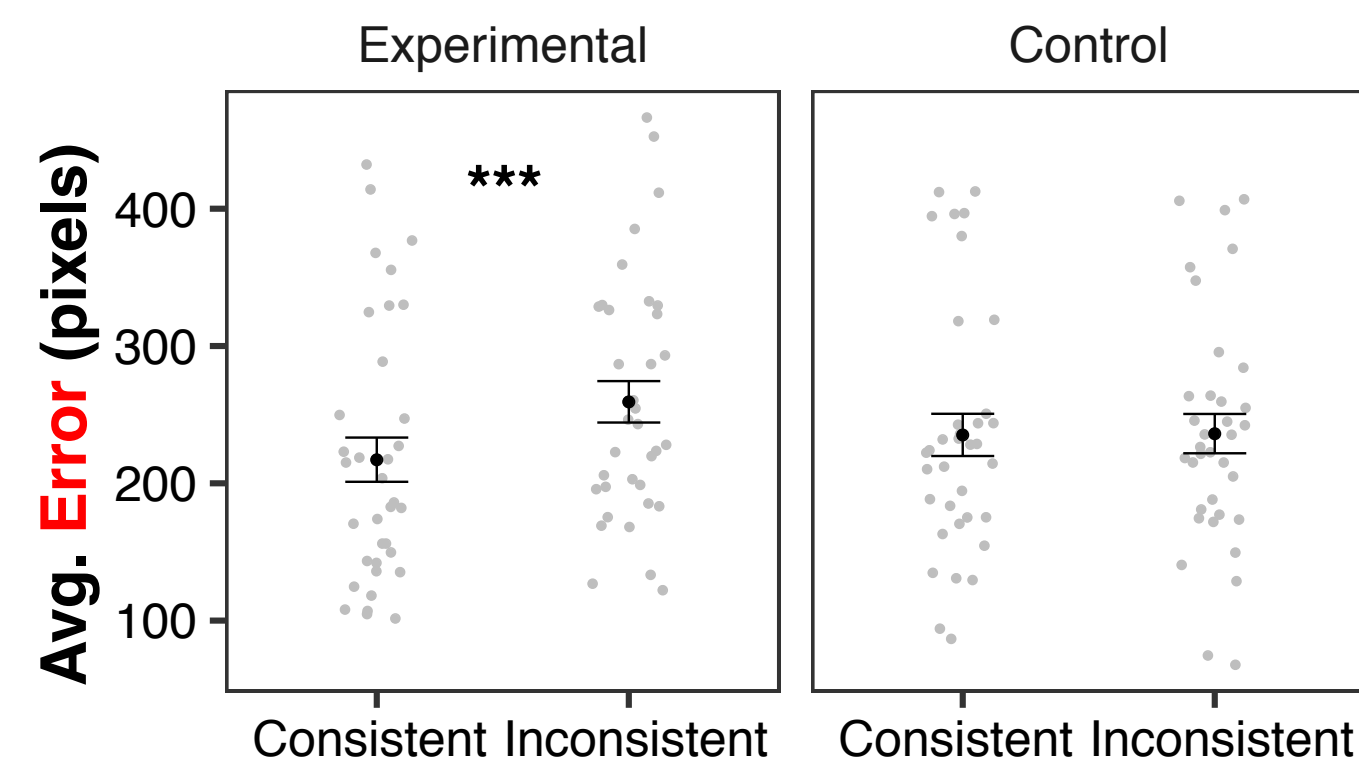
Typicality judgments
Sort by whether these are typical (good examples) or atypical (bad examples) of **BIRDS**.
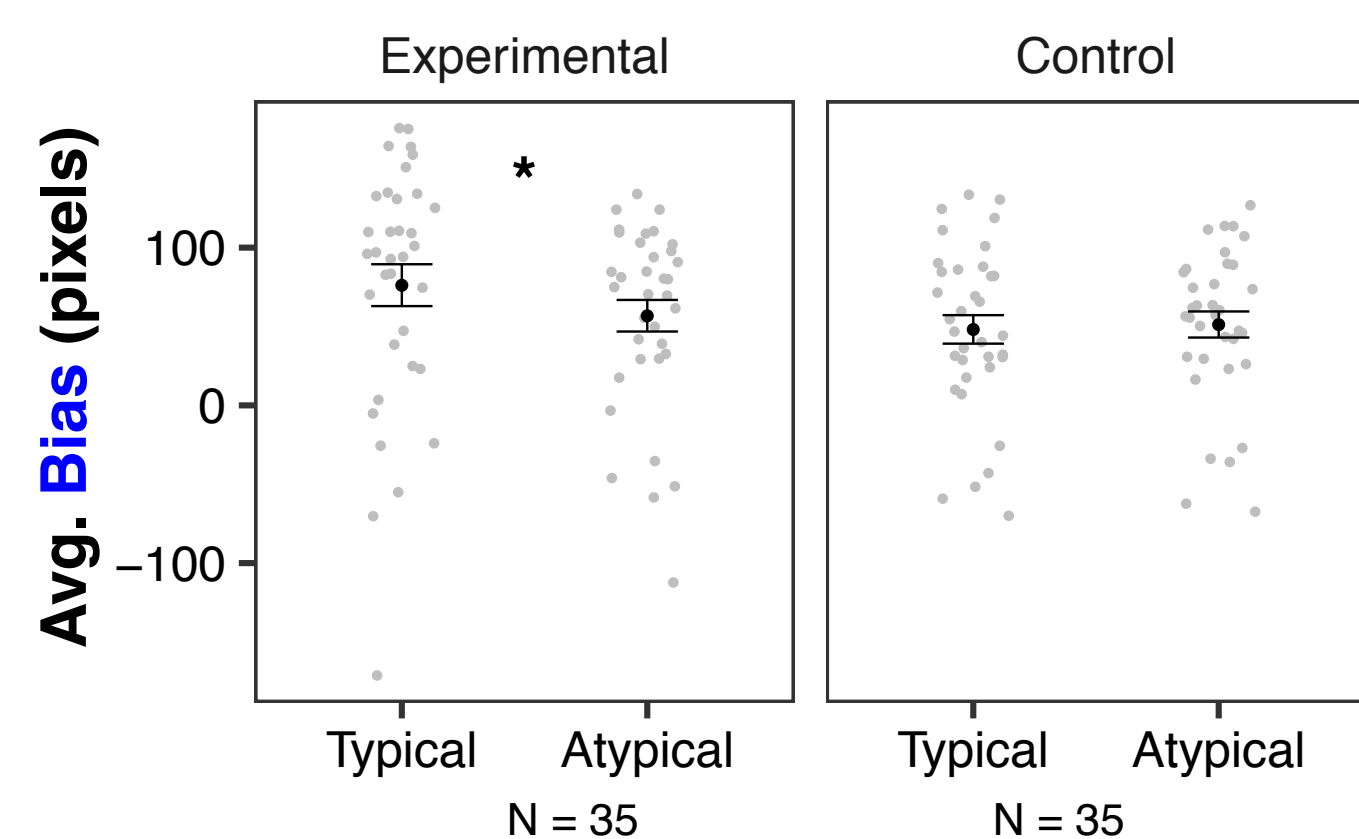Most Typical ← → Most Atypical
20 images per category
N = 27 per category

4 animal categories: birds, mammals, sea, insects (80 images)
4 object categories: kitchen, office, furniture, clothes (80 images)

Item locations
Colors indicate category membership, dots indicate center of each category cluster
Control group: images shuffled across locations, within super-ordinate category

Experimental *** | Control
Avg. Error (pixels) — Consistent / Inconsistent

As in Expt 1, memory is more precise for items located near category neighbors.

Experimental * | Control
Avg. Bias (pixels) — Typical / Atypical
N = 35 | N = 35

As in Expt 1, memory for typical category members is more biased toward category neighbors, relative to atypical members.

Experiment 3

Typical items share more features with category neighbors[9], and thus may look more similar. Are typical items biased because they are confused with visually similar neighbors?
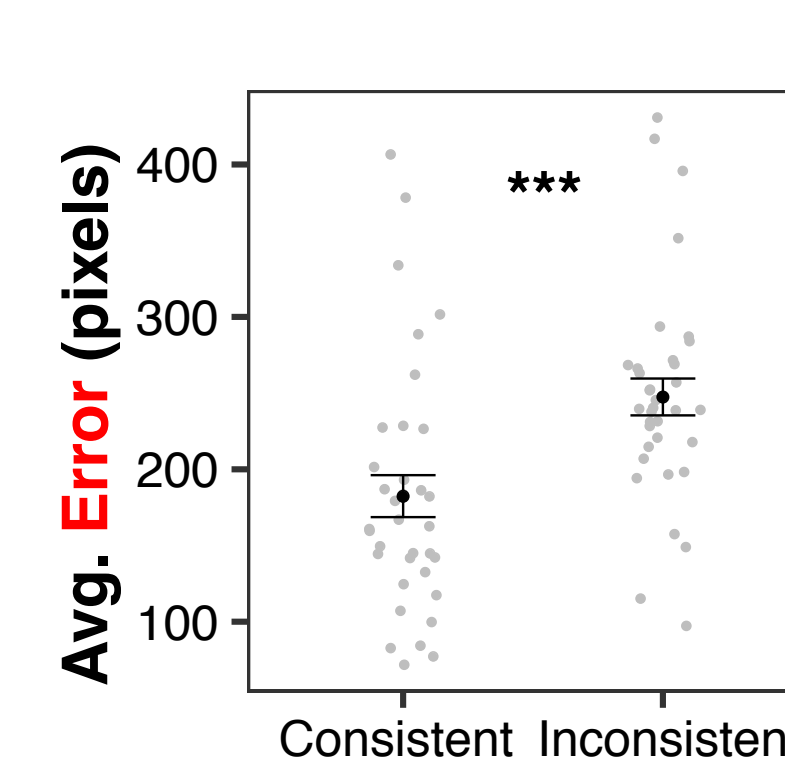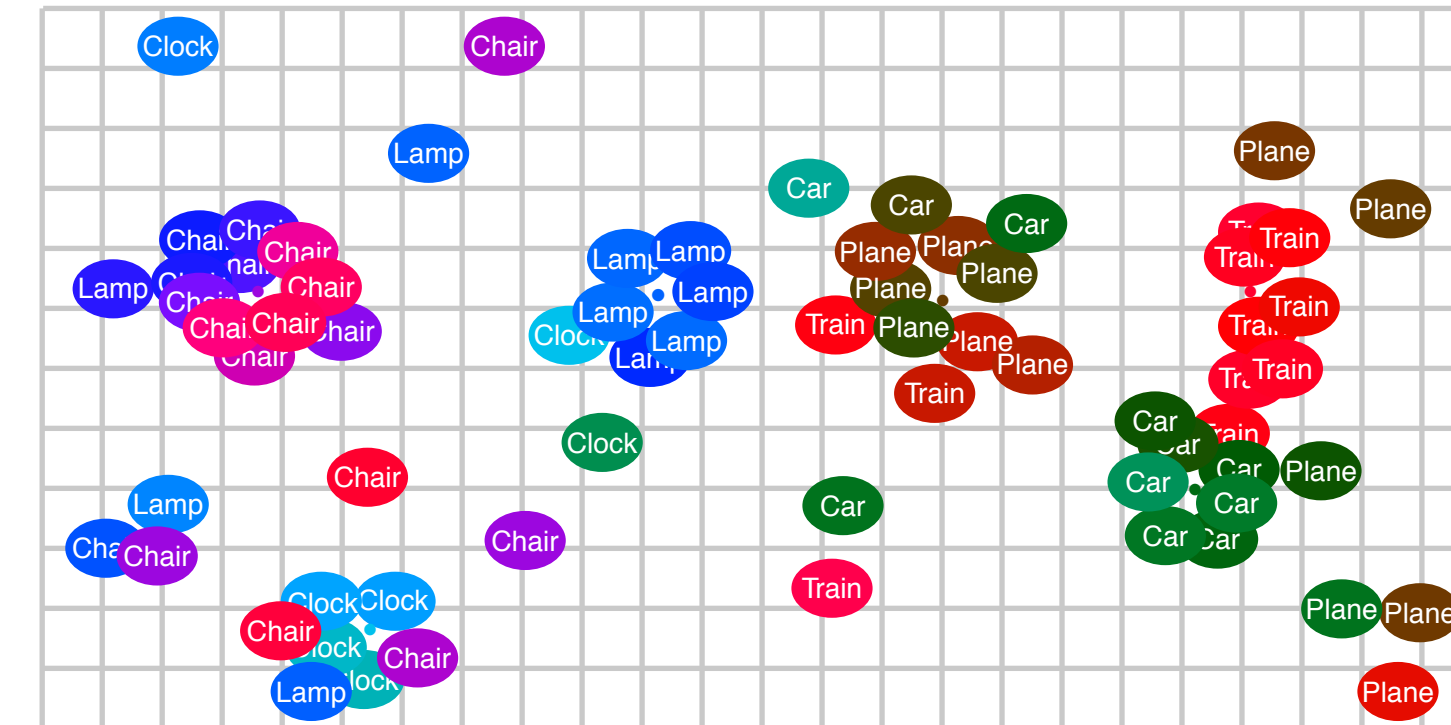
Visual 'categories'
Mapped 6 'categories' of items onto locations from Expt 1
Colors of items drawn from 6 distributions centered around equidistant angles of a color wheel

'Atypical' Colors ← 'Typical' Colors → 'Atypical' Colors

3 furniture 'categories': chairs, lamps, clocks (35 images)
3 vehicle 'categories': trains, cars, airplanes (35 images)

Item locations
Labels indicate category membership, colors indicate color of image
Colors of cluster center indicate mean of the category's color distribution

Experimental ***
Avg. Error (pixels) — Consistent / Inconsistent

Memory is more precise for items located near other images from the same color 'category'.

*
Avg. Bias (pixels) — Typical / Atypical
N = 35

* p < 0.05
** p < 0.01
*** p < 0.001
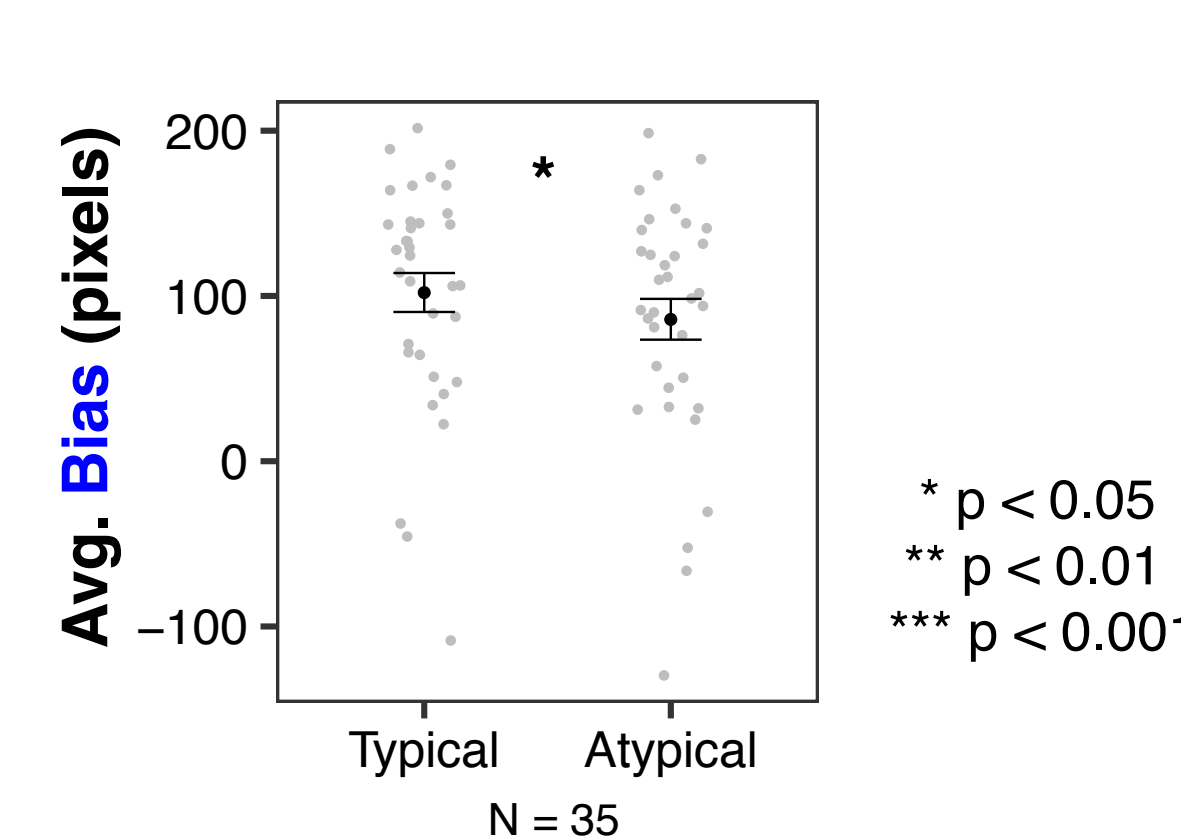
Typically-colored items are more likely to be retrieved closer to category neighbors, relative to atypically-colored items.

Experiment 4

The unique features of items consistent with prior knowledge are often forgotten[10]. Are typical items more biased because of more efficient/less precise item encoding?

Retrieval task
New instructions: Choose an item and drag to its location
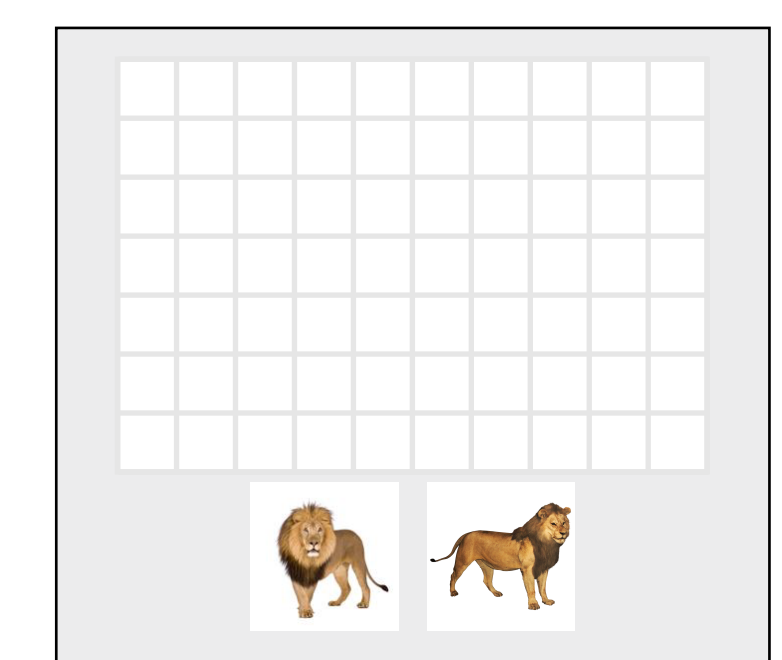
3 animal categories: birds, mammals, sea (35 images)
3 object categories: kitchen, office, tools (35 images)

Item memory
Experimental * | Control
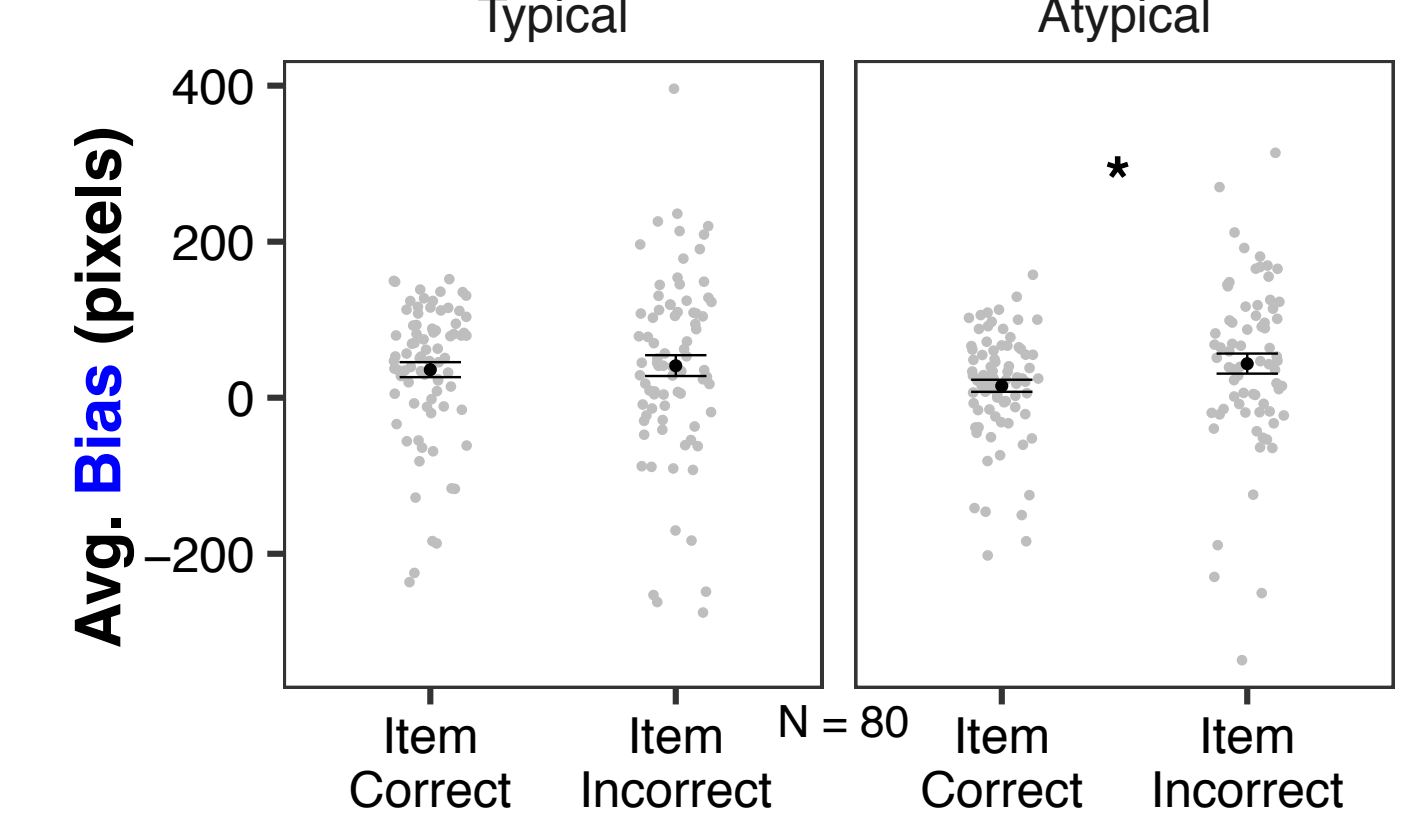Proportion Correct — Typical / Atypical
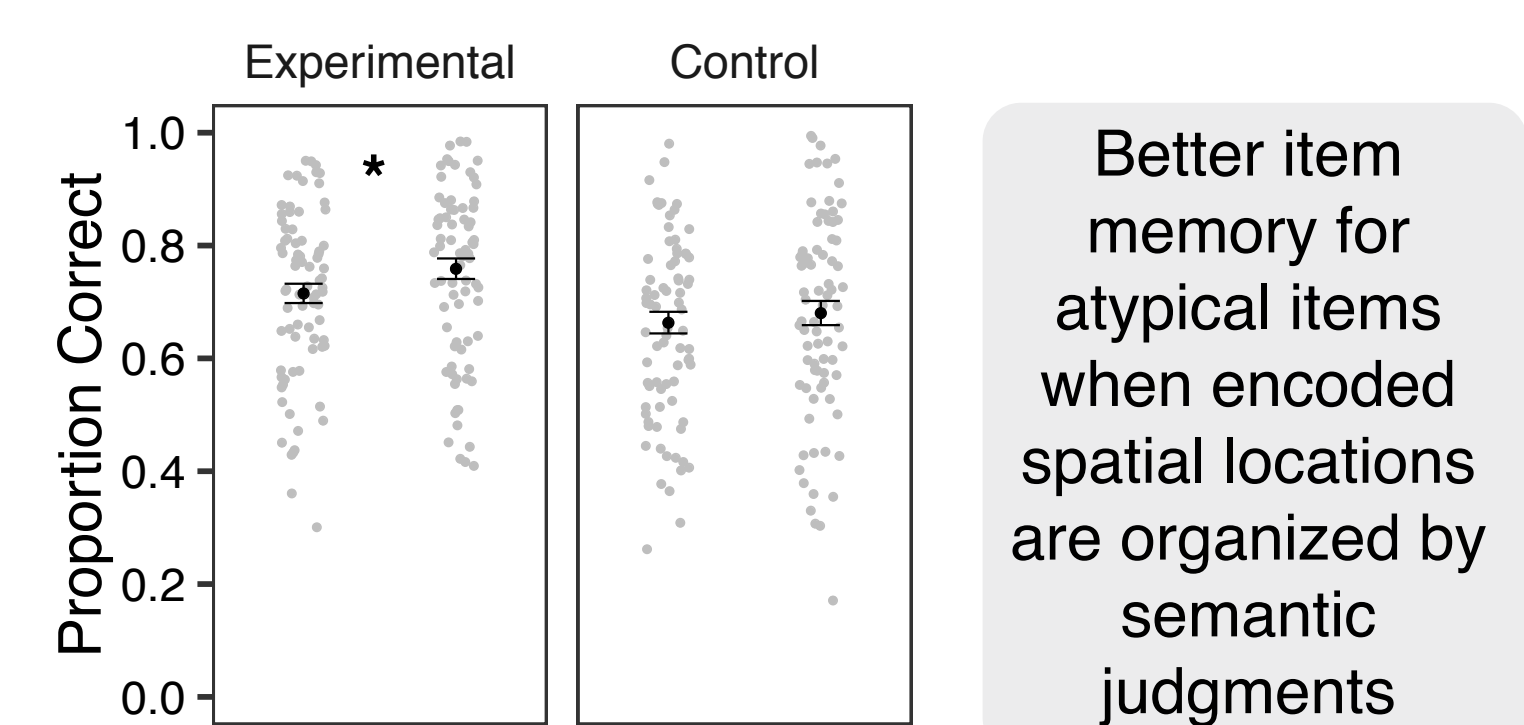
Better item memory for atypical items when encoded spatial locations are organized by semantic judgments

Item Correct *** | Item Incorrect ***
Avg. Error (pixels) — Consistent / Inconsistent
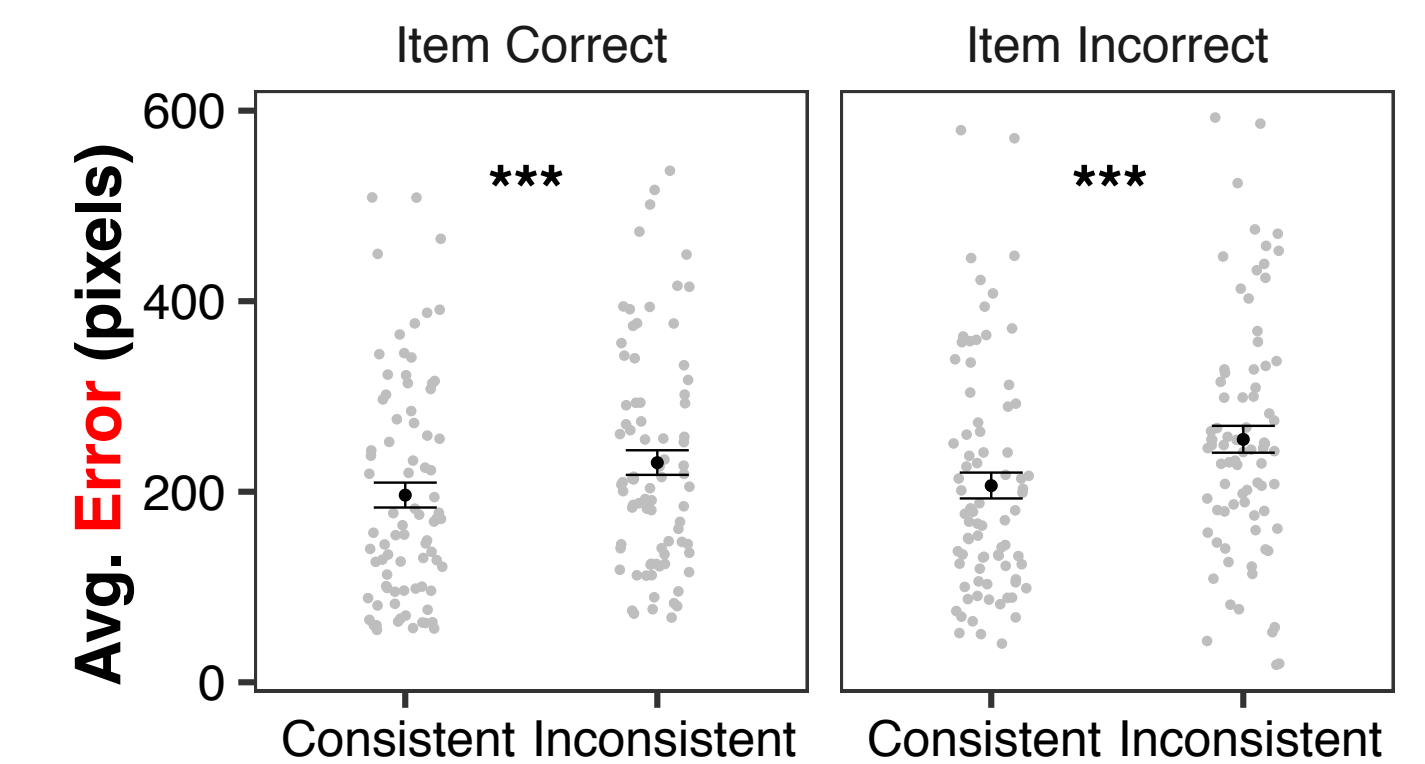
Influence of consistency on precision is not modulated by item memory.

Typical | Atypical *
Avg. Bias (pixels) — Item Correct / Item Incorrect
N = 80

Atypical items with incorrect item memory were more biased, whereas item memory did not influence bias of typical items.

Conclusions

Across three experiments, memory was more **precise** for items located near category neighbors — when location memory benefited from semantic knowledge (Expts 1, 2, 4).

For items far from category neighbors, retrieval of typical category members was more **biased** towards category neighbors relative to atypical members (Expts 1, 2, 4).

These effects are not limited to semantic categories but also extend to color (Expt 3), suggesting that the similarity of features between items dictates how they are remembered, regardless of whether the features are semantic or visual.

Category typicality also influences how unique, task-irrelevant details are remembered (Expt 4). Typical items may be encoded more efficiently, due to their stronger association with category neighbors, but at the cost of memory for their unique features.

References
1. Bartlett 1932 A Theory of Remembering
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6. Patterson et al 2007 PTRSB: BS
7. Deyne et al 2008 Behav Res Methods
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