Semantic influences on episodic memory distortions

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Introduction

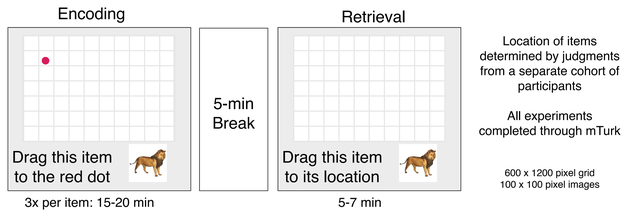
Existing semantic knowledge changes how we learn new information by facilitating encoding of related items[1-2] and accelerating their cortical representation[3]. However, prior knowledge can also distort new encoding, resulting in false memories or confabulation[4-5].

Leveraging the organization of semantic memory may help to understand when new memories are faciliated 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, and less disruption by brain damage[6].

Examining how new memories are formed in the context of this semantic organization may lead to a better understanding of the interactions between semantic and episodic memory.

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

Design

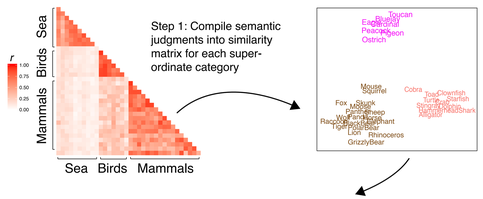


Location of items determined by judgments from a separate cohort of participants

All experiments completed through mTurk

600 x 1200 pixel grid
100 x 100 pixel images

Determining item locations (Experiments 1, 3, and 4)



Step 1: Compile semantic judgments into similarity matrix for each super-ordinate category

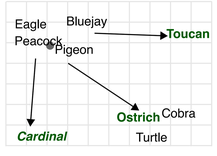
Step 2: Project similarity matrix into two dimensions with multi-dimensional scaling

Step 3: Determine category membership with k-means clustering

Step 4: Determine (a)typical members by distance from each item to its cluster centroid (gray dot)

Step 5: Move (a)typical items to pseudo-random locations

Step 6: Counter-balance side of screen for each super-ordinate category

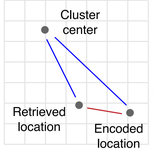


Conditions

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

Analysis

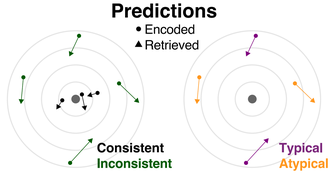
Example retrieval trial



Error:
Retrieved - Encoded
Positve values:
Less precise memory

Bias:
(Encoded - Cluster) -
(Retrieved - Cluster)
Positive value:
More bias

Predictions



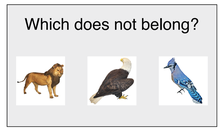
More **precise** memory for items near the cluster center

More **biased** memory towards cluster center for typical items

Experiment 1

Is memory more precise when the locations of items relate to category membership? Are typical items more biased towards category neighbors than atypical items?

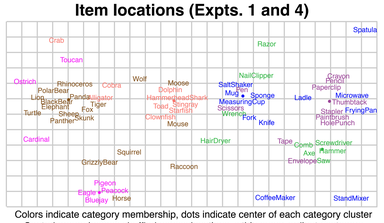
Semantic judgments



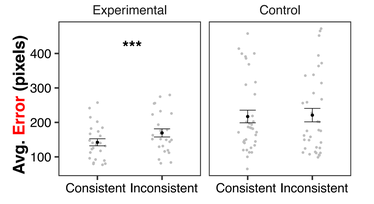
2620 trials per super-ordinate category
N = 21

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

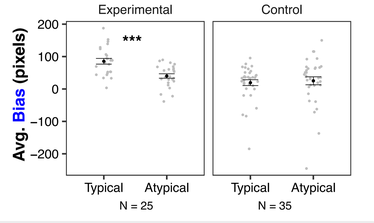
Item locations (Expts. 1 and 4)



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



Memory is more precise for items located near category neighbors.

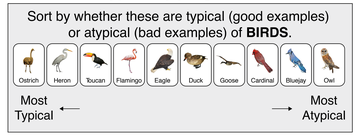


Memory for typical category members is more biased toward category neighbors, relative to atypical members.

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?

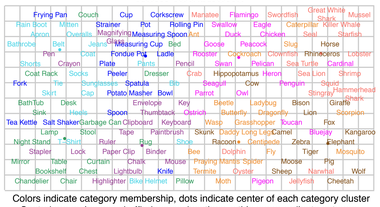
Typicality judgments



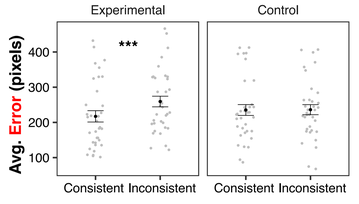
20 images per category
N = 27 per category

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

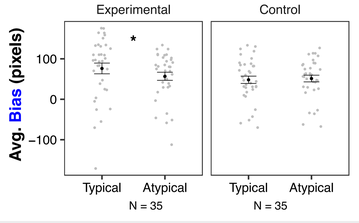
Item locations



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



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



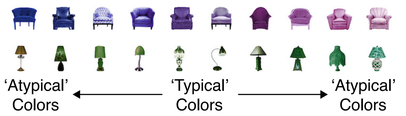
As in Expt 1, memory for typical category members is more biased toward category neighbors, relative to atypical members.

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?v

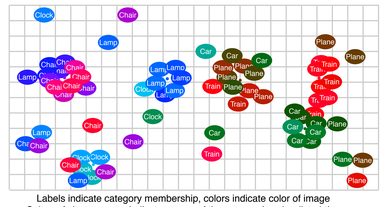
Visual 'categories'

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

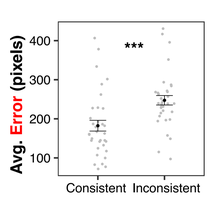


3 furniture 'categories': chairs, lamps, clocks (35 images)
3 vehicle 'categories': trains, cars, airplanes (35 images)

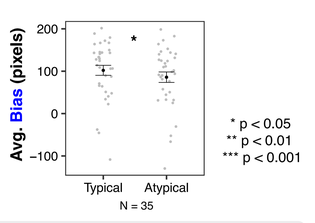
Item locations



Labels indicate category membership, colors indicate color of image
Colors of cluster center indicates mean of the category's color distrubtion



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

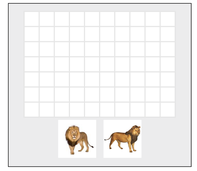


Typically-colored items are more likely to be retrieved closer to category neighbors, relative to atypically-colored items.

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?

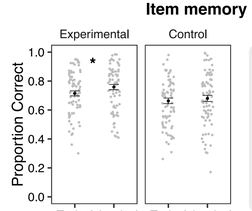
Retrieval task



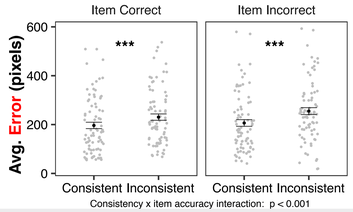
New instructions:
Choose an item and drag to its location

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

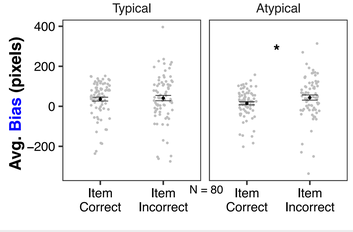
Item memory



Better item memory for atypical items when encoded spatial locations are organized by semantic judgments



Influence of consistency on precision is stronger when items are not correctly recognized.



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).

The observed effects are not limited to semantic categories but also extend to color categories (Expt 3). This suggests that the similarity of features between items dictates how they are remembered, regardless of whether the features are semantic or visual. However, biases due to visual versus semantic similarity may be underpinned by different neural processes.

Typical items were biased towards neighbors regardless of item memory accuracy, whereas atypical items were less biased towards neighbors when the specific image was correctly recognized (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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