Representations formed by procedural and declarative category learning are supported by overlapping sets of cortical areas

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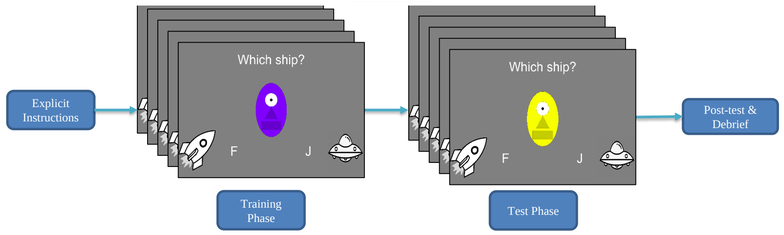
Background

- Categories can be learned through declarative or procedural mechanisms[1,2] , which map on to distinct memory systems[3,4].
- How do procedural and declarative knowledge interact?
- In a behavioral study, procedural knowledge interfered with declarative rule use—even though participants were unaware of the procedural knowledge[5].

Research Question: **Do procedural and declarative learning form distinct stimulus space representations or contribute to a single shared representation?**

Procedure

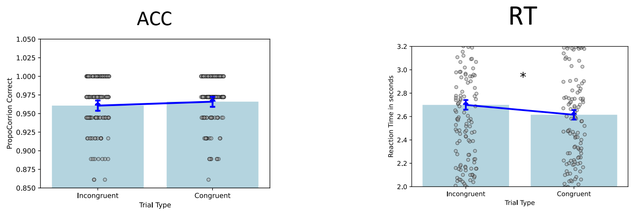
Task



Outside MRI
196 unique trials
Feedback after each trial
80% Congruent
20% Incongruent

MRI Image acquisition
192 unique, novel trials
No feedback
80% Congruent
20% Incongruent

Behavioral Results



On average, RTs were slower for incongruent trials.
→Color (procedural knowledge) affected performance even though participants were not aware of it.

Representational Similarity Analysis

Stimulus Design

The stimuli could be classified into categories using either a completely diagnostic, verbalizable eye/mouth rule, OR a probabilistic color distribution

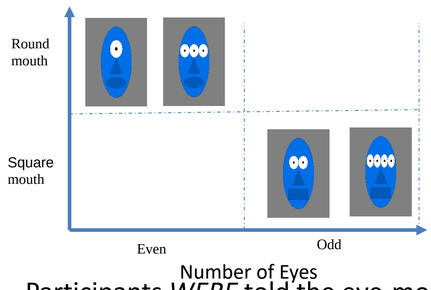
Theoretical Matrices

Theoretical dissimilarity matrices were constructed using either the declarative categorical rule (eye/mouth) or the probabilistic procedural color distribution.

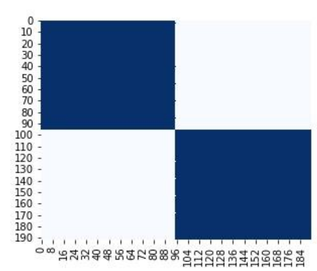
RSA Searchlight Results (*n*=13)

Searchlight RSA analysis was performed using RSAToolbox in python. Spearman correlations between each search RDMs and each of the theoretical matrices were calculated. Across participants, correlations were stronger and more consistent with the declarative theoretical matrix. However, many participants showed correlations in consistent regions for the procedural matrix.

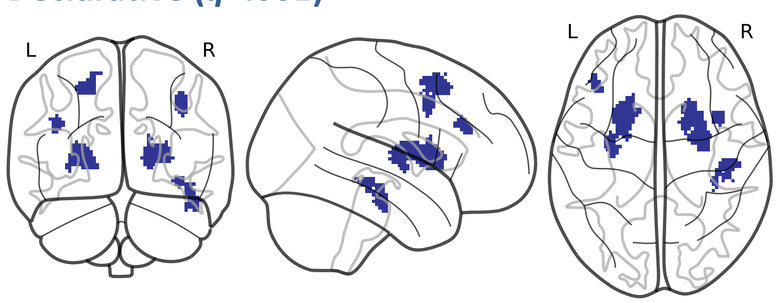
Declarative



Declarative

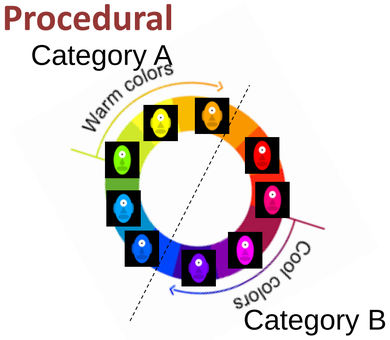


Declarative (*q*<.001)

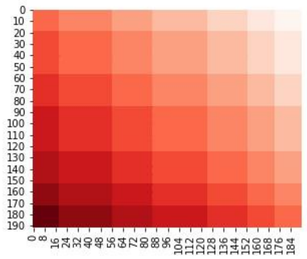


Participants *WERE* told the eye-mouth rule for categorization.

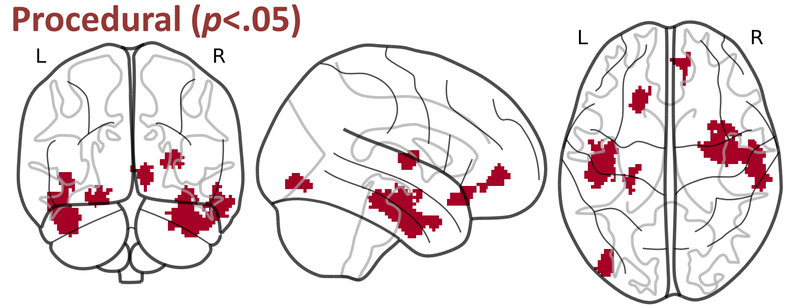
Procedural



Procedural



Procedural (*p*<.05)



Participants *were NOT* told about the color distributions. At debrief, most were unaware of color-category associations. HOWEVER, color information affected RTs.

- Both procedural and declarative matrices correlated with regions in the **ventral temporal lobe, medial temporal lobe**, and **basal ganglia**
- However, **some voxels in each region correlated with *both* matrices**
- These overlapping areas within ROIs may support a representation of the stimulus space that integrates declarative and procedural learning.

References

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