The Effects of Concurrent Task Interference on Explicit Category Learning

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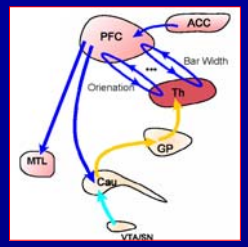
Summary

Evidence from cognitive, neuroimaging, and neuropsychological studies suggests that human category learning is mediated by multiple learning systems. Recent neuroimaging studies suggest that these various systems may compete during category learning. For example, Poldrack and Packard (2003) reported late training activation in the basal ganglia that was accompanied by medial temporal lobe de-activation. The present study attempts to provide the first behavioral evidence of this hypothesized competition between category-learning systems. One group of healthy young adults learned novel categories under typical single-task conditions during the first part of training and later while performing a simultaneous numerical Stroop task. A second group learned the same novel categories while performing the simultaneous numerical Stroop task the entire time. The first group out-performed the second group until the Stroop task was introduced then the first group's performance decreased to the level of the second group.

Category Learning Systems

COVIS Explicit System

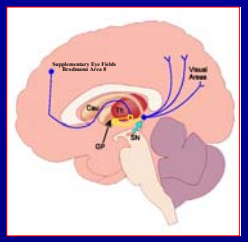
- Uses working memory and executive attention
- Declarative



PFC = Prefrontal Cortex
ACC = Anterior Cingulate
Th = Medial Dorsal Nucleus of Thalamus
GP = Globus Pallidus
Cau = Caudate Nucleus
VTA = Ventral Tegmental Area
SN = Substantia Nigra
MTL = Medial Temporal Lobe
Excitatory Projection (Glutamate)
Inhibitory Projection (GABA)
Dopamine Projection

COVIS Implicit System

- Uses a form of procedural learning
- Non-declarative



Evidence for Separate Category Learning Systems

	Explicit System	Implicit System
Feedback Ashby, Queller, & Berretty (1999, *Perception & Psychophysics*) Ashby, Maddox, & Bohil (2002, *Memory & Cognition*) Maddox, Ashby, & Bohil (2003, *JEP:LM&C*) Maddox. Ashby, Ing, & Pickering (in press, *Memory & Cognition*)	Flexible in use of feedback -- Unsupervised learning possible -- Observational training as good as feedback training -- Delaying feedback by a few seconds does not interfere with learning Feedback signal must be actively processed	Sensitive to nature and timing of feedback -- No evidence of unsupervised learning -- Observational training less effective than feedback training -- Feedback delays disrupt learning Feedback signal processed automatically
Category Representation Ashby, Ell, & Waldron, (2003, *Memory & Cognition*)	Learns abstract category labels	Learns response positions
Dual Task Interference Waldron & Ashby (2001, *Psychonomic Bulletin & Review*)	Susceptible to interference from a dual-task that activates frontal cortex	Little interference from a dual-task that activates frontal cortex

Evidence for Interactions Between Category Learning Systems

fMRI

- Negative relationship between activity in MTL and caudate nucleus during probabilistic classification learning
  Poldrack & Packard (2003)
- Patients with Parkinson's Disease showed less activation in caudate nucleus and greater activation in prefrontal cortex during probabilistic classification learning compared to controls
  Moody, Bookheimer, Vanek, & Knowlton (2004)

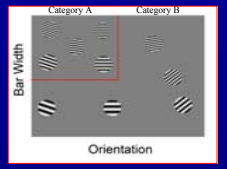
These results suggests competition between category learning systems

Behavioral

No Behavioral Studies

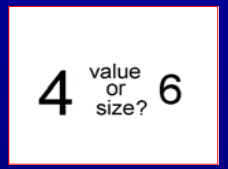
Current Study

Categorization



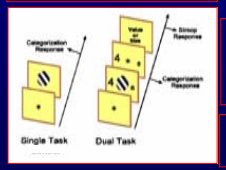
Working memory used to correctly classify stimuli

Numerical Stroop



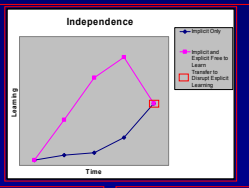
Working memory used to decide which number is larger on relevant dimension

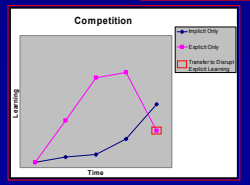
Design

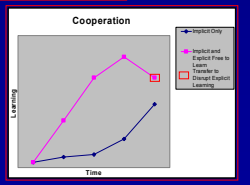


Two Conditions:
- First group performed Single Task (Categorization) for 80 trials then transferred to Dual Task (Categorization & Numerical Stroop) for 20 trials (n=36)
- Second group performed Dual Task (Categorization & Numerical Stroop) for 100 trials (n=33)

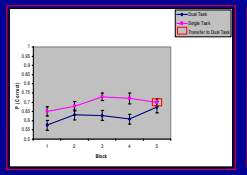
Predicted Results







Study Results



Before transfer, Single Task group performed better than Dual Task group, $F(1,67) = 9.187$, $p = .003$

After transfer, the group previously performing the Single Task did not perform differently than the group performing the Dual Task the entire time, $F(1,67) = .472$, $p = .495$

Conclusions

Results suggest independence of the explicit and implicit systems

The difference between current result and other studies could be a result of early vs. late learning

Future Directions
- Extend learning and transfer
- fMRI study using same methods

Reprints:
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