Investigating contributions of memory systems to concept generalization using individual differences in cognitive abilities

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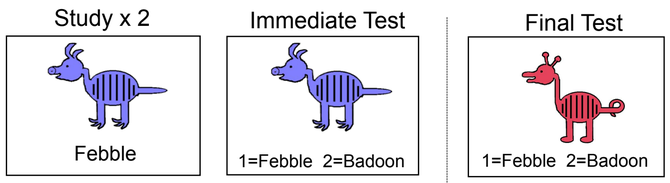
Introduction

- Individuals vary in how well they learn new concepts. Is concept learning related to individual differences in other cognitive abilities, such as IQ and working memory?
- Both declarative (hippocampus, prefrontal cortex)[1] and procedural (caudate, posterior visual cortex)[2,3] memory regions implicated in concept learning. Does their task-related activation track individual differences in concept learning?
- Do cognitive and neural predictors explain common or complementary variance in concept learning?

Method

First session: Cognitive assessment
- Using WAIS-IV
- Measurements include: working memory (WM), processing speed (PS), verbal comprehension (VC), perceptual reasoning (PR) -> IQ

Second session: Concept Generalization Task



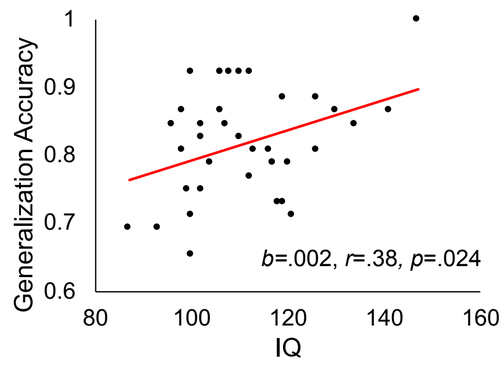
Stimuli
- 8 binary features with prototype structure
- Studied stimuli were 2 features away from prototypes

Behavioral Analyses
- Accuracy = generalization accuracy on new stimuli during final tests
- Bivariate correlations of IQ's and generalization
- Multiple regression
  (predictors: subcomponents of IQ; DV: generalization)

fMRI Analyses
- Task vs Baseline analysis
- Used anatomically defined ROIs
- Bivariate correlations of ROI activations and generalization
- Multiple regression (predictors: ROIs; DV: generalization)

Behavioral Predictors (N=36)

	Mean	SD
IQ	111.2	13.44
Working Memory	104.8	16.29
Processing Speed	106.8	13.98
Verbal Comprehension	118.0	17.72
Perceptual Reasoning	105.5	10.51
Generalization	.82	.080



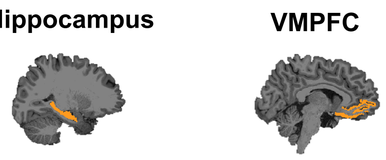
Multiple regression: Subcomponents of IQ predicting generalization

Predictors	Beta	t	p
Working Memory	.001	1.25	.220
Processing Speed	.000	-.44	.662
Verbal Comprehension	.001	1.45	.158
Perceptual Reasoning	.001	.317	.754

Overall model fit: $F(4,31) = 1.72$, $p=.172$, $R^2 = .18$

IQ significantly predicted generalization accuracy. This was not driven by any single subcomponent of IQ.

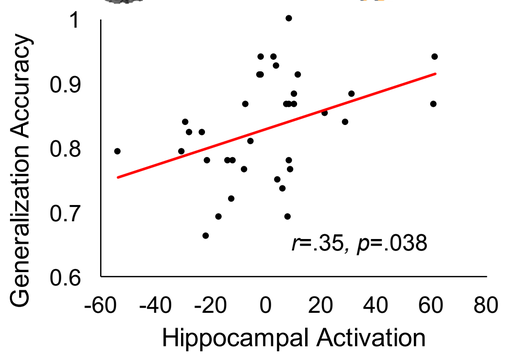
Neural Predictors (N=35)



Multiple regression: task-based ROI activation predicting generalization

Predictors	Beta	t	p
Hippocampus	.003	2.53	.017
VMPFC	-.001	-.92	.365
Caudate	-.001	-1.04	.306
Lateral Occipital	< 0.001	-.01	.995

Overall model fit:
$F(4,30) = 2.14$, $p=.100$, $R^2 = .22$



Hippocampal activation tracked generalization accuracy.

Behavioral + Neural Predictors

Multiple regression: hippocampal activation and IQ predicting generalization

Predictors	Beta	t	p
Hippocampus	.001	2.65	.013
IQ	.002	2.66	.012

Overall model fit: $F(2,32) = 6.32$, $p=.005$, $R^2 = .28$

Hippocampal activation and IQ predict distinct variance in concept generalization.

Conclusion

- IQ positively predicted concept generalization. The correlation was not driven by any single subcomponent of IQ.
- Hippocampal activation positively predicted concept generalization, indicating a role for the declarative memory system.
- IQ and hippocampal activation each predicted unique aspects of concept generalization.

References

1. Bowman & Zeithamova (2018) *J.Neuro*
2. Segar & Cincotta (2005) *J.Neuro*
3. Segar & Miller (2010) *Annual review of neuroscience*

Acknowledgements

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