Becoming self-directed:
Abstract representations support endogenously cued switching in children

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Background

❖ Children become increasingly skilled at actively maintaining goals in the service of flexible behavior, allowing them to break habits and switch between tasks.

❖They succeed first with exogenous (externally-provided) goals, and only later with endogenous (internally-driven) goals.

❖Little previous research has examined endogenous flexibility in children, yet it is pervasive in everyday life, and integral to the ability to control one's own behavior, a key aspect of development.

Current Study

❖What mechanisms support endogenous flexibility?

- Investigate through verbal fluency (VF) task: Children generate words from category and decide endogenously when to switch between subcategories (Experiments 1 &2).
- Relate to more constrained and established switching task: Flexible Item Selection Task (FIST).[1]

❖Do abstract, categorical representations support endogenous flexibility?

- Endogenous flexibility may impose greater demands on selection processes inherent in deciding what to do.
- Abstract representations may reduce selection demands to aid endogenous control.
- Test through individual differences analyses (Experiment 2) and experimental manipulation (Experiment 3).

❖ All Studies: Children 5 years (+/- 2 months)

Endogenous Flexibility Task: Verbal Fluency

❖Say as many category items as possible in 1 min. (e.g. animals).

- Good performance requires endogenous switching between subcategories (e.g. from farm animals to zoo animals).[2]

❖ Depends on prefrontal cognitive control[3] and undergoes protracted period of development (through adolescence).[4]

❖Current study:

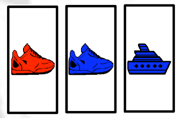
- Children complete practice category, then animal and food categories.
- Code number of switches (weighted by cluster size)

Good Performance Example		Poor Performance Example	
Word	**Time**	**Word**	**Time**
Lion	0:01	Elephant	0:01
Zebra	0:04	Jaguar	0:02
Elephant	0:05	Jaguar (repeat)	0:11
Hippo	0:07	Lion	0:29
Rhino	0:10	Tiger	0:30
Giraffe	0:11	Elephant (repeat)	0:46
Tiger	0:22		
Turtle	0:30		
Fish	0:39		
Cat	0:42		
Dog	0:44		
Lizard	0:46		
Snake	0:58		

More Constrained & Established Switching Task: FIST

❖Select a pair that matches on one dimension (e.g. color), then select a pair that matches on a different dimension (e.g. shape).

❖ Code proportion of correct switches (given correct first pair)



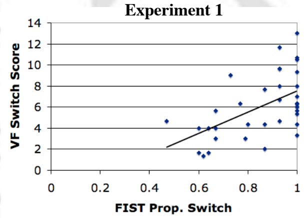
Verbal Fluency Taps Cognitive Flexibility in Children

❖ Endogenous switching during verbal fluency predicts switching on FIST (Experiments 1 & 2):

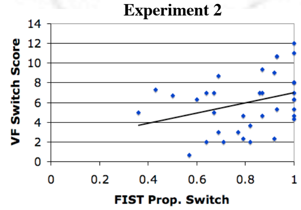
- Controlling for age ($r(34)=.553$, $p<.001$, $r(34)=.438$, $p=.008$)
- Controlling for general ability:
  - Visual priming $r(33)=.552$, $p=.001$, $r(33)=.428$, $p=.010$
  - Vocabulary $r(33)=.348$, $p=.041$, $r(33)=.368$, $p=.030$

❖Suggests more complex verbal fluency task taps the flexibility processes of interest.

Experiment 1



Experiment 2



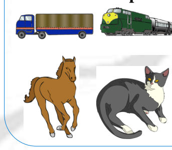
Abstract Representations Predict Endogenous Flexibility

❖Abstract, categorical representations assessed with picture-sorting task:

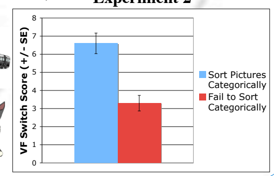
- Children asked to "Make piles of all the pictures that go together"
- Sort pictures categorically=sort category members together and separate from other categories (e.g. vehicles separate from animals).

❖Children who demonstrate abstract, categorical representations switch more during verbal fluency ($t(25)=3.09$, $p=.005$, $d=1.04$)

Picture Examples



Experiment 2



Causal Relation Between Abstract Representations & Endogenous Flexibility

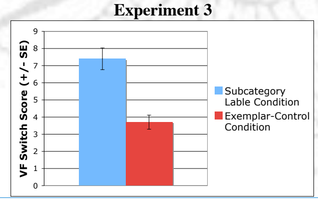
❖Promote the use of subcategory representations:

- Subcategory condition: Experimenter provided initial subcategory labels during instructions (e.g. "vegetables" when producing foods).
- Exemplar-control condition: Experimenter provided exemplars (e.g. "onion") without labeling subcategory.

❖As predicted, children in the subcategory condition switched more during VF than those in the exemplar-control condition ($t(22)=3.17$, $p=.004$, $d=1.16$).

- Not limited to subcategories children were presented with: switched more to both labeled subcategories (e.g. vegetables) ($t(22)=2.35$, $p=.028$, $d=.88$) and other subcategories (e.g. fruit) ($t(22)=2.27$, $p=.033$, $d=.85$).

Experiment 3



Abstract Representations & Selection

❖Previous research suggests abstract representations support switching [1,5]; we argue that these may be particularly relevant when selection demands are high.

❖Choosing what to switch to endogenously requires selection between competing alternatives (e.g. many animals in VF).

❖Abstract, categorical representations may constrain the search space, reducing selection demands (e.g. to a small set of subcategories rather than all exemplars in VF).

- Selection demands (quantified as LSA entropy [5]) substantially lower between and within subcategories (e.g. zoo animals, farm animals) than between all exemplars in category (e.g. all animals).

❖Thus, the development of abstract, categorical representations may be particularly important for development of endogenous flexibility, and becoming self-directed.

Conclusions & Directions

❖ Children's verbal fluency related to performance on a more constrained and well-established switching task:

- Suggests more complex VF measure taps the flexibility processes of interest.

❖Children's verbal fluency also linked to abstract, categorical representations in both individual difference analyses and experimental manipulation.

- Suggests role of abstract representations in reducing selection demands to aid endogenous control.

❖Future directions: directly test role of selection in mediating relation between abstract representations and endogenous flexibility.

References

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Acknowledgements

This research was supported by grants from the National Institutes of Health (RO1 HD37163 and P50-MH079485). Thanks to the Cognitive Development Center undergraduate research assistants who helped with coding data.

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