A Tale of Two Flexibilities

Development of and Effects of Labels on Consecutive and Concurrent Cognitive Flexibility

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Agenda

- What is cognitive flexibility?
- Cognitive flexibility in preschoolers
- Consecutive and concurrent cognitive flexibility
- Inductive and deductive tasks (labels)
- Study 1: development of two flexibilities
- Study 2: examining effects of labels
- Bonus: what kids say
- Summary and Open Questions
Cognitive Flexibility

The ability to think about something in more than one way
Why Study Cognitive Flexibility?

- Nonverbal intelligence (Siegler & Svetina, 2002)
- Academic achievements (Blair & Razza, 2007)
- Creativity (Diamond, 2006)
- Perspective taking (Perner et al., 2002)
Why Study Preschoolers?

- Preschoolers: 3-5 years old (before 1\textsuperscript{st} grade)

- Significant developments during preschool years (e.g., Cragg & Chevalier, 2012; Garon et al., 2008).
The Classic Task: DCCS

Target Cards

Pre-Switch: Shape
Post-Switch: Colour
Aspects of Cognitive Flexibility
Two Factors

- Type of cognitive flexibility
  - Consecutive
  - Concurrent

- Type of Task
  - Inductive
  - Deductive
Cognitive Flexibility Type

- **Consecutive cognitive flexibility**
  - Considering several dimensions one at a time
  - Also termed switching or set-shifting

- **Concurrent cognitive flexibility**
  - Considering several dimensions simultaneously
  - (based on Perner et al., 2002)
  - Very little research with preschoolers
Jacques and Zelazo (2005)

- Deductive tasks: all information is given
- Inductive tasks: an inference step is required

- Essential difference: dimensions identified

- General Findings: deductive tasks easier than inductive tasks.
- BUT almost only consecutive tasks.
Some Examples
Modified Object Classification Task for Children (M-OCTC)

Based on Smidts et al. (2004)
Multidimensional Card Selection (MCS)
Research with preschoolers focused on consecutive cognitive flexibility

Concurrent cognitive flexibility assumed to develop later

Deductive tasks are easier than inductive tasks: labels help children succeed on cognitive flexibility tasks (Doebel & Zelazo, 2013).
Study 1
Study 1: Questions

- Are consecutive and concurrent cognitive flexibility distinct skills? How do they relate?

- What develops first?

- What is the relation to type of task (inductive/deductive)?
Methods

- Participants: 121 preschoolers.
  - 3-Year-Olds ($N = 59$)
    - 37-47 months ($M = 43.5, SD = 2.4$)
    - 34 girls
  - 4-Year-Olds ($N = 62$)
    - 47-59 months ($M = 52.4, SD = 3.4$)
    - 30 girls
## Cognitive Flexibility Tasks

<table>
<thead>
<tr>
<th></th>
<th>Consecutive</th>
<th>Concurrent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inductive</strong></td>
<td>M-OCTC, M-FIST</td>
<td>Matrix sort</td>
</tr>
<tr>
<td><strong>Deductive</strong></td>
<td>DCCS</td>
<td>Matrix completion, MCS</td>
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Participant’s Score: Number of tasks performed above chance.
What We Found
Cognitive Flexibility Type Comparison By Age

Average Number of Tasks Passed

Consecutive Cognitive Flexibility

Concurrent Cognitive Flexibility

3-Year-Olds
4-Year-Olds

* Significance Level
Task Type Comparison By Age

Average Number of Tasks Passed

Deductive Tasks | Inductive Tasks

3-Year-Olds | 4-Year-Olds

* Denotes statistical significance.
Task Type By Cognitive Flexibility Type Interaction

Proportion of Tasks Passed

Consecutive Inductive
Consecutive Deductive

3-Year-Olds
4-Year-Olds
What does it mean?

- Concurrent cognitive flexibility ≠ consecutive cognitive flexibility in preschoolers.
  - Interesting area
  - Three-Year-Olds did well on consecutive cognitive flexibility

- Interaction between type of cognitive flexibility and type of task

- But…
  - Different inductive and deductive tasks
  - 3-year-olds not very good at concurrent cognitive flexibility
Study 2

Effects of Labels
Generally, labels help children on cognitive flexibility tasks.

Inhibitory control explanation: Labels help direct attention to the relevant dimension (Kirkham et al., 2003).

Representational change explanation: Labels help reflect on the hierarchical structure of the embedded rules (Zelazo et al., 2003).

Both theories apply to consecutive cognitive flexibility, but what about concurrent cognitive flexibility?
Study 2 – Purpose and Method

- Examine effects of labels on concurrent cognitive flexibility performance.
- Experimental manipulation of labels
- Two concurrent cognitive flexibility tasks:
  - Preschool Matrix Completion Task
  - Matrix Sort Task
- Order counterbalanced.
Preschool Matrix Completion Task: Labeled
Matrix Completion Task: Unlabeled
Matrix Sort Task: Labeled
Participants

4-year-olds ($N = 84$)
- 48-59 months old ($M = 53.5; SE = .37$)
- 42 girls
- 43 (17 girls) received labeled condition

5-year-olds ($N = 76$)
- 60-71 months old ($M = 65.3; SE = .35$)
- 45 girls
- 41 (24 girls) received labeled condition
What We Found
## Results – Matrix Sort

<table>
<thead>
<tr>
<th></th>
<th>No Labels</th>
<th>Labels</th>
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<tbody>
<tr>
<td>4-Year-Olds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-Year-Olds</td>
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</tr>
</tbody>
</table>

### Percentage of children performing above chance

- **No Labels**
  - 4-Year-Olds
  - 5-Year-Olds

- **Labels**
  - 4-Year-Olds
  - 5-Year-Olds
4-Year-Olds' performance on Matrix Completion

Number of Correct Trials

- Matrix Completion First
- Matrix Sort First

No Labels | Labels
5-Year-Olds' performance on Matrix Completion

Number of Correct Trials

- Matrix Completion First
- Matrix Sort First
Labels interfered with 5-year-olds’ performance on the Preschool Matrix Completion Task, unless they saw the Matrix Sort Task first.

Matrix Sort Task performance was unaffected.

Segmentation?
Complexity difference
Bonus Condition

- Do children focus on one dimension?
- Another 36 preschoolers (12 5YOs and 24 4YOs)
- Preschool Matrix Completion Task first
- Labeled condition
- Examining children’s labels
Preschool Matrix Completion Task
What We Found
Children's Labels By Age

Average Number of Labels

4-Year-Olds

5-Year-Olds

- Bi-dimensional (correct) Label
- Uni-dimensional Label, Column Dimension
- Uni-dimensional Label, Row Dimension
Performance on Preschool Matrix Completion Task By Age

Number of Trials Correct

- Regular Labeled
- Labeled with Delay

4-Year-Olds
5-Year-Olds
Findings Summary

- Labels seem to hinder children’s performance on concurrent cognitive flexibility tasks
- Labels seem to direct child’s attention to one dimension (consistent with inhibitory control theory)
- When we get 5-year-olds to produce a verbal label themselves, they do better (consistent with representational change theory).
Open Questions

- Is concurrent cognitive flexibility an extension of consecutive cognitive flexibility?
- What is the role of other cognitive skills?
- How does this map onto later developmental outcomes?
- How can we help children figure this out?
Thanks to...

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- Dr. Deepthi Kamawar
- My lab-mates
  - Katherine Andrews
  - Corrie Vendetti
  - Andrea Astle
Thank You!

Questions?
References


