A place for everything and everything in its place: The role of executive function in children's organizational strategy use

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Introduction

- Organizational strategies involve the sorting and clustering of conceptually similar information to enhance memory (Bjorklund, Coyle, & Gaultney, 1992), and do not appear spontaneously until 8-years-old (Schwenck, Bjorklund, & Schneider, 2009).
- The first signs of strategy use appear as children begin to develop executive function (EF; Marcovitch & Zelazo, 2009), and performance on EF tasks predicts organizational strategy use in 8- to 12-year-olds (Schleepen & Jonkman, 2012).
- Four- to 6-year-olds can be trained to use organizational strategies, however, only 6-year-olds show a memory benefit (Schlagmüller & Schneider, 2002).
- The current study examined the relationship between organizational strategy use and two cognitive abilities associated with EF —cognitive flexibility (CF) and working memory (WM) — in 4- to 6-year-olds. Children were presented with an organizational strategy use task, a measure of CF (Dimensional Change Card Sort; DCCS), and a measure of WM (Backwards Digit Span; BDS).

Methods

Participants

- Twenty-four 4-year-olds (*M* age = 4.40 years, *SD* = .27), 24 5-year-olds (*M* age = 5.32 years, *SD* = .24), and 24 6-year-olds (*M* age = 6.49 years, *SD* = .31)

Design and Procedure

Organizational Strategy Use (Schwenk et al., 2009)

- The experimenter demonstrated a sorting strategy by organizing 6 cards into 2 categorically similar groups —body parts and vegetables — and had children explain why the pictures were sorted into 2 categories.
- Children were then presented with 9 cards containing pictures from 3 categories (i.e., furniture, fruits, and animals; see Figure 1).
- During a 1 minute study period, children were asked to "sort the pictures in groups that belong together, and try to remember the pictures together that belong together."
- After a 30 second delay, a free recall test was administered.
- Recall was scored as the number of items generated during free recall.
- Clustering during free recall was assessed by calculating Ratio of Repetition scores (RR; Bousfield, 1953).

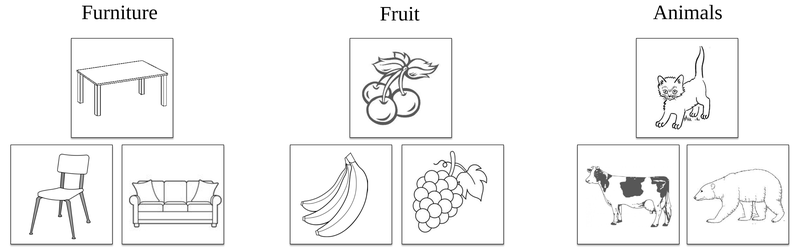
Dimensional Change Card Sort, Borders Version (Zelazo, 2006)

- Children were instructed to sort cards that varied on two dimensions (i.e., shape and color) to conflicting target cards (e.g., if they were sorting yellow flowers and green cars they had to match them to green flowers and yellow cars).
- After six trials sorting by one dimension, children were asked to switch rules and sort by the other dimension.
- Children who sorted at least 5 trials correctly passed the postswitch condition, and played the borders version. Children were instructed to sort by one dimension if the card had a border and the other dimension if it did not. Children were scored as passing the task if they sorted 9 out of 12 cards correctly.
- Performance was scored as the total number of cards sorted correctly across all phases.

Backwards Digit Span (Carlson, Moses, & Breton, 2002)

- Children were asked to reproduce lists of 2, 3, 4, and 5 digits backwards.
- Performance was scored based on the longest list children reproduced correctly. Children who failed to reproduce a 2-digit list were assigned a score of 0.

Figure 1. Examples of Organizational Strategy Task Pictures



Results

Effects of EF on Organizational Strategy Use

- Performance on the DCCS and BDS was significantly correlated, $r(70) = .52$, $p < .01$, and an EF composite score was created.
- Hierarchical linear regressions were performed with recall and clustering as the dependent variables, and the predictor variables entered in two steps: (1) age, and then (2) the EF composite.
  - Age predicted both increased recall, $R^2 = .19$, $F(1,68) = 16.09$, $p < .001$, and clustering, $R^2 = .19$, $F(1,68) = 15.67$, $p < .001$. Above and beyond the effects of age, children with higher EF scores recalled more items, $\Delta R^2 = .12$, $F(1,67) = 11.07$, $p = .001$, and produced more clusters, $\Delta R^2 = .08$, $F(1,67) = 6.92$, $p = .01$.
  - The addition of EF to the model rendered the contribution of age insignificant.

Differing effects of WM and CF on Organizational Strategy Use

- Previous research has shown that CF and WM offer differential predictive power in research on children's memory (Miller, Chatley, Marcovitch, & McConnell Rogers, in press).
- Identical regressions as conducted above were performed examining the contributions of CF and WM to recall and clustering during organizational strategy use.
  - Recall was predicted by both CF, $\Delta R^2 = .09$, $F(1,67) = 8.15$, $p = .006$, and WM, $\Delta R^2 = .07$, $F(1,67) = 6.12$, $p = .02$.
  - Clustering was predicted by CF, $\Delta R^2 = .06$, $F(1,67) = 5.79$, $p = .02$, but WM predicted clustering with only marginal significance, $\Delta R^2 = .03$, $F(1,67) = 2.97$, $p = .09$.
- Children's performance on the DCCS is generally distributed bimodally (Zelazo, 2006) and performance is often scored using a pass/fail criteria.
- To assess whether group differences in performance predict recall and clustering, one-way ANOVAs were conducted with DCCS performance as the independent variable.
  - Recall differed by DCCS performance, $F(2, 68) = 9.74$, $p < .001$, and Tukey's HSD comparisons at the .05 level showed that children who passed postswitch and children who passed the borders condition recalled more items than children who failed postswitch (see Figure 2).
  - Clustering differed by DCCS performance, $F(2,68) = 8.42$, $p = .001$, and Tukey's HSD comparisons at the .05 level showed that children who passed postswitch and children who passed the borders condition had higher RR scores than children who failed postswitch (see Figure 3).

Figure 2. Item Recall by DCCS Performance

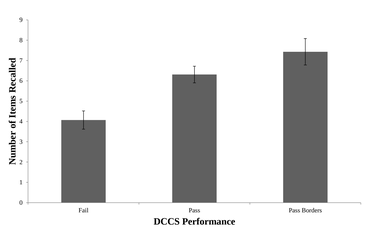
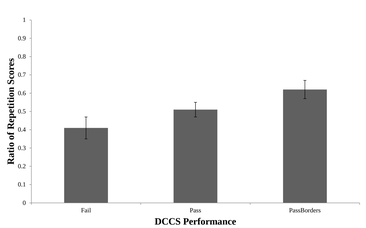


Figure 3. RR Scores recall by DCCS Performance



Discussion

•Organizational processing is typically spontaneous in adults (Schwenck et al., 2009) but may require training in preschoolers due to limited but developing EF abilities. Preschoolers' ability to use and benefit from trained organizational strategies is predicted by EF.

- Overall, children with higher scores on tasks related to EF showed more clustering during recall and recalled more items.

•Tasks that measure different aspects of EF — WM and CF — offer distinct predictive value in assessment of organizational strategy use.

•WM task performance predicts only increased recall; this is a finding which replicates previous research showing that WM predicts recall (but not clustering) in children under 8 years old (Schneider, Kron, Hunnerkopf, & Krajewski, 2004).

•The development of CF predicted both increased recall and clustering during recall.

- Children's ability to consider information in multiple contexts (i.e., item specific and category membership) is necessary for successful organizational strategy use.

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