The Relation between Memory for Temporal Context and Executive Function in Preschool and School-Age Children

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Development and Understanding of Children's Knowledge

Introduction

- Time is an essential feature of episodic memory—memory for events from a specific time and place (Tulving, 1972). Temporal memory (i.e., memory for 'when') development is important for cognitive and socio-emotional outcomes.
- Memory for temporal context (e.g., placing events on conventional time scales) improves substantially from 4 to 8 years of age (Friedman, 1991; Pathman et al., 2013). To recall the temporal context of events, Friedman (1993) discussed how adults and children reconstruct the time of an event by combining recalled details with time knowledge.
- Reconstruction abilities also emerge in early childhood and show marked development during the transition to middle childhood (Friedman, 2014). To engage in reconstruction, children may use executive function (EF) skills given the need to manipulate event representations and consider flexibly episodic information and semantic knowledge.
- The goal of the current study was to use a novel design to examine how the development of reconstruction from early to middle childhood relates to EF.

Method

Participants

- Forty 4- to 5-year-olds, *M* age = 59.24 months, 25 females
- Forty-one 6- to 7-year-olds, *M* age = 83.00 months, 17 females

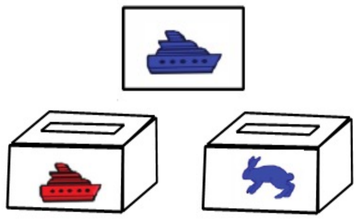
All sessions were conducted on Zoom.

Working memory: Backward Digit Recall (Wechsler, 2003)

- The experimenter said strings of digits (e.g., "1-3"), and the participant was instructed to repeat the string in backward order (e.g., "3-1").
- There were two practice trials, which both included 2-digit strings, and then the task continued with participants receiving 2 trials per string length, starting with 2 digits and ending with 8 digits.
- Participants continued the task until they produced incorrect response to both trials of a digit string.
- Participants received .5 point for each correct trial, and a total score was calculated by summing all the points for all correct trials.

Cognitive flexibility: Dimensional Change Card Sort (DCCS; Zelazo, 2006)

- Participants sorted a series of cards (e.g., blue boats and red bunnies) according to either color or shape.
- The task consists of three levels (pre-switch, post-switch, and borders), with the sorting rule changing between each level.
- Pre-switch level: participants sorted cards by one dimension (e.g., color).
- Post-switch level: participants sorted by the other dimension (e.g., shape).
- Borders level: participants sorted cards by color and shape, depending on whether cards have a black border.
- Participants received a score based on how many levels they passed (1, 2, or 3).

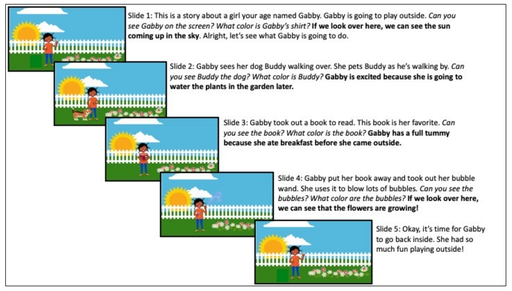


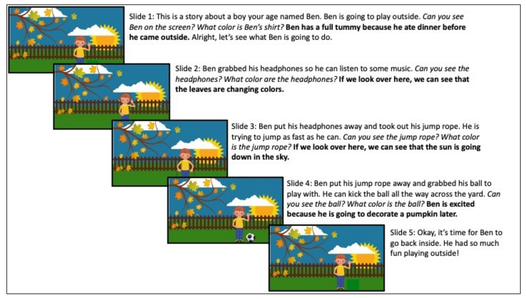
Method (cont.)

Story Task

Encoding:

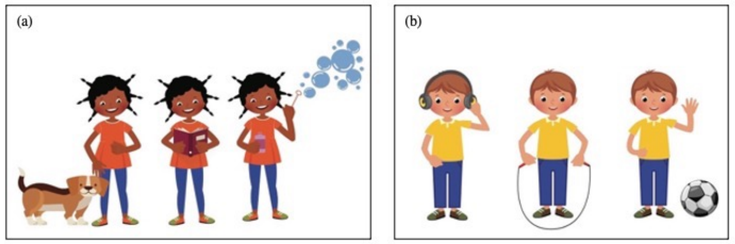
- Participants heard two stories about child characters participating in actions outside (e.g., blowing bubbles) that took place in specific temporal contexts (e.g., Fall, Morning; Spring, Night).
- For each story, the experimenter included temporal cues (e.g., leaves changing colors, sun coming up) but never explicitly stated the season or time.





Retrieval:

- Participants first answered forced-choice **temporal judgment** questions about the season and time of day of each story
- Participants next answered forced-choice **temporal cue** questions about all the season and time of day cues
- While answering questions for each story, participants viewed pictures of the character on the screen



Results

Scoring:

- We calculated **temporal context scores** by summing the number of correct responses to the season and time questions (4 total).
- Temporal context scores provide a measure of reconstruction abilities given that participants need to recall temporal cues from the story and combine that with their time knowledge to respond correctly.
- We calculated **temporal cue scores** by summing the number of correct responses to the temporal cue questions (8 total).
- Temporal cue scores provide a measure of children's memory for contextual information that is related to the temporal context of the stories.
- We also calculated an **EF composite** by calculating z-scores for each task and then summing the z-scores.

Correlation Analyses:

- We conducted bivariate correlations for each age group to examine relations between temporal context scores and temporal cue scores with EF.

4- to 5-year-olds:

- Temporal judgment scores & EF: $r(39) = .252$, $p = .117$
- Temporal cue scores & EF: $r(39) = .433$, $p = .005$

6- to 7-year-olds:

- Temporal judgment scores & EF: $r(40) = .476$, $p = .002$
- Temporal cue scores & EF: $r(40) = .306$, $p = .052$

Discussion

- In this task, participants needed to draw on their memory for temporal cues to recall the season and time of each story. The pattern of results for temporal judgments could suggest that older children used EF skills to reconstruct the temporal context.
  - It is possible that more advanced EF abilities allowed older children to encode more story information by controlling attention and monitoring story details, which then increased the likelihood that older children would recall relevant temporal cues when making temporal judgments.
- There was no association between younger children's EF and temporal judgment scores, which could indicate that they did not use EF skills to engage in reconstruction.
  - It is possible that younger children's EF abilities were not advanced enough to engage in reconstruction. As a result, younger children might have used a different strategy to recall the temporal context of the stories, such as familiarity-based processes, which rely on a feeling of knowing as opposed to recollection of event information (Yonelinas, 2002).
  - Perhaps age-related changes in EF abilities help to explain why there is such a dramatic shift in memory for temporal context and reconstruction abilities from early to middle childhood.
- Temporal cue scores were related to EF in both older and younger children. This relation could stem from the use of EF when encoding and retrieval event information. During encoding, if children keep more story details in mind, they might be more likely to remember them later. During retrieval, if children remember a certain temporal cue (e.g., the sun was coming up), that could serve as a cue to additional information (e.g., the character ate breakfast).
- Future directions of this work include examining how other factors associated with memory for temporal context (e.g., knowledge of time patterns) and use of temporal language (e.g., before, after) relate to temporal memory development in early and middle childhood.
- The findings from the current study have implications for children's ability to construct a life story based on memory for events, which contribute to the creation of a self-identity (Friedman, 1993; Nelson & Fivush, 2004). In addition, relations between EF and temporal memory abilities in childhood provide useful information in legal settings when children are needed to provide eyewitness testimony.

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