Breakfast comes after Dinner?: The Relation between Preschoolers' Temporal Memory, Time Knowledge, and Cognitive Flexibility

Kathleen M. Bettencourt, Jessica R. Barselow, & Stuart Marcovitch

University of North Carolina at Greensboro

Introduction

Temporal memory (i.e., memory for 'when'), develops more slowly than memory for 'who' and 'where' (Lee, Wendelken, Bunge, & Ghetti, 2016). Children start including temporal information in reports of personal events at the end of preschool (Reese, 2009).

Memory for temporal context is the ability to place events in time, typically using conventional time scales (e.g., days, months, seasons). Friedman (1993) suggested that placing events in time requires the combination of recalled details and knowledge of conventional time scales (e.g., months, seasons). During the transition from early to middle childhood, children improve in their understanding of conventional time patterns (e.g., ordering the months; Friedman, 1978).

Cognitive flexibility, a component of executive function (EF) that involves shifting between mental sets, shows rapid development across early childhood (Garon, Bryson, & Smith, 2008; Zelazo & Müller, 2002). Like memory for context, the development of cognitive flexibility also stems from changes in children's representational abilities (Marcovitch & Zelazo, 2009; Zelazo, 2004; Zelazo, 2015; Zelazo, Müller, Frye, & Marcovitch, 2003).

Time knowledge likely impacts temporal memory in early childhood. If preschoolers have a basic understanding and awareness of what certain time scales indicate (e.g., in winter it is cold outside), they can begin to place experiences in time more accurately.

Cognitive flexibility likely impacts preschoolers' ability to coordinate event details with time knowledge during retrieval, given the need to switch between event information and semantic knowledge.

The goal of the current study is to investigate the role of cognitive flexibility and time knowledge in 4- and 5-year-olds' memory for temporal context of personal events, Given previous research, we predict that 5-year-olds will have better temporal context memory than 4-year-olds.

Method

Participants
- Forty-five 4-year-olds, *M* age = 54.58 months, *s* = 3.09, 19 females
- Forty-three 5-year-olds, *M* age = 65.19 months, *s* = 3.67, 24 females

Experimenter-Child Interview (ECI; Larkina & Bauer, 2010):
- The ECI is an open-ended interview focusing on events children have recently experienced.
- For each participant, a parent provides 2 events that the child has experienced in the last 4 weeks.
- Parents chose events that were unique, one-time occurrences. Example events include: trips to science centers or museums, receiving an award at school, and attending parades.

- Participants receive a temporal context score for the interview based on the number of words or phrases that refer to the time of an event (e.g., day, month, season).

Examples: yesterday, in May, 3 days ago, on Tuesday

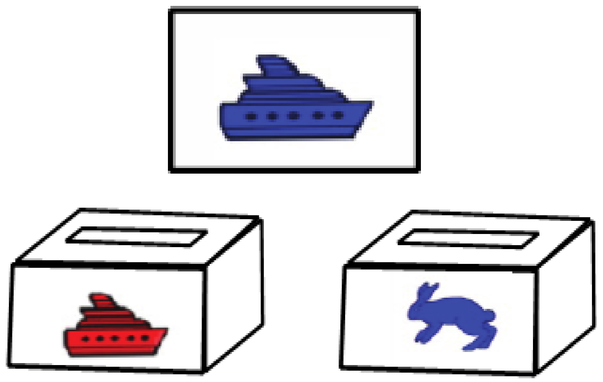
Method (cont.)

Time Knowledge: Children's Conventional Time (CCT; Scales & Pathman, 2019)
- Participants answer 3 forward and 3 backward questions about the order of meals.
- Participants receive 1 point for each correct response.

Examples:
"If you've had breakfast, what is the next meal going *forward* in time you'll eat?"

"If you've had breakfast, what is the next meal going *backwards* in time?"

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 or not cards have a black border.
- Participants received a score based on how many levels they passed (1, 2, or 3).



Results

Temporal Memory
- There were no significant differences between 4- (*M* = 0.44, *SE* = .10) and 5-year-olds' (*M* = 0.60, *SE* = .13) temporal memory, *t*(86) = -1.012, *p* = 0.314.

Time Knowledge

2 (Direction: Forward, Backward) x 2 (Age: 4, 5) mixed ANOVA:
- Main effect of direction, $F(1, 84) = 29.98$, $\eta^2 = .26$, $p < .001$ - better performance on forward (*M* = 2.08, *SE* = .10) compared to backward questions (*M* = 1.21, *SE* = .12).
- Main effect of age, $F(1, 84) = 29.98$, $\eta^2 = .05$ $p = .049$ - 5-year-olds (*M* = 1.80, *SE* = .11) performed better overall than 4-year-olds (*M* = 1.50, *SE* = .11).

Results

Temporal Memory, Time Knowledge, & Cognitive Flexibility

We ran a series of correlations between age, temporal memory, DCCS performance, and CCT scores. Temporal memory was related to DCCS performance and CCT forward scores, and marginally related to age. See Table 1.

We conducted a hierarchical regression with temporal context score as the dependent variable. Age was entered as an independent variable in the first step, DCCS performance was added in the second step, and CCT forward scores were added in the third step. See Table 2.

	1.	2.	3.	4.
1. Age	--			
2. Temporal Context Score	.200^	--		
3. DCCS Borders	.432**	.301**	--	
4. CCT Forward	.226*	.219*	.298**	--
5. CCT Backward	.240*	.152	.046	.018

Table 1. Correlations between age, temporal memory, DCCS performance, and CCT scores.

**$p < .01$; *$p < .05$; ^$p < .10$

Model 1	B	Std. Error	β	t	Sig.
(Constant)	-.224	.192		-1.165	.247
Age	.006	.003	.205	1.920	.058
Model 2					
(Constant)	-.219	.187		-1.172	.244
Age	.003	.003	.088	.755	.452
DCCS	**.106**	**.046**	**.266**	**2.294**	**.024**
Model 3					
(Constant)	-.220	.187		-1.180	.241
Age	.002	.003	.072	.619	.538
DCCS	**.093**	**.047**	**.233**	**1.964**	**.053**
CCT Forward	.026	.021	.133	1.215	.228

Table 2. Hierarchical regression with temporal memory as the dependent variable.

Discussion

- We did not find differences between 4- and 5-year-olds' memory for temporal context of personal events.
- We found that children who performed better on the DCCS and CCT forward questions included more temporal context information in their memory reports.
- Given that DCCS performance predicted temporal memory over and above age and CCT forward scores, we have evidence that cognitive flexibility is more influential than time knowledge during the preschool period.
  - It is possible that cognitive flexibility—characterized by the ability to shift between and integrate different representations—is impacting children's ability encode more context relevant information (e.g., different colored leaves on the ground).
  - During retrieval of events, better cognitive flexibility might be helping children make better inferences about 'when' an event occurred based on event details.
  - It is also possible that time knowledge does play a larger role in temporal memory development, but the CCT task is not an effective assessment.
- These results suggest that children's cognitive flexibility is an especially important factor for temporal memory development during the preschool years.
- Future directions of this work include examining how other EF components (e.g., working memory and inhibitory control) contribute to temporal memory during the preschool period. If children have better working memory, they could keep more event details in mind during retrieval, which could provide more cues to the time of an event. If children have better inhibitory control, they could be more resistant to interference from similar events or events that occurred close together in time.

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