Influence of Executive Functioning on Memory for Contextual Details and False Recognition

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Introduction

- Improvements in children's memory, particularly 3-6-years-olds stem from
  1) increases in the ability to identify previously encountered items,
  2) increases in the ability to recall contextual details associated with these items (e.g., location; e.g., Drummey & Newcombe, 2002; Riggins et al., 2009),
  3) and decreases in false recognition of new items as previously encountered (i.e., committing false alarms, FA; e.g., Lindsay et al., 1991; Lloyd et al., 2009)

- Executive functioning, the ability to strategically plan and organize behavior, also shows significant development during early childhood (Diamond, 2006). Some components of executive functioning include: working memory, inhibition (conflict, delay), and cognitive flexibility.

- In developmental populations:
  - Working memory is related to recognition memory(Ruffman et al., 2001).
  - Conflict inhibition is related to memory for contextual details (Drummey & Newcombe, 2002; Cycowicz et al., 2001; Ruffman et al., 2001) and false recognition (Melinder et al., 2006; Roberts & Powell, 2005; Ruffman et al., 2001).
  - Cognitive flexibility is related to memory for contextual details (Picard et al., 2012).

- The aim of the current study was to examine how the core components of executive function were related to memory for contextual details and false recognition taking into account general intelligence.

Methods

Participants

- Data were collected from 31 3-year-old children (20 boys, mean age = 3.3 ± .15 years, range = 3.05 – 3.57) and 25 6-year-old children (12 boys , mean age = 6.23 ± .16 years, range = 6.00- 6.52). An additional 26 children were excluded because of failure to meet inclusion criteria (n = 6), incomplete behavioral data (n = 12), and noncompliance (n = 8).

Behavioral Assessments

- Memory Paradigm (Sessions 1 & 2)

- General Intellectual Ability
  - WPPSI Block Design (Session 3)
  - WPPSI Receptive Vocabulary (Session 1)

- Executive Functioning(Session 3)
  - **Working Memory:** Forward Digit Span
  - **Conflict Inhibition:** Day/Night (Gerstadt et al., 1994; Passler et al., 1985)
  - **Delay Inhibition:** Delay of Gratification Task (Carlson, 2005)
  - **Cognitive Flexibility:** Dimensional Change Card Sort (DCCS; Zelazo, 2006)

- The Sessions 1 and 2 took place 1-2 days apart and Session 3 took place within a month of those sessions with most occurring within one week.

- Undergraduate research assistants coded actions performed by the children during Session 2, the Day/Night task, and the DCCS task.

Session 1: Memory Encoding
- 54 items
  - 2 locations(Figure 1)
  - 3 actions
- Children required to imitate action
- Receptive Vocabulary

Delay *M* = 1.3 days

Session 2: Memory Retrieval
- Behavioral memory assessment
- 57 previously viewed items and 27 novel distracters
  - Old/new
  - Action
  - Location

Delay *M* = 5.75 days

Session 3: Executive Function
- Digit Span
- Day/Night
- Delay of Gratification
- DCCS
- Block Design

Figure 1

Memory Paradigm

Day/Night Task

Dimensional Change Card Sort

Results

Table 1

Performance by 3- and 6-year-olds on episodic memory, general intellectual ability, and executive function measures.

	3-year-old children (n = 31)		6-year-old children (n = 25)		MANOVA statistics	
	M	SE	M	SE	F	P
Memory						
Item Recognition (%)	82.2	3.5	85.5	3.9	.41	.52
Contextual Details (%)	49.0	1.5	58.0	1.7	14.99	<.01**
False Recognition (%)	29.3	5.4	9.9	6.0	5.8	.02*
Intellectual Ability						
Receptive Vocabulary	22.48	.74	30.32	.82	50.03	<.01**
Block Design	16.36	.75	27.64	.83	102.47	<.01**
Executive Functioning						
Day/Night Task	7.32	.84	13.04	.93	20.78	<.01**
Delay of Gratification	.68	.08	.88	.08	3.26	.08
Digit Span	8.16	.54	12.52	.60	29.07	<.01**
DCCS	5.84	.91	14.64	1.01	41.71	<.01**

* Significant at p < .05 ** Significant at p < .01

Table 2

Hierarchical multiple regression analysis predicting recognition memory using age, general intellectual ability, and executive functioning measures as predictors

	R^2	*F*	Δ*F*	β	*t*
Item Recognition					
Step 1: Age group	.01	.41	.41		
Step 2: General intellectual ability	.02	.46	.51		
Step 3: Executive functioning	.12	1.11	1.43		

* Significant at p < .05

Results

Table 3

Hierarchical multiple regression analysis predicting memory for contextual details using age, general intellectual ability, and executive functioning measures as predictors specifically for children who performed above chance on location (> 50%) and action (>33%) details (20 3-year-olds and 21 6-year-olds)

	R^2	*F*	Δ*F*	β	*t*
Contextual Details					
Step 1: Age group	.22	14.99*	14.99*		
Step 2: General intellectual ability	.23	7.70*	.53		
Step 3: Executive functioning	.26	2.85*	.55		
Age group				.21	.88
General intellectual ability				.14	.88
Forward Digit Span				.08	.38
Day/night				.46	2.35*
Delay of Gratification				.11	.67
DCCS				-.31	.38

* Significant at p < .05. DCCS = Dimensional change card sort

Table 4

Hierarchical multiple regression analysis predicting false recognition using age, general intellectual ability, and executive functioning measures as predictors

	R^2	*F*	Δ*F*	β	*t*
False Recognition					
Step 1: Age group	.10	5.80*	5.80*		
Step 2: General intellectual ability	.11	3.17*	.58		
Step 3: Executive functioning	.33	3.93*	3.96*		
Age group				.20	1.09
General intellectual ability				.05	.39
Forward Digit Span				-.12	-.76
Day/night				-.09	-.59
Delay of Gratification				-.08	-.67
DCCS				-.56	-3.06*

* Significant at p < .05. DCCS = Dimensional change card sort

Discussion

- The present study is unique because we examined all four components of executive functioning(Cycowicz et al., 2001; Drummey & Newcombe, 2002; Picard et al., 2012; Ruffman et al., 2010).
- These findings suggest that conflict inhibition is related to memory for contextual details and that cognitive flexibility is related to false recognition even when controlling for age and general intellectual ability. These findings are important because they 1) show that particular executive functioning abilities influence memory for contextual details and 2) highlight the importance of considering individual differences in cognitive abilities.

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