The Temporal Organization of Free Recall in Childhood

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Introduction

- Free recall measures are often used to study episodic memory, memory for past events from a particular time and place (Tulving 1972).
- In free recall paradigms, adults study lists of words, for example, and then are asked to recall the words from the list. Memory is measured by the number of items (e.g., words) recalled.
- Researchers also examine the *order* in which the items are recalled (temporal organization) and find evidence of:
  - Temporal clustering: adults recall in succession items that are experienced closer in time (e.g., Kahana, 2006)
  - Spatial clustering: adults tend to recall in succession landmarks that are geographically close to each other (Miller, Lazarus, Polyn & Kahana, 2013)
  - Semantic clustering: items tend to be recalled consecutively with other semantically related words from the study list (Manning & Kahana, 2012).
- Relatively few studies have examined the temporal organization of free recall in children (e.g., Jarrold et al., 2015)
- Previous studies in both the child and adult memory literature often use lab-based stimuli (e.g., word or object-based study lists), learned and tested in one day.

Purpose:

- Investigate children's memory for events that were experienced
  - in a naturalistic environment, with engaging events
  - over the course of one week.
- Examine age-related differences in the number of events recalled
- Examine the order in which events are recalled

Method

Participants

- 4 to 5-year-olds (n = 46; M_{age} = 5.20, SD_{age} = .52; 26 girls, 20 boys)
- 6 to 7-year-olds (n = 49; M_{age} = 6.97, SD_{age} = .56; 30 girls, 19 boys)
- 8 to 10-year-olds (n = 52; M_{age} = 9.11, SD_{age} = .74; 27 girls, 25 boys)

Procedure

Naturalistic Encoding Phase

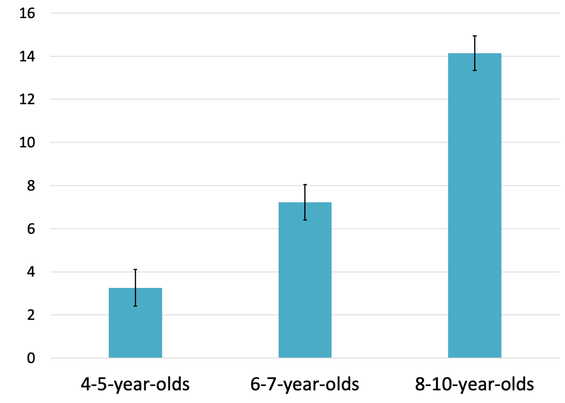
- Children attended a 5-day summer camp at a local zoo (full-day; Monday to Friday)
- Children engaged in various games and activities, including visits to unique animal exhibits each day of camp
- For example, a child may go to the "Rainforest" exhibit from 9:30am to 10:30am, followed by a visit to the "Tundra" exhibit from 10:30am to 11:30am.
- Experimenters were provided with camp schedules, and we knew which animals were at each exhibit.
- Children were not told they would need to remember events/animals for future testing

Test Phase

- Children took part in a short testing session on the last day of camp (Friday).
- To assess free recall, experimenters said: "*You met so many different and cool animals this week. But I wasn't there. Let's play a game. Can you tell me the names of all the animals you saw this week?.*"
- Children were asked to name all the animals they saw, and were prompted with follow up questions to elicit complete recall (*"Can you tell me more? "What are some other animals you visited?")*

Results

Number of items (i.e., animals) recalled

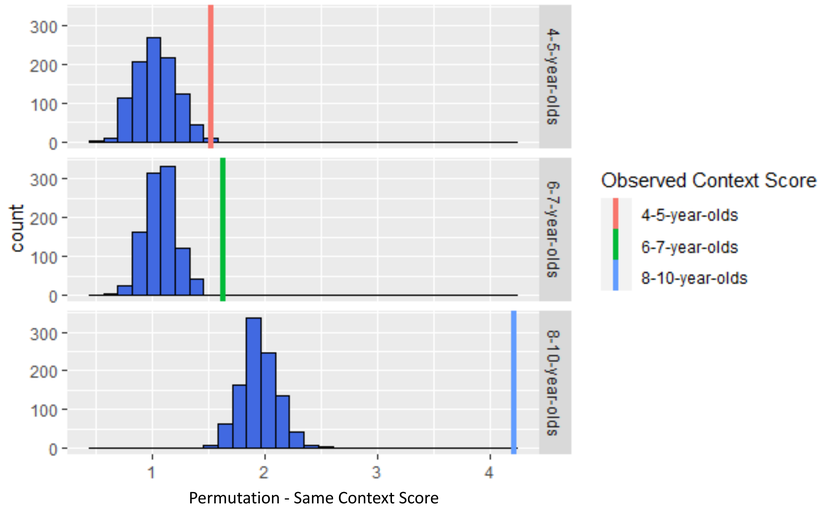


- Analysis of variance analysis (ANOVA) revealed age-related improvements in the number of animals recalled, F(2, 144)= 44.54, p<.0001, partial eta squared=.38.
- 4- to 5-year-old children recalled fewer animals than 6- to 7-year-olds, and 6- to 7-year-olds recalled fewer animals than 8- to 10-year-old children.
- The above excludes intrusions and animals for which we cannot pinpoint a precise time of encoding (e.g., chipmunks which could have been encountered anywhere at the zoo; if a child recalled 'hippo' but there are two different types of these animals)

Results

Temporal/Spatial Clustering

- Using schedules, we calculated a 'same context' score for each child: the number of times successively recalled animals were experienced in the same temporal/spatial context.
  - Same context scores (when accounting for number of items recalled) did not show significant age-related differences, F(2, 144)= 2.294, p=.11
- To determine if children were showing evidence of same context clustering, we then created a "permutation distribution" for each age group (based on randomizing the order of responses; 1000 permutations, paralleling past adult studies).
- All age groups showed evidence of clustering (observed same context scores higher than permutation distributions; ps<.001).
- Graphs below include participants who recalled at least 4 items (since recall with fewer items could lead to unstable estimates of organization)



Conclusions

This study advances our understanding of how memory is organized across development (findings of age-related differences and similarities) and the engagement of executive processes during memory search, while highlighting the utility of naturalistic memory studies (dynamic events, experienced over multiple days).

- We found age-related improvements in recall in middle to late childhood. This is consistent with previous work using laboratory studies showing age-related improvements in children's memory accuracy (see Bauer, 2007 for review).
- This study adds to our knowledge about the temporal organization of free recall and shows that even in early childhood, children are showing clustering effects that parallel those found in adults.
- Overall children recalled many items. Other studies have found that compared to engaging and autobiographical events, lab-based stimuli (words, pictures on a computer screen) may underestimate children's memory (e.g., Pathman et al., 2013).
- This study adds to our knowledge about children's learning in informal learning environments like zoos, museums and science centers.
- Future analyses will examine other clustering effects (e.g., semantic clustering).

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Acknowledgements

Thank you to the families that took part in the study, and to the Toronto Zoo. We thank members of the MDLaB at York University for their help with data collection and scoring.

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