

# EEG Correlates of Toddler Recognition and Recall Memory Performance

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## INTRODUCTION

During infancy and early childhood, recognition memory is typically assessed using visual-paired comparison, where children discriminate between novel and familiar stimuli. Similarly, studies focusing on early recall memory tend to employ measures of non-verbal recall, including elicited or deferred imitation. Despite tremendous developments in language comprehension and production by 24 months of age, there currently exists no single standardized measure to verbally assess both recognition and recall for children under the age of 3.

One of the goals of this study was to develop a task appropriate for 24-month-olds to assess both recognition and recall. Another goal of this study was to examine patterns of brain-electrical activity (EEG) associated with the task. Evidence from adult studies reveals dissociation between cortical areas, as recall is associated with frontal lobes and recognition with temporal lobes. In this study, EEG was used to examine these associations between brain function and recall and recognition processes in toddlers.

## PARTICIPANTS



Participants in this study were 40 2-year-old toddlers (24-26 months) who had previously been recruited for an ongoing longitudinal investigation spanning infancy and early

childhood, and examining individual differences in cognitive and emotional development. As infants, these children were recruited from the New River Valley area of southwest Virginia. Infants were recruited if they were born within 2 weeks of their expected due dates and experienced no prenatal or birth complications. At birth, all infants weighed at least 2,500 grams, required no oxygen at birth, and had no neurological diagnoses.

## METHODS

### •Grocery Store Game

- The experimenter produced a small opaque shopping bag and told the child that they were going to play the “grocery store” game.
- The experimenter displayed 3 actual food items one at a time as they were verbally labeled and placed inside the bag (familiarization).

### •Memory Assessments

- Immediate Recall-** After the last item was placed in the bag, children were asked, “What did we put in the bag?”. Children responded verbally to identify recalled items.
- Immediate Recognition-** Recognition of remaining items (not immediately recalled by the child) was examined using a forced choice procedure in which the child was asked to choose between two items (familiar item and novel one) to identify what was placed in the bag.

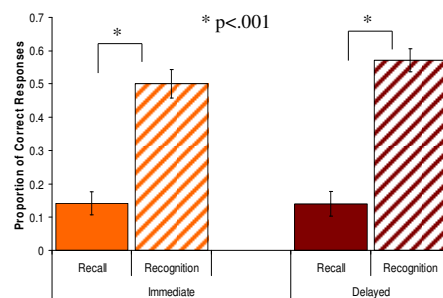
\*\*\*The shopping bag was then set aside for approximately 20 minutes.\*\*\*

- Delayed Recall-** Children again responded verbally to identify recalled items, this time after the delay.
- Delayed Recognition-** Using identical procedures as in the immediate recognition test, delayed recognition was assessed.

### •Continuous 6-9 Hz EEG

- EEG was collected during a baseline period and throughout the familiarization and immediate testing of recognition and recall.
- Change scores were calculated from each site by subtracting baseline power values from task-related power. Positive scores indicate cortical activation, and negative scores indicate cortical deactivation.
- This is the typical pattern for infant and young child EEG activation during cognitive tasks.

## RESULTS



• A 2 (Task) x 2 (Delay) repeated measures MANOVA was conducted to assess differences in memory measures.

• Main Effect for Task:

• Hotelling's Trace:  $F(1, 38) = 93.125, p < .001$ .

• Better performance on Recognition than Recall tasks

• No Main Effect for Delay or Interactions

## RESULTS

	Recall		Recognition	
	Immed.	Delayed	Immed.	Delayed
Fp1/2	.52 / .62	.39 / .59	.36 / .27	-.02 / .20
F3/4	.43 / .11	.41 / .28	.18 / .00	.16 / .15
F7/8	.40 / -.02	.41 / .12	.10 / .03	-.15 / -.03
T3/4	.08 / .12	.07 / .07	.27 / .39	.03 / .20
T5/6	.03 / .22	.27 / .17	.06 / .28	.35 / .26

\*Bold r-values are significant at the  $p < .05$  level.

Differential patterns of EEG were associated with each memory process.

- Immediate and delayed recall performance were both associated with bilateral activation at various frontal scalp locations,  $r's = .39-.59, p's < .05$ . Better performance on recall tasks was associated with baseline-to-task increases in EEG Power at these sites.
- Immediate recognition performance was associated with right temporal and left frontal activation,  $r's = .39$  and  $.36$  respectively,  $p's < .05$ . Thus, better performance on this task required activation in both frontal and temporal regions.
- Delayed recognition performance was associated with left temporal activation,  $r = .35, p < .05$ . Better performance on the delayed recognition task recruited only activation from the temporal lobe.

## DISCUSSION

These data suggest that even in early childhood, a striking dissociation can be observed between frontal processing of recall memory and temporal processing of recognition memory. These findings represent some of the first data to show that this dissociation is present and active in a period of early childhood when the frontal lobe is undergoing major structural and functional transition. Subsequent examinations will track the mnemonic and neurological development of these children in efforts to explore developmental pathways of these processes.