



## INTRODUCTION

The purpose of this study was to examine, within-subjects, the relations between infants' performance on tasks assessing three different forms of memory function: spatial working memory, recognition memory, and explicit memory. Task selection was guided by developmental work exploring neural correlates of cognition. The spatial working memory was investigated with a looking A-not-B task (Bell & Adams, 1999) in which high performance has been associated with brain electrical activity at frontal scalp electrodes (Bell, 2001, 2002). Novelty preference, as a measure of recognition memory (Nelson, 1995), was examined using visual paired comparison, typically associated with the temporal lobe function. Infants who prefer novelty show activation at temporal scalp electrodes (Morasch & Bell, 2005). Finally, recent investigations of explicit memory, classically associated with temporal lobe function, have indicated that patterns of frontal lobe activity are predictive of memory performance after a delay (Bauer et al., 2003). A between-subjects deferred imitation design was used to assess explicit memory.

We hypothesized that performance on the spatial working memory and recognition memory tasks, having been associated with different areas of brain electrical activity, would be independent. In addition, we hypothesized that, as a group, 12-month-old infants would not demonstrate an overwhelming visual preference for novelty. This is consistent with Colombo et al. (2001) who showed that preference for novelty declines over the first year of life and is absent after 9 months. In addition, because explicit memory performance has been associated with both the frontal and temporal areas, it was hypothesized that explicit memory would be related to both spatial working memory and recognition memory.

## PARTICIPANTS



Participants in this study were 48 12-month-old infants recruited from the New River Valley area of southwest Virginia. Infants were recruited to participate in 2 visits scheduled 24 hours (+/- 2 hours) apart. Infants were recruited if they were born within 2 weeks of their expected due dates and experienced no prenatal or birth complications. All infants weighed at least 2,500 grams at birth, required no oxygen at birth, and had no neurological diagnoses.

## Spatial Working Memory

**Procedure:** A looking version of the A-not-B task, developed by Bell & Adams (1999), was used to assess spatial working memory. Infants searched for a hidden toy by making eye movements to one of two identical hiding locations. The direction of the infant's first eye movement after being brought to midline was scored as either correct or incorrect. With continued success, reversal trials and delays between hiding and finding were used.

**Descriptives:** 46 Infants contributed complete data. Scale scores ranged from 0 to 9 with a mean of 4.57 ( $SD=2.31$ ). As in previous work in our lab, spatial working memory performance was divided into high (scale scores of 4 and above) and low (scale scores below 4) performers.

### Scale Scores

- 0 Does not look with just 1 bucket
- 1 Looks with 1 bucket, but mostly same-side errors
- 2 Looks with 2 buckets, but mostly same-side errors
- 3 A-not-B error with 2 buckets at 0-sec delay
- 4 Successful A-not-B at 0-sec delay
- 5 Successful A-not-B at 2-sec delay
- 6 Successful A-not-B at 4-sec delay
- 7 Successful A-not-B at 6-sec delay
- 8 Successful A-not-B at 8-sec delay
- 9 Successful A-not-B at 10-sec delay

## Recognition Memory



vs.



**Procedure:** Using a visual paired comparison procedure, infants encoded the familiarization puppet by accruing 4 looks, each separated by a 3-second look away from the puppet. Approximately 20 minutes after familiarization, infants were allowed to look at both the novel and familiar puppets for 30 seconds to establish visual preference.

**Descriptives:** 42 Infants contributed complete data. Percentage of time looking at the novel glove served as the dependent measure with a mean of 42.89% ( $SD=2.02$ ). As in previous work in our lab, recognition memory performance was divided using Fagan's criterion into either novelty preferring (above 53% of the time looking at the novel glove,  $n=10$ ) or non-prefering (less than 53% of the time spent looking at the novel glove,  $n=32$ ).

## Explicit Memory

**Procedure:** A between-subjects deferred imitation task was used to assess explicit memory (Hayne, 2004). Infants in the *Demonstration Group* encoded as the puppet's mitten was removed, shaken 3 times to ring the bells inside and replaced. This sequence occurred 5 times over a 60 second period. Infants in the *Activity-Matched Control Group* encoded as the puppet, with bells affixed to its back, was shaken in the same pattern as the demonstration group to control for visual and audio experience. All infants were tested 24 hours later (+/- 2 hours). Infants were given 90 seconds from the time they touched the puppet to imitate the target actions.

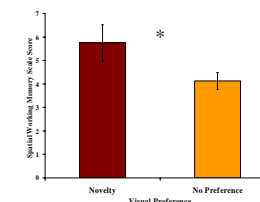
**Results:** 48 Infants contributed complete data. During the retrieval task after a 24-hour delay, there were no group differences in infants' latency to touch the puppet. However, there were significant group differences in the number of target behaviors reproduced ( $F(1, 47)=25.741, p<.05$ ). Infants who saw the demonstrated target actions reproduced more target actions ( $M=1.625, SD=1.377$ ), than those infants in the activity matched control condition ( $M=0.125, SD=.448$ ).



## RESULTS

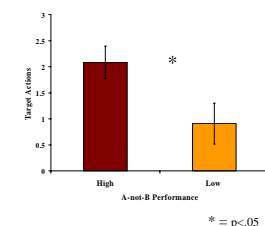
### Recognition Memory & Spatial Working Memory

A relation was found between recognition memory group and spatial working memory performance. Upon examination of the spatial working memory means, infants who preferred novelty scored higher the spatial working memory task ( $M=5.75, SD=.77$ ) than infants who did not display a visual preference for novelty ( $M=4.12, SD=.38; F(1, 42)=4.571, p<.05$ ).



### Spatial Working Memory & Explicit Memory

A relation was found between spatial working memory group and explicit memory performance (number of target actions, so Demonstration condition infants only). Upon examination of the explicit memory means, infants who were high performers on the spatial working memory task produced more target actions ( $M=2.08, SD=.39$ ) than infants who were low spatial working memory performers ( $M=.91, SD=.31; F(1, 21)=4.64, p<.05$ ).



### Recognition Memory & Explicit Memory

Again, to explore relations among these two tasks, it was necessary examine the performance of only the infants in the Demonstration condition of the deferred imitation task. There was no relation between recognition memory group (visual preference for novelty) and explicit memory performance (number of target behaviors produced),  $F(1, 21)=.154, p=.699$ .

## DISCUSSION

The analysis of infants' performance on these three separate memory tasks revealed several interesting relations. Performance on the Spatial Working Memory (SWM) task was related to both recognition memory (novelty-preferring infants had higher SWM than non-preferring infants), as well as explicit memory performance (high SWM performers produced more target actions than low SWM performers). However, there was no relation between recognition and explicit memory performance. Working memory has been described by Diamond (1990) as indistinguishable from sustained attention. It may be that the quality of sustained attention, which drives SWM performance, is related, not to retrieval, but the encoding processes during the recognition and explicit memory tasks. In addition, increased frontal lobe activity has been associated with the quality of sustained attention and high performance on the SWM task. Further investigations of these tasks might focus on the attentional components of information processing, as well as frontal lobe activity, as sources of individual differences in memory performance.