



INTRODUCTION

By the end of the first year of life, long-term recall memory has emerged in infants, often noted by success on tests of deferred imitation, measured both by reproduction of target actions of a novel event sequence, and by ordered recall of the sequence of those observed events. Although recent studies have indexed the quality of a long-term memory during a delay by employing event-related potentials as a predictor of delayed recall performance (Bauer, Carver, & Nelson, 2003), to date, there have been no direct investigations of task-related changes in cortical activity during the phases of the infant deferred imitation task.

In this study, we examined infant brain electrical activity (EEG) during the encoding phase of the deferred imitation paradigm. This physiological measure is especially appropriate for cognitive assessment during the low motoric demands of the encoding phase of the imitation paradigm. As a measure of explicit memory performance, deferred imitation has classically been associated with temporal lobe function (Nelson, 1995). However, recent evidence implicates the involvement of the frontal lobes in successful ordered recall after a delay (Bauer et al., 2003). Therefore, we were interested in the baseline-to-task cortical activity at both frontal and temporal scalp sites.






We hypothesized that infants in the demonstration condition would have different EEG patterns in frontal scalp locations as compared to infants in the activity-matched control condition. In addition, we hypothesized that infants in the demonstration condition would have different EEG patterns in temporal scalp locations as compared to infants in the activity-matched control condition.

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.

DEFERRED IMITATION PROCEDURE

Electrode Application		With the infant seated on the caregiver's lap, the experimenter applied EEG and ECG electrodes as an assistant entertained the infant.
Baseline Recording		Baseline physiology was collected as the experimenter manipulated an infant toy and tapped her fingernails for 60 seconds.
Encoding Groups	 DEMO GROUP  CONTROL GROUP	Demonstration Group: Infants 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. Activity-Matched Control Group: Infants 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.
Retrieval		Infants were tested for recall 24 hours later (+/- 2 hours). All infants were given 90 seconds from the time they touched the puppet to imitate. Dependent measures were the number of target actions and sequential pairs of actions reproduced.

RESULTS

Behavioral Results

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 ($F(1, 47) = 25.741, p < .0001$). 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 ($M = 0.125, SD = .448$). In addition, infants in the demonstration group ($M = 0.833, SD = 0.816$) produced more ordered pairs of actions ($F(1, 47) = 21.235, p < .0001$) than infants in the control group ($M = .042, SD = 0.204$).

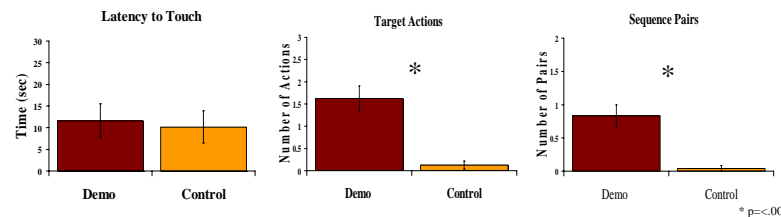
Physiological Results

There were no frontal or temporal differences in baseline EEG between infants who were in the demonstration or control groups. In addition, a repeated-measures MANOVA revealed no significant group differences in baseline-to-task related changes in brain electrical activity at either frontal or temporal scalp sites.

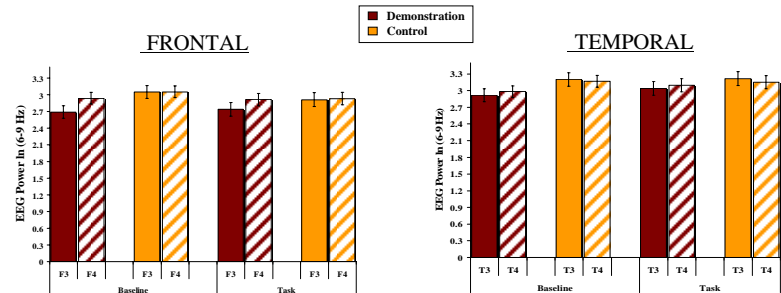
Individual Differences

Within the demonstration condition (n=24) there were no significant differences in baseline to task related brain electrical activity associated with either number of target actions reproduced or correctly ordered pairs of actions reproduced.

BEHAVIORAL RESULTS



PHYSIOLOGICAL RESULTS



DISCUSSION

Although, as predicted, infants in the demonstration condition reproduced more target actions and correctly ordered sequence pairs of actions than did infants in the activity-matched control group, patterns of brain electrical activity at both frontal and temporal scalp sites during encoding could not differentiate between the two groups, nor were they related to success within the demonstration group. Indeed, regardless of group, neither encoding display elicited significant baseline-to-task EEG Power changes, which was unexpected in light of the robust behavioral results. Perhaps with a more salient or exciting display, attention-related baseline-to-task changes during encoding may be observed. In addition, individual differences in successful imitation may be driven by variability in another phase of the paradigm, such as storage or retrieval (Bauer et al., 2005). Future studies should focus on a more in-depth physiological investigation of the phases of explicit memory creation and retrieval, perhaps utilizing a within-subjects design to capture individual differences in explicit memory performance.