Relations Between Infant Brain-Electrical Activity and Toddler Recognition Memory

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INTRODUCTION

Individual differences in infant cognition, including attention measures and recognition memory, have been found to be related to cognitive development in later childhood (Rose & Feldman, 1995; 1997). As a result of this consistent research finding, there has been a great deal of attention given to individual differences and neural networks involved in the development of attention and memory processes. Individual differences in visual attention during the familiarization phase of infant memory paradigms have been highly correlated with the establishment of novelty preferences within the first year of life. Posner (Posner & Raichle, 1995) has suggested that the frontally-mediated vigilance attentional network of the brain is involved in effortful sustained processing of continuous visual stimuli. It may be that individual differences in the functioning of this vigilance attention network during infancy contribute to individual differences in later childhood cognitive processes. However, temporal lobe function has classically been associated with performance on tasks assessing explicit and pre-explicit memory systems (Nelson, 1995). For these reasons, our investigation focused on task-related activations at both frontal and temporal sites during infancy as potential predictors of cognition in toddlerhood, specifically, recognition memory performance.

Brain-electrical activity was explored as a possible source of variance in the establishment and expression the encoding process. In this study, we examined the EEG activity of 69 10-month-old infants during baseline and the familiarization phase of the infant recognition memory paradigm. Changes in task-related brain-electrical activity during infancy were considered in relation to delayed recognition memory performance at 2-years of age. 24-month recognition memory was assessed using a toddler version of the visual paired comparison paradigm, asking children to encode and recognize 3 novel objects (common food items) across a 25-minute delay.

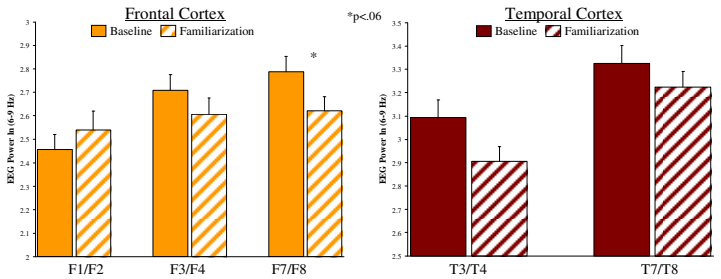
PARTICIPANTS

Participants in this study were recruited as infants from the New River Valley area of southwest Virginia. Of the original sample of 105 5-month old infants, 89 returned and contributed complete physiological and behavioral data at 10 months (+/- 2 weeks). At the 24-month assessment (+/- 2 months), 69 of these children returned and contributed behavioral data.

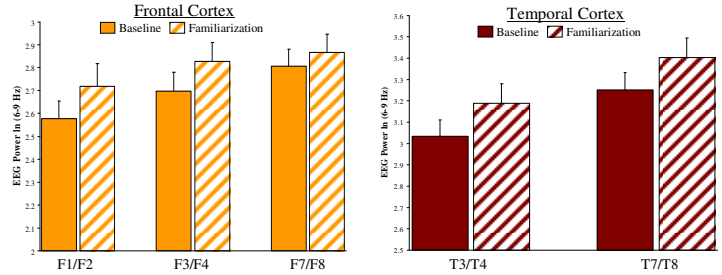
RECOGNITION MEMORY PROCEDURES

Electrode Application		With the infant seated on the caregiver's lap, the experimenter applied EEG electrodes as an assistant entertained the infant.
Baseline Recordings		Baseline physiology was collected as the experimenter manipulated an infant toy and tapped her fingernails for 60 seconds.
Infant Encoding		At 10-months, EEG was collected as infants encoded the familiarization puppet by accruing 4 looks, each separated by a 3-second look away from the puppet (Diamond, et al., 1997).
Toddler Recognition		At 24-months, toddlers watched as 3 common food items were placed into a bag. After a 25-minute delay, each familiar item was paired with another, novel item. Toddlers were asked to recognize which of the items had been placed in the bag.

Toddler VPC Performance (High)



Toddler VPC Performance (Low)



RESULTS

Behavioral Results

Performance on the toddler recognition memory task was coded and dichotomized as either high performance (2 or 3 correct responses, n=41) or low performance (0 or 1 correct response, n=28).

Behavioral and Physiological Results

A repeated measures MANOVA revealed a Performance Group x Task Phase x Region interaction (Hotelling's Trace, p=.027). Regional analyses indicated a Performance Group x Task Phase interaction at posterior frontal (F7/8) scalp locations (Hotelling's Trace, p=.06). Further examination of the means revealed that infants who performed well on the delayed recognition task at 2 years showed baseline-to-task decreases in EEG power values at frontal, but not temporal sites during infant encoding, whereas toddlers who demonstrated poor delayed recognition showed no attention- related changes at these sites as infants.

DISCUSSION

These results are of interest for several reasons. First, attention-related changes in infant EEG discriminated cognitive performance during toddlerhood. That this effect was isolated to the frontal cortex is particularly interesting, as this supports Posner's argument for a frontally-mediated anterior attention network. This serves as further evidence that individual differences in infant attentional processing may be predictive of later cognitive performance.

Second, whereas successful performance on a working memory measure of infant and preschool cognition has been associated with task-related increases in concurrent EEG power values (Bell, 2002; Wolfe & Bell, 2004), the data reported here indicate that a different EEG pattern is apparent when relating infant EEG to later toddler recognition memory abilities. We recorded toddler EEG during the recognition memory task and our next task is to analyze these concurrent data to see if the usual pattern of task-related increases in EEG is apparent.

Finally, as we continue to follow this cohort of children, we will be able to determine whether toddler EEG during recognition memory tasks is associated with performance on recognition memory tasks during later preschool years.