

Reaching vs. Looking: Individual Differences in EEG and HP Variability from 5 to 10 Months

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Introduction

Recently, Bell and Adams (1999) argued that prefrontal cognitive skills of working memory and inhibitory control essential for reaching performance on the A-not-B task (Diamond, K. Prevor, Callender, & Druin, 1997) are also essential for looking performance on the task. Using a within-subjects research design, Bell and Adams demonstrated comparable performance on reaching and looking A-not-B tasks among 2 different groups of 8-month-old infants. If cognitive skills are comparable across response modality, the only developmental differences in reaching and looking A-not-B performance should involve maturation of circuitry associated with the actual response itself. The purpose of this study was to assess developmental changes in performance on reaching and looking versions of the A-not-B task in the same group of infants. The hypothesis was that looking performance would be superior to reaching performance prior to 7 or 8 months of age. Before that age the coordination of gross motor movement with the working memory and inhibitory skills appears too difficult for the young infant's repertoire. After this age, however, performance on the two tasks should be comparable.

The neuropsychological model also accounts for individual differences in frontal lobe development. Thus, it also was hypothesized that after 8 months of age there would be individual differences in performance such that some infants would continue to perform at a higher level on the looking task. Other infants, however, would perform at a higher level on the reaching task, or at equal levels on reaching and looking. Each of these patterns of development were hypothesized to be associated with different patterns of frontal EEG activity across age (Bell & Fox, 1992). Heart period was recorded and HP variability computed to explore possible individual differences in attentional abilities associated with A-not-B performance. Richards & Casey (1991) have speculated that the frontal lobe and limbic areas interact with respiration centers in the brain stem during attention. The result of this interaction is a decrease in respiratory sinus arrhythmia, a component of HP variability. Thus, looking task performance may result in decreases in HP variability relative to baseline levels.

Participants & Methods

Fourteen infants (8 male) were participants in this longitudinal investigation. Infants were healthy, full-terms born to upper-middle-class parents in Montgomery County, Virginia. Infants were seen monthly between 5 and 10 months of age for a total of 6 visits.

At monthly testing sessions, each infant participated in reaching and looking tasks, both designed to assess working memory and response inhibition in similar contexts. The reaching task was very active and required refined gross motor skills for success. It is considered the more difficult task because of the extra memory demands associated with reaching. The looking task was very passive, requiring only glancing eye movements during task performance. It is considered to be a much easier task (Ahmed & Ruffman, 1998; Hofstadter & Reznick, 1996); however, that notion has recently been questioned (Bell & Adams, 1999; Smith, Thelen, Titzer, & McLin, 1999). EEG and HP were recorded during baseline and looking task assessment. Artifact associated with gross motor movements during reaching task precluded EEG recording during the reaching version of the task.

Reaching & Looking Tasks



Reaching Task

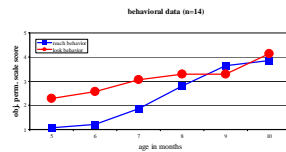
- 1 = object partially covered (one cloth)
- 2 = object completely covered (one cloth)
- 3 = object hidden under 1 of 2 identical cloths, but A-not-B error
- 4 = A-not-B with 0 delay
- 5 = A-not-B with 2-sec. delay
- 6 = A-not-B with 4-sec. delay



Looking Task

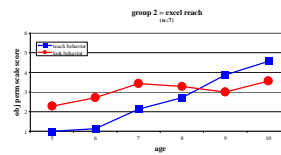
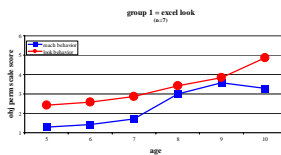
- 1 = object partially covered (one tub)
- 2 = object completely covered (one tub)
- 3 = object hidden under 1 of 2 identical tubs, but A-not-B error
- 4 = A-not-B with 0 delay
- 5 = A-not-B with 2-sec. delay
- 6 = A-not-B with 4-sec. delay

Behavioral Data

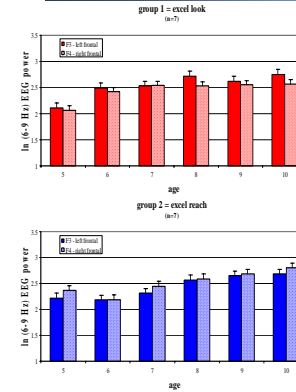


MANOVA main effects & interactions:
modality --- $F(1,13)=15.37, p=.002$
age --- Wilks' $\lambda=.11$, approx. $F(5,9)=14.53, p<.001$
modality X age --- Wilks' $\lambda=.29$, approx. $F(5,9)=4.50, p=.025$
 modality differences at 5, 6, 7 months (all $p's \leq .001$)
 no modality differences at 8, 9, 10 months (all $p's > .13$)

Examination of behavioral data of individual infants revealed 2 patterns of development. All infants performed at a higher level on the looking task until 8 months of age. At that point, group 1 continued to perform better on the looking task relative to the reaching task. Group 2, however, showed better performance on the reaching task (or equivalent reaching and looking) at 9 & 10 months of age relative to their performance on the looking task.



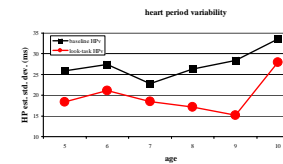
Frontal EEG Data



MANOVA main effects & interactions:
modality --- $F(1,12)=5.42, p=.038$
age --- Wilks' $\lambda=.14$, approx. $F(5,8)=9.79, p=.003$
group X hemi --- $F(1,12)=10.25, p=.008$

At medial frontal scalp locations (F3,F4) the group that continued to perform at a higher level on the looking task exhibited greater left frontal EEG power values, while the group that performed at a higher level on the reaching task by 9 & 10 months exhibited greater right frontal EEG power values.

HP Variability Data



MANOVA main effects & interactions:
condition --- $F(1,12)=9.60, p=.009$

The infants in this study exhibited lower HP variability during the working memory/inhibitory control portion of the looking task relative to baseline HP variability. Individual differences in behavioral development were not associated with HP variability measures.

Conclusions

As predicted, this group of infants performed at a higher level on the looking version of the task from 5 to 7 months of age. From 8 to 10 months of age, there were individual differences in development associated with specific patterns of frontal brain electrical activity. Although frontal EEG asymmetries have been reported in relation to A-not-B performance at 8 months of age (Bell, 2000; Bell & Fox, 1997), the patterns noted here appear to be persistent with respect to age and may represent some underlying individual difference in brain structure and/or functioning. Examination of EEG at other scalp locations in this data set will allow us to determine whether this pattern is specific to frontal recording sites. HP variability has yielded information concerning individual differences in cognition in other infant studies (Linnemeyer & Porges, 1986; Richards, 1987), but in this study initial analyses show no association. There was, however, less HP variability for all infants during the looking task as predicted.