

Individual Differences in Spatial Memory at 12 Months of Age: Contributions from Walking Experience and Brain Electrical Activity

Denise R. Adkins, M.S. & Martha Ann Bell, Ph.D.

INTRODUCTION

The relation between self-locomotion and performance on spatial cognition tasks has been examined in behavioral (Acredolo & Evans, 1980; Acredolo, Adams & Goodwyn, 1984; Bai & Bertenthal, 1992; Bertenthal, Campos & Kermonian, 1994) and electrophysiological research (Bell & Fox, 1997). Briefly, it has been shown that hands-and-knees crawlers score higher on spatial cognition tasks than non-crawlers and that hands-and-knees crawlers display greater frontal and occipital baseline EEG power values relative to non-crawlers. Previous work in this area has focused on hands-and-knees crawling as the means of locomotion. More recent research attempts to study the interrelations between cognitive and motor development have focused on older infants who locomote by walking (Berger, 2004; Clearfield, 2004). The purpose of the current study was to investigate individual differences in spatial cognition with respect to walking experience and brain electrical activity in 12-month-old infants. It was specifically hypothesized that:

- 1) Novice walkers would show higher power in the central region than non-walkers and experienced walkers because the central region has been associated with learning new motor movements, posture control, locomotion and purposeful movement (Billard, 2000; Diamond, 1990b; Massion, Viallet, Massarino, & Khalil, 1989; Miyai, Tanabe, Sase, Eda, Oda, Konishi, Tsunazawa, Suzuki, Yanagadi, & Kubota, 2001).
- 2) Walkers will score higher than non-walkers on the spatial memory tasks.
- 3) Infants scoring higher on the spatial cognition tasks will evidence higher EEG power in frontal and parietal regions.

PARTICIPANTS



50 12-month-old infants, aged 52-55 weeks, (26 male, 24 female) were recruited through the Virginia Tech Developmental Sciences database for this study. Behavioral and physiological data were available for 43 infants. Infants were born to middle- and upper-middle-class parents. All parents had at least a high school diploma. The sample was predominantly Caucasian.

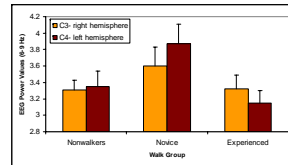
PROCEDURE

Baseline EEG was recorded for 2 minutes. Then, infants participated in the Object Retrieval (Diamond, 1990) task and the classic reaching A-not-B task to assess spatial memory. Both tasks required the infant to recall where the object was in space. The tasks differed in the occlusion of the toy. Infant locomotor status was obtained via parent report and verified at the end of the session.

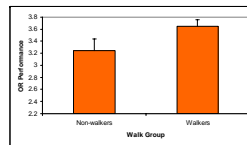


RESULTS

Hypothesis 1: Novice walkers showed greater EEG power than experienced walkers ($t(24) = 2.41, p = .02$) and a trend for greater power than nonwalkers ($t(29) = 1.71, p = .10$) in the right central scalp location. There were no power differences among the groups at left central.

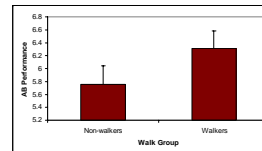


Hypothesis 2: There was a trend for walkers ($n=26$) to score higher than non-walkers ($n=17$) on the OR task ($F(1, 41) = 3.90, p = .055$). No difference was seen between walkers and non-walkers on the AB task ($F(1, 41) = 1.81, p = .19$).

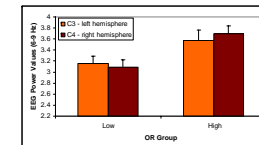
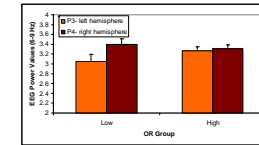
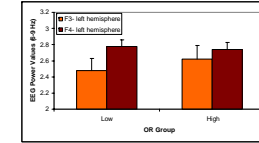


OR coding (Bell & Fox, 1992, as per Diamond):
 2= Lean and look while reaching
 3= Lean and look, sit up and reach
 4= No lean and look

A-not-B coding (Bell & Fox, 1997):
 4= 0-sec delay 7= 6-sec delay
 5= 2-sec delay 8= 8-sec delay
 6= 4-sec delay 9= 10-sec delay



RESULTS, cont.



Hypothesis 3: Infants who scored higher on the OR task showed higher EEG power values in left medial frontal ($t(41) = 1.97, p = .056$), and left parietal ($t(41) = 2.47, p = .02$) areas than infants scoring lower on the OR task. Higher scoring infants also showed greater power in the left and right central region than lower scoring infants ($F(1, 41) = 5.33, p = .02$). There were no EEG differences between AB performance groups.

CONCLUSION

Hypothesis 1: EEG differences in the central region for the 3 walk groups may be related to experience-expectant synaptic bursts (Bruer & Greenough, 2001) or experience-dependent connections formed by learning new motor movements, posture control, a new form of locomotion and purposeful movement. Hypothesis 2: Infants who were walking showed a trend for higher performance on the OR task than non-walkers. However, there were no differences between walking groups on the AB task. It may be that changes which occur due to the transition from crawling to walking influence spatial memory performance on certain types of tasks. Hypothesis 3: There were no EEG differences among AB performance groups, unlike previous work with younger infants (Bell & Fox, 1997). However, consistent with the hypothesis, infants scoring higher on the OR task had greater EEG power in left medial frontal, left parietal and left and right central scalp locations. Frontal and parietal areas have been associated with spatial memory performance (Bell & Fox, 1992, 1997) and central areas are suggested as necessary for successful OR task performance (Diamond, 1990).