Infant Language Assessment Predicts Later Math Disabilities

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Background and Significance

Prevention of cognitive disabilities currently remains out of reach. Yet, interventions are crucial to maximizing developmental outcomes later in life. To be effective, interventions must occur at the earliest age possible to mitigate potential developmental problems. This study is an attempt to identify newborn infants at-risk for developing math disabilities later in life.

Several studies used assessment tests at relatively late ages in order to predict future cognitive abilities (Aarnoudse-Moens et al., 2013; Kiechl-Kohlendorfer et al., 2013). More recent research used MRI scans of neonate brains to investigate the relationships between academic abilities and preterm births (Ullman et al., 2015). While these studies laid groundwork for prediction models, they primarily focused on physiological and social factors associated with preterm births.

The present research examined possible precursors of math disabilities utilizing event-related potential (ERP) brain wave responses recorded from infants within 36 hours after birth. We hypothesized that infant brain responses to speech and nonspeech stimuli could predict individual predispositions to developing math difficulties later in life.

Methods

Each stimulus contained an initial 50-ms rapid-frequency transition followed by three steady state formants lasting 250 ms in duration. Rise and decay times were matched at 4 ms across stimuli. All stimuli were identical in peak intensity and duration. Stimuli were presented using an 8-Ohm speaker positioned 1 m above the infant’s head and equidistant from each ear. Intensity of stimuli was 80 dB SPL(A) as measured at the infant’s ear. EEG activity and behavioral state were monitored throughout the testing session and were used to determine when stimuli were presented to the infant. Infants were presented information only during quiet, awake states as determined by both behavioral and EEG indices.

Results

The averaged ERP amplitude and latency for N1, N2, and P2 peaks for each stimulus and each infant were analyzed using regression procedure in which the speech stimuli were used to predict quantitative performance as measured on the Stanford-Binet math subset administered at four years of age.

Example Stanford-Binet Quantitative Test Items

- “Two children are playing ball. Another child comes to play with them. How many children will there be then?”
- “Point to the picture that shows the girl standing between the tree and the boy.”

Methods (Continued)

Auditory evoked responses to speech and nonspeech stimuli recorded from newborn, 1, 2, and 3 years of age.

Discussion

The present findings suggest that early auditory discrimination abilities may relate to later emerging quantitative skills by four years of age. This pattern of responding suggests that those with better quantitative skills later in life show more advanced nervous system development at birth, which could allow for finer auditory distinctions. The present study, while showing a definite relationship between brain responses shortly after birth and differences in quantitative skills at four years of age, does not necessarily mean acoustic discrimination, per se, is critical for subsequent skill development. However, it does suggest some relationship exists between early auditory discrimination skills and the emergence of some aspects of later emerging cognitive development.

References


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