Infant Language Assessment Predicts Later Math Disabilities

Aaron T. Halvorsen
University of Nebraska - Lincoln, aaron.halvorsen@huskers.unl.edu

Dennis Molfese
University of Nebraska-Lincoln, dmolfese2@unl.edu

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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 NIH R01 HD073202 and NIH R01 HT17860 to focus on speech and auditory processing in newborns. The results of the ANOVA for each stimulus and 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.

Methods (Continued)

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 80-Hz 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 at four years of age. ERPs to five stimuli produced an r across analogs (et al., 2013). More recent research used NIH R01 HD073202 and NIH R01 HT17860 to focus on speech and auditory processing in newborns. The results of the ANOVA for each stimulus and 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

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 network 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.

Methods

Auditory evoked responses to speech and nonspeech stimuli recorded from newborn, 1, 2, and 4 years of age.

Auditory stimulus was presented to 84 infants within 36 hours after birth. Auditory event-related potential (ERP) brain responses to stimuli were recorded from six electrode sites. Two electrodes were placed on left and right frontal (Fp1, Fp2), left and right temporal (T3, T4), and left and right parietal (P3, P4), and referred to linked ears (A1, A2). Two electrodes were placed supraorbital and canthal of the left eye to monitor eye movements and muscle artifacts. Mean electrode impedances were 1.5 kOhms before and after the test sessions. All electrode impedances were within 1 kOhm of each other.

Stimuli consisted of two computer-synthesized, consonant-vowel speech syllables (/ba/, /ga/), each composed of three formants with bandwidths of 60, 90, and 120 Hz (formant 1, 2, and 3 respectively). An additional two nonspeech analogs were used as control, each composed of three sine waves matched to the center frequency for each of the three formants of the speech syllables with 1 Hz bandwidth.

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 at four years of age. ERPs to five stimuli produced an r² of 0.332 in predicting performance. These predictors are displayed in the model summary of Table 1. The results of the ANOVA for each predictor are presented in Table 2.

Table 1

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References


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 network 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.

Acknowledgments

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