Mismatch Responses to Pure Duration Changes in 4-, 7-, 10- and 14-Month-Old Infants
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Introduction
Infants’ ability to detect duration change is crucial for their speech development. Mismatch Negativity (MMN) – an auditory event-related potential (ERP) component that represents pre-attentive change detection processing. Main advantage of using MMN to study change detection in infants - it can be elicited without attention, thus does not require infant’s attention and cooperation. Therefore, makes it a useful tool for examining infants’ ability to discriminate duration changes. However, most infant MMN research has focused on frequency or phonetic changes (e.g. Cheour et al., 1998; Kushnerenko et al., 2002; He et al., 2007). Only a few studies have examined pure duration changes (Caspian et al., 2002; Cheour et al., 2002; He et al., 2009). Not all of these studies have examined infants of different ages.

Primary Aim: To examine infant MMN generated by duration deviations using pure tones.
Secondary Aim: To investigate if duration MMN differs as a function of age.

Methods and Materials

MMN and EEG Paradigm:
- 85% standards = 100ms (including 10ms rise/fall times).
- 15% Deviants = 50ms (including 10ms rise/fall times).
- 1000Hz, 80dB SPL pure tones.
- Mean SOA = 400ms (range 350 - 450 ms).
- Tones presented with two speakers placed in front of the infants.
- White noise background.
- 124 EEG sensors (Electrical Geodesics, Inc).
- EEG Acquisition Rate: 250Hz.

Participants:
- 4-month-olds (N = 14); 7-month-olds (N = 16); 10-month-olds (N = 15); 14-month-olds (N = 14).
- Exclusion criteria included: hearing problems, any history of epilepsy or head injury, any familial history of schizophrenia and psychiatric disorder.

MMN and Statistical Analysis:
- Electrodes interested: Fz, T3 and T4.
- Band-pass filter 1-30Hz.
- Segmented -100ms to 500ms.
- Artefact rejection (max - min > 150 μV; exclude the front row of electrodes).
- Baseline corrected to the period -100ms to 0ms.
- Average reference.
- Averaging to standards and deviants separately.
- MMN Difference wave = Deviant - Standard.
- Any subject with less than 65 accepted deviant epochs was excluded.
- Mean MMN amplitudes = mean voltage over 25ms periods in the time window of 100ms - 400ms.
- Two-tailed t tests on the mean MMN amplitude of each of the 25ms-periods at Fz, T3 and T4.

Results

Figure 1: The grand average waveforms corresponding to standard, deviant and MMN difference responses for the 4-month-old group at Fz, T3 and T4 electrodes.

Figure 2: The grand average waveforms corresponding to standard, deviant and MMN difference responses for the 7-month-old group at Fz, T3 and T4 electrodes.

Figure 3: The grand average waveforms corresponding to standard, deviant and MMN difference responses for the 10-month-old group at Fz, T3 and T4 electrodes.

Results (cont.)

Figure 4: The grand average waveforms corresponding to standard, deviant and MMN difference responses for the 14-month-old group at Fz, T3 and T4 electrodes.

Statistical Results:
- 4-month-olds:
  Mean MMN amplitude did not differ significantly from 0V for any of the 25ms-periods from 100-400ms at Fz, T3 and T4 electrodes.
- 7-month-olds:
  Mean MMN amplitude differed significantly from 0V for the 25ms-period from 150-275ms at Fz electrode (as indicated by the shaded area of Figure 2).
- 10-month-olds:
  Mean MMN amplitude differed significantly from 0V for the 25ms-period from 200-225ms at T3 electrode (as indicated by the shaded area of Figure 3).
- 14-month-olds:
  Mean MMN amplitude differed significantly from 0V for the 25ms-period from 200-225ms at T3 electrode (as indicated by the shaded area of Figure 4).

Discussion and Conclusion
Our results suggest that duration MMN was generated by pure tones in infants 7 months and older in the left temporal region. It should be noted that the duration MMN detected does not seem to correspond to the frontal component of MMN.

Possible reasons for this:
1) The orientation of MMN dipole(s) generated by pure duration tones in infants might be different to that in adults.
2) Since the frontal generator system has been suggested to represent the downstream attention-switching system, initiated by the temporal change-detection change generators in adults (Rousseau et al., 2006), the current paradigm might be not sensitive enough to activate the attention-related frontal component in infants.
3) The employed paradigm is not sensitive enough to generate infant MMN, particularly when complex tones generate larger MMN in adults than pure tones (Terassi et al., 2000).

Further analysis will be needed to determine if the MMN responses are real.