Introduction

Language delays are a risk factor for language disorders such as Specific Language Impairment (SLI).

Auditory short term memory deficits have been shown to be a predictor of language development in children with SLI.

The mismatch negativity (MMN) of event-related potentials (ERPs) is thought to represent auditory sensory memory.

The conventional MMN oddball paradigm is lengthy, especially when testing for several durations of auditory sensory memory and thus, can be prohibitive in studies involving young children who do not tolerate long testing sessions. A time-saving MMN paradigm was developed by collapsing the standard tones into trains allowing for many stimuli to be delivered in a very short time while preserving a 7-11 s standard to deviant tones.

This time-saving MMN oddball paradigm has been used to investigate auditory sensory memory in young children.

One study included children ages 2 to 5 years, but did not use the same interstimulus interval (ITI) across the ages (2 yr olds received 500 and 1000 ITI; 3 and 4 yr olds received 500 and 2000 ITI, and 5 yr olds received 3000 and 5000 ITI).

The other study only included 4 year olds and investigated a 500 ms ITI and 2000 ms ITI.

Consequently, the same ITIs have not been used in young children across 2 to 5 years of age incorporating a within-study design.

Methods

Participants

36 Children (10 girls and 18 boys) 2 to 5 years of age (M=43 months, SD=12.9) completed the study.

Procedures

Participants were seated quietly in a relaxed position while watching an animated silent video (Shaun the Sheep) during the auditory stimulus presentation.

Mismatched Negativity Paradigm

4 conditions (different inter-train intervals; ITI) with 700 standard and 100 deviant tones each. Standard tones were 1000 Hz and had a duration of 100 ms.

Deviant tones were 1200 Hz and had a duration of 100 ms. Each block contained 4 tones and was led with either a standard or a deviant tone (See Figure 1). 8 blocks of each ITI (500, 1000, 2000, 3000) ms presented in random order. A block consisted of 50 trials of the same ITI.

Electrophysiological Recordings

Biosemi EEG-ActiveTwo system

32 scalp sites, 2 bipolar eye monitors

Recorded at A-D Flakes-1024 Hz

Bandwidth-2644 Hz; Gain: 1000

Offline filter 22-32 Hz band pass for scoring MMN

EEG artifact rejection of (100–1200 μV)

Only FZ site reported here for ERP applications

MMN scored as average voltage with 210-250 ms window post stimulus onset

Electrophysiological Recordings

Table 1. Mean amplitudes of ITIs.

<table>
<thead>
<tr>
<th>ITI (ms)</th>
<th>Averaged Amplitude Mean (μV)</th>
<th>Standard Deviation (μV)</th>
</tr>
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<tbody>
<tr>
<td>500</td>
<td>3.55</td>
<td>1.34</td>
</tr>
<tr>
<td>1000</td>
<td>4.28</td>
<td>2.12</td>
</tr>
<tr>
<td>2000</td>
<td>5.03</td>
<td>2.85</td>
</tr>
<tr>
<td>3000</td>
<td>6.85</td>
<td>3.64</td>
</tr>
</tbody>
</table>

Figure 2. 3-way ANOVA testing statistically significant differences between standard and deviant by time and scalp-site.

Figure 3. Grand averaged ERP of FZ for each ITI. Grey area depicts significance shown in Table 1 and Figure 4

Results

MMN

Averaged amplitude of MMN was largest for the 1000 ITI and smallest for the 3000 ITI (see Table 1 and Figure 4).

Significant Differences were found between 1000 ITI and 3000 ITI (see Table 1 and Figure 4).

Relationship Between MMN and Language Measures

Separate 2-Step Regression Models were used to evaluate the relationship of MMN to language development across the period of 2 to 5 years of age.

For Expressive Language:

Step 1 revealed that age by itself was a significant predictor of expressive language, R2=.76, F(1, 33)=105.94, p<.0005

Step 2 revealed full model predictive expressive language, R change =.044, F= 24.24, p<.0005

Examination of Beta weights reveal only MMN of the 3000 ITI was a significant predictor, t=2.16, p=.04 (see Table 2)

Conclusions

The MMN of the 3000 ITI condition was a significant predictor for expressive language, R2=.76, F(1, 33)=105.94, p<.0005. Notably the MMN amplitude for the 500 ITI was smaller than the 3000 ITI. The two-year-olds had larger MMN amplitudes than the five-year-olds. This is converse of what is expected based on previous research.

Acknowledgements:

Funded in part by Office of the Minister of Research, Science and Technology, New Zealand, International Mobility Fund to SSI TR, WLC & Occupational Therapy Department, Colorado State University to PD & WG.

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References


