

## ORIGINAL ARTICLE

### Mismatch Negativity in Children with Specific Language Impairment

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**Objective;** The purpose of this study was to investigate the Mismatch negativity (MMN) in specific language impairment (SLI) children for better understanding of the nature of the problem.

**Materials & Methods;** This prospective study comprised 39 SLI children and 33 children with normal hearing and language development. The children were evaluated through a diagnostic protocol that included Arabic language test and audiological assessment.

**Results;** We found that MMN waveform was clear and robust in SLI children in the expected latencies and amplitude in comparison with the normal control children.

**Conclusion;** We concluded that auditory processing that reflect pre-attentive process in SLI children are intact and other factors might be incriminated in the causation of their delayed language development.

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Specific language impairment (SLI) is an unexplained developmental difficulty in acquisition of expressive language<sup>[1]</sup>. This language impairment could not be explained by any developmental disabilities such as mental retardation, neuromotor impairments, persistent sensory-motor deficits, autism or any pervasive cognitive defects, or any environmental deprivation<sup>[2]</sup>. This difficulty has been defined principally by a discrepancy between the child's achievement and chronological age expectations provided by norms for the language measures employed in the diagnosis, i.e. chronological age discrepancy<sup>[3]</sup>. Children with SLI have problems with understanding and formulating language and they have, also, difficulty with specific social tasks that affect their group cooperation<sup>[4]</sup>. Hallmark characteristics of those children include the late onset of first words and word combinations and pronounced difficulty with grammatical morphology<sup>[5]</sup>.

It has been postulated that children with a SLI have an impaired ability to process rapid or brief sounds. They are less able to process rapid auditory information than children with normal spoken language skills. These children with SLI have a fundamental perceptual limitation affecting processing of rapid or brief stimuli, and this has disproportionately severe consequences for language learning. Deficits and/or differences in timing, magnitude and topography of the neural activity associated with a child's auditory discriminative processes would have implications for higher-level cognitive processing of sound, which is necessary for language development<sup>[6]</sup>.

Mismatch negativity (MMN) is an electrophysiological measure that reflects auditory discrimination as it indexes the underlying neural process and correlates well with behavioural discrimination<sup>[7, 8]</sup>. The MMN can be elicited by

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infrequent changes in a sequence of a repetitive auditory stimulus or features of the auditory stimulus.<sup>[9]</sup> This can be achieved by using a passive “oddball paradigm”. That is, stimuli are presented in a sequence in which a “standard” stimulus occurs most of the time, and a “deviant” stimulus occurs a small percentage of the time. A computer-based averaging system tracks and sorts the response to standard stimulus and the response to deviant stimulus, and then they are subtracted from each other<sup>[10]</sup>. It is automatic, pre-attentive response to stimulus change. It can be elicited in the absence of attention<sup>[11]</sup>. Since MMN is a pre-attentive measure, it can be used with children, and it is likely not to involve attentional, cognitive, or integrational processes. It can reflect discrimination of fine differences in auditory stimuli<sup>[10, 12]</sup>.

The purpose of this study was to investigate and to measure the Mismatch negativity results in children suffering from specific language impairment in order to evaluate their discrimination of fine differences in auditory stimuli that reflect their pre-attentive process for better understanding of the nature of the problem and to compare them with normal language development children.

## **Materials & Methods**

Two groups of children (SLI and control) participated in this prospective study. One group (SLI group) included 39 children with their ages ranged from 3 to 11 years (mean =  $5.6 \pm 1.7$  years) who attended the Phoniatric unit, University Hospitals, and had been diagnosed by the Phoniatrician as having specific language impairment. The other group (control group) included 33 children with normal hearing and normal language development with their chronological ages matched the SLI children. The ages of the control children ranged from 3 to 10 years (mean =  $5.4 \pm 1.3$  years).

*All the children were evaluated through a diagnostic protocol that is applied in Phoniatric Unit/Faculty of Medicine and included:*

## **I-Elementary diagnostic procedures:**

A-Patient/Parent interview: Children who had other risk factors that could adversely affect global or language developmental outcome e.g. low birth weight, a history of neonatal asphyxia or other serious illness and a major congenital malformation or chronic illness were excluded from the study.

B-Vocal tract examination: Cases with palatal abnormality e.g. cleft palate, submucous cleft etc. was excluded from the study.

## **II-Clinical diagnostic aids:**

A- I.Q. assessment: using Stanford Binet intelligence scale (Thorndike et al; 1986)<sup>[13]</sup>.

B- Language evaluation: using the Arabic Language test<sup>[14]</sup>. A total language age was calculated for every child.

C- Audiological evaluation: Carried out in the Audiology Unit, Faculty of Medicine and included:

1- Otoscopy.

2- Play audiometry: All children passed a pure-tone audiometric screening of both ears at 20 dB HL air and bone conduction thresholds (at 500-4000 Hz) using a Madsen OB 822 pure-tone and in a sound treated booth.

3- Immittanceometry was done with acoustic reflexes using an Interacoustics immittance meter model AZ7. Acoustic immittance testing was performed before the electrophysiological evaluation by MMN to rule out affection of the middle ear.

4- All participants in this study subjected to electrophysiological study using Bio-Logic evoked potential set (Bio-logic recording system version 5.64 model 317). MMN was recorded and analyzed as regard its latency in msec and amplitude in  $\mu V$ .

*Mismatching negativity (MMN) parameters:*

The auditory stimuli were presented in oddball paradigm, and MMN response was recorded for each child. The stimuli were train of 750 Hz tone burst standards (probability = 0.8) occasionally replaced by

1,000 Hz tone burst deviants (probability = 0.2). Tones were presented at 75 dB pe SPL. Children were seated in a sound attenuated chamber and were instructed to ignore the auditory stimuli. They were given a pictured storybook to look at during the MMN recording. Responses were recorded using surface electrodes and separate averages were computed for standards and deviants. Averaged waveforms were digitally filtered and baseline corrected. MMN was observed by subtracting waveform obtained to stimuli presented as standards from those obtained to deviants. MMN amplitude was measured for each child at the peak latency obtained at Fz and the latency was measured at the midpoint of the component peak.

Mean and standard deviation were used to describe data. The t- test was used to test for the differences in the latencies and amplitude between the SLI group and control group. P was considered significant if  $< 0.05$ .

## Results

### (A) Results of I.Q. assessment and language evaluation:

All children fell within the normal range of Performance IQ (i.e. between 90 and 110, with a mean of  $102 \pm 1$  for SLI group and a mean of  $108 \pm 1.5$  for the control group) on Stanford Binet intelligence scale. The delay in total language age of the SLI group was  $11 \pm 1$  month below the age-appropriate language performance level as measured by a standard language test (Arabic language test<sup>[14]</sup>) (Table 1). The control group children all passed the Arabic language test with their total language ages were within the age-appropriate language performance level.

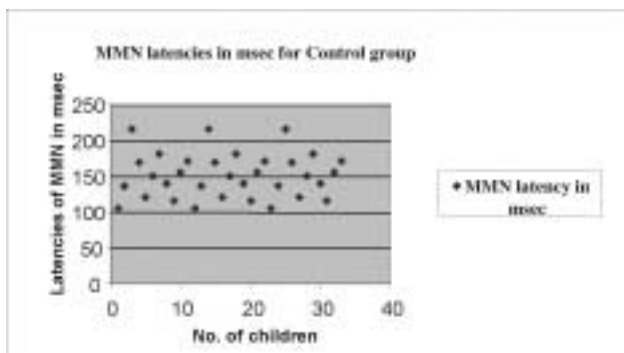
### (B) Results of audiological evaluation:

The control children had a clear and robust MMN waveform. Their MMN latency ranged from 105.2 msec to 215.3 msec with mean latency of  $150.63 \pm 31.16$  msec (Table 2, Figure 1). The amplitude of MMN in this group was ranged from  $10.2 \mu\text{V}$  to  $22.3 \mu\text{V}$  with mean amplitude of  $15.96 \pm 3.48 \mu\text{V}$  Table 2, Figure 2). Similarly, the SLI children exhibited a clear and robust MMN waveform. MMN latency ranged from 100.3 msec to 210.3 msec with mean latency of

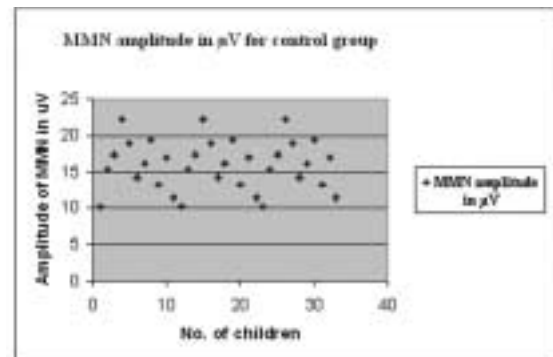
**Table 1.** Mean  $\pm$  SD of the total language ages ( in months ) for SLI children (n = 39 ) and the delay from their age-appropriate language performance level( in months ):

	Language Age	The delay
Total language age	$55.2 \pm 1.4$	$11 \pm 1$

SD: standard deviation; SLI: Specific Language Impairment



**Figure 1.** Latencies in msec of MMN for control group.  
MMN: Mismatch Negativity; msec: milliseconds; No: number



**Figure 2.** Amplitude in  $\mu\text{V}$  of MMN for control group.  
MMN: Mismatch Negativity; msec: milliseconds; No: number

**Table 2.** Mean ( standard deviation of MMN latencies (in msec) and amplitude (in  $\mu V$ ) for both SLI and control groups:

	MMN latencies in msec	MMN amplitude in $\mu V$
SLI Group	152.39 $\pm$ 33.17	14.63 $\pm$ 3.84
Control Group	150.63 $\pm$ 31.16	15.96 $\pm$ 3.48

MMN: Mismatch Negativity; msec: milliseconds; SLI: Specific Language Impairment;  $\mu V$ : microvolts

152.39  $\pm$  33.17 msec (Table 2, Figure 3). The amplitude of MMN in this group was ranged from 9.76  $\mu V$  to 22.4  $\mu V$  with mean amplitude of 14.63  $\pm$  3.84  $\mu V$  (Table 2, figure 4).

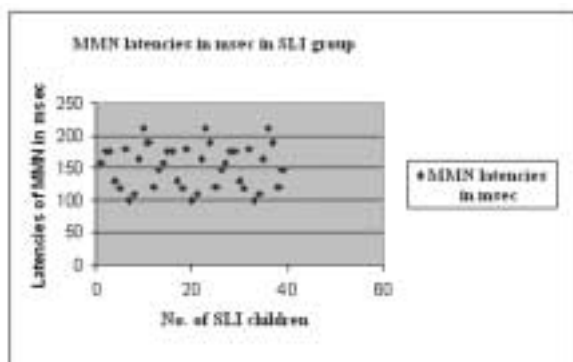
Statistically non-significant differences were detected between specific language impairment children and children with normal hearing and normal language development as regards the latencies of MMN in msec and the amplitude of the waveform in  $\mu V$ . ( $p > 0.05$ ).

## Discussion

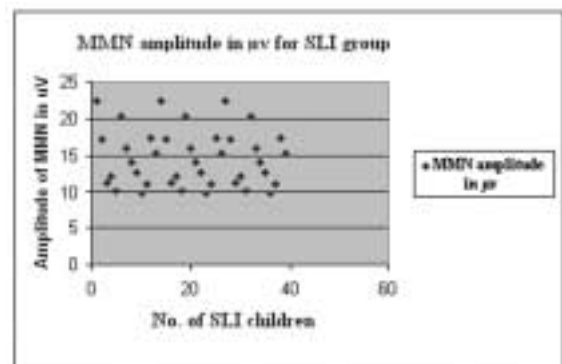
The purpose of this study was to investigate and to measure the Mismatch negativity results in children suffering from specific language impairment in order to evaluate their discrimination of fine differences in auditory stimuli that reflect their pre-attentive process for better understanding of the nature of the problem and to compare them with normal language development children.

Many consonants, such as /p/, /b/, /t/, etc. are distinguished only by a brief portion of the acoustic signal lasting some 40 ms, a temporal processing problem would make it difficult to discriminate speech sounds, even though the child has normal peripheral hearing.

As MMN is pre-attentive automatic response that can be elicited using a passive “oddball paradigm”, it can be used as a tool for evaluation of the pre-attentive process in children. In this study, MMN was used as an index of the presence or absence of pre-attentive process in SLI children and to compare their response with the normal language development for the chronological age. MMN responses were recorded and analyzed as regards the waveform latencies in msec and amplitude in  $\mu V$ . The results showed that MMN was observed in both groups and that MMN waveforms were clear and robust in SLI children in the expected latencies and amplitude in comparison with the control normal language development children with a statistically non-significant differences detected between both groups. These findings are in agreement with Kraus et al. (1992) in which they found that MMN was robust in children, and it is a good indicator of the pre-attentive process measurement.<sup>[15]</sup> McArthur and Hogben (2001) found that only a subgroup of children with a SLI have impaired rapid auditory processing<sup>[16]</sup>. On the other hand, Gopnik (1997) has concluded that the grammatical deficits seen in SLI cannot be attributed to underlying auditory processing



**Figure 3.** Latencies in msec of MMN for SLI group.  
MMN: Mismatch Negativity; msec: milliseconds; No: number



**Figure 4.** Amplitude in  $\mu V$  of MMN for SLI group.  
MMN: Mismatch Negativity; msec: milliseconds; No: number

problems<sup>[17]</sup>. Similarly, in their study, Bishop et al. (1999) found no difference between the rapid auditory processing skills of children with a SLI and their control children<sup>[18]</sup>.

Tallal (1988) reported that SLI children have difficulties in discriminating rapidly presented tones and in sequencing tones presented in rapid sequence. She argued that children with SLI are specifically impaired in the ability to process rapidly presented information<sup>[19]</sup>.

Our study indicates that the neurophysiological measures of auditory processing that reflect pre-attentive process in SLI children are intact. We suppose that other factors, rather than pre-attentive auditory processing might be incriminated in the causation of delayed language development in SLI children that need further research work. Further studies are also recommended to determine the prognostic rule of MMN in other children with delayed language development due to specific etiologies e.g. autism and mental retardation.

## **Conclusion**

MMN waveform was clear and robust in SLI children in the expected latencies and amplitude in comparison with the control normal language development children. This indicates that the neurophysiological measures of auditory processing that reflect pre-attentive process in those children are intact. We concluded that other factors, rather than auditory processing might be incriminated in the causation of delayed language development in SLI children that need further research work.

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