

Explaining the Variability in Sensory Gating Measures in Children

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Purpose

Explore the contribution of following variables to account for individual differences in sensory gating.

- Maturation as measured by Age
- Organization of the brain's response to auditory stimuli differing in intensity and frequency
- Diagnosis of a sensory processing disorder

Introduction

Studies of sensory gating in children with and without disabilities have shown large within group variances. Freedman, et al. (1987) studied 108 typical children aged 1-19 years. They reported that the P50 T/C ratio in typical children ranged from 0 to 1. Myles-Worsley et al. (1996) examined the developmental and genetic influences on the P50 sensory gating in 127 participants ages 10-39 years. Contrary to Freedman et al. (1987), their results indicated that there was not a difference in the P50 ratio between children and adults. Kemner, et al. (2002) examined 12 children with autism and 11 children without autism aged 7-13 years. The mean P50 T/C ratio for typical children was .47 (S.D. = .50) and for children with autism was .28 (S.D. = .36). Marshall, et al. (2004) included a group of 10 outgoing children, a group of 12 socially withdrawn children, and an "unselected" group of 10 children, all within the ages of 7-13 years old. The mean P50 T/C ratio across whole sample was .90 (S.D. = .53). Lincoln et al. (1995) investigated N1 and P2 amplitude and latency differences based on changes in stimulus intensity and frequency (Hz), assessing the regulation of sensory input in children 8 to 14 years old with and without autism. According to Lincoln et al. (1995), children with autism do not show an increase in N1 amplitude in response to increased auditory stimuli intensity compared to normal children.

Characterizing the sources of the individual differences in sensory gating in young children may lead to better early detection and treatment of children with sensory processing disorders.

References

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Method

Participants

- 18 Adults aged 21 to 55 years
- 39 children aged 5 to 12 years
 - 18 typical children (8 females and 10 males)
 - 21 children with sensory processing disorders (5 females and 16 males)

Procedures

- Participants were seated in a semi-reclined position with eyes opened quietly listening to auditory clicks and tones
- Auditory threshold testing
- Sensory Gating ERP paradigm
 - Click intensity = ~ 85 dB SPL
 - Click duration = 3 ms
 - Paired-clicks paradigm with SOA = 500 ms
 - Time between presentation of pairs = 10 s
 - 120 pairs of clicks were presented while watching a silent movie
- Sensory Registration ERP paradigm
 - 100 presentations of each of 4 auditory stimuli
 - 1 kHz at intensity = 50 dB SPL
 - 1 kHz at intensity = 70 dB SPL
 - 3 kHz at intensity = 52 dB SPL
 - 3 kHz at intensity = 73 dB SPL
 - Each tone duration = 50 ms with 10 ms ramps
 - Time between presentation of stimuli = 2 s
 - Presented in random order with 3 breaks while staring at a fixed object on computer screen

Electrophysiological Measurements

- BioSemi EEG ActiveTwo system
- 32 scalp sites, 2 bipolar eye monitors
- Recorded at A-D Rate=1024 Hz, Bandwidth=268 Hz, Gain: 1000
- Offline filter 10-200 Hz band pass for scoring P50
- Offline filter .23-30 Hz band pass for scoring N1&P2
- EOG artifact rejection (+/- 100 µV)
- Cz site used for statistical analyses

Results

Comparisons in Sensory Gating – P50

- Significant differences between the amplitude of conditioning click (click 1) and that of test click (click 2) were found for all 3 groups - see black text on Figure 1.
- P50 T/C ratios were lowest for Adults and highest for children with SPD – see blue text.
- Significant differences between Adults and children with SPD as well as between Typical children and children with SPD – see green text.

Comparisons in Sensory Gating – N100

- Significant differences between the amplitude of conditioning click (click 1) and that of test click (click 2) were found for all 3 groups - see black text on Figure 2.
- N100 T/C ratios were lowest for Adults and highest for children with SPD – see blue text.
- Only a significant difference between Adults and children with SPD was found though the difference between Adults and Typical children approached significance – see green text.

Developmental Trends

- For the Typical children both P50 and N100 T/C ratios were significantly correlated with age (P50, $r = -.64, p = .004$; N100, $r = -.52, p = .028$) (see red lines in Figures 3 & 4).
- Age did not correlate with P50 ($r = -.03$) nor N100 ($r = -.01$) T/C ratios for the SPD children (see blue lines in Figure 3 & 4).

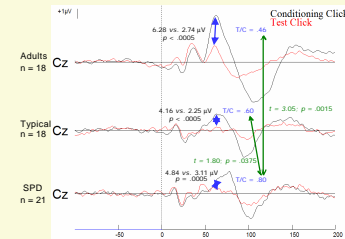


Figure 1 – Grand averaged waveforms for each group showing Sensory Gating responses at P50

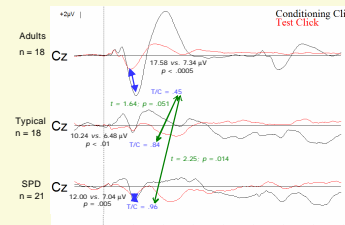


Figure 2 – Grand averaged waveforms for each group showing Sensory Gating responses at N100

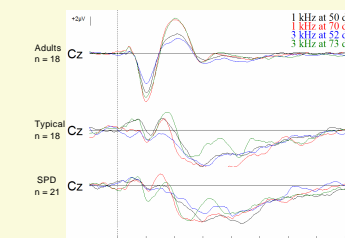


Figure 5 – Grand averaged waveforms for each group showing responses during the Sensory Registration Paradigm

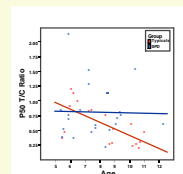


Figure 3 – Age by P50 T/C ratios for each child group

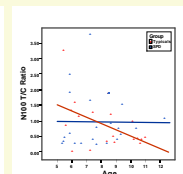
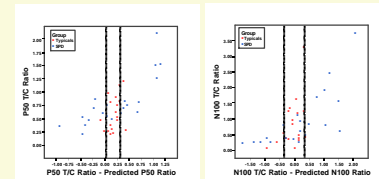


Figure 4 – Age by N100 T/C ratios for child group

Sensory Registration

- Typical children displayed more variability in their response to the tones than adults and children with SPD were even more variable than typical children (see Figure 5).
- A regression analysis (3 step model) revealed that the P50 T/C ratios can be predicted from the N1 and P2 peak-to-peak amplitude and latency measures of the 4 tones for the Typical children but not for the SPD children.
 - $R^2 = .83$ (Adj. $R^2 = .63$) $F_{(9,15)} = 4.28, p = .026$.
 - Age accounted for 41% of the variance.
 - N1 amplitudes & latencies accounted for 27%
 - P2 amplitudes & latencies accounted for 15%
- Residuals derived from the prediction equation of the above analysis for Typical and SPD children reveal that the SPD children are distributed above and below levels of the Typical children (see below left).
- A similar pattern of results was found when predicting N100 T/C ratios from the 4 tones (see below right).



Conclusions

- Children with SPD displayed significantly less sensory gating than typical children (P50) and adults (P50 and N100) and displayed more variability than the other two groups.
- There was a developmental trend in sensory gating in both the P50 and N100 for Typical children but not for children with SPD.
- Organization of auditory responses to intensity and frequency manipulations predict P50 gating in Typical children, but not in children with SPD. Factors other than age and auditory organization must account for the sensory gating variability seen in children with SPD.

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