

Validating Modifications to the Sensory Gating ERP Paradigm

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Purpose

- To validate the sensory gating ERP paradigm with the following modifications:
 - Have the participants watch a silent movie vs. stare at a fixed asterisk
 - Increase the auditory stimulus intensity
 - Employ more trials of paired-clicks
- To examine if there is a gender effect in the sensory gating ERP paradigm

Introduction

The traditional auditory sensory gating paradigm has been extensively studied in individuals with schizophrenia (e.g., Nagamoto et al., 1989; Olincy et al., 2002). However, studies sometimes fail to demonstrate group differences in sensory gating due to the large within-group variance (e.g., Kemner, et al., 2002; Olincy et al., 2002). In order to demonstrate significant group differences in sensory gating between persons with and without disorders, designing a valid and reliable sensory gating ERP paradigm that minimizes the within-group variance is important. For instance, Kiskey et al. (2004) and Marshall et al. (2004) have used a modified gating paradigm (i.e., watching a silent movie) in studies involving schizophrenia patients and healthy children, respectively. Nevertheless, children displayed a large within-group variance (i.e., Marshall et al., 2004), but less variance was found in adults (i.e., Kiskey et al., 2004). This inconsistent finding between adults and children may be due to the maturational effect, attention, numbers of trials, and stimulus intensity. White et al (2006) demonstrated that the stimulus intensity plays a key role in sensory gating. White et al (2005) also found that adult females display less gating and more variance than males during stress. The purpose of this study is to validate the modified gating paradigm compared to the traditional gating paradigm using two different stimulus intensities. Gender differences in gating performance were examined.

References

- Kemner, C., Oranje, B., Verbaten, M.N., & van Engeland, H. (2002). Normal P50 gating in children with autism. *Journal of Clinical Psychiatry*, 63, 214-217.
- Kiskey, M. A., Noecker, T. L., & Günther, P. M. (2004). Comparison of sensory gating to mismatch negativity and self-reported perceptual phenomena in healthy adults. *Psychophysiology*, 41, 604-612.
- Marshall, P. J., Bar-Haim, Y., & Fox, N. A. (2004). The development of P50 suppression in the auditory event-related potential. *International Journal of Psychophysiology*, 51, 135-141.
- Myles-Worsley, M., Coon, H., Byrnes, W., Waldo, M., Young, D., & Freedman, R. (1996). Developmental and genetic influences on the P50 sensory gating phenotype. *Biological Psychiatry*, 39, 289-295.
- Nagamoto, H. T., Adler, L. E., Waldo, M. C., & Freedman, R. (1989). Sensory gating in schizophrenics and normal controls: Effects of changing stimulation interval. *Biological Psychiatry*, 25, 549-561.
- Olincy, A., Ross, R. G., Harris, J. G., Young, D. A., McAndrews, M. A., Cawthra, E., et al. (2002). The P50 auditory event-related potential in adult attention-deficit disorder: Comparison with schizophrenia. *Biological Psychiatry*, 47, 969-977.
- White, P. M., Kanazawa, A., & Yee, C. M. (2005). Gender and suppression of mid-latency ERP components during stress. *Psychophysiology*, 42, 720-725.
- White, P. M., & Yee, C. M. (2006). P50 sensitivity to physical and psychological state influences. *Psychophysiology*, 43, 320-328.

Method

Participants

- Thirty-one healthy adult volunteers with no known disorders (16 females & 15 males) between 20 and 38 years of age ($M = 26.24$; $SD = 3.69$).

Procedures

- Participants were randomly assigned to either high intensity or low intensity group.
- Each participant engaged in both traditional and modified sensory gating ERP paradigms in a counterbalanced order.
- Traditional Sensory Gating ERP Paradigm
 - Participants stared at a fixed asterisk on the computer screen while listening to clicks
- Modified Sensory Gating ERP Paradigm
 - Participants watched a silent video while listening to clicks
- Participants were seated in a relaxed position with eyes opened
- Participants engaged in an auditory threshold testing before the two gating paradigms
- Stimulus Presentation in the 2 Gating Paradigms
 - Click intensity = High (50 dB HL) or Low (20 dB HL)
 - Click duration = 3 ms
 - Paired-clicks with 500 ms SOA
 - Time between presentation of pairs = 10 s
 - 120 paired-clicks were presented

Electrophysiological Measurements

- BioSemi EEG ActiveTwo system
- 32 scalp sites
- 4 eye channel monitors
- A-D Rate = 1024 Hz
- Bandwidth = 0-268 Hz
- Gain: 1000
- Reference: Left earlobe
- Offline filter: 10-200 Hz band pass for scoring P50
- Offline filter: .23-30 Hz band pass for scoring N100
- EOG artifact rejection (+/- 100 μ V)
- Cz site was used for statistical analyses

Results

Findings for Sensory Gating – P50

- P50 Amplitude:** The planned comparisons from the **Intensity x Paradigm x Click** ANOVA revealed significant differences between the amplitude of **Conditioning click** and that of **Test click** for each level of the intensity and paradigm - see Figure 1.
- P50 T/C Ratio:** The **Intensity x Gender x Paradigm** ANOVA revealed:
 - Intensity** ($F[1,27] = 4.70, p = .039$)
 - Gender** ($F[1,27] = 1.05, p = .315$)
 - Paradigm** ($F[1,27] = .14, p = .714$)
 - Intensity x Paradigm** ($F[1,27] = 1.213, p = .28$)
 - Gender x Paradigm** ($F[1,27] = 3.096, p = .09$)

Findings for Sensory Gating – N100

- N100 Amplitude:** The planned comparisons from the **Intensity x Paradigm x Click** ANOVA revealed significant differences between the amplitude of **Conditioning click** and that of **Test click** for each level of the intensity and paradigm - see Figure 2.
- N100 T/C Ratio:** The **Intensity x Gender x Paradigm** ANOVA revealed:
 - Intensity** ($F[1,27] = 4.36, p = .046$)
 - Gender** ($F[1,27] = .86, p = .362$)
 - Paradigm** ($F[1,27] = 1.66, p = .208$)
 - Intensity x Paradigm** ($F[1,27] = .067, p = .80$)
 - Gender x Paradigm** ($F[1,27] = .023, p = .88$)

Gender Differences

- P50 T/C Ratio:** Although the ANOVA did not show the **Gender** effect, the planned comparisons indicated:
 - High intensity in the traditional paradigm:** Females ($M = .72, SD = .44$) vs. Males ($M = .50, SD = .16$) - $t = 2.369, p < .025$
 - Low intensity in the traditional paradigm:** Females ($M = 1.02, SD = .43$) vs. Males ($M = .83, SD = .46$) - $t = 1.963, p < .05$
- N100 T/C Ratio:** Although the ANOVA did not reveal **Gender** effects, the planned comparisons indicated that females ($M = 1.01, SD = .85$) have a significantly higher T/C ratio than males ($M = .68, SD = .38$) for the low intensity ($t = 1.868, p < .05$) in the **traditional** paradigm.

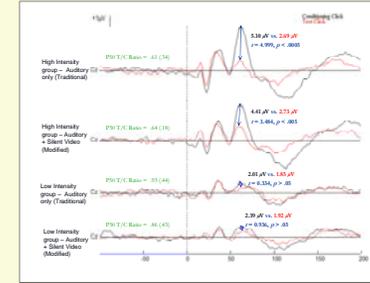


Figure 1 – Grand averaged ERPs for each level of the intensity and paradigm showing sensory gating responses at P50

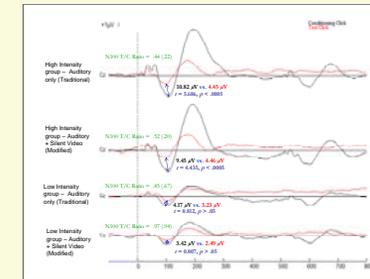


Figure 2 – Grand averaged ERPs for each level of the intensity and paradigm showing sensory gating responses at N100

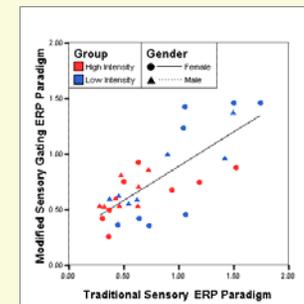


Figure 3 – Correlation between two paradigms – P50 T/C Ratio

Correlations between Two Paradigms

- P50 T/C Ratio:** The partial Pearson correlation controlling for intensity revealed that there was a significant relationship between the two paradigms ($r = .727, p < .0005$) - see Figure 3.
- N100 T/C Ratio:** The partial Pearson correlation controlling for intensity revealed that there was a significant relationship between the two paradigms ($r = .774, p < .0005$) - see Figure 4.

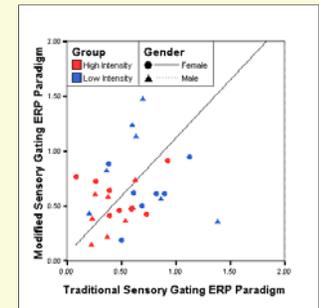


Figure 4 – Correlation between two paradigms – N100 T/C ratio

Conclusions

The modified paradigm is as valid and reliable as, and perhaps better than the traditional paradigm for studying sensory gating in adults based on these findings:

- Participants displayed stronger gating and less variance for the high intensity compared to low intensity clicks.
- The mean T/C ratio differences between paradigms were minimal but the variance was 46% lower in the modified paradigm (high intensity while watching a movie) as compared to the traditional paradigm.
- Females displayed less gating than males in the traditional paradigm but not in the modified paradigm.

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