

Manipulation of Attention in the Sensory Gating ERP Paradigm

William J. Gavin, Wen-Pin Chang, & Patricia L. Davies
Department of Occupational Therapy, Colorado State University



Purpose

- To determine if manipulating the participants' attention towards rather than away from the auditory stimuli affects sensory gating.
- To determine if attentional demands interacts with the effect of stimulus intensity during sensory gating.

Introduction

Traditionally, sensory gating paradigm is thought to measure two different processing mechanisms: stimulus filtering (P50 gating) and passive attention switching (N100 gating, Kiskey et al., 2004). While the effects of attentional demands on sensory gating has been investigated in a number of labs, controversy still exists.

Guterman et al. (1992; 1994) showed in healthy adults that P50 sensory gating suppression can be greatly reduced and even reversed when attention is drawn to the second click of a pair of clicks in both a counting task and button press task. In contrast, both Jerger et al. (1992) and White et al. (1997) investigated the effects of attention by requiring the individual to press a button when a pair of clicks was heard but not to a single click. These two studies found that both P50 amplitude and T/C ratio were not influenced by such an attentional manipulation suggesting that the P50 sensory gating mechanism is preattentive and hard-wired. However, the N100 gating decreased with this attention manipulation.

Subsequently, White et al (2006) found that P50 gating is not entirely preattentive and may reflect declines in attention or vigilance, fatigue and drowsiness over the course of recording session.

Thus, the main purpose of this study is to examine whether both P50 and N100 gating processes could be manipulated by simply directing the participant's attention toward the auditory stimuli (i.e., the focused attention paradigm) rather than away from the stimuli (i.e., the modified sensory gating paradigm).

References

- Guterman, Y., & Jossiasen, R. C. (1994). Sensory gating deviance in schizophrenia in the context of task related effects. *International Journal of Psychophysiology*, 18, 1-12.
- Guterman, Y., Jossiasen, R. C., Bashore, T. R. (1992). Attentional influence on the P50 component of the auditory event-related potential. *Journal of Psychophysiology*, 12, 197-209.
- Jerger, K., Biggins, C., & Fein, G. (1992). P50 suppression is not affected by attentional manipulations. *Biological Psychiatry*, 31, 365-377.
- 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.
- White, P. M., & Yee, C. M. (1997). Effects of attentional and stressor manipulations on the P50 gating response. *Psychophysiology*, 38, 531-539.
- White, P. M., & Yee, C. M. (2006). P50 sensitivity to physical and psychological state influences. *Psychophysiology*, 43, 320-328.

Method

Participants

- Thirty-two healthy adult volunteers with no known disorders (16 females & 16 males) between 20 and 32 years of age ($M = 25.6$; $SD = 3.1$).

Procedures

- Participants were seated in a relaxed position with eyes opened.
- Participants began session by engaging in an auditory threshold testing procedure.
- Each participant then engaged in 2 ERP paradigms presented in a counterbalanced order.

Focused Attention Sensory Gating Paradigm

- Participants stared at a fixation point on the computer screen while listening to 168 paired-clicks and 84 single clicks presented randomly.
- Participants were instructed to press mouse immediately after hearing a single click but not hearing a paired-click.
- Half way through the paradigm the intensity of the clicks changed from either high to low or low to high with order counterbalanced across subjects.

Modified Sensory Gating ERP Paradigm

- Participants watched a silent video while listening to 160 paired-clicks.
- Half way through the paradigm the intensity of the clicks changed from either high to low or low to high counterbalanced across subjects.

Stimulus Presentation in the 2 Gating Paradigms

- Click intensity: High=60 dB HL; Low=30 dB HL
- Click duration = 3 ms
- Paired-clicks with 500 ms SOA
- Time between presentation of stimuli = 8 s

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 Peak-to-Peak Amplitude

A **Run Order** x **Click** x **Paradigm** x **Intensity** ANOVA revealed:

- Sensory gating occurs independent of the attentional focus of the participants (**Click** $F_{1,30} = 68.59$, $p < .0005$; and see Figure 1 for comparisons of C1 vs C2 for each paradigm at each intensity)
- However, P50 amplitude was higher for both clicks in Focus Attention compared to Modified Sensory Gating paradigm (**Paradigm** $F_{1,30} = 15.27$, $p < .0005$; and see Table 1 for planned comparisons)
- P50 amplitude is directly associated with stimulus intensity (**Intensity** $F_{1,30} = 70.93$, $p < .0005$)
- Sensory gating is stronger at high stimulus intensity compared to the low stimulus intensity (**Intensity** x **Click** $F_{1,30} = 27.06$, $p < .0005$)
- The **Run Order** of paradigm presentation was also significant ($F_{1,30} = 8.33$, $p = .007$)

P50 T/C Ratio

A **Run Order** x **Paradigm** x **Intensity** ANOVA revealed:

- A significant main effect for **Intensity** ($F_{1,30} = 4.66$, $p = .039$) was found
- However, for the modified paradigm only, sensory gating is significantly better at high intensity compared to low intensity ($t_{30} = 2.46$, $p < .01$)
- Significant main effect was found for **Run Order** ($F_{1,30} = 8.87$, $p = .006$)

Findings for Sensory Gating – N100

N100 Peak-to-Peak Amplitude

A **Run Order** x **Click** x **Paradigm** x **Intensity** ANOVA revealed:

- A main effect for **Click** ($F_{1,30} = 52.51$, $p < .0005$) was found
- However, evidence of gating occurs independent of the attentional focus of the participants at high intensity only (**Intensity** x **Click** $F_{1,30} = 52.51$, $p < .0005$; and see Figure 2 for comparisons of C1 vs C2 for each paradigm at each intensity)
- N100 amplitude was higher for both clicks in Focused Attention compared to Modified Sensory Gating paradigm (**Paradigm** $F_{1,30} = 78.72$, $p < .0005$; and see Table 2 for planned comparisons)
- N100 amplitude directly associated with stimulus intensity (**Intensity** $F_{1,30} = 91.63$, $p < .0005$)

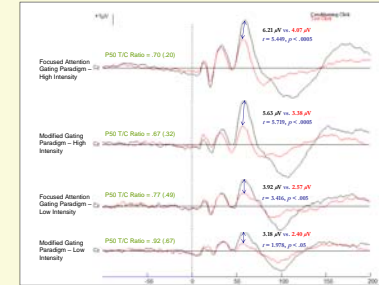


Figure 1 – Grand averaged ERPs for each level of the intensity and paradigm showing sensory gating responses at P50

Table 1 – Comparison of mean P50 peak-to-peak (μ V) amplitude of the two paradigms at each click ($df = 30$).

Click	Focused Attention	Modified Gating	t	p
High Intensity				
Conditioning	6.2	vs 5.6	2.86	< .005
Test	4.1	vs 3.4	3.38	< .005
Low Intensity				
Conditioning	3.9	vs 3.2	3.61	< .0005
Test	2.6	vs 2.4	.83	ns

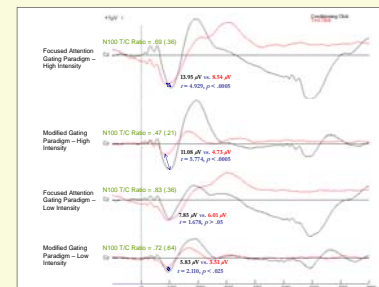


Figure 2 – Grand averaged ERPs for each level of the intensity and paradigm showing sensory gating responses at N100

N100 T/C Ratio

The **Run Order** x **Paradigm** x **Intensity** ANOVA revealed:

- Focusing participants attention to click stimuli significantly reduced sensory gating at N100 (**Paradigm** $F_{1,30} = 5.63$, $p = .024$)
- Sensory gating at N100 was significantly better at high for high intensity stimuli compared to low intensity clicks (**Intensity** $F_{1,30} = 6.96$, $p = .013$)
- In the high intensity click, the T/C ratio obtained in the modified gating paradigm was significantly lower than that in the focused attention paradigm ($t_{30} = 2.29$, $p < .025$).

Table 2 – Comparison of mean N100 peak-to-peak (μ V) amplitude of the two paradigms at each click ($df = 30$).

Click	Focused Attention	Modified Gating	t	p
High Intensity				
Conditioning	14.0	vs 11.1	5.16	< .0005
Test	8.5	vs 4.7	6.82	< .0005
Low Intensity				
Conditioning	7.9	vs 5.8	3.64	< .005
Test	6.0	vs 3.5	4.49	< .0005

Conclusions

Manipulation of attention does influence sensory gating in adults without neurological disorders.

- The focusing of attention toward the auditory stimuli produced an increase in the amplitude of both P50 and N100 components for both conditioning and test clicks, particularly for high intensity stimuli.
- Stimulus intensity did influence the T/C ratios.
- Focusing attention toward the stimuli increased the N100 T/C ratio but not P50 T/C ratio.

Acknowledgements: Funded in part by Department of Occupational Therapy, Colorado State University to PLD & W.J.G.

Address correspondence to: William J. Gavin, Colorado State University, 219 Occupational Therapy, Fort Collins, CO 80523.

E-mail: bill.gavin@colorado.edu