

# An ERP Study of Inhibitory Response During Cell Phone Use

Nicole A. Scott, Victor M. Magaña, Ekarin E. Pongpipat, Nathan L. Salehi, Toppacio Rodriguez, Vanessa Camacho, Emilio A. Valadez, Jeremy Neswald, & Jose P. Abara  
The Neuroscience Lab - Department of Psychology, California State University, Northridge

## INTRODUCTION

Recent studies have argued that cell phone use could compromise the ability to attend and concentrate on task demands such as those relating to driving (Kemker et al., 2009). Included in those task demands is the requirement of executive control of attention such as effortful processing of incoming information, detection of correct and incorrect choices, and the ability to withhold responses. Inhibition of responses is argued to be an important function of executive control (Norman & Shallice, 1986). The P3 generated by a NoGo task is reported to relate to inhibition of responses (Strik, Fallgatter, Brandeis, & Pascual-Marqui, 1998). A study using a stop-signal task revealed that P3 components differ in scalp topography depending on whether the participant was successful or unsuccessful in inhibiting their response. Successful trials had a fronto-central maximal amplitude while unsuccessful trials showed a more classic P3 topography with greatest parietal amplitude (Kok, Ramautar, De Ruiter, Band, & Ridderinkhof, 2004). Additionally, the NoGo P3 showed greater amplitude for successful inhibition relative to unsuccessful inhibition trials. These findings suggest that the P3 component elicited by successful performance was related to efficient inhibition of a motor response.

This study examined the brain electrical activity pattern for inhibitory responses between control and cell phone conditions. The inhibitory responses under control and cell phone conditions were compared using electroencephalography (EEG) procedures during a continuous performance task (CPT).

## HYPOTHESES

1. The topography of the P3 amplitude for the NoGo stimulus is expected to follow an anterior maximal distribution.
2. The parietal P3 amplitude is expected to be attenuated following a NoGo response, in comparison to anterior leads.
3. The topographical pattern for NoGo P3 amplitudes are expected to differ between control and cell phone conditions.

## METHODS

### Participants

- EEG Data
- 14 CSUN college students

### Stimulus Parameters

- 1500 ms duration for each stimulus

### Number of Stimuli

- 387 stimuli; 40 NoGo letter sequences

### Electrode Placements

- Fz, Cz, Pz, Oz
- Reference to linked earlobes with a forehead ground

### Recording Parameters

- Low frequency filter = 0.1 Hz; High Frequency filter = 100 Hz
- Vertical (VEOG) and Horizontal (HEOG) eye movements were recorded

### Processing Parameters

- Low Pass = 25 Hz; High Pass = 0.3 Hz
- Artifact rejection: Scalp = +/- 200  $\mu$ v; HEOG = +/- 100  $\mu$ v

- Epoch = 1700 ms
- Baseline Correction = 300 ms pre-stimulus onset
- VEOG Correction = method suggested by Semlitsch, et al. (1986)

### Peak Identification

- Based on the grand average of the ERPs during NoGo responses (see Figure 1)

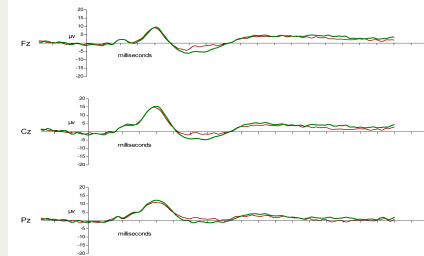


Figure 1. Grand average waveform at Fz, Cz, and Pz for no cell phone (NC, red) and cell phone (C, green) conditions.

### Attention Task

- Participants were administered an AX-CPT while their brain electrical activities were recorded
- Participants were required to attend to a sequence of letters presented one at a time on a computer screen



Figure 2. An example of the attention task, AX-CPT.

### Response Requirements

- Look for the letter "A" and withhold a button press response if it is NOT followed by an "X"

### Experimental Condition (C)

- Participants were administered an AX-CPT task with an active cell phone held with an apparatus at ear level

### Control Condition (NC)

- Participants were administered an AX-CPT task without an active cell phone

## RESULTS

### P3 Amplitude and Topography

- Non-Significant Interaction Effect of Condition (C, NC) by Lead (Fz, Cz, Pz)
  - $F(2, 26) = .336, p = .653$

- No significant difference in P3 amplitude between cell phone use and no cell phone use irrespective of leads

- Non-Significant Effect of Condition (C, NC)
  - $F(1, 13) = 1.858, p = .196$

- No significant difference in P3 amplitude between cell phone use and no cell phone use

Table 1. P3 amplitude means and standard error for conditions across leads

Condition	Fz	Cz	Pz
	M (SE)	M (SE)	M (SE)
NC	11.63 (1.84)	17.19 (2.38)	13.43 (1.66)
C	12.63 (1.76)	18.68 (2.31)	14.29 (1.55)

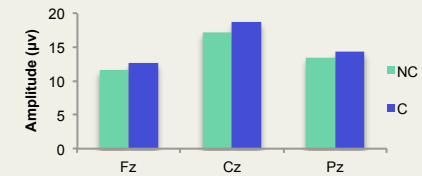


Figure 3. P3 amplitude for conditions across leads.

- Significant Main Effect of Lead (Fz, Cz, Pz)
  - $F(2, 26) = 21.395, p < .01$

- A higher amplitude was observed at the central site compared to the posterior site (Fz < Cz > Pz).

Table 2. P3 amplitude means and standard error across leads

Lead	Mean	SE
Fz	12.13	1.75
Cz	17.93	2.29
Pz	13.86	1.54

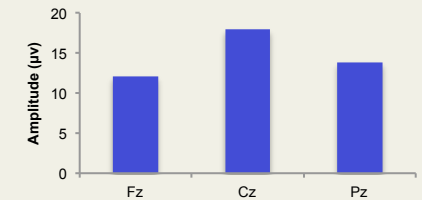


Figure 4. P3 amplitude across leads.

### P3 Latency

- Non-Significant Interaction Effect of Condition (C, NC) by Lead (Fz, Cz, Pz)
  - $F(2, 26) = .431, p = .649$

- No significant difference in P3 latency between cell phone use and no cell phone use irrespective of leads

Table 3. P3 latency means and standard error for conditions across leads

Condition	Fz	Cz	Pz
	M (SE)	M (SE)	M (SE)
NC	315.31 (11.37)	331.23 (10.09)	321.92 (7.15)
C	316.85 (10.52)	324.15 (8.04)	321.08 (6.80)

- Significant Effect of Condition (C, NC)
  - $F(1, 13) = 7.496, p = .017$

- Significant difference in P3 latency between cell phone use and no cell phone use (C > NC)

Table 4. P3 latency means and standard error for conditions

Condition	Mean	SE
NC	348.93	8.75
C	364.17	9.43

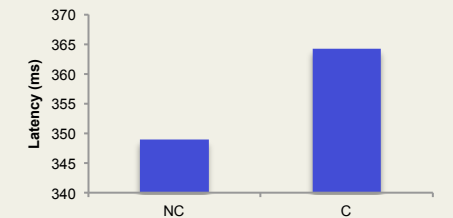


Figure 5. P3 latency by condition.

- Non-Significant Main Effect of Lead (Fz, Cz, Pz)
  - $F(2, 26) = 2.682, p = .106$

- No significant difference in P3 latency among leads

Table 5. P3 latency means and standard error across leads

Lead	Mean	SE
Fz	362.82	9.09
Cz	350.96	7.14
Pz	355.86	10.85

## CONCLUSION

The present study examined the effects of cell phone use on the P3 for an inhibitory response. The results show a central maximal distribution of the P3 amplitude. This topographical pattern was observed for both conditions. As for the P3 amplitude, it did not differ between control and cell phone conditions. Analyses of the P3 latency, however, yielded difference between conditions. The cell phone use condition produced a delayed P3 latency compared to the P3 latency for the control condition. This difference in the P3 latency pattern suggests that cell phone use affects the processing time of the neural network for an inhibitory response.

The above findings suggest that the neural resources allocated for inhibitory response are not affected by cell phone use. However, the findings suggest that cell phone use delays the processing time of the allocated neural resources during an inhibitory response.

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