The Effects of Cell Phone Use on the P3 of the Event-Related Potentials and on Response Time

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

INTRODUCTION

Much concern has been raised about cell phone use and its harmful effects on the brain. The communication of neural networks for cognition and behavior rely on electrical and chemical signals. Researchers posit that cell phone frequency waves disrupt the neural pattern of communication, possibly compromising the function of the brain. Blackman et al. (1988), found that the response of brain tissue in developing chick embryos was altered by power-line electrical fields. Kemker et al. (2009) reported that the performance of their participants was impaired by cell phone conversations on a battery of cognitive tasks. Cell phone use affects cognitive functioning and behavior as indexed by observable overt behaviors. As such, there is a large population that is potentially at risk of the effects of cell phone on the brain.

Electroencephalography (EEG) involves the scalp recording of brain electrical activity using electrodes. The voltage fluctuations that occur in a time-locked portion of an EEG in a response to a stimulus are referred to as event-related potentials (ERPs). ERPs can be used to index cognitive functions such as selective attention.

Studies on attention have reported that the amplitude of the P3 is affected by perceptual and cognitive processes such as stimulus evaluation, detection, motor responding, and/or inhibition response (Sutton et al., 1965; Picton, 1990; Shukla et al., 2000).

This study used the P3 and reaction time to evaluate the effects of cell phone use on attention and the neural resources allocated to attention. The P3 component of the ERPs from EEG recording was used as a physiological measure during an AX-CPT condition. Reaction time recording was also used as a behavioral measure .

HYPOTHESES

1. Cell phone use is expected to affect P3 during selective attention.
2. Cell phone use is expected to affect the neural network for selective attention.
3. Cell phone use is expected to affect reaction time for selective attention.

METHODS

Participants
- EEG Data
  - 13 CSUN college students

Stimulus Parameters
- 1500 ms duration for each stimulus

Number of Stimuli
- 387 stimuli; 40 Target (GO) 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 µv; HEOG = +/- 100 µv
- 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 brain activation during selective attention task (see Figure 1)

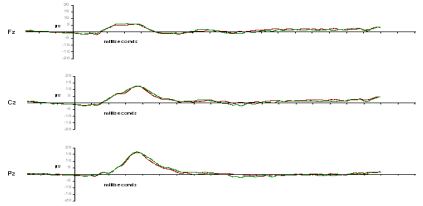

Figure 1. Grand average waveform at Fz, Cz, and Pz for NC (red) and C (green) conditions.

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 make a button press response as quickly and as accurately as possible if it is followed by an "X"

Experimental Condition (C)
- Participants were administered an AX-CPT task with an active cell phone held at ear level with an apparatus

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 by Lead
  - $F(2, 24) = 3.427$, $p = .075$
- 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)
  - $F(1, 12) = .056$, $p = .817$
- 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 *M (SE)*	Cz *M (SE)*	Pz *M (SE)*
NC	8.26 (1.22)	13.85 (1.14)	17.54 (1.22)
C	7.42 (1.19)	14.35 (1.38)	18.34 (1.60)

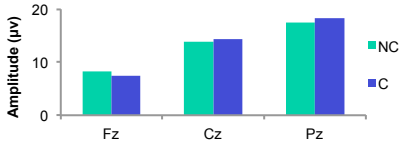

Figure 3. P3 amplitude for conditions across leads.

- Significant Main Effect of Lead (Fz, Cz, Pz)
  - $F(2, 24) = 30.730$, $p < .01$
- A higher amplitude was observed at the posterior site compared to the anterior site

Table 2. *P3 amplitude means and standard error across leads.*

Lead	*Mean*	*SE*
Fz	7.84	*1.17*
Cz	14.10	1.19
Pz	17.94	1.37

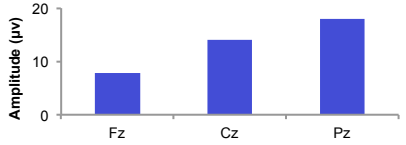

Figure 4. P3 amplitude across leads.

Reaction Time
- Non-Significant Effect of Condition (C, NC)
  - $t(12) = 1.170$, $p = .265$
- No significant difference in reaction time cell phone use and no cell phone use

Table 3. *Reaction time means and standard error for conditions.*

Condition	*Mean*	*SE*
NC	354.55	18.26
C	344.69	18.48

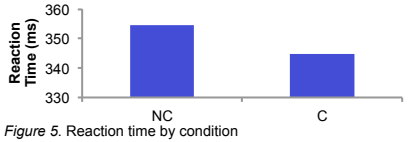

Figure 5. Reaction time by condition

P3 Latency
- Non-Significant Interaction Effect of Condition by Lead
  - $F(2, 24) = .351$, $p = .616$
- No significant difference in P3 latency between cell phone and no cell phone irrespective of leads

- Non-Significant Effect of Condition (C, NC)
  - $F(1, 12) = .150$, $p = .705$
- No significant difference in P3 latency between cell phone and no cell phone use

Table 4. *P3 latency means and standard error for conditions across leads.*

Condition	Fz *M (SE)*	Cz *M (SE)*	Pz *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)

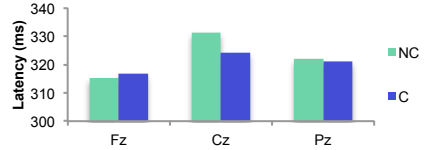

Figure 6. P3 latency for conditions across leads.

- Non-Significant Main Effect of Lead (Fz, Cz, Pz)
  - $F(2, 24) = 2.141$, $p = .160$
- No significant difference in P3 latency among leads

Table 5. *P3 latency means and standard error across leads.*

Lead	*Mean*	*SE*
Fz	316.08	9.84
Cz	327.69	8.01
Pz	321.50	6.34

CONCLUSION

The present study examined the effects of cell phone use on selective attention. The results suggest that cell phone use did not affect brain activations relating to attention. The hypothesis that cell phone use is expected to affect the neural network for selective attention was not observed. The P3 amplitude and latency for both conditions did not differ. However, the expected P3 for attention was observed. The amplitude of the P3 was maximal at the posterior site and attenuated at the anterior site. This topographical pattern of the P3 was observed for both NC and C conditions. The hypothesis on reaction time was also not supported. The behavioral responses did not differ between conditions. The findings provide support that cell phone use does not affect the electrophysiology for attention.

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