Cell Phone Use Delays Inhibitory Response

California State University Northridge

Ekarin E. Pongpipat, Victor M. Magaña, Vanessa Camacho, Jeremy Neswald, Darius Barb, Christopher Lenik, Grace Castillo, Alireza Arab, & 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 (Strayer & Johnston, 2001). 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 decreased P3 Latency has been correlated with superior cognitive performance (Pelosi et al., 1992). In contrast, an increase in P3 latency has been correlated with normal aging (Fiell Walhovd, 2001) and rising levels of dementia (Polich & Corey-Bloom, 2005). 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). 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 NoGo P3 latency is expected to differ between control and cell phone conditions.
2. The P3 amplitude for the NoGo stimulus is expected to follow an anterior maximal distribution.
3. The P3 amplitude at the posterior site is expected to be attenuated following a NoGo response, in comparison to anterior leads.

METHODS

Participants
- EEG Data
  - 14 CSUN college students

Stimulus Parameters
- 400 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 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 the ERPs during NoGo responses (see Figure 1)

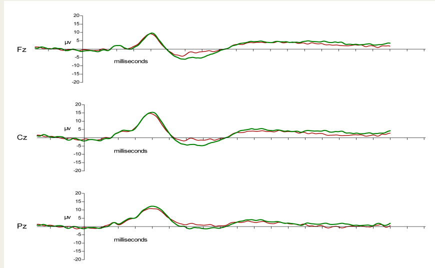

Figure 1. Grand average waveform at Fz, Cz, and Pz for no cell phone (NC, red) and cell phone (C, green) conditions.

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

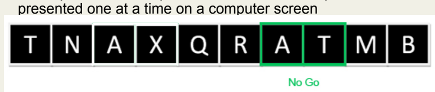

Figure 2. An example of the attention task, AX-CPT.

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 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

- 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 1. *P3 latency means and standard error for conditions across leads*

	Fz	Cz	Pz
Condition	*M (SE)*	*M (SE)*	*M (SE)*
NC	355.00 (8.91)	341.71 (6.86)	350.07 (12.28)
C	370.64 (9.77)	360.21 (9.65)	361.64 (10.56)

Table 2. *P3 latency means and standard error for conditions*

Condition	Mean	SE
NC	348.93	8.75
C	364.17	9.43

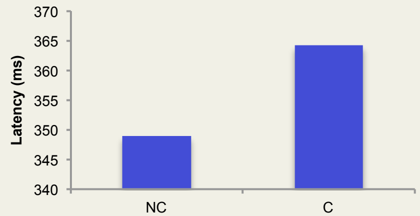

Figure 3. P3 latency by condition.

- 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 3. *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

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

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

	Fz	Cz	Pz
Condition	*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)

- 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

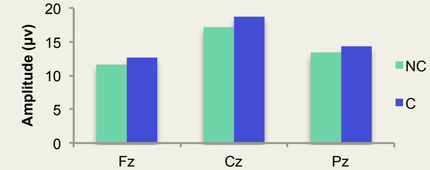

Figure 4. P3 amplitude for conditions across leads.

- 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 5. *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

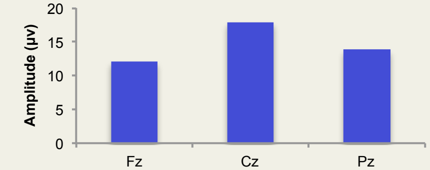

Figure 5. P3 amplitude across leads.

CONCLUSION

The present study examined the effects of cell phone use on the P3 for an inhibitory response. Analyses of the P3 latency yielded a significant difference between conditions. The cell phone use condition produced a delayed P3 latency compared to the P3 latency for the control condition. The difference in the P3 latency pattern suggests that cell phone use affects the processing time of the neural network for an inhibitory response. The results also 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.

The above findings suggest that cell phone use delays the processing of the allocated neural resources during an inhibitory response. This relationship provides support for the detrimental effects of cell phone use on task demands such as those relating to driving.

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