



Modulation of Early Visual Processing by Selective Attention in Adolescents: An ERP Study

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Abstract

Despite a growing understanding of the neurological underpinnings of visual selective attention in adults (e.g. Mangun and Hillyard, 1991) relatively little is known about the development of visual selective attention and its neurological underpinnings. Studies with adults suggest that early in visual processing, approximately 100 milliseconds following stimulus presentation, processing of a visual stimulus is enhanced as a function of attention (e.g. Di Russo, Martinez and Hillyard 2003; Handy and Khoe 2005; Hillyard, Vogel, and Luck 1998; Mangun and Hillyard, 1991, 1995; Mangun and Fannon, 2007). Moreover, these changes early in processing may influence later processing, allowing attended items to be fully processed while unattended items are filtered out or processed at a lower level. This study was designed to examine visual selective attention within adolescents using event related potentials (ERPs). Fourteen adolescents (ages 14 to 17) completed a visual oddball task in which they were asked to attend to a lateralized display composed of an attended and unattended stimulus. ERPs were analyzed for occipital and parietal electrodes, specifically O1, O2, OZ, and PZ for the P300 (a component that is thought to reflect target detection) and O1 and O2 for the P1 (an early visual processing component occurring approximately 100 milliseconds post stimulus). Results suggest that by 300 milliseconds, adolescents, like adults, have effectively selected targets. Moreover, similar to adults, lateralization of the P1 demonstrates selective attention via enhancement of early visual processing.

Background

Selective attention modulates early processing in adults. Specifically the P100, associated with visual processing, changes in amplitude as a function of attention (e.g. Di Russo, Martinez and Hillyard 2003; Handy and Khoe 2005; Hillyard, Vogel, and Luck 1998; Mangun and Hillyard, 1991, 1995; Mangun and Fannon, 2007). Previous research suggests that

- children show modulation of early brain processes as a function of selective auditory attention (Bartgis, Lilly, & Thomas, 2003, Maatta, Paakkinen, Saavalainen & Partanen, 2005, Perez-Edgar & Fox, 2005, Sanders, Stevens, Coch, & Neville, 2006, Taylor & Khan, 2000).

- selective attention modulates latency of early components in children using visual stimuli (Taylor and Khan, 2000).

Therefore, this study will examine changes in *amplitude* as a function of selective attention for *visual stimuli* in children. It is hypothesized that visual selective attention will modulate both amplitude and latency of the P100 for adults and children.

Methods

Participants were asked to complete a covert attention task while electrophysiological recordings were acquired.

Participants

- 14 Adolescents (8 Males, 6 Females, mean age = 15.85, SD = 1.16, 6 White, 7, Asian, 1 Hispanic)

- Participants were recruited from a summer program at Hampshire College. Participants were excluded from participation if they were left handed, had visual impairments that could not be corrected with glasses/contacts, were diagnosed with or suspected learning disorders, were currently on psychotropic medications, or if they were born premature (ie less than 36 weeks). Participants received \$10 -20 for participation.

Electrophysiological Recordings

- ERPs were collected using a SYNAMPS2 amplifier with SCAN recording software. Thirty-two channel tin ElectroCaps using a linked-mastoid reference were used with a sampling rate of 1000Hz and a filter of .1 to 100Hz. Additionally recordings from VEOG and HEOG were collected to detect and exclude trials containing blink artifacts.
- Recordings from OZ, PZ, O1, and O2 were averaged by condition and analyzed.

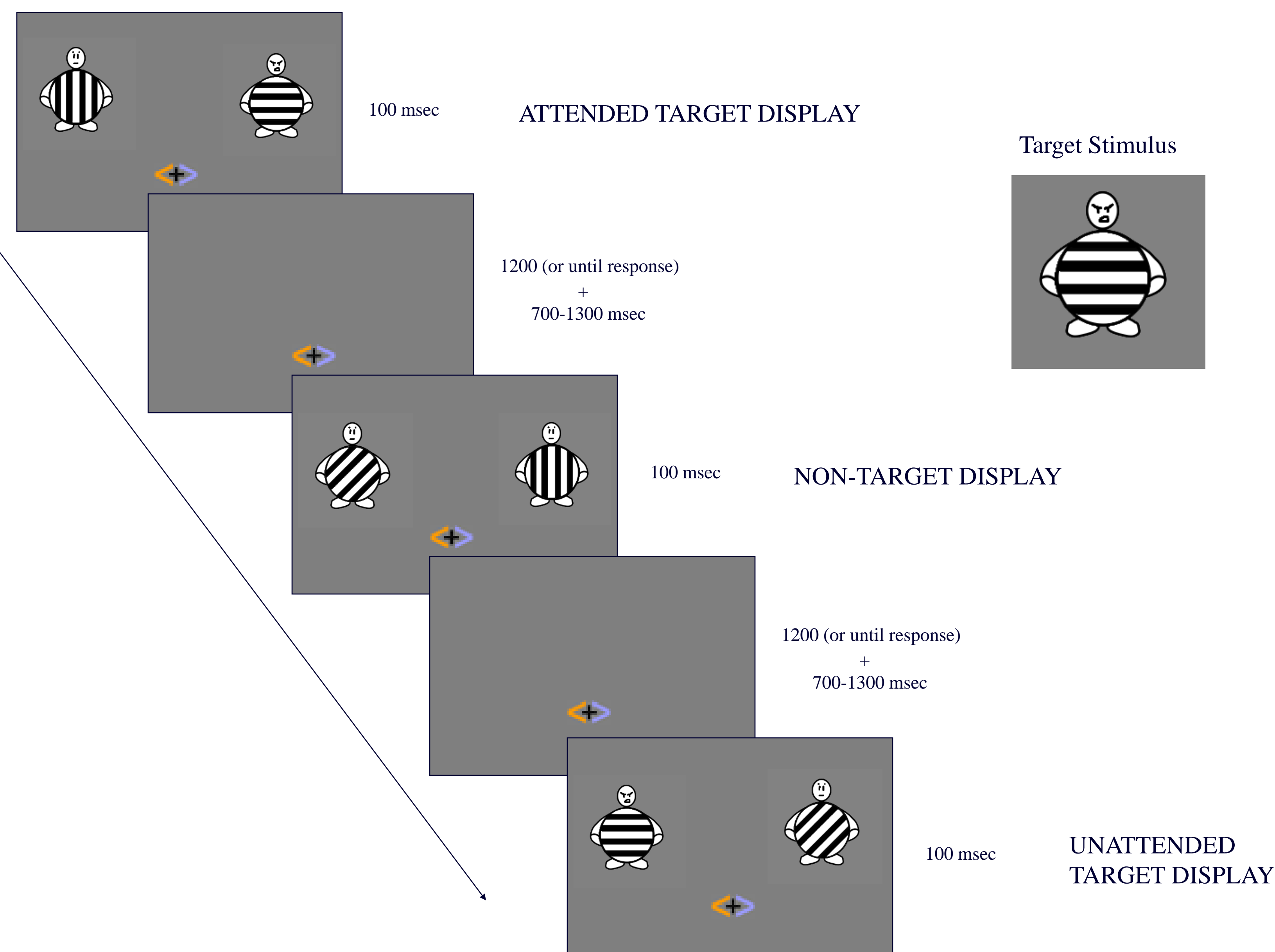
Selective Attention Task:

- 400 trials
- 60% of were non-target trials, 20% were attended targets, and 20% unattended targets

- Participants were asked to attend to one side of the screen and press a button if the target item, the “ERP Bandit,” appeared on the attended side. They did not respond to non-targets and unattended targets.

- ERPs were analyzed for each condition at occipital leads (O1, OZ, and O2)

Methods (cont.)



Accuracy and Reaction Time

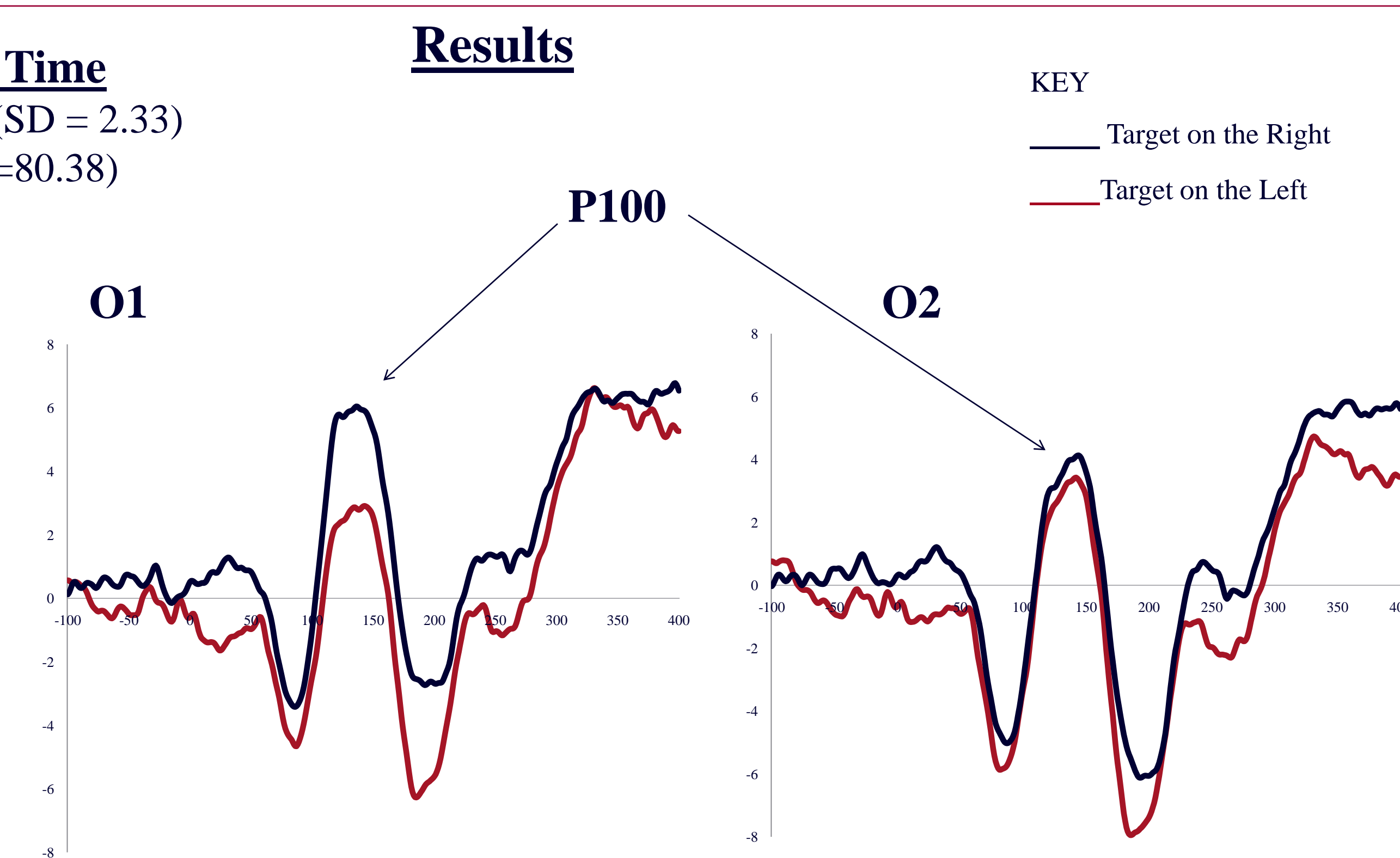
- Mean Accuracy = 98.35% (SD = 2.33)
- Mean RT = 549.5 msec (SD = 80.38)

Average Amplitude P100

2(Hemisphere) x 2(Electrode) Repeated Measures ANOVA

- Significant Main Effect of Hemisphere
- $F(1, 13) = 8.36, p = .013^*$

- Attend Right
 - $t(13) = -2.58, p = .023^*$
- Attend Left
 - $t(13) = 1.86, p = .086$



Electrophysiological Data

Average Amplitude P300

3(Condition) x 4(Electrode) Repeated Measures ANOVA

- Main Effect of Condition

- $F(2, 26) = 22.08, p < .001^*$

- Attended Targets vs. Unattended Targets

- $t(13) = 3.38, p = .005^*$

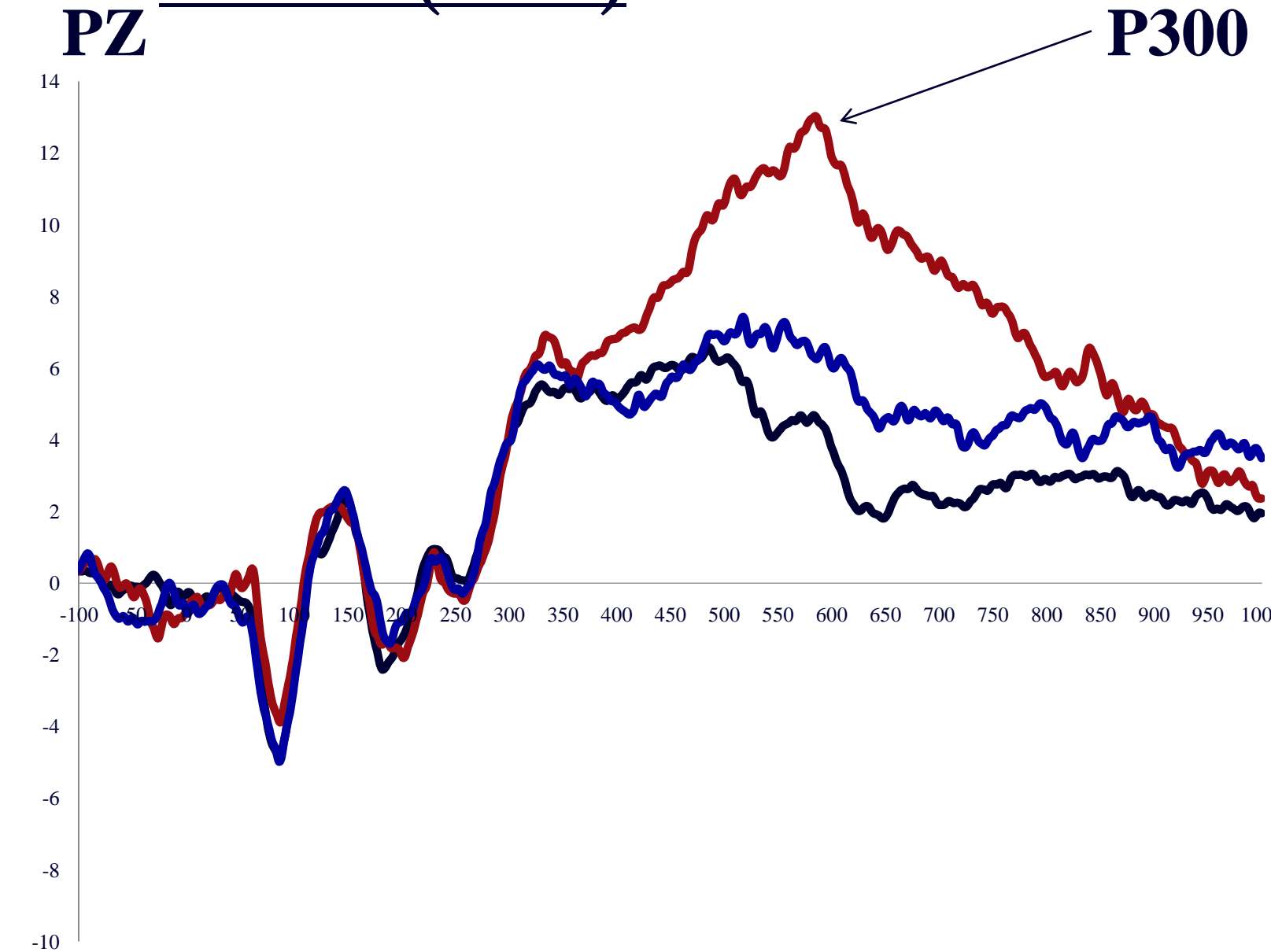
- Attended Targets vs. Non-Targets

- $t(13) = 8.20, p < .001^*$

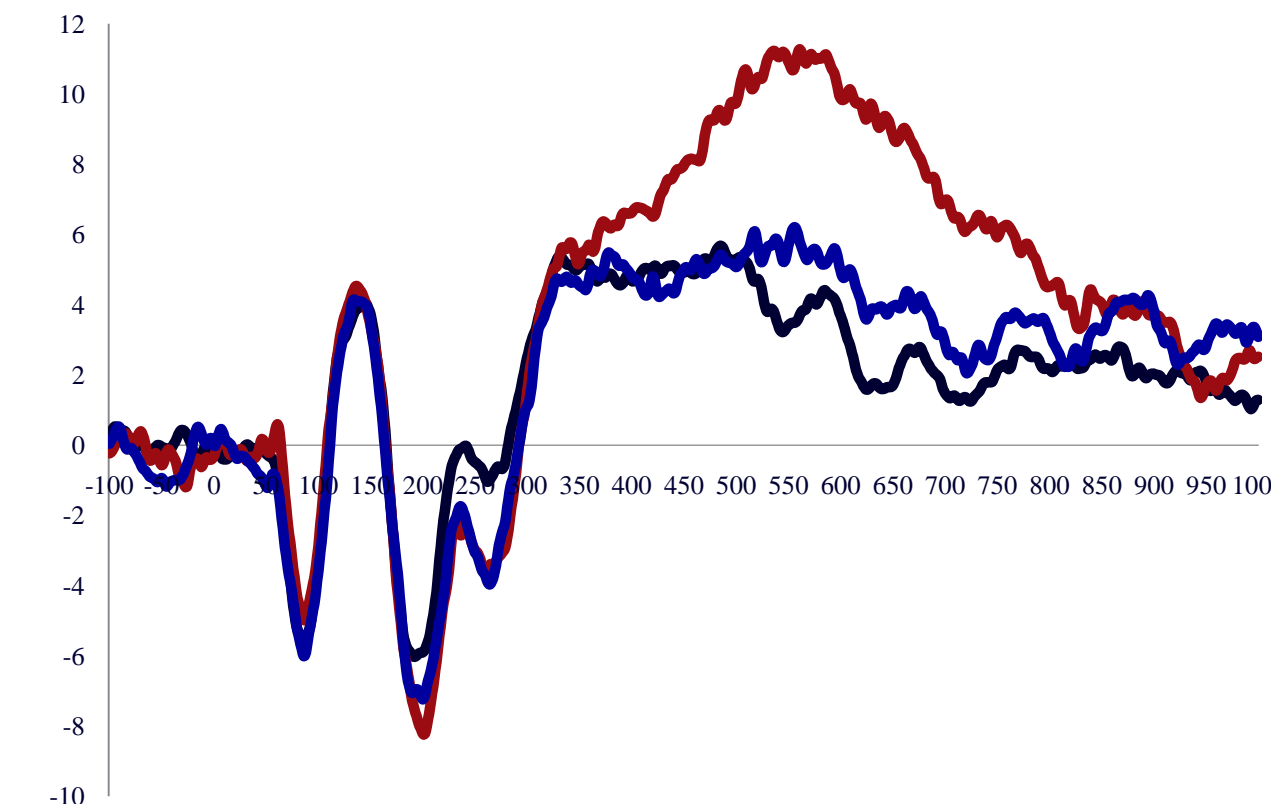
KEY

- Attended Targets
- Unattended Targets
- Non-targets

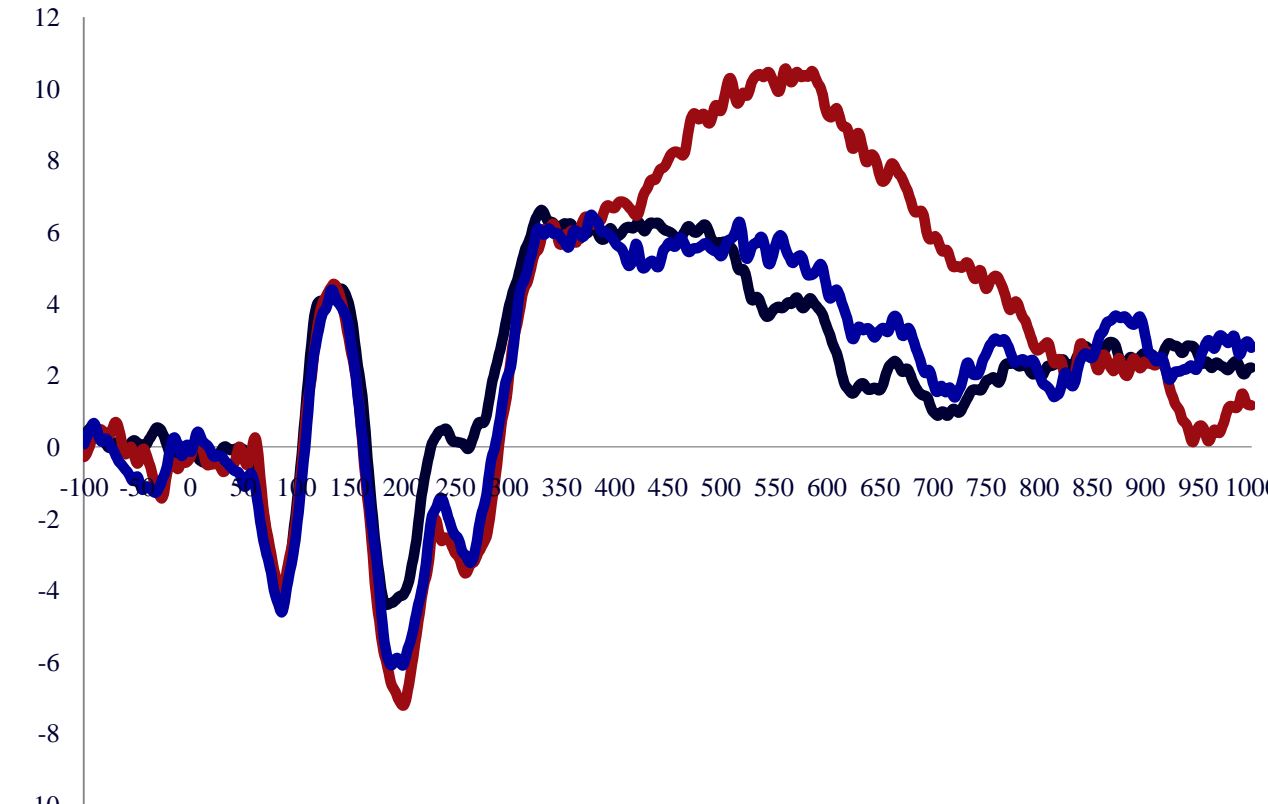
Results (cont.)



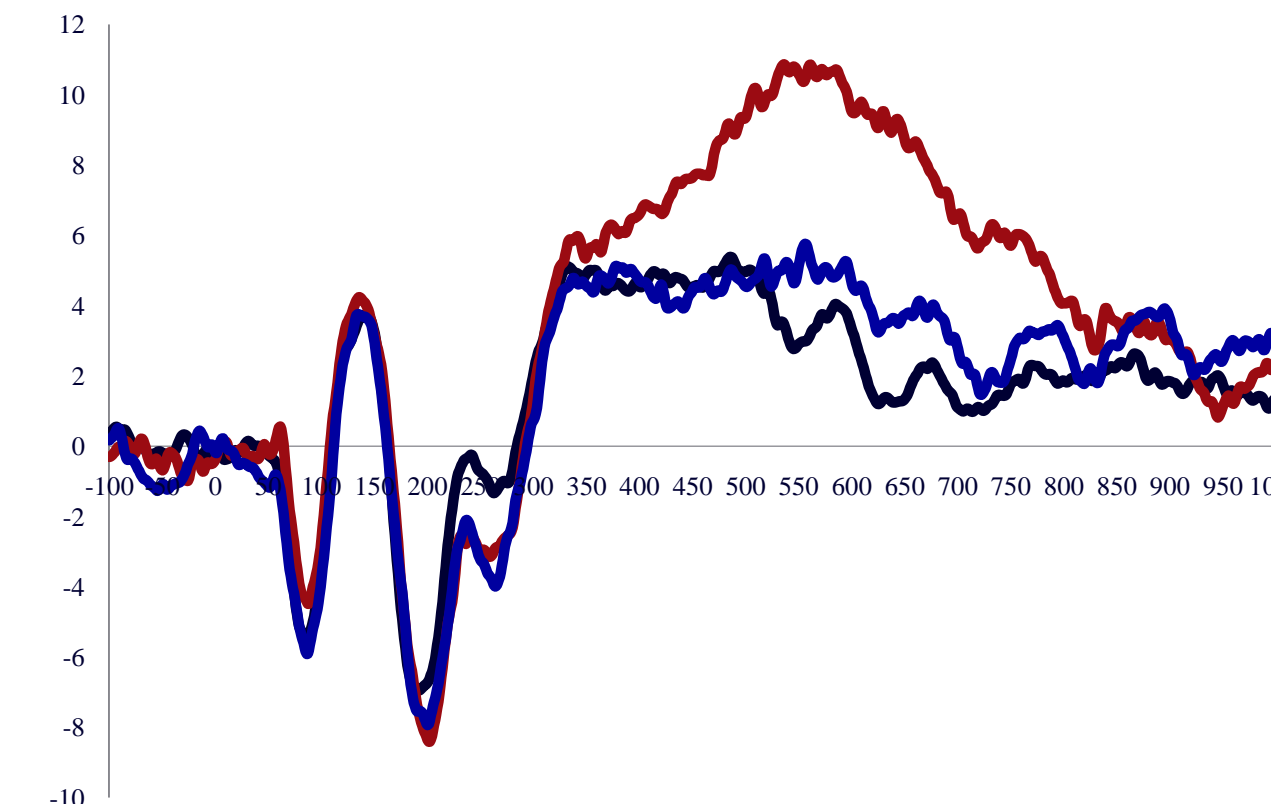
OZ



O1



O2



Discussion

- Behavioral Data suggests that teenagers perform this task at ceiling levels, effectively using selective attention to respond only to attended targets.

- ERP data shows increased amplitude to the attended hemisphere as evidenced by significant increases at the P100 at O1 and OZ showing similar effects of selective attention to adult populations (e.g. Mangun and Hillyard 1991).

- Moreover, the P300 demonstrates effective selection at the P100 allow for reduced processing of unattended target items and enhanced processing of target items.

=> This study suggests that adolescents, like adults show modulation of the P100 and P300 to visual stimuli as a function of selective attention.

Further Information

For further information on projects in this lab visit the website at <http://helios.hampshire.edu/~jwcCS/JCcouperus.htm>, or contact the first author at jcouperus@hampshire.edu.

Acknowledgements

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