Expression of Facilitation and Suppression in Visual Selective Attention in Adolescents

Jane W. Couperus, PhD
Hampshire College

Brittany Alperin
Hampshire College

Abstract

Selective attention modulates activity at early levels of visual processing, as is reflected in changes in the P1 event-related potential (ERP) component. Recent research suggests that the process of selection may involve both the relative enhancement of the signal of the attended stimulus as well as relative suppression of the unattended stimulus (e.g., Couperus and Mangun, 2010). However, while studies suggest facilitation is present even in young children (e.g., Harter et al., 1989), the development of suppression in visual selective attention has not been deeply explored. This study examined these two processes in adolescents (11-17 years) using a spatial cuing paradigm. We examined target and distracter processing as a function of the expectancy of distracter presence versus absence. Participants were cued to the spatial location of a target (100% valid cues) as well as to the presence or absence of distracters in the opposite hemifield (70% valid cues). Analysis of distracter-present displays in adults typically show that in addition to relative enhancement of the occipital P1 in the hemisphere contralateral to the target, processing contralateral to distracters is reduced when a distractor is anticipated compared to when the presence of a distractor is not anticipated. In contrast, in this study, only relative facilitation contralateral to the attended target was seen in adolescents. Additionally, analysis of processing prior to cue onset do not show affects of attention or distractor anticipation. These findings suggest that both enhancement and suppression are involved in visual-spatial selective attention in adults, but that suppression may still be undergoing development in adolescence.

Background

Selective attention modulates early processing in adults. Specifically when cued to the attended location, processing is modulated both following the cue indexed by frontal components such as the Anterior Directing Negativity (ADAN) and during stimulus processing as indexed by occipital components such as the P100. Previous research suggests:

- **Adults and children show facilitation of the attended signal both prior to and during stimulus presentation** (e.g. Couperus, under review, Couperus and Mangun, 2010, Dale et al., 2008, Di Russo, et al., 2003; Handy and Khoe 2005; Harter et al., 1989, Hillyard, et al.,1998; Mangun and Hillyard, 1991, 1995; Mangun and Fannon, 2007).
- **Adults show evidence of suppression of the unattended signal both prior to and during stimus presentation** (Couperus and Mangun, 2010, Kelly, et al., 2006; Serences, et al., 2004; Slotnick, et al., 2003; Worden, et al., 2000).
- **While adolescents have shown evidence of facilitation** (e.g. Couperus, under review) **suppression has not been studied in this population.**

Therefore, this study will examine changes in amplitude both prior to and during the presentation of visual stimuli to examine the functioning of ***facilitation*** and ***suppression*** in adolescence.

Methods

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

Participants

- 14 Adolescents (7 Males, 7 Females, mean age = 14.28, SD =1.81, 12 White, 2, Asian)
  - Participants were recruited from the Pioneer Valley in Western MA. Participants were excluded from participation if they had visual impairments that could not be corrected with glasses/contacts, were currently on psychotropic medications, or if they were born premature (ie less than 36 weeks). Participants received $10 -20 for participation.

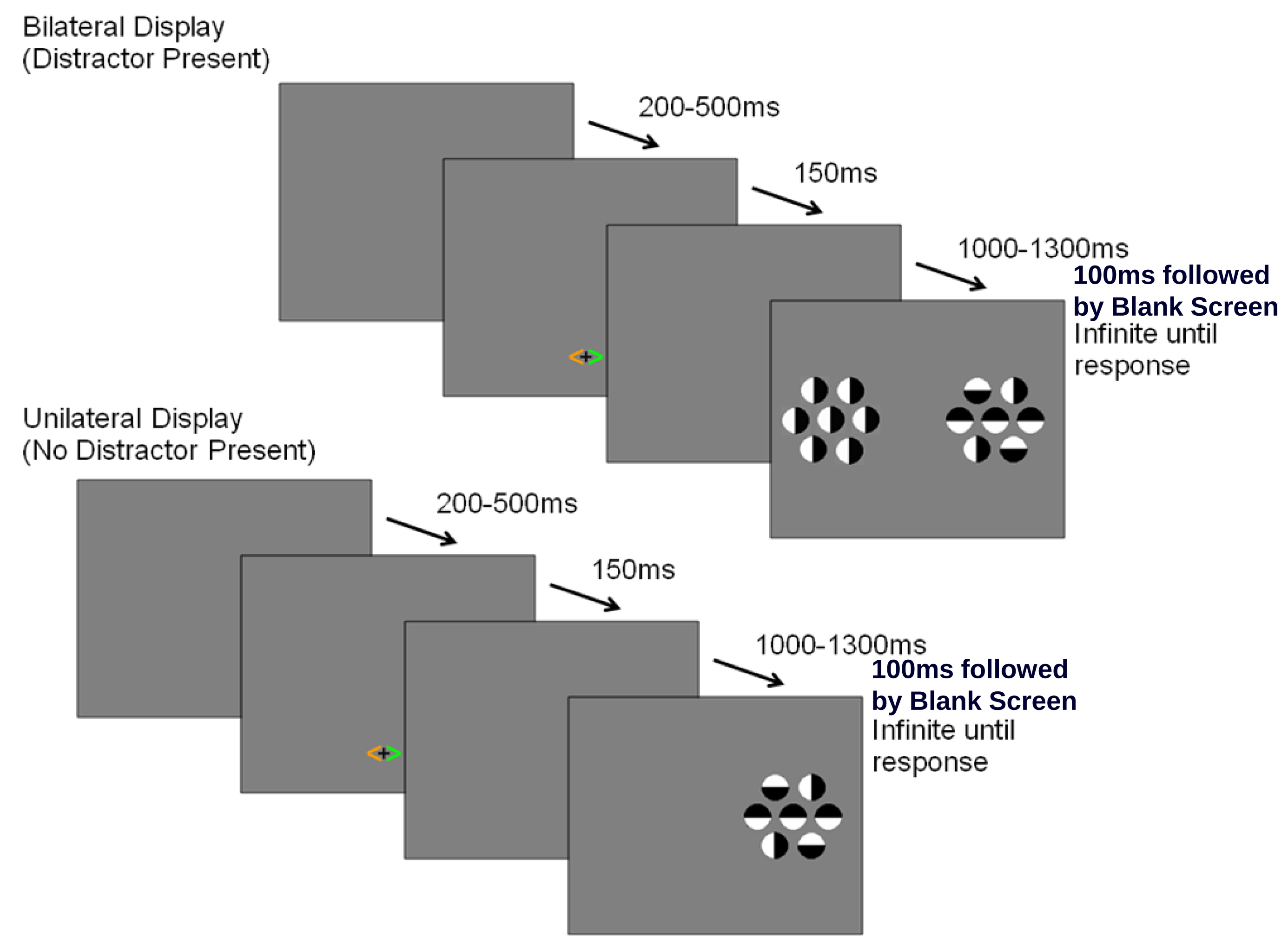
Electrophysiological Recordings

- 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 F3, F4, O1, and O2 were averaged by condition and analyzed.

Methods (cont.)

Selective Attention Task
(Based on Couperus and Mangun 2010):

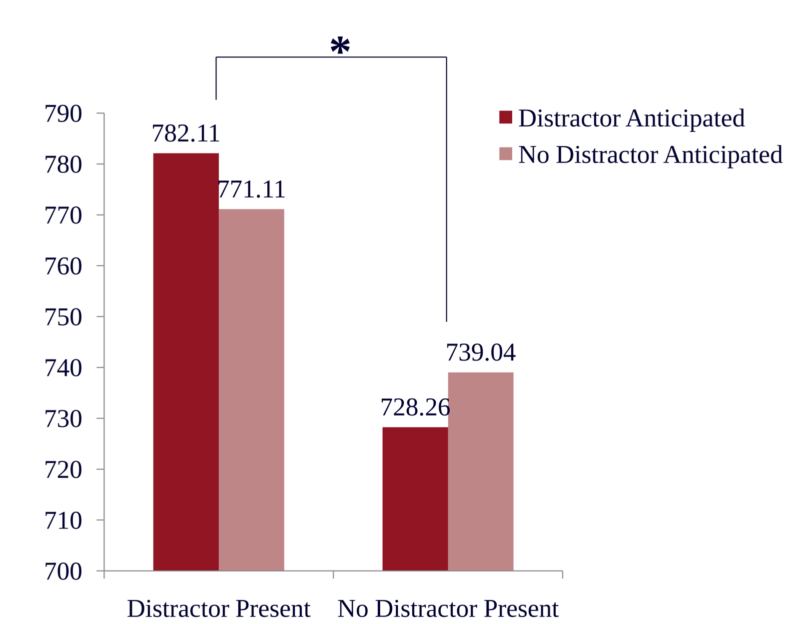
- ➢800 trials
  - ➢50% of visual stimuli were bilateral displays, 50% were unilateral displays
  - ➢70% were correctly cued to both the target side and presence of a distractor, 30% were cued to the correct side, but incorrectly cued to the presence of a distractor
- ➢**Participants were asked to attend to one side of the screen and press one button if the center row of circles was black on top and a different button if the center circles were white on top.**
- ➢**ERPs were analyzed for each condition at frontal leads (F3 and F4) following the cue for all displays and occipital leads (O1 and O2) following the target stimuli during bilateral displays**



Results

Accuracy and Reaction Time

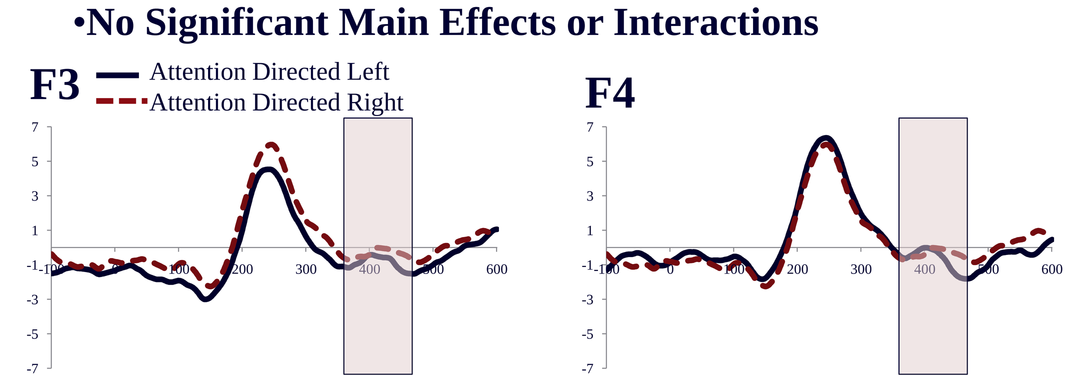
- Mean Accuracy = 65.0% (SD = 10.3)
  - This is comparable to previous studies (Couperus and Mangun, 2010)
- Mean Reaction Time (msec)



ADAN: Following the Cue Contralateral to the Direction of Attention

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

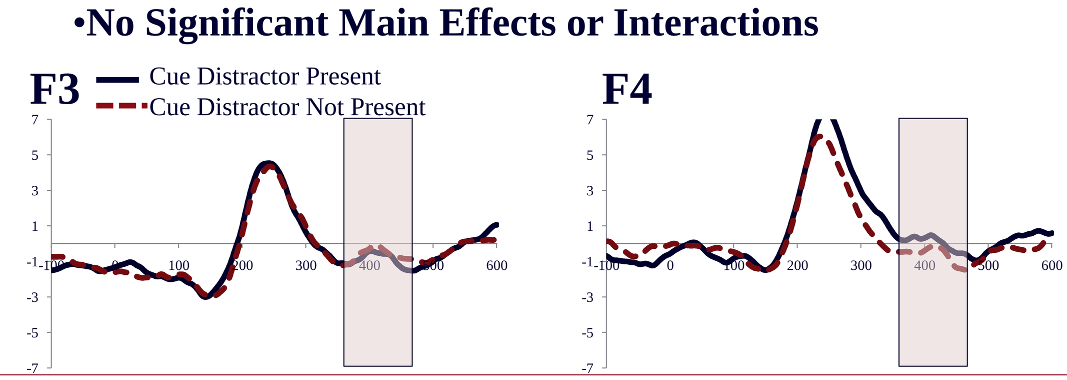
- **No Significant Main Effects or Interactions**



ADAN: Following the Cue as a Funtion of Distractor Presence

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

- **No Significant Main Effects or Interactions**



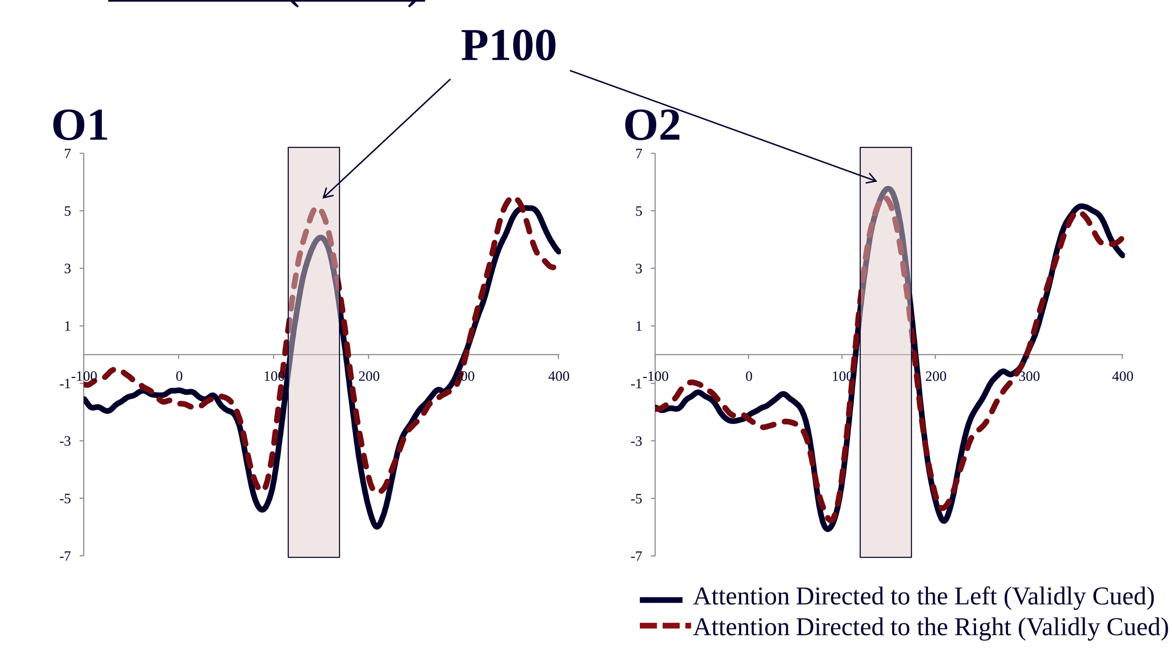
Results (cont.)

Electrophysiological Data

P100: Contralateral to Targets as a Function of Attention

2(Hemisphere)x 2(Electrode) Repeated Measures ANOVA) –correctly cued for distractor presence

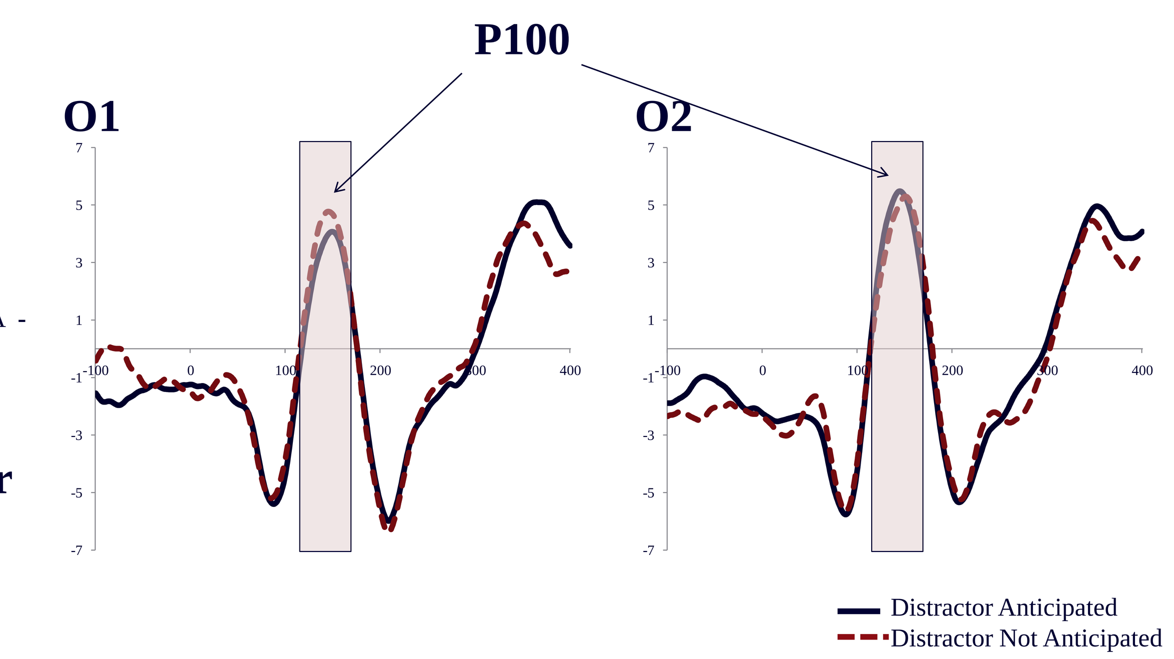
- **Significant Interaction between Hemisphere and Electrode**
- F(1,13)=4.65,p=.05*



P100: Contralateral to Distractors as a function of Distractor Anticipation

2(Cue Type)x 2(Hemisphere) Repeated Measures ANOVA - contralateral to distractor when distractor correctly cued compared to invalidly cued

- **No Significant Main Effects or Interactions**



Discussion

- Behavioral Data suggests that teenagers perform this task similarly to adults in previous studies, effectively using selective attention to perform the task.
- ERP data shows facilitation during stimulus processing contralateral to the attended target location as evidenced by significant increases at the P100 at O1 and OZ showing similar effects of selective attention to adult populations (e.g. Couperus and Mangun, 2010; Mangun and Hillyard 1991).
- However, no significant effects of suppression were seen during either processing following the cue or during stimulus processing.

  An important caveat is that facilitation was also not seen prior to stimulus onset although ERP data suggest that this may be an issue of power and waveforms suggest such an effect.

=> This study suggests that adolescents, like adults show modulation of the P100 to visual stimuli as a function of selective attention, specifically showing facilitation. However, evidence of suppression is not seen in this paradigm.

Further Information

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

Acknowledgements

This work was funded by a small grant from Hampshire College. Please send comments or questions to jcouperus@hampshire.edu