Perceptual Load Modifies Processing of Distractor Stimuli Both In the Presence and Absence of Target Stimuli

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Abstract

Previous research has suggested that perceptual load influences early visual processing by narrowing the focus of visual selective attention (Handy et al., 2001). However, the paradigms utilized have measured changes in electrophysiological activity to unattended probe stimuli presented in the absence of target stimuli (e.g. Barnhardt et al., 2008, Couperus, 2009; Handy et al., 2001). This design does not allow for the effects of perceptual load to be fully appreciated. According to Lavie (1995), increases in perceptual load serve to narrow the focus of attention such that fewer resources are available for processing distractor stimuli. Thus, this effect should be seen both in the presence and absence of target stimuli. Moreover, with increases in target processing decreases in distractor processing should be seen. To examine this, participants were presented with a bilateral or unilateral display and asked to perform a discrimination task at either low or high perceptual load. Electrophysiological responses to both the attended (target) and unattended (ie distractor) stimuli were then compared at the P100 and N100. As in previous studies, attention effects were seen at the P100 and were amplified when the target stimulus was presented at high perceptual load at the N100 when the stimulus was presented alone. Affects of perceptual load, but not attention were seen at the N100 when both target and distractor were presented simultaneously. Thus data support previous studies that suggest effects of perceptual load are influenced by top down processes (e.g. Couperus 2009, Theeuwes et al., 2004) and support Lavie's theory more generally.

Background

Research suggests that perceptual load modulates selective attention at early levels of processing, however, the neurological underpinnings of this modulation are less clearly understood. Specifically the N100, associated with visual processing, changes in amplitude as a function of attention. Previous research suggests that

- **•P100 amplitude is reduced to a non-lateralized parafoveal probe stimuli when a target is presented at high perceptual load** (Handy, Soltani and Mangun, 2001; Couperus, 2009).
- **•Attention effects at the N100 are modulated by perceptual load for lateralized stimuli, however, this modulation has shown both increases** (Barnhardt et al., 2008, Handy and Mangun, 2000) **and decreases** (Fu et al. 2009) **with high levels of perceptual load while no such changes are seen at the P100**.
- **•Finally, no studies have examined the effects of perceptual load on processing of spatially separated target and distractor stimuli when presented simultaneously.**

Therefore, this study will examine changes in selective attention as a function of perceptual load for lateralized stimuli both in the presence and absence of stimultaneous distractor and target stimuli. It is hypothesized that perceptual load will modulate selective attention in both conditions, but that effects on distractor processing will differ when presented simultaneously with target stimuli as compared to when presented alone as "probe" stimuli.

Methods

Participants were asked to complete a unilateral or bilateral discrimination task at both low and high perceptual load while electrophysiological recordings were acquired.

Participants

•16 Adults (6 Males, 10 Females, mean age = 19.12, SD =1.59, 13 White, 1 Hispanic, 2 Asian)

Participants were recruited from Hampshire College in Amherst, MA. 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 $20 for participation.

Electrophysiological Recordings

•ERPs were collected using a SYNAMPs2 amplifier with SCAN 4.3 recording software. Thirty-two channel tin ElectroCaps using a linked-mastoid reference were used with a sampling rate of 250Hz 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 O1 and O2 were averaged by condition and analyzed.

Methods (cont.)

Unilateral Perceptual Load Task:

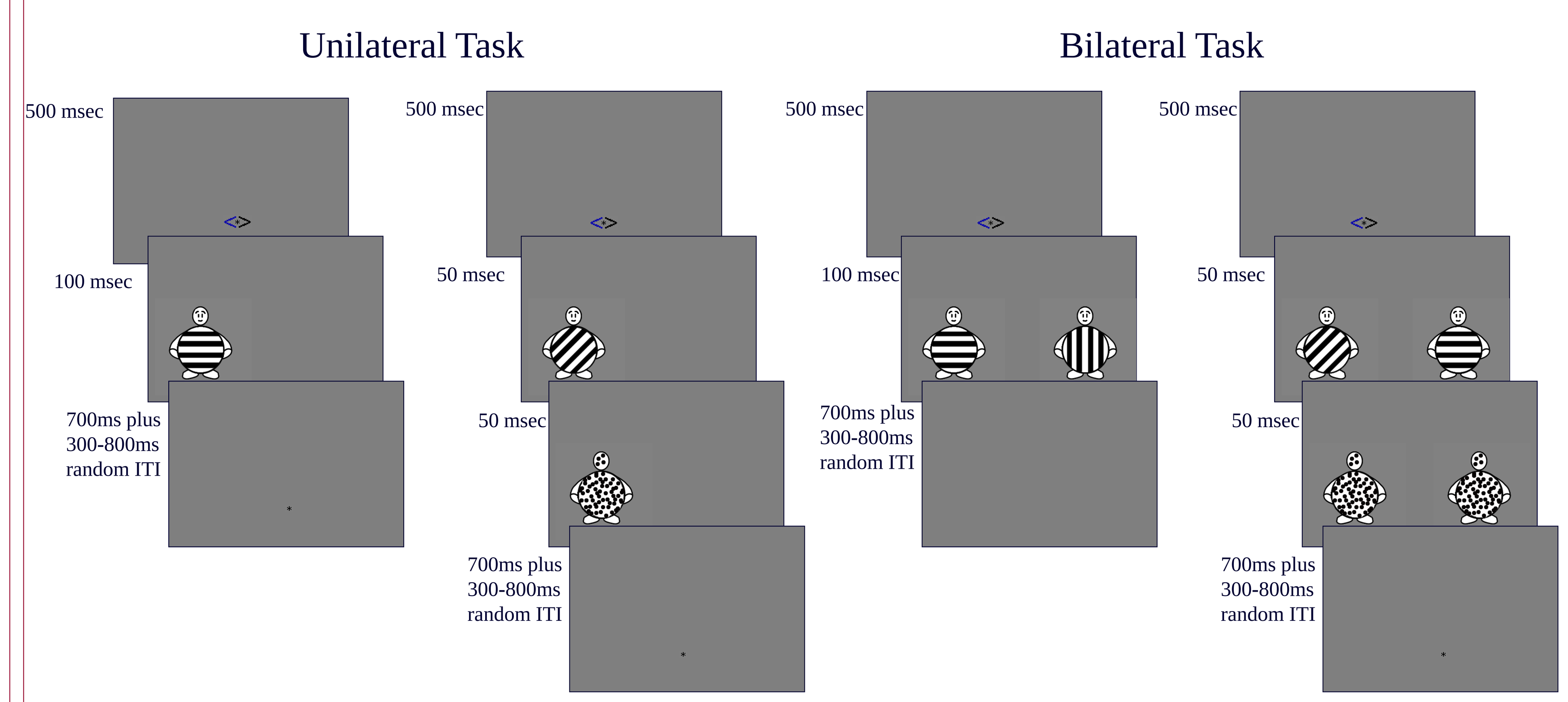
- ➢800 trials in each Perceptual Load Epoch
  - ➢20% target stimuli, 80% non-target stimuli
  - ➢50% of stimuli in each hemifield
    - ➢60% validly cued (targets 100% validly cued)

Bilateral Perceptual Load Task:

- ➢400 trials in each Perceptual Load Epoch
  - ➢20% target stimuli, 80% non-target stimuli
  - ➢50% of stimuli in each hemifield

➢Participants were asked to press one button if the target stimulus had diagonal stripes and asked to do nothing if the stimulus had vertical or horizontal stripes.

➢ ERP responses to both attended and unattended non-targets were analyzed.



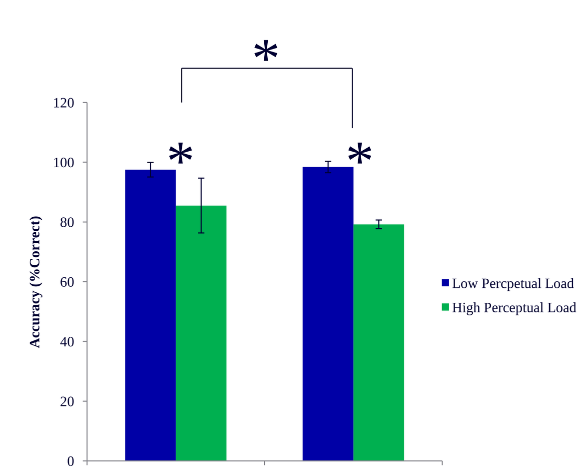
Results

Behavioral Results

2(Task) x 2 (Perceptual Load) MANOVA

•Higher Accuracy for Unilateral Displays and Low Perceptual Load Conditions

- •Main Effect of Load $F(1,15)=31.93$, $p<.001$
- •Main Effect of Task: $F(1,15)=11.67$, $p=.004$
- •Interaction of Load and Task: $F(1,15)=19.76$, $p<.001$



ERPs: Attention Effects

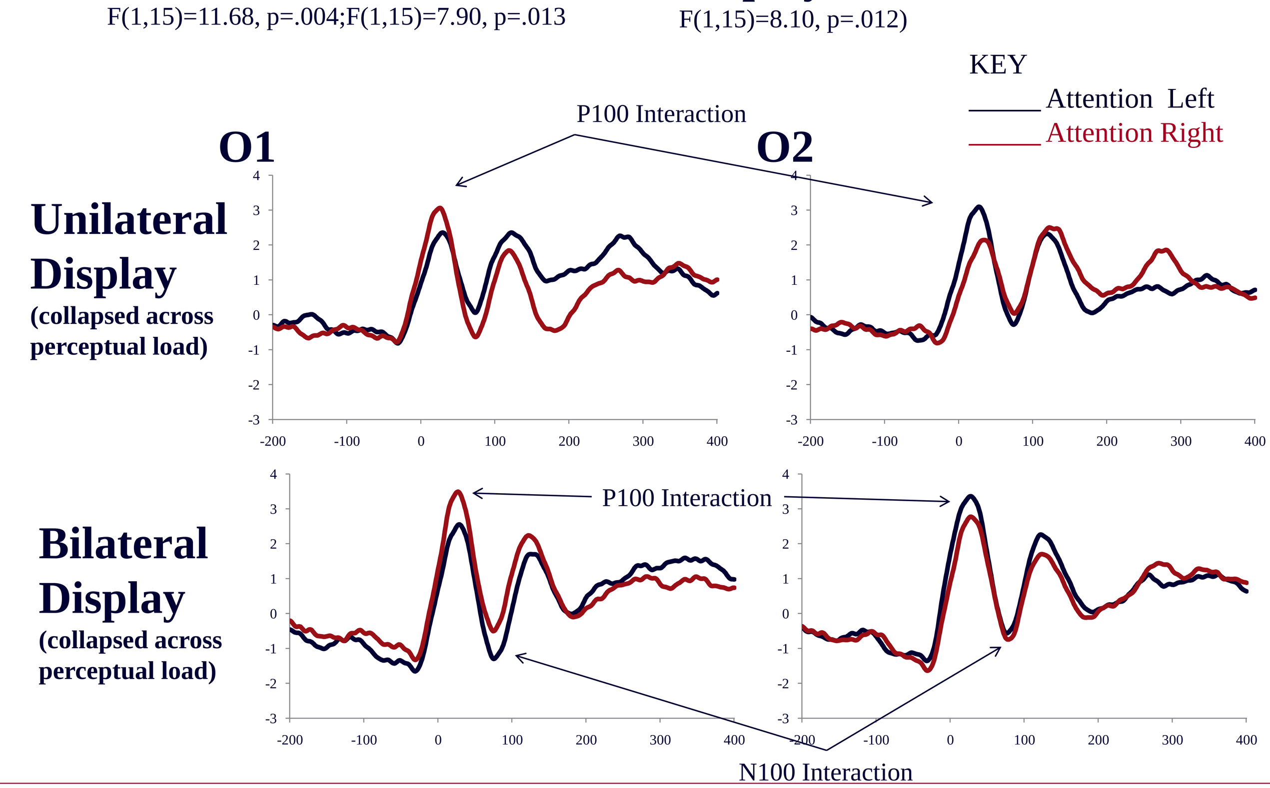
2(Perceptual Load) x 2(Hemifield of Presentation) x 2(Electrode) Repeated Measures MANOVAs

P100: Interaction: Hemifield and Electrode in Unilateral and Bilateral Displays

$F(1,15)=11.68$, $p=.004$;$F(1,15)=7.90$, $p=.013$

N100: Interaction: Hemifield and Electrode in Bilateral Displays

$F(1,15)=8.10$, $p=.012$)



ERPs: N100 Perceptual Load Effects

2(Perceptual Load)x2(Hemifield) x 2(Electrode) Repeated Measures MANOVAs

Unilateral Display

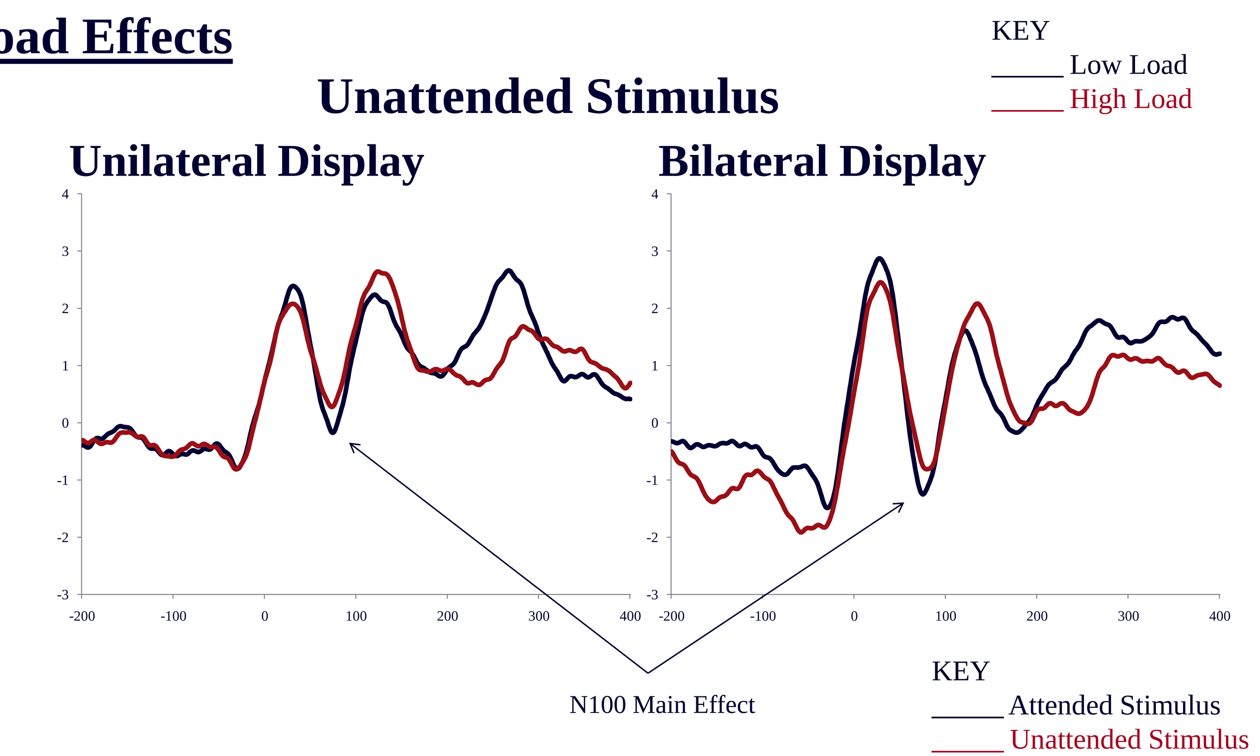
•Main effect of Perceptual Load

$F(1,15)=5.26$, $p=.037$)

Bilateral Display

•Main effect of Perceptual Load

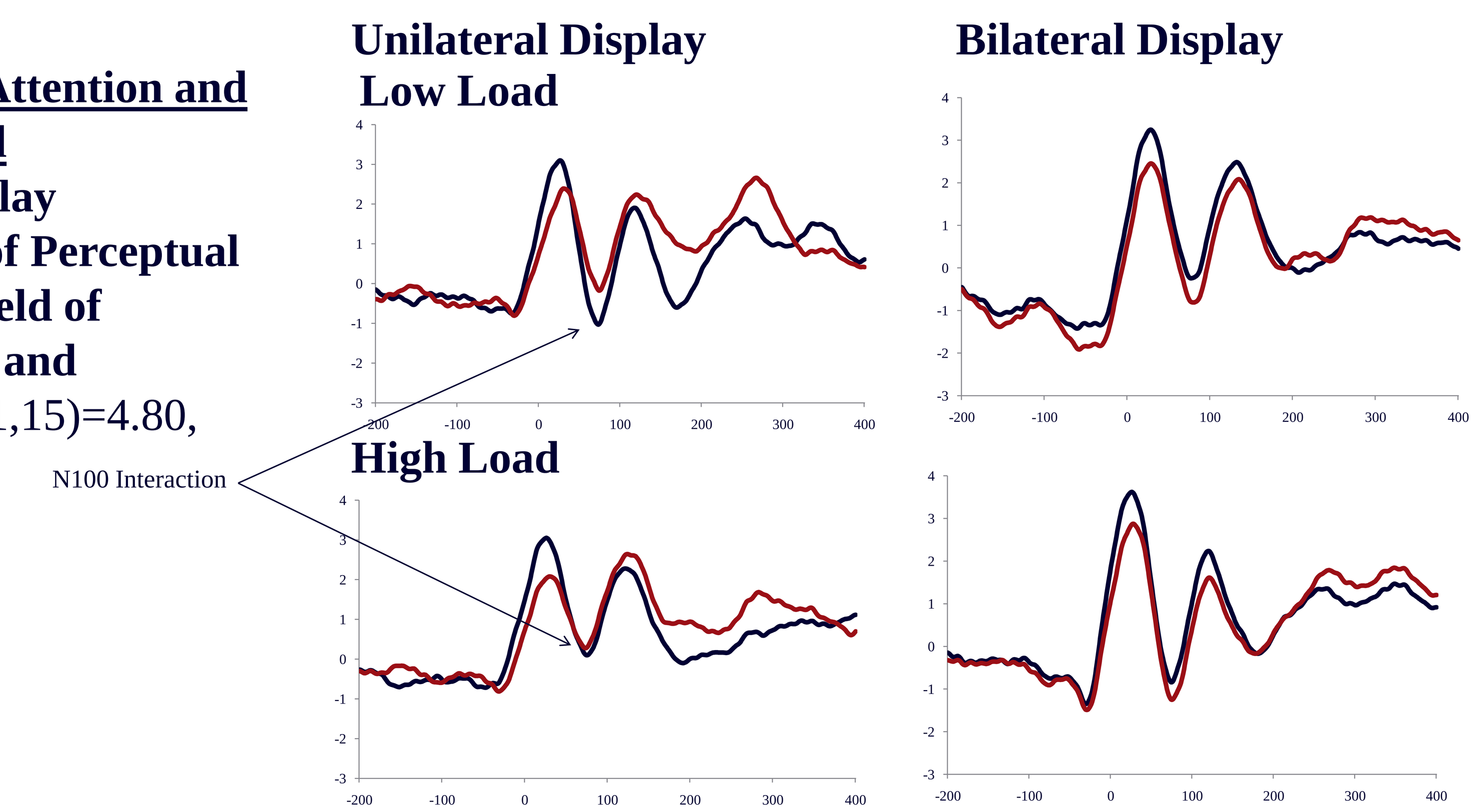
$F(1,15)=4.81$, $p=.045$



Interactions of Attention and Perceptual Load

•Unilateral Display

•Interaction of Perceptual Load, Hemifield of Presentation, and Electrode $F(1,15)=4.80$, $p=.045$



Discussion

● Attention effects were shown at the P100 for both unilateral and bilateral displays and at the N100 for bilateral displays. Moreover, no effects of perceptual load were seen in the P100 for either unilateral or bilateral displays as has been shown in previous studies.

●Perceptual load influenced processing at the N100 for bilateral displays but did not show an interaction with attention effects. Stronger N100s were seen for low perceptual load stimuli as compared to high perceptual load stimuli extending previous findings to bilateral displays.

●Attention was influenced by perceptual load at the N100 in unilateral displays with stronger N100's to attended as compared to unattended stimuli, replicating previous studies (Barnhardt et al., 2008 and Handy and Mangun, 2000). However, in contrast to earlier studies attention differences were stronger at low perceptual load as compared to high perceptual load.

=> This study suggests that perceptual load modifies processing of an attended stimulus when it is presented alone as well as when presented simultaneously with an unattended stimulus.

References

Please see handout, download this poster and references from the web at http://helios.hampshire.edu/~jwcCS/JCouperus.htm, or contact the first author at jcouperus@hampshire.edu.

Acknowledgements

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