Working Memory and External Stroop Tasks: Comparison of Interference and Conflict Adaption Response Time and ERP (N450) Effects

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INTRODUCTION

- What is the extent to which working memory (WM) operates under the guidance of a dedicated control module (Baddeley, 2010), or more general processes of attention (Chun, 2011)?
- WM as ***internally directed attention*** (Cowan, 1988) motivates research on WM /attention relationships (e.g., Stroop & WM, Kane & Engle, 2003), and begs questions of possible common processing mechanisms, and neural systems for internally and externally directed attention.
- Kiyonaga & Egner (2014), found evidence for similarities between internal and external attention using a WM analog of the Stroop interference task.

Further Comparison: Internal (WM) & External Stroop Tasks

- The present study used a **modified version of the internal (WM) Stroop task** (Kiyonaga & Egner, 2014) and a matching external (traditional) Stroop tasks.
- ***Conflict Adaptation* (CA)**, reduced Stroop interference following an incongruent (i.e., word and color differ) versus a congruent (i.e. word and color the same) trial has been proposed as a behavioral measure of transient cognitive control processes (Botvinick et al., 2001).
- ***Congruency-Related Neuroelectric Markers* (ERPs)**, can provide evidence for common neural systems operating to control distractor interference.
- **Stroop tasks** typically yield an **N450** (i.e., negative deflection of the incongruent minus congruent trial ERPS waves at about 450 ms post-stimulus).
- **Flanker tasks**, by contrast, often yield an **N2** (i.e., negative deflection of the incongruent minus congruent trial ERP waves at about 200 ms post-stimulus).

Questions

- **Will Internal (WM) & External Stroop tasks yield similar congruency-related N2 & N450 effects?**
- **Will Internal (WM) & External Stroop tasks yield similar behavioral (i.e., response times) results?**

Method

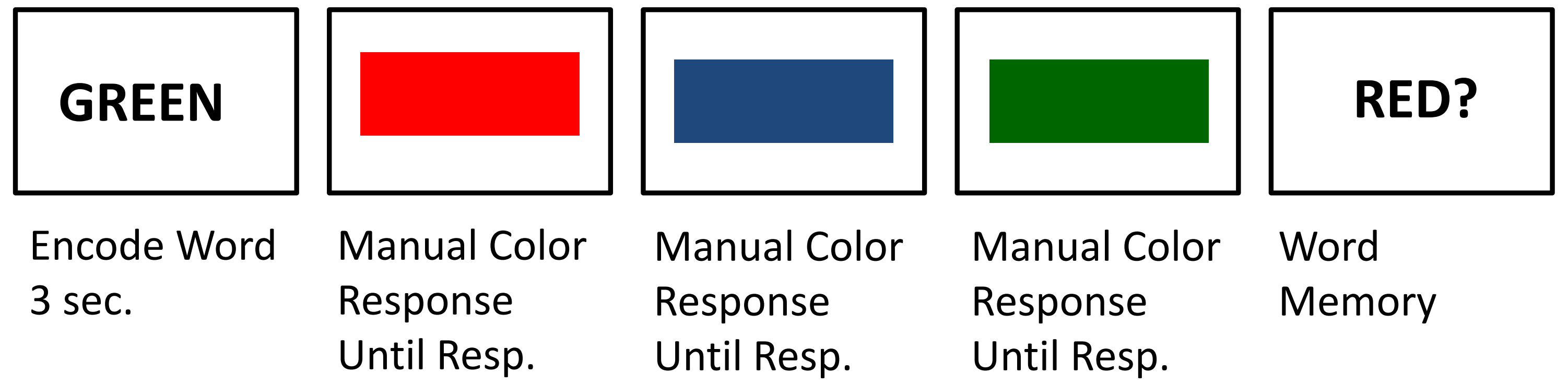
- 25 right handed participants, 2 dropped due to too many artifact trials
- 81 randomly ordered trial sequences crossed stimulus parameters, 70% congruent trials
- Button press response, color of patch & final memory test

EEG Measurement

- 64 channel cap (expanded 10-20 cap) Nueroscan SynAmps 2 system
- Filtered (0.1, 30 Hz), artifact rejection 100 µV peak-to-peak, epoched (-200, 1000 ms)
- Electrodes of Interest: Central Parietal Left (**CP3**) & Right (**CP4**)

TASKS

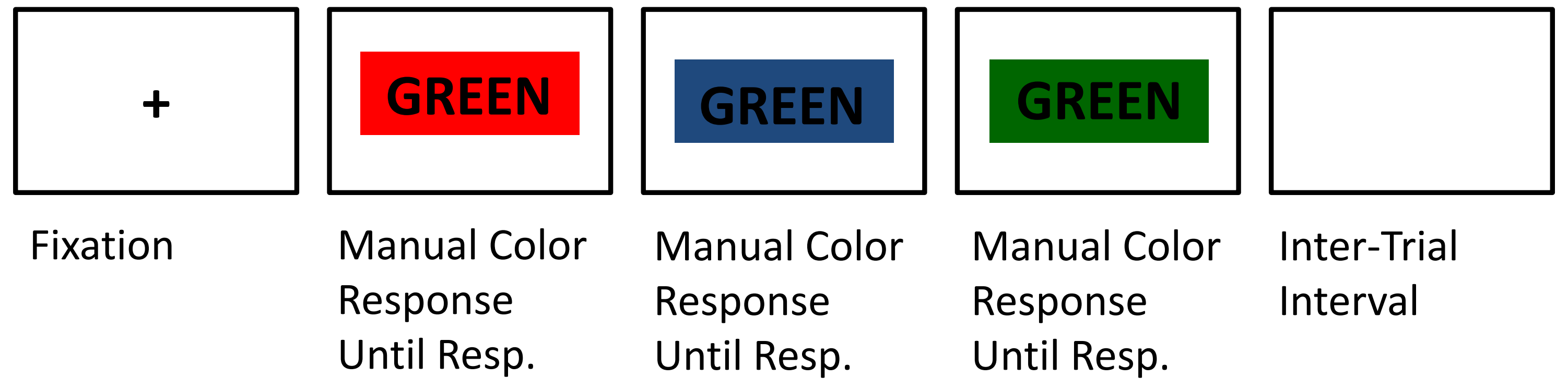
- **Internal (WM) Interference Task** (modified Kiyonaga & Egner, 2014): Stroop-like analog, begins with single memory word, then 3 successive color patch displays (manual response), then 4th display of recognition memory for word.



GREEN | RED?

Encode Word 3 sec. | Manual Color Response Until Resp. | Manual Color Response Until Resp. | Manual Color Response Until Resp. | Word Memory

- **External Interference Task**: Same as the Internal task, but with repeated presentation of the word instead of holding it in WM (also no memory test).



\+ | GREEN | GREEN | GREEN

Fixation | Manual Color Response Until Resp. | Manual Color Response Until Resp. | Manual Color Response Until Resp. | Inter-Trial Interval

RESULTS

Behavioral Interference Effect (Incon– Con):
All sig. (p<.01) except Internal Task Display 2 condition (p = .17)

Conflict Adaptation (CA, reduced Stroop Interfered following Incongruent trial):
Sig. Prior x Current Congruency interactions, all conditions
Sig. reduced CA from Display 2 to 3, both tasks

Congruency-Related ERP (greater negative deflection for incongruent wave):
N450 marginally sig., p= .064, External Stroop, fronto-central distribution, 400-500 ms
N2 marginally sig., p=.064, Internal Stroop, fronto-central distribution, 350-500 ms window

Region of Interest: Sites FC1, FCZ, FC2 (see scalp maps)

References

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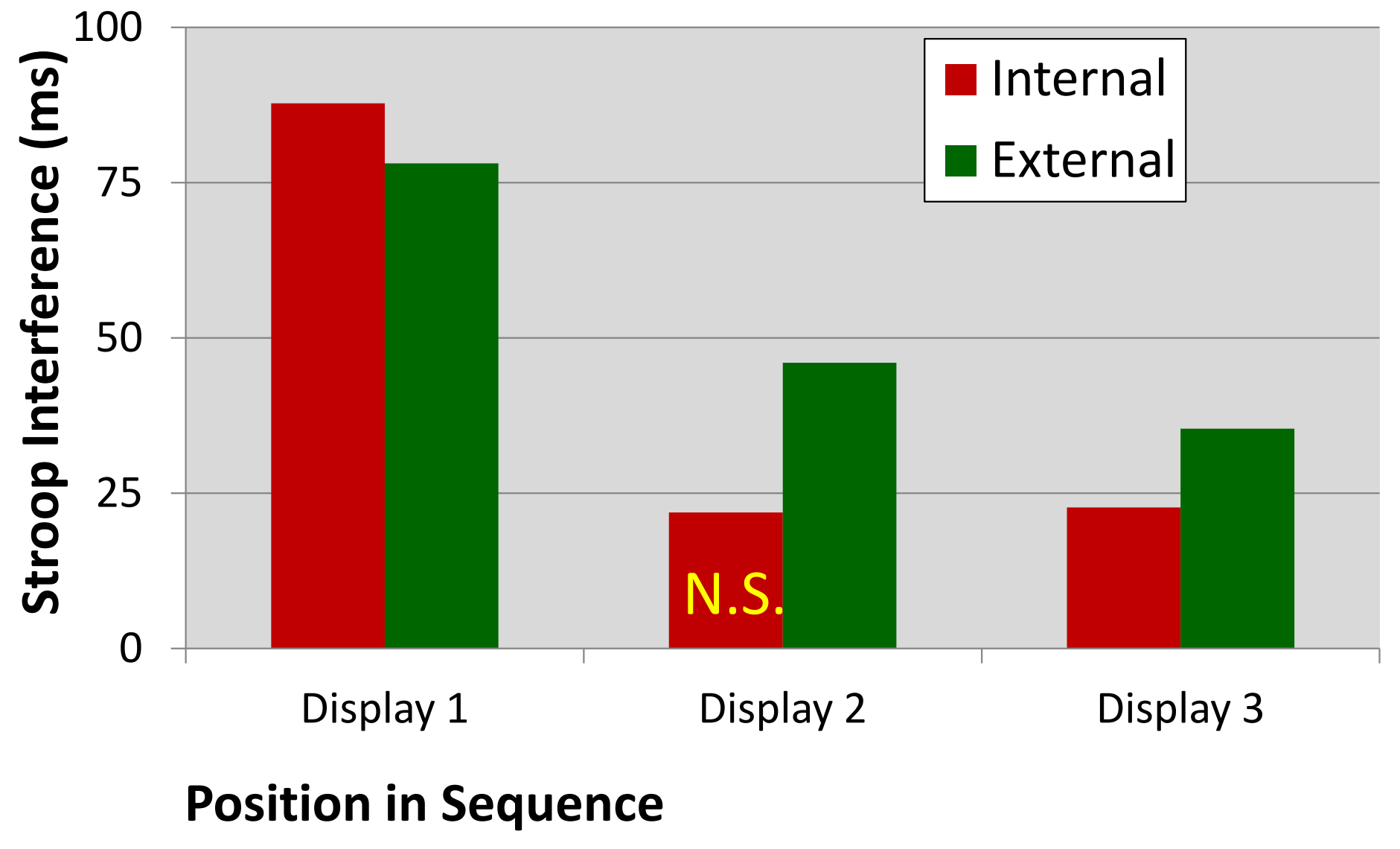
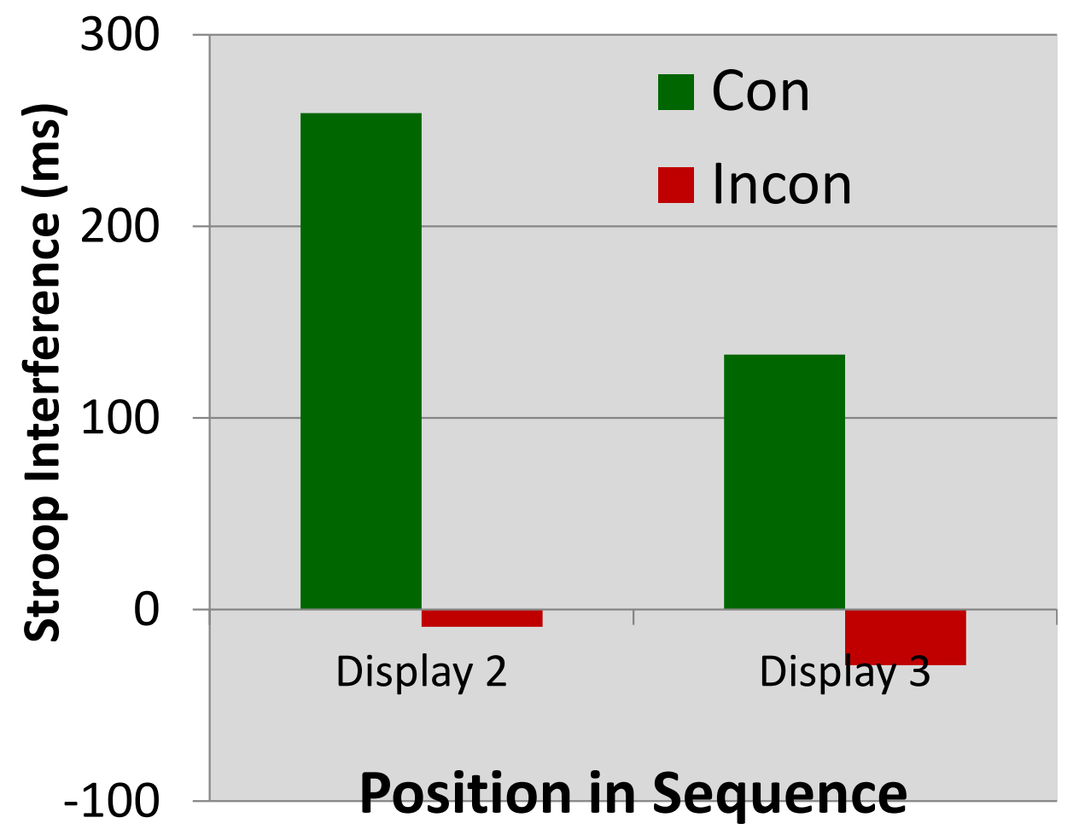
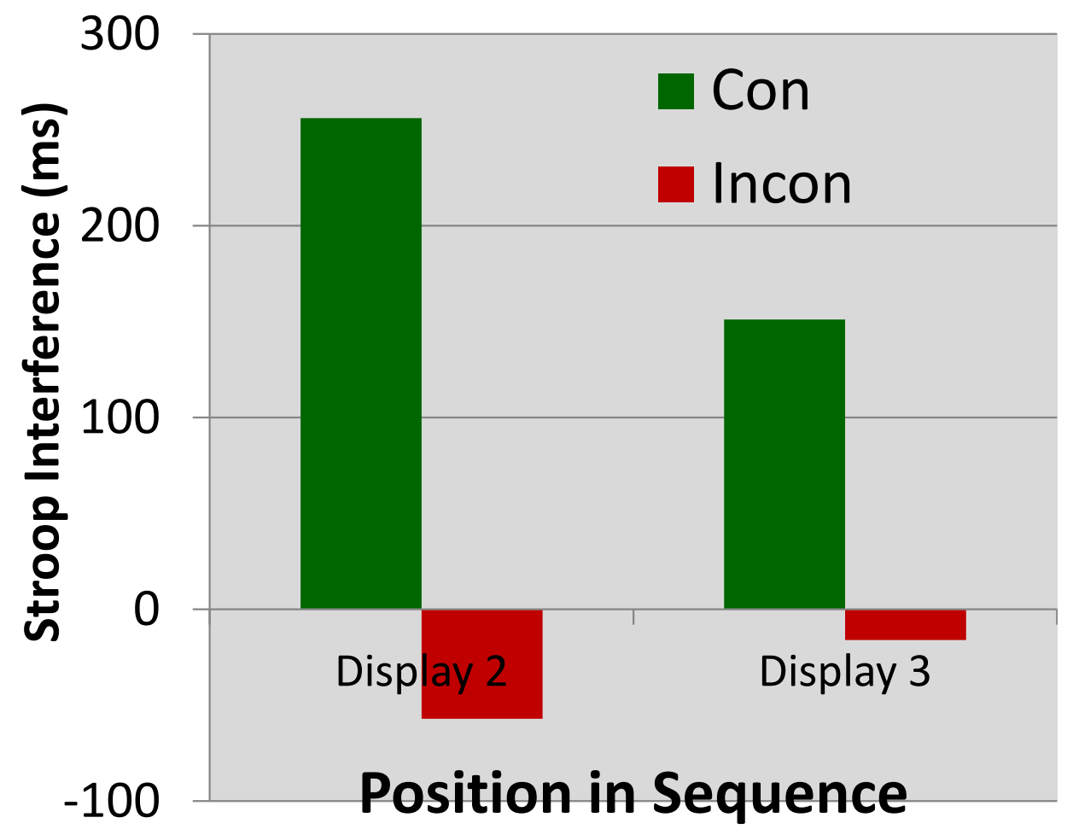
Stroop Effects

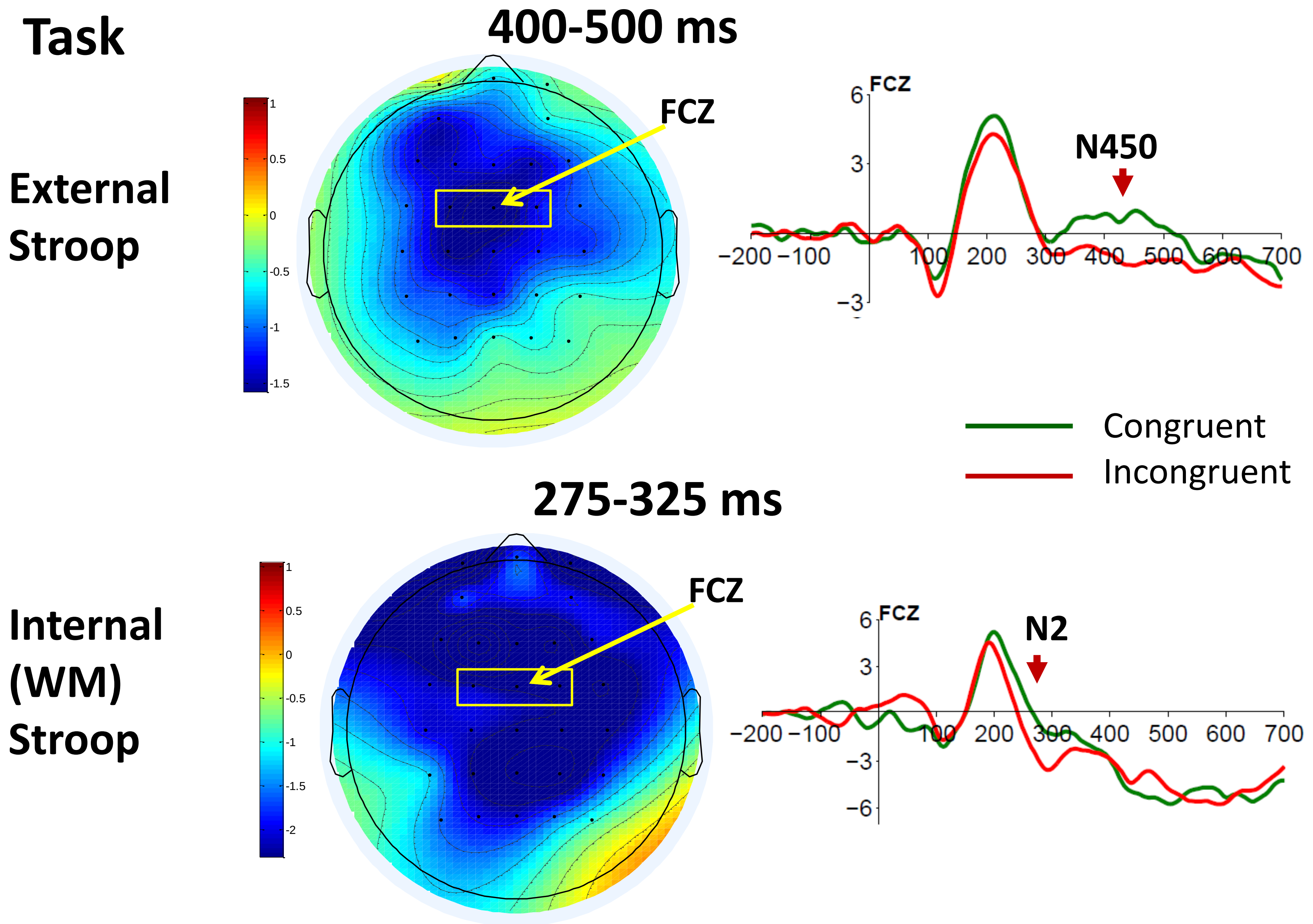


Conflict Adaptation
Internal Stroop



Conflict Adaptation
External Stroop





DISCUSSION

1. Consistent with Kiyonaga and Egner (2014) the behavioral Stroop interference effects are quite similar across Internal and External tasks. However, the Display 2 interference effect was not significant for the Internal Task condition, perhaps indicating a tendency for occasional lapses of maintenance of activation of the distractor in WM.
2. Conflict Adaptation effects were equivalent. Repetition of the word in WM or on successive displays led to a similar reduction in Conflict Adaptation for both tasks. Adaptive control responses to distractor conflict may be similar for internal and external attention.
3. The most surprising finding of this study is the emergence of an N2-like congruency-related ERP effect for the Internal (WM) task. By contrast, the External task yielded an N450 effect as expected for a variant of a traditional Stroop task. These results point to an earlier neural response to conflict in the stimuli for the Internal task that bears some similarity to the N2 effect often found during Flanker interference tasks. However, these results are tentative due to both effect not reaching statistical sig. (p = .064 for both effects).