

# Working Memory and External Stroop Tasks:

## Comparison of Conflict Adaptation Effects in Response Times and ERPs (N450)



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### INTRODUCTION

- WM control as a form of *internally directed attention* (Cowan, 1988), instead of the result of a dedicated control module (Badddeley, 2010), has driven recent WM research (Chun, 2011), with similarity of WM control to visual distractor conflict processing (e.g., Stroop conflict & WM, Kane & Engle, 2003) of particular interest.
- Kiyonaga & Egner (2014), recently reported similar effects of manipulation of cognitive control demands for external (traditional visual distractor conflict) and internal (WM distractor) Stroop interference tasks.
- Motivated by cognitive control theory (Botvinick et al., 2001), research on event-related potential (ERP) markers of conflict processing (Larson et al., 2014) support dual processes of conflict detection (N2, N450) and conflict adjustment and resolution (N2, conflict SP).
- P3 has been related to attention to, and repetition of, distractors and targets (Clayson & Larson, 2011).
- We previously reported on a comparison of internal (WM) and external (visual) matched Stroop tasks that yielded equivalent Stroop interference effects in RTs, but differing ERP markers of conflict processing (N2 for internal, N450 for external, and no conflict SP for either version).

### Conflict Adaptation: Internal (WM) & External Stroop Tasks

- The present analysis of an expanded sample will focus on conflict adaptation effects for additional trials not included in our earlier report (i.e., 2<sup>nd</sup> and 3<sup>rd</sup> display in a 3-display sequence).
- **Conflict Adaptation (CA)**, reduced distractor interference following a conflict versus a non-conflict trial, allows assessment of transient conflict adjustment (Botvinick et al., 2001).

### Question

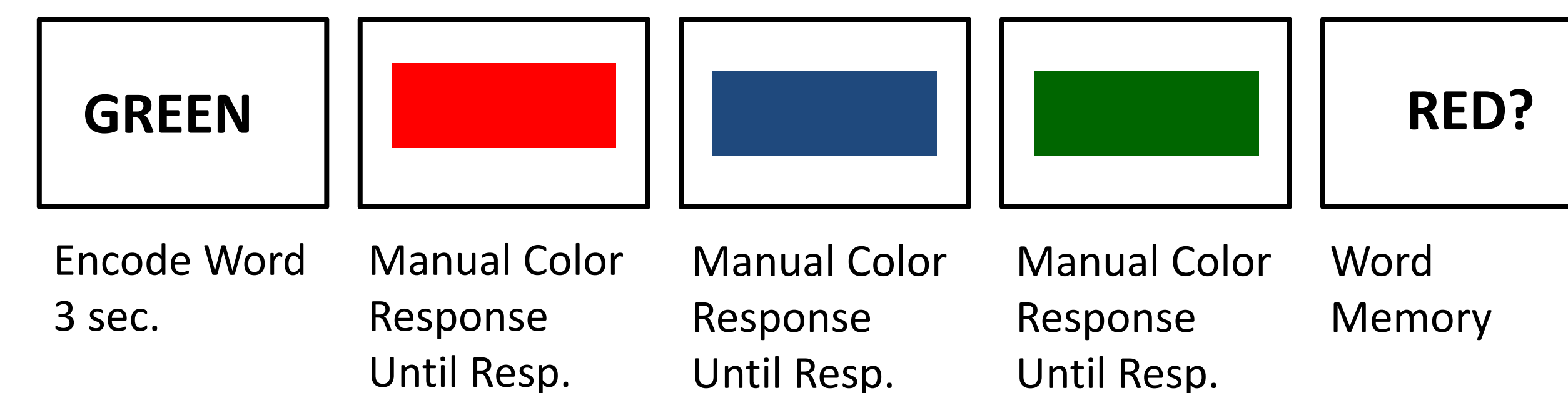
**Will Internal (WM) & External Stroop tasks yield similar conflict-related ERP effects related to conflict adaptation across a sequence of displays?**

### DISCUSSION

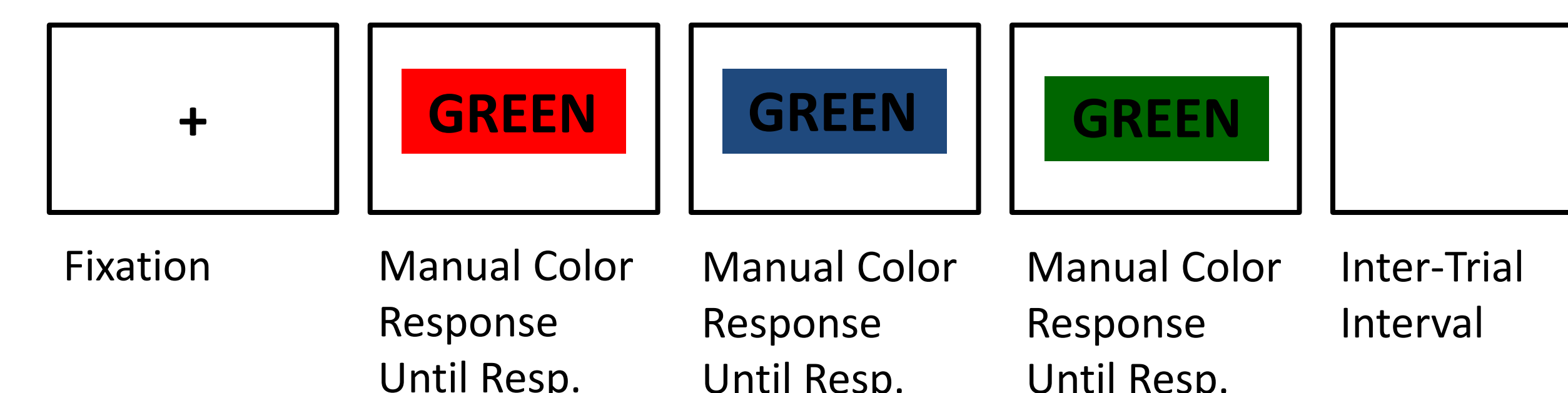
1. Kiyonaga and Egner (2014) reported that both the internal and external Stroop tasks were similarly sensitive to a range of experimental manipulations, in terms of the Stroop interference effects assessed in RTs. We add to their observations the result that RT-based conflict adaptation effects are also similar across the tasks.
2. However our results suggest notable differences in ERP markers of cognitive control processes across the tasks. In a previous report, we found that ERP markers associated with conflict processing differed across the two tasks on the 1<sup>st</sup> display of the 3-display sequences. The external task yields an N450 and the external task yielded an N2, suggesting conflict processing more similar to a Flanker interference task (Larson, et al., 2014).
3. The present analysis of the 2<sup>nd</sup> and 3<sup>rd</sup> displays yielded ERP markers associated with conflict adaptation (i.e., resulted in a prior trial by current trial interaction) that, again, differed across the tasks. The external task yielded evidence of an N450 (somewhat masked by a P3 effect) and a robust conflict SP effect, whereas the internal task yielded only a nonsignificant trend for an N2, followed by a significant P3. These results suggest greater conflict detection, adjustment and resolution in the external task.
4. Both tasks yielded P3 effects associated with conflict adaptation, with the incongruent-incongruent sequences yielding robust P3 peaks for both. This suggests that both tasks resulted in similar sensitivity to target repetitions. However, the internal task also yielded an increased P3 for incongruent-incongruent sequences.

### TASKS

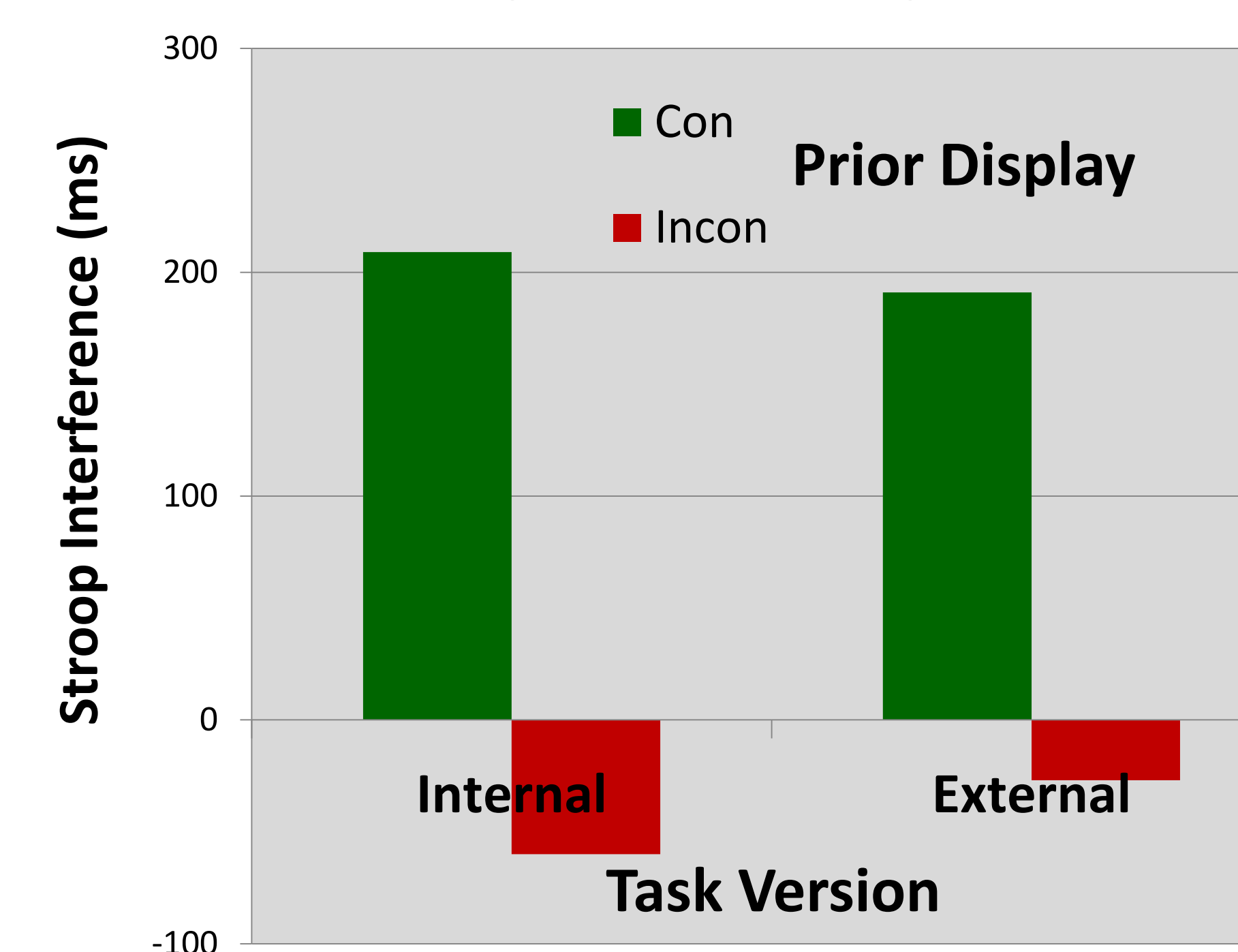
- **Internal (WM) Conflict Task** (modified Kiyonaga & Egner, 2014): Stroop-like analog, begins with single memory word, then 3 successive color patch displays (manual response), then 4<sup>th</sup> display of recognition memory for word.



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



### Conflict Adaptation: Response Times



### Method

- 39 right handed participants, 7 dropped due to too many artifact trials or equipment failure
- 2 blocks of 81 randomly ordered trial sequences of 3 displays, conflict adaptation assessed for 2<sup>nd</sup> & 3<sup>rd</sup> displays, button press response for color then final memory test, 67% conflict trials

### EEG Measurement

- 64 channel cap (expanded 10-20 cap) Neuroscan SynAmps 2 system
- Filtered (0.1, 30 Hz), artifact rejection 100  $\mu$ V peak-to-peak, epoched (-200, 1000 ms)
- Electrodes of Interest: FCz (frontal-central) & CPz (central-parietal)

### CONFLICT ADAPTATION RESULTS

**Response Times (CA, reduced Stroop Interference following Conflict trial):**

Sig. Prior x Current Conflict interactions, both internal and external tasks,  $p < .001$

**Internal (WM) ERPs (sig. Prior x Current Conflict interactions):**

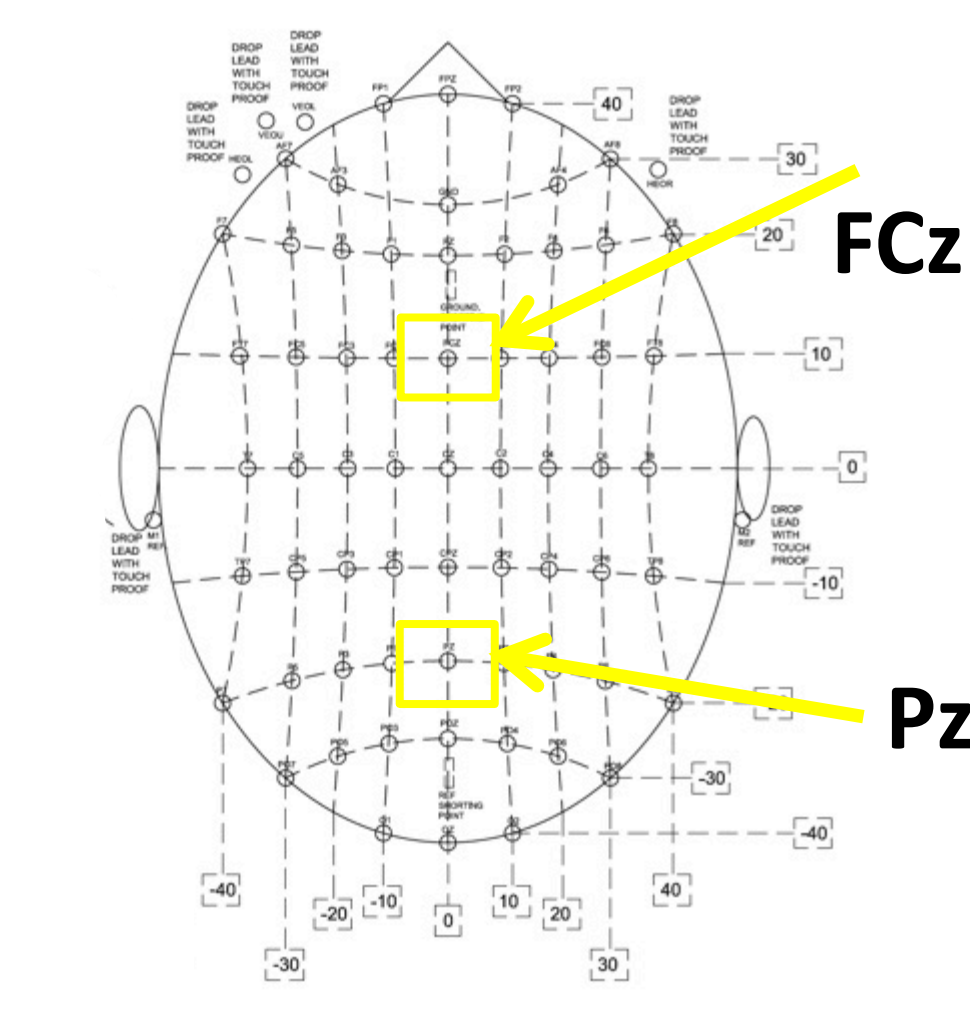
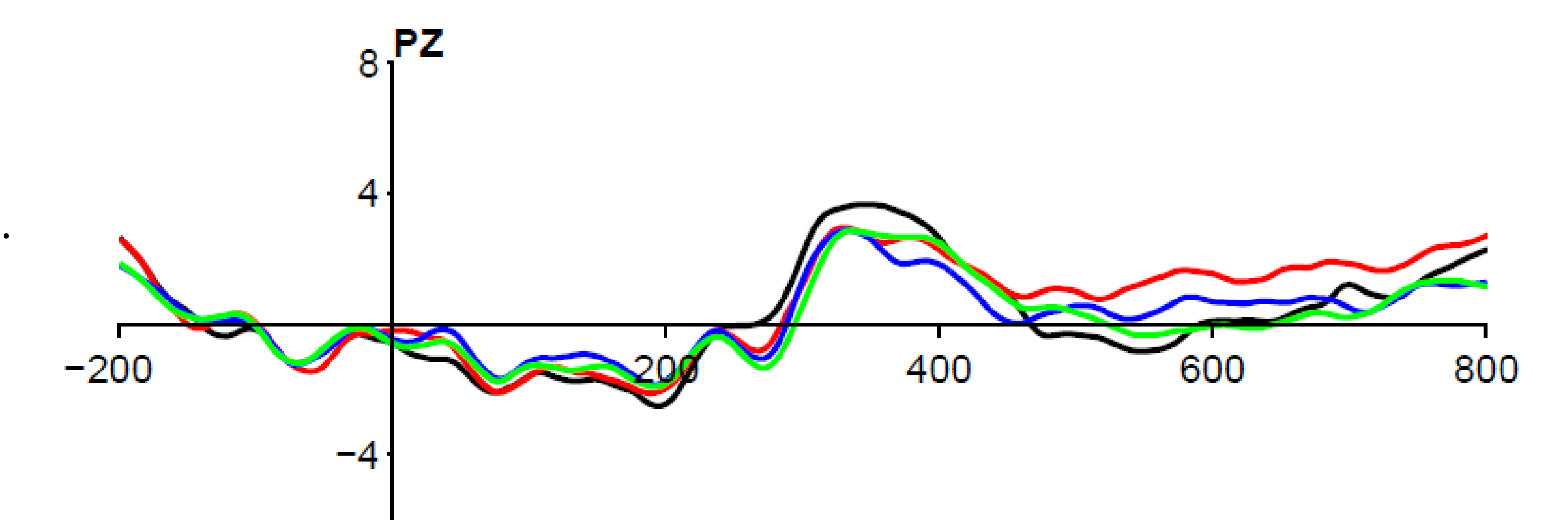
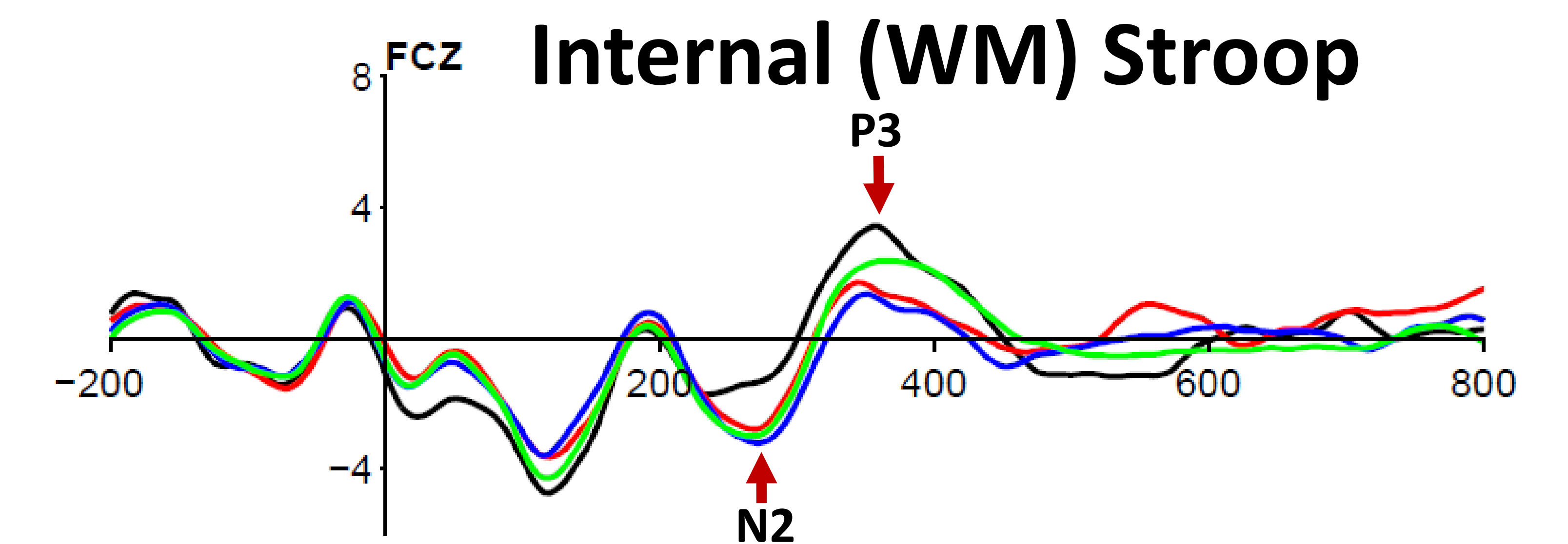
N2 marginally sig.,  $p = .069$ , FCz, 250-350 ms window

P3,  $p = .040$ , FCz, 350-450 ms window

**External (visual) ERPs (sig. Prior x Current Conflict interactions):**

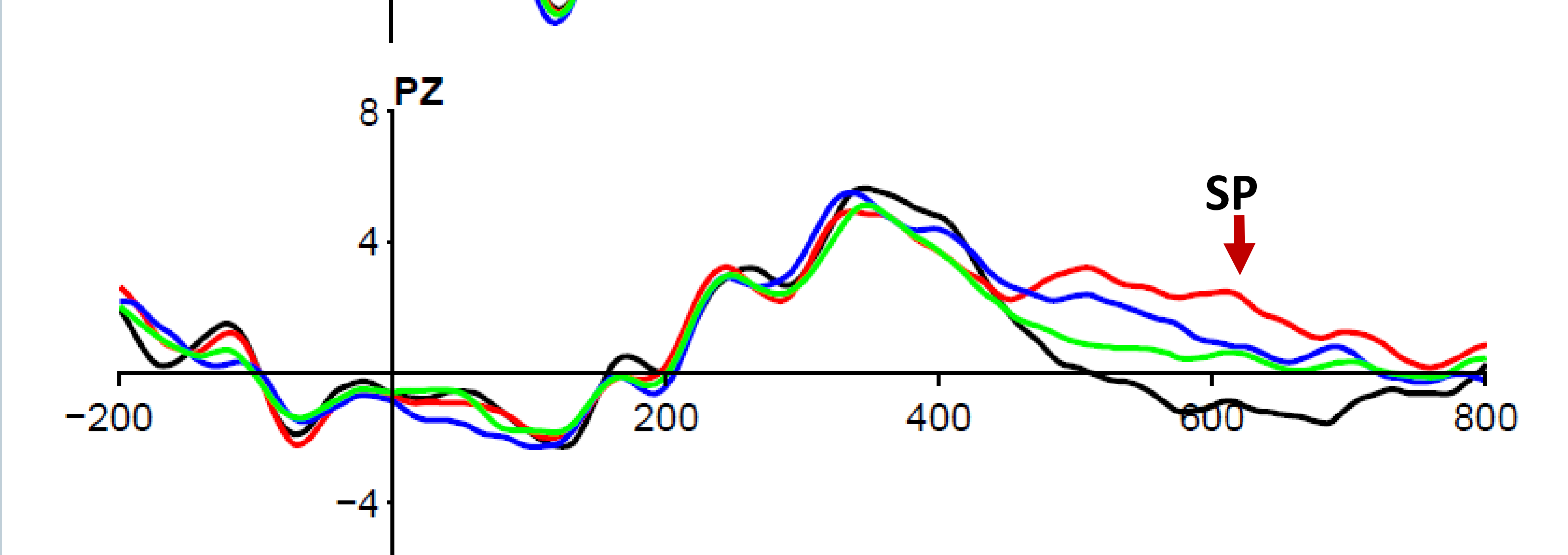
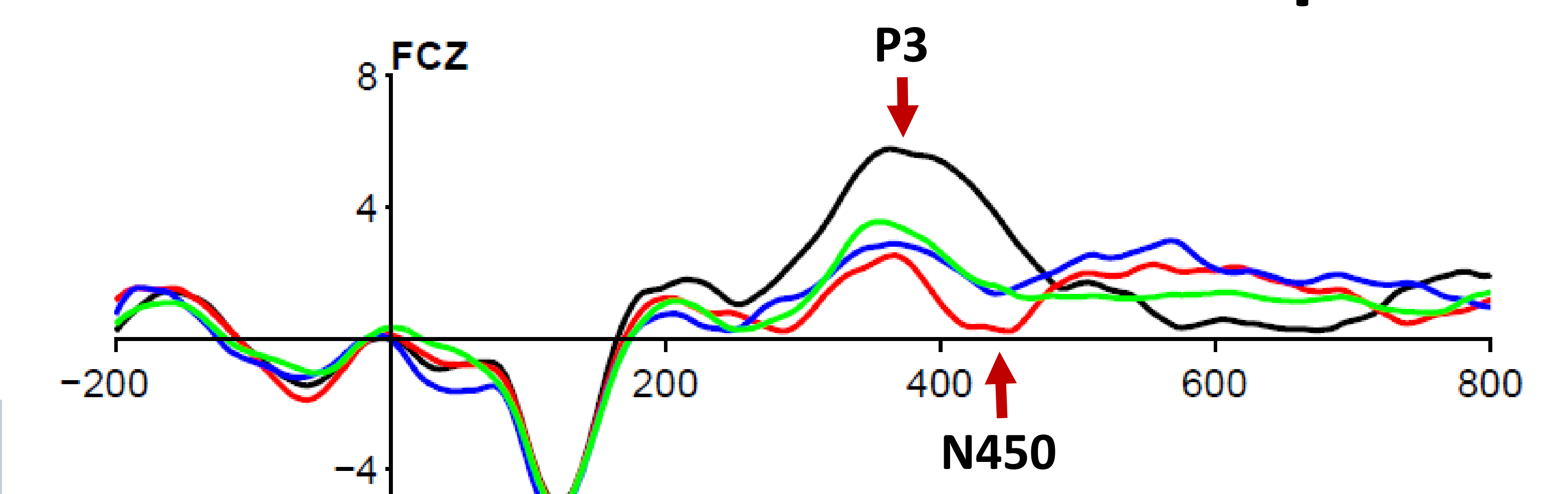
P3/N450,  $p = .010$ , FCz, 350-450 ms window

Conflict SP,  $p < .001$ , Pz, 500-650 ms window



- Congruent-Congruent
- Congruent-Incongruent
- Incongruent-Congruent
- Incongruent-Incongruent

### External Stroop



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