

Behavioral and Electrophysiological Evidence of Contingent Attentional Capture by Color Distractors

Capture by Color Distractors

Cipriani, G. A.¹, Carboni, A.¹, Kessel, D.²

¹CIBPsi, Facultad de Psicología, UdelAR; ²Facultad de Psicología, Universidad Autónoma de Madrid

INTRODUCTION: Feature-based attention to color (FBAC) is defined as the facilitation or suppression of color processing throughout the visual field, regardless of spatial location. In humans and rhesus monkeys, evidence from steady-state visual evoked potentials, fMRI and single-unit recordings revealed that these effects are exerted in the visual cortex.

All previous studies have analyzed the endogenous effect of attention, while the exogenous attentional modality –which would operate within a 300 ms window– remains unexplored. In addition, evidence from a spatial attention paradigm revealed that, depending on whether color is or is not a relevant feature for a task (i.e., contingent or not with endogenously attended task goals), irrelevant color singletons within the 300 ms window were able to capture or not spatial attention.

The aims of the present two experiments were three: first, to assess the existence of FBAC within the exogenous window; second, to determine whether this effect is exogenous and/ or depends on endogenous attention; and third, to evaluate whether stimulus-onset asynchrony between a color distractor and the target modulates this FBAC effect.

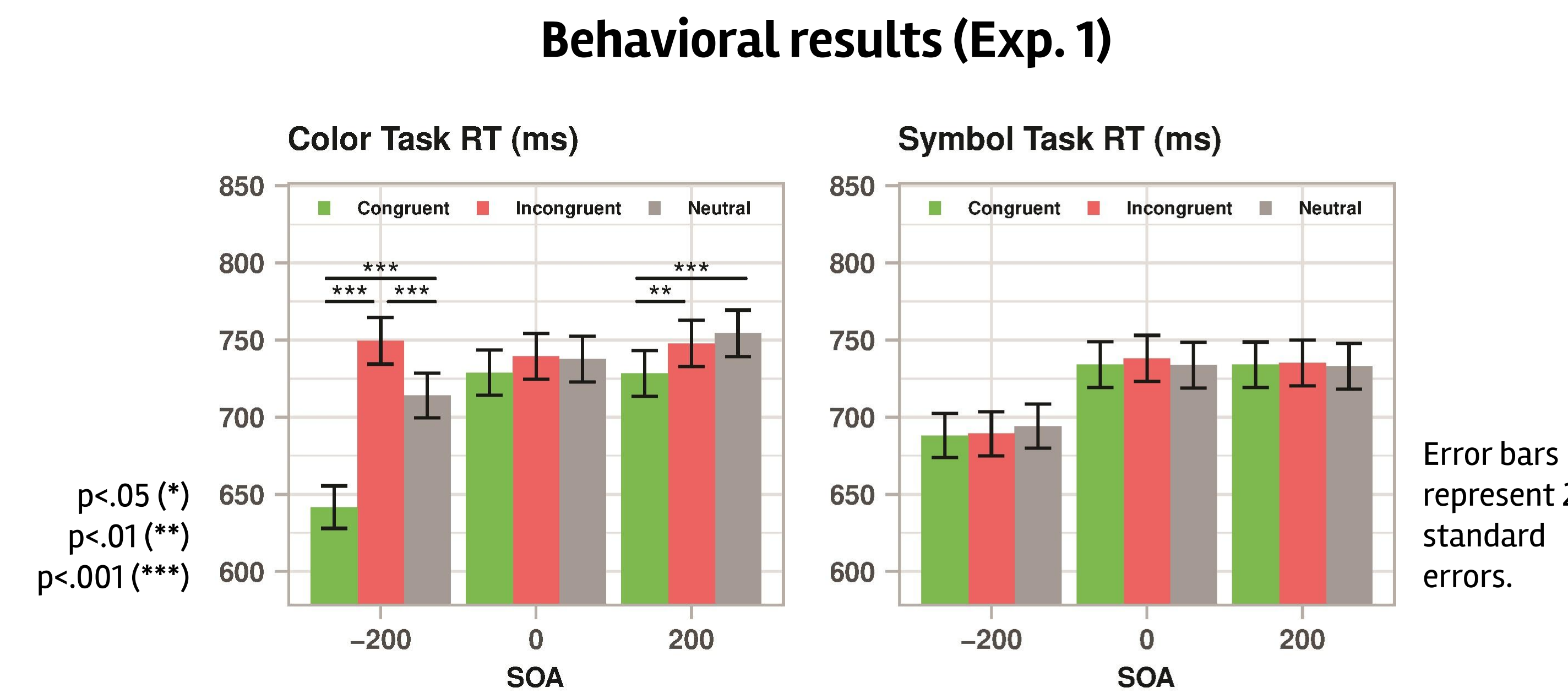


Fig. 2. Reaction Time Results. For RT and accuracy analyses, two GLMMs were proposed with *Task*, *SOA*, and *Congruence* as fixed effects; and *Trial* and *Participant* as random effects. For the RT GLMM, an inverse gaussian with an identity link function was selected, while for the accuracy GLMM a binomial with a logit link function was used. For each model an analysis of deviance was performed. For each significant effect, post-hoc t tests were performed and adjusted by the Holm–Bonferroni procedure. For each non-significant contrast, a Bayes Factor was calculated to determine the evidence for the null (no effect) or the alternative hypothesis. For the accuracy GLMM, both main and interaction effects were non-significant. For the RT GLMM, all Bayes Factors for the non-significant contrasts supported the null hypothesis.

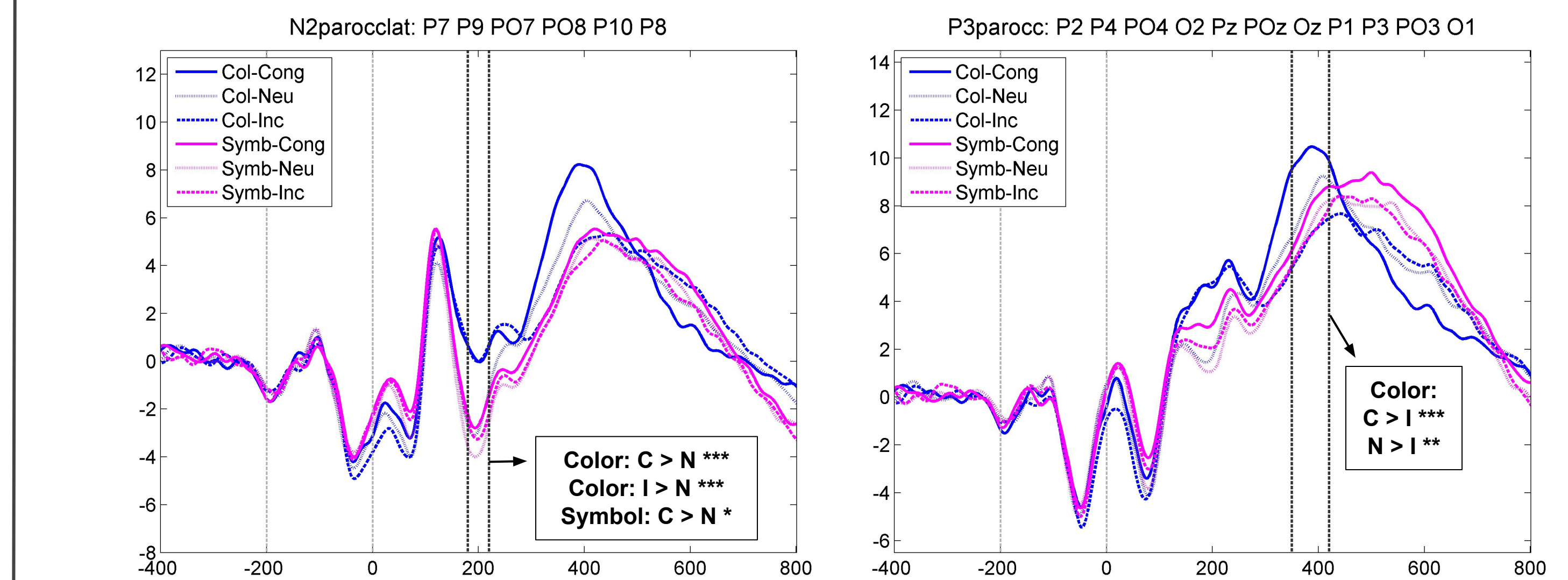
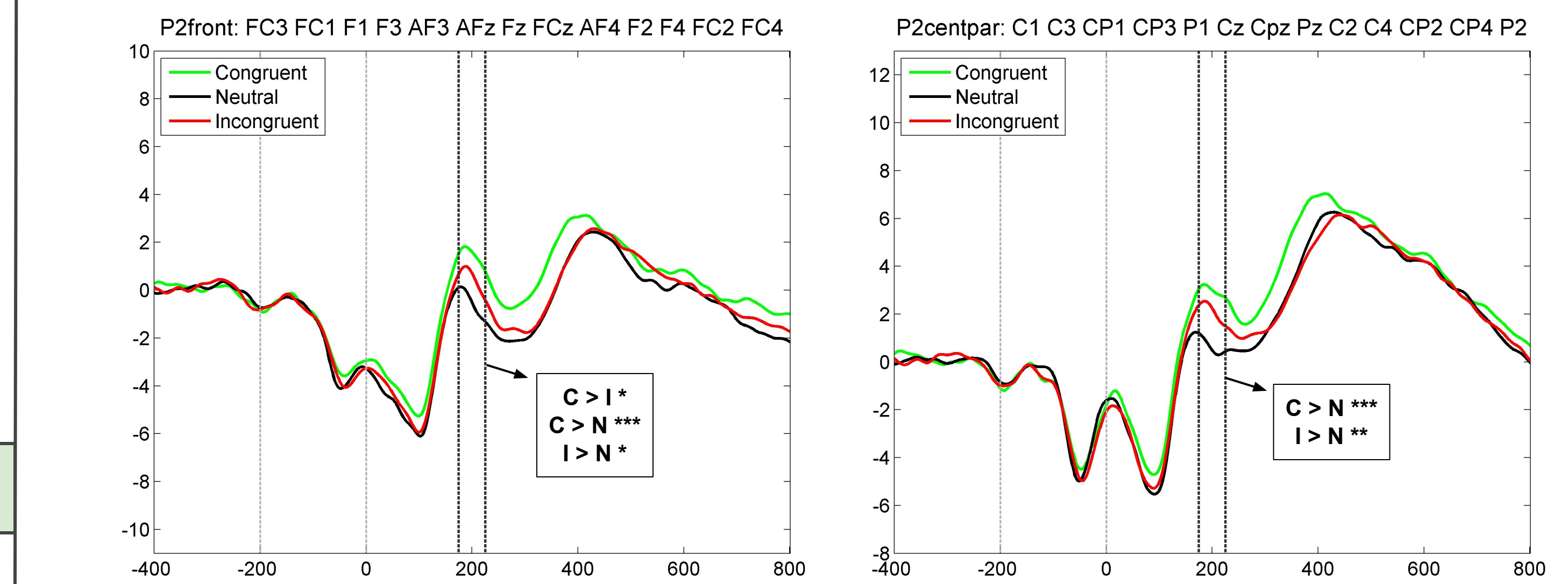
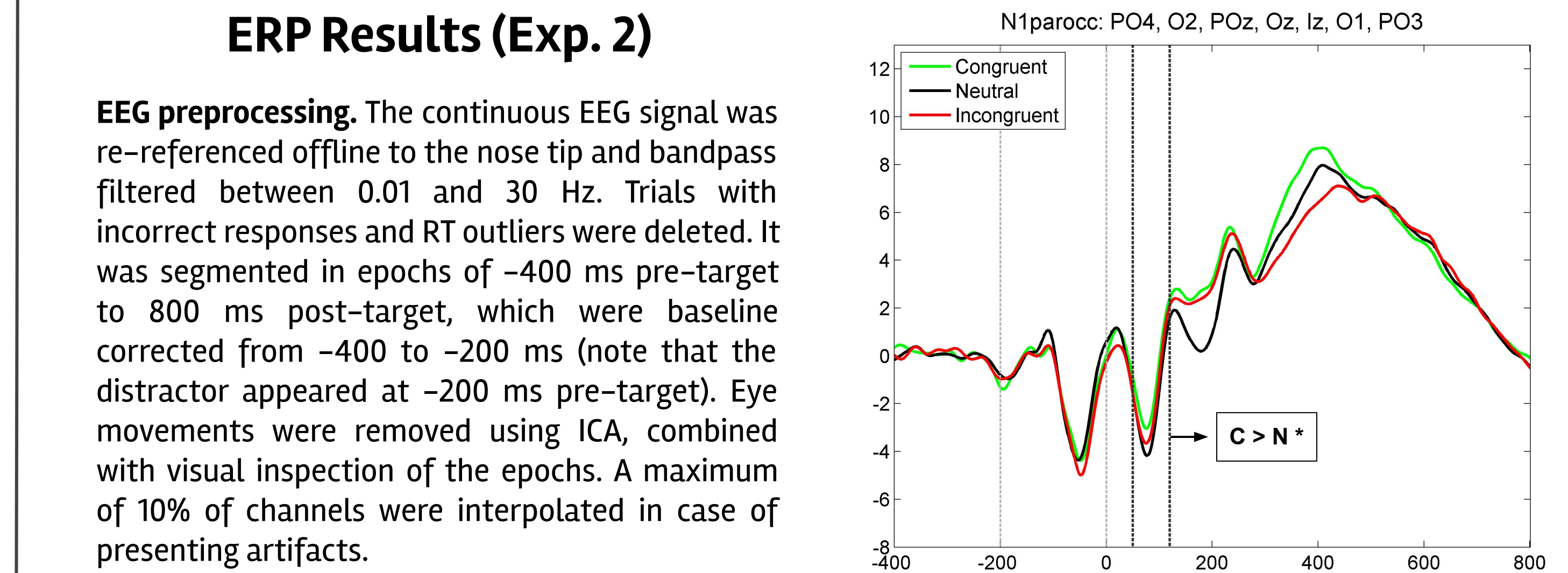
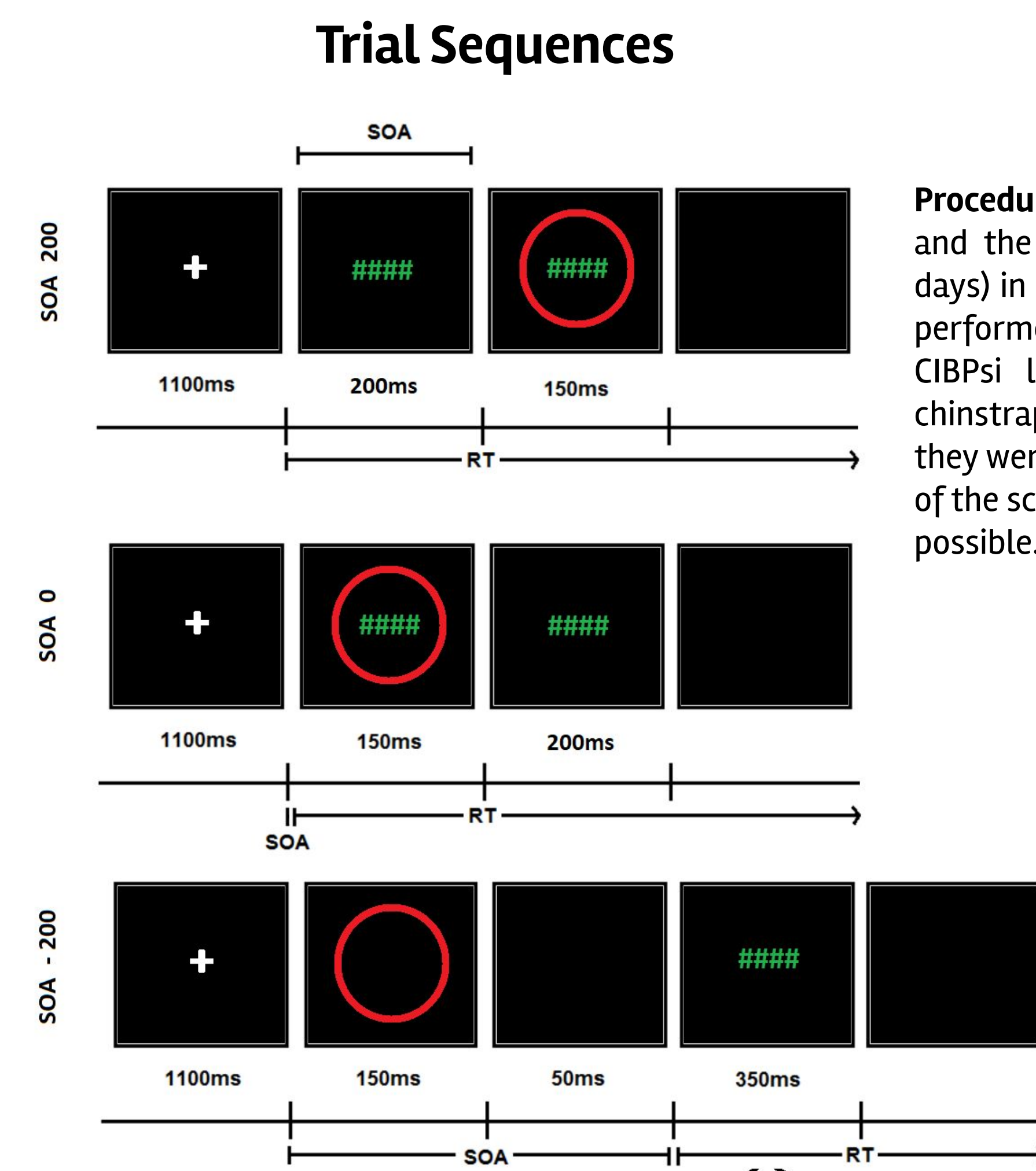


Fig. 5. Window Analysis for ERP Components. A window analysis of ERP component amplitudes was performed in a data driven fashion. Component amplitude was determined as the maximum (positive) or the minimum (negative) value within the temporal interval around the peak (shown by vertical dashed black lines) for the topographies, where the components were most pronounced. Subsequently, an ANOVA was performed for each component with *Task* and *Congruence* as fixed effects and *Participant* as a random effect. Only components with significant main/ interaction effects and significant adjusted post-hoc t tests are shown (significant differences within the boxes).

EXPERIMENT 1: Behavioral Task

- Participants:** 54 right-handed (41 women), age 18 to 31, task naive
- Independent Variables:**
 - Task: *Symbol (not contingent), Color (contingent)*
 - Stimulus Onset Asynchrony (SOA): *–200, 0, 200 ms*
 - Target-distractor congruence: *Congruent, Neutral, Incongruent*



Procedure. Participants performed the Color Task and the Symbol Task in different days ($M = 7.5$ days) in a counterbalanced order. Both tasks were performed in silent and dark conditions within the CIBPsi lab. Participants rested the chin on a chinstrap and the head on a head support, while they were instructed to fix their eyes on the center of the screen and to answer as fast and accurate as possible.

Trials and Stimuli. Each computerized task was composed of 432 trials (48 trials per condition), which were randomly presented. Participants were instructed to press the corresponding key to the color or the symbol of the stimulus in the Color and Symbol tasks, respectively. The stimulus had one of four possible colors (red, green, blue, or yellow) and symbols ('#', '%', '\$', or '&'), which were balanced for each experimental condition.

Distractors. Color rings were used as distractors. They were presented in the visual periphery (9.6°). The same four possible stimulus colors were used to generate congruent and incongruent conditions, while grey was used for the neutral condition.

Fig. 1. Trial Sequences. The three trial sequences for the different SOAs of both tasks are shown. The correct answer is indicated.

EXPERIMENT 2: Behavioral Task + EEG

- Participants:** 41 right-handed (30 women), age 18 to 31, task naive
- Independent Variables:**
 - Task: *Symbol (not contingent), Color (contingent)*
 - Target-distractor congruence: *Congruent, Neutral, Incongruent*

EEG recording: 64 channels



EOG recording:
2 electrodes for vertical EOG
2 electrodes for horizontal EOG

Trial Sequence

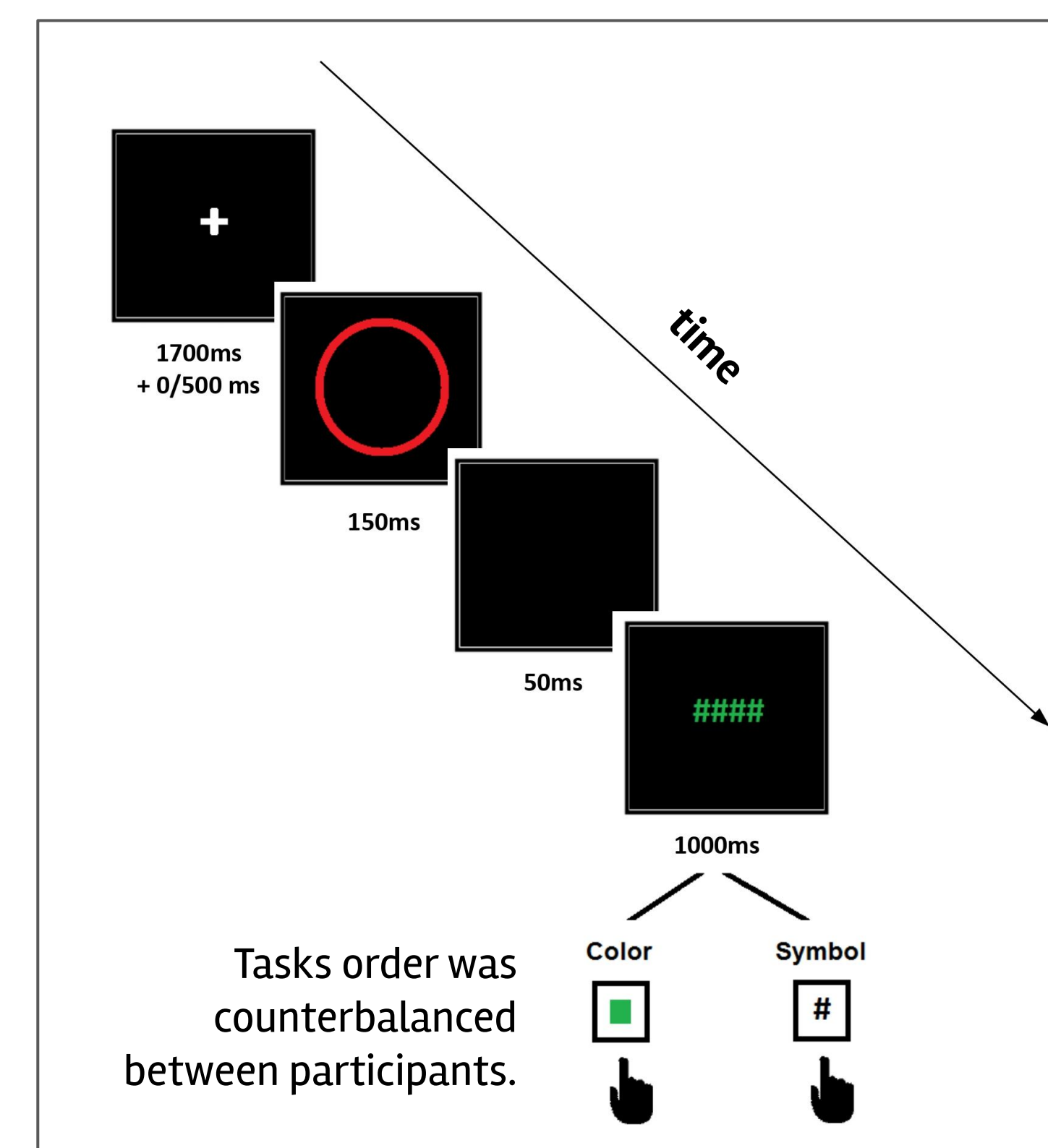


Fig. 3. Trial Sequence. Trial sequence with a –200 SOA. 70 trials per condition were presented (210 in total).

Behavioral Results (Exp. 2)

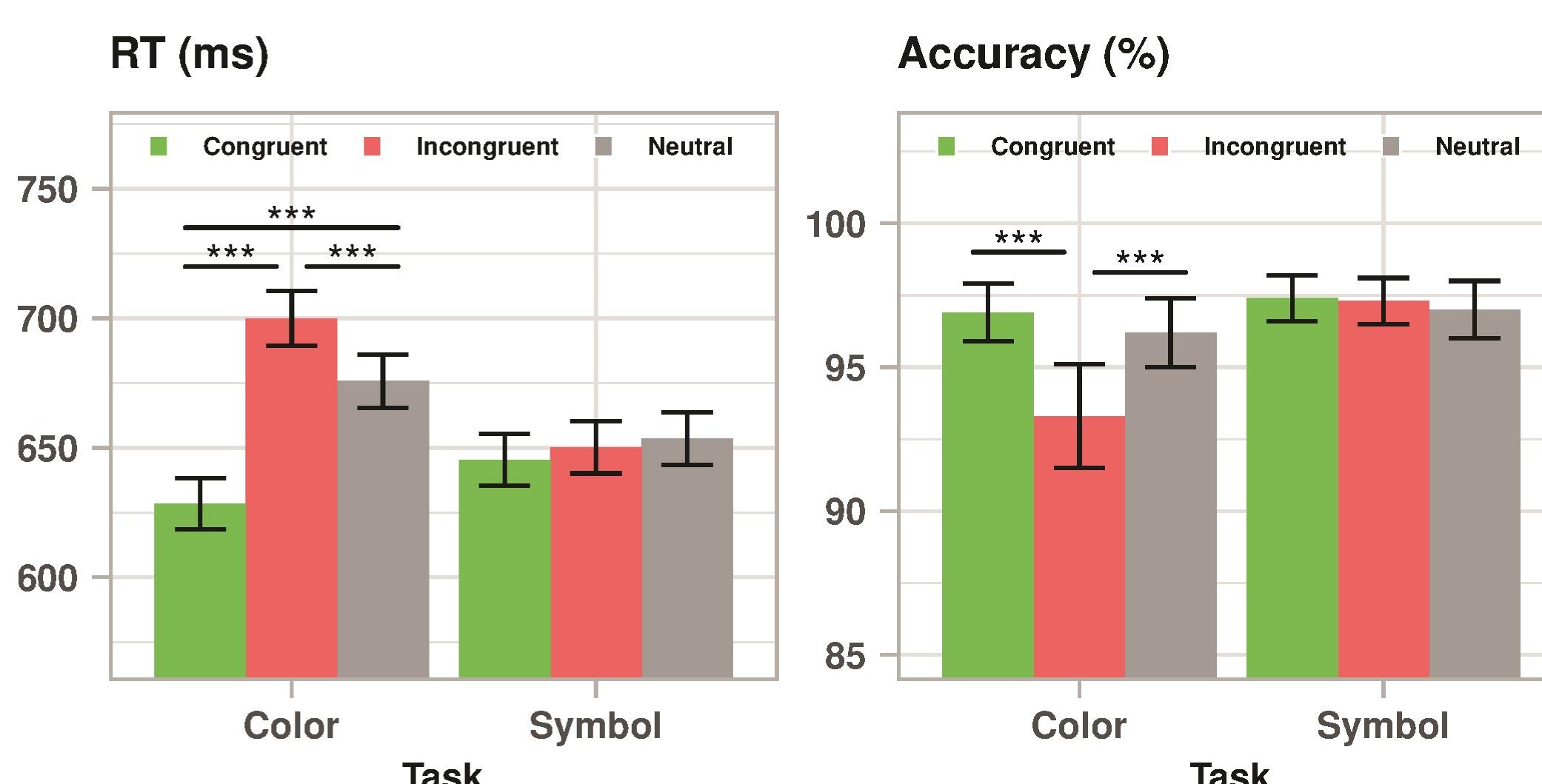


Fig. 4. Behavioral Results. The same analyses as for Experiment 1 were carried out, without the SOA factor. Bayes Factors also supported the null hypothesis for all non-significant contrasts.

CONCLUSION: Our behavioral results of both experiments show the existence of an attentional capture by color distractors only for the Color Task. Hence, this capture is contingent on task goals ruling out an exogenous FBAC explanation. This capture is maximum when the distractor is presented 200 ms before the target, and it is reflected as a facilitation and interference by congruent and incongruent distractors, respectively.

At the neural level, after target onset, parieto-occipital N1 reflected an early facilitation effect of congruent distractors. Subsequently, frontal and centro-parietal P2 reflected a color effect of distractors. In line with the contingent capture, parieto-occipital N2 and P3 components reflected a color effect and the interference effect, respectively, only for the Color Task. Though, a congruent effect in N2 was also found for the Symbol Task.

In sum, these results show: 1) no evidence for early exogenous FBAC; 2) evidence for color capture and facilitation effects at intermediate latencies after target onset; 3) evidence for top-down goal contingent FBAC at later latencies.