

Disentangling the roles of cue visibility and knowledge in learning cognitive control

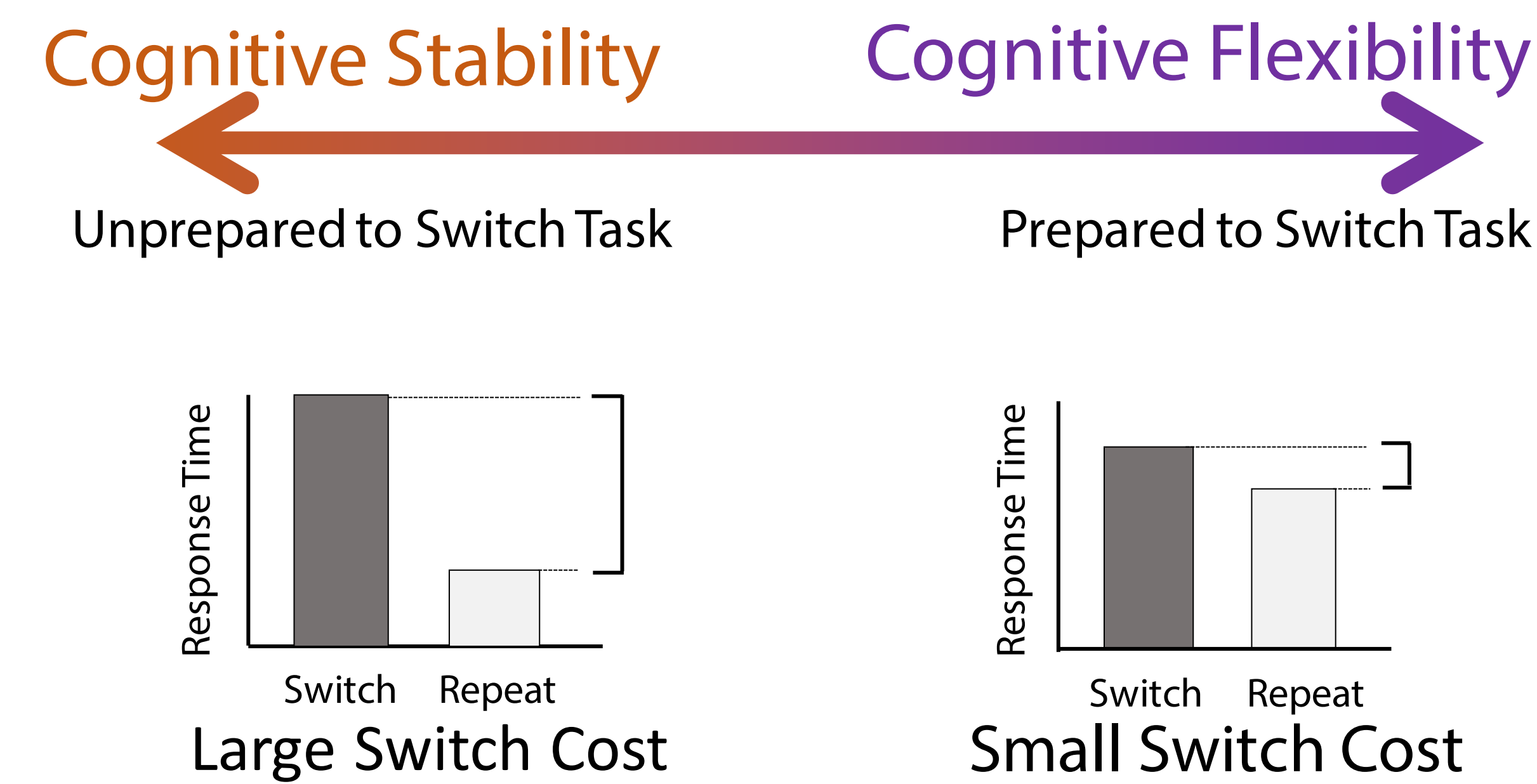
Ziwei Zhang, Christina Bejjani, Jack Dolgin, and Tobias Egner | Department of Psychology and Neuroscience and Center for Cognitive Neuroscience | Duke University

✉ correspondence to christina.bejjani@duke.edu, @chbejjani, @jbdolg, @Egnerlab | Supported in part by NIMH R01 MH 087610



Background: Subliminal Cueing of Control

Farooqui and Manly (2015, Psych Sci) raised the possibility that control-learning is more effective when cues of control demand are presented subliminally.



Our Design (<https://osf.io/7jfbp/>):

- Manipulate conscious cue perception & predictive cue knowledge independently
- 2x2 design with an overall 25:75 switch:repeat context, a task-switching paradigm with two predictive cues and one nonpredictive cue

	cue visibility	
	1: subliminal	2: supraliminal
cue knowledge		
1: implicit	subliminal, implicit (E1)	supraliminal, implicit (E3)
2: explicit	subliminal, explicit (E2)	supraliminal, explicit (E4)

Behavioral Prediction:

- Participants will use contextual cues to modulate control such that switch costs will be reduced following predictive vs. nonpredictive cues.

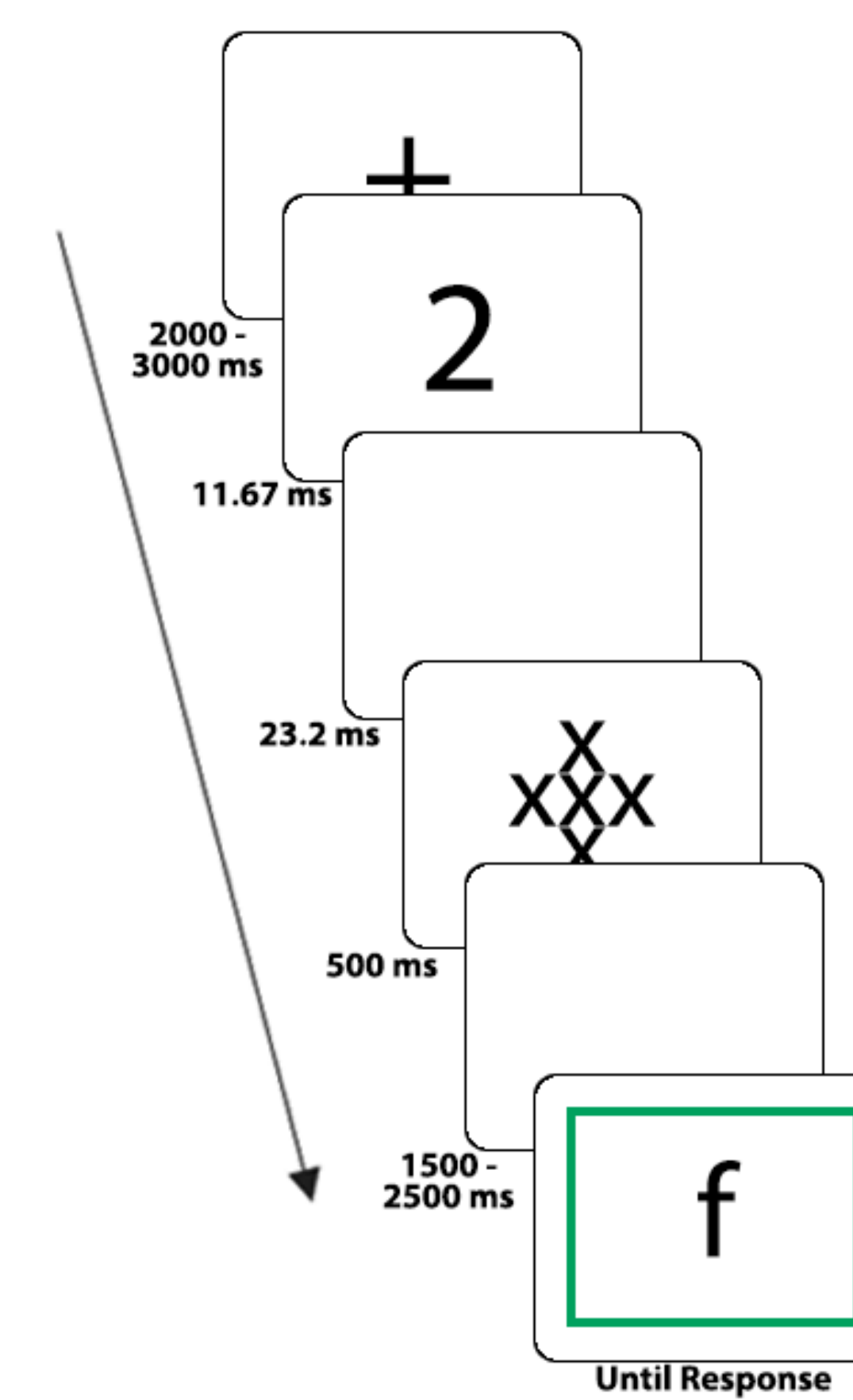
Hypotheses:

- If the conclusions from Farooqui & Manly (2015) were warranted, we should observe smaller switch costs for subliminal (E1-2) vs. supraliminal (E3-4) cueing.
- Traditional views on control, however, would predict the smallest switch costs under the supraliminal and explicit knowledge conditions (E4).
- Current theories of action control would predict the smallest switch costs under the implicit knowledge condition (E1, E3).
- If pre-emptive control operations can be prepared and triggered by the cues ("action-triggers"), we should observe smaller switch costs in E2-4 vs. E1.

References:

Bugg & Crump (2012). Frontiers in Psychology. Monsell (2003). Trends in Cognitive Science. Kunde, Kiesel, and Hoffmann (2003). Cognition. Hommel (2013). Frontiers in Psychology. Abrahamse et al. (2016). Psychological Bulletin. van Gaal, De Lange, and Cohen (2012). Frontiers in Human Neuroscience. Kunde, Reuss, and Kiesel (2012). Advances in Cognitive Psychology.

E1: Subliminal, Implicit



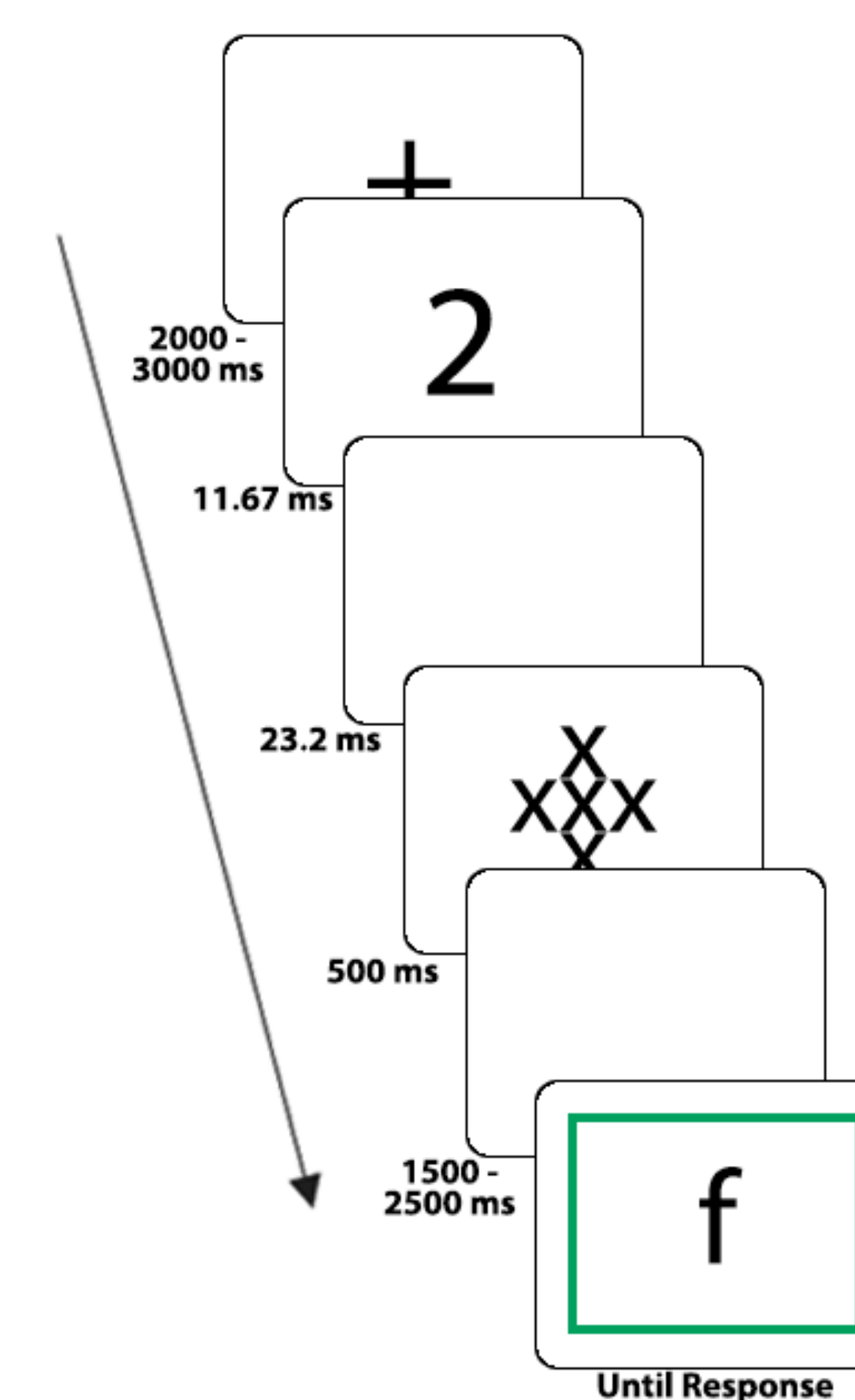
Methods:

- After 50 trials, response threshold set to 60th percentile for correct response on repeat trials
- After 100 trials, the threshold is revised.

Post-test Questionnaire:

- 3 participants correctly identified and noticed the cue type
- Masking was successful, since participants could not identify cues

E2: Subliminal, Explicit



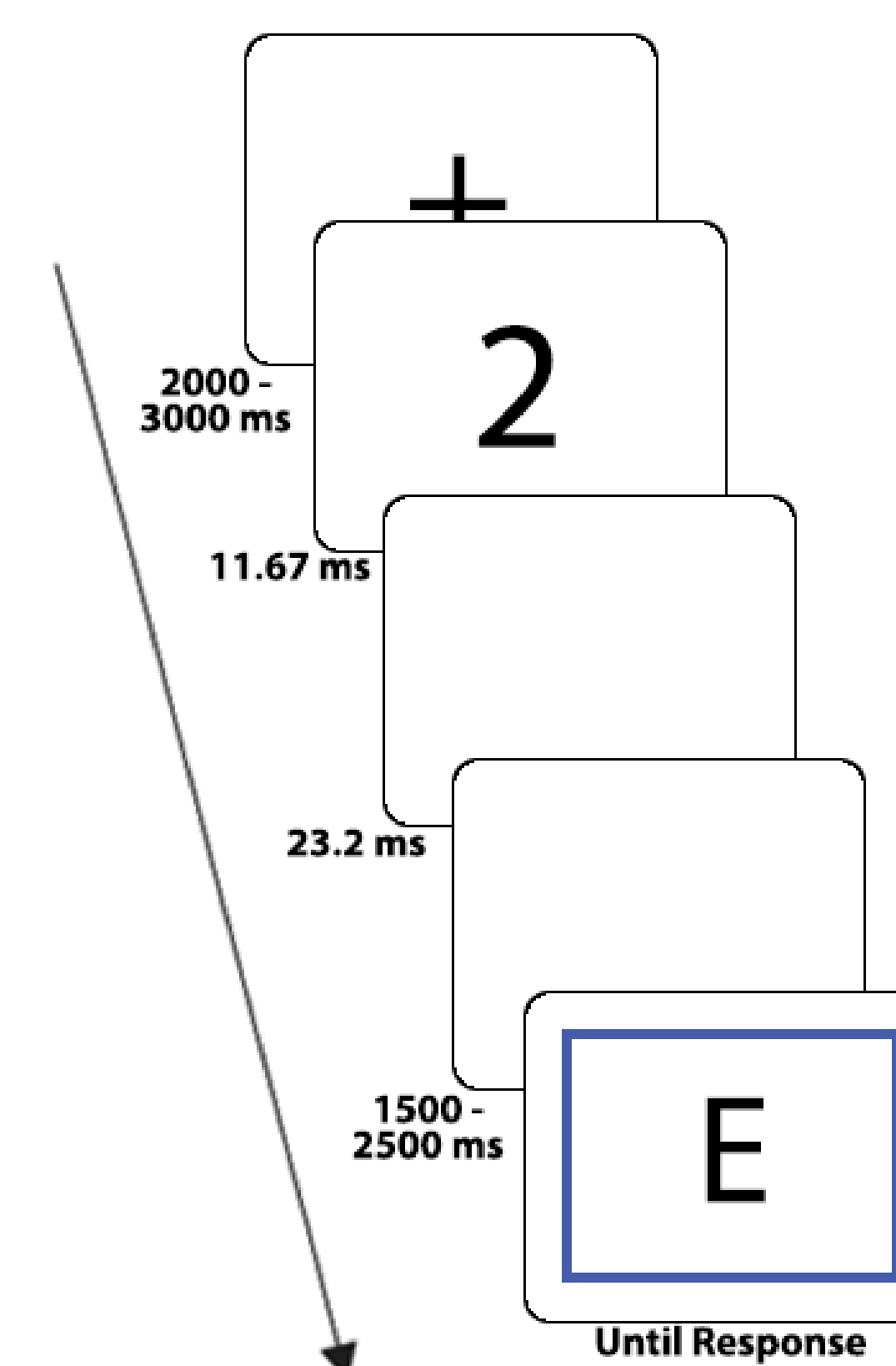
Methods:

- Explicit instructions at the beginning about the roles of each number cue (e.g., nonpredictive, predictive switch/repeat)

Post-test Questionnaire:

- Masking was successful, since participants could not identify cues, but they couldn't remember the cue associations.
- We may need to rerun E2 and add in attention checks

E3: Supraliminal, Implicit



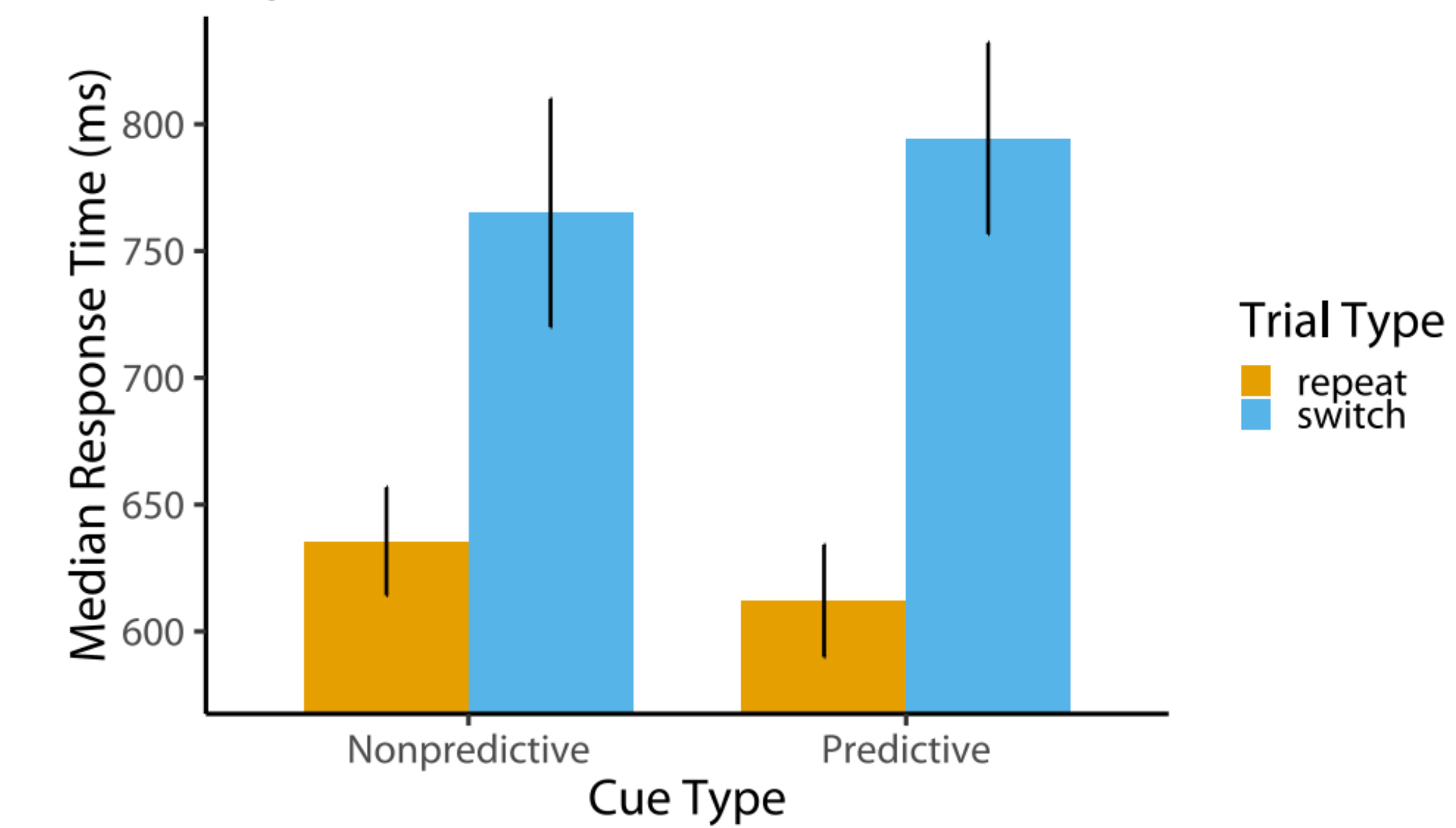
Methods:

- Cues no longer masked; need n=20

Post-test Questionnaire:

- 5 participants reported noticing a systematic relationship between the cues and hard/easy trials.
- Participants rated the number cues as being less predictive than 50% ("somewhat predictive")
- Participants didn't match the cues to their trial types above chance

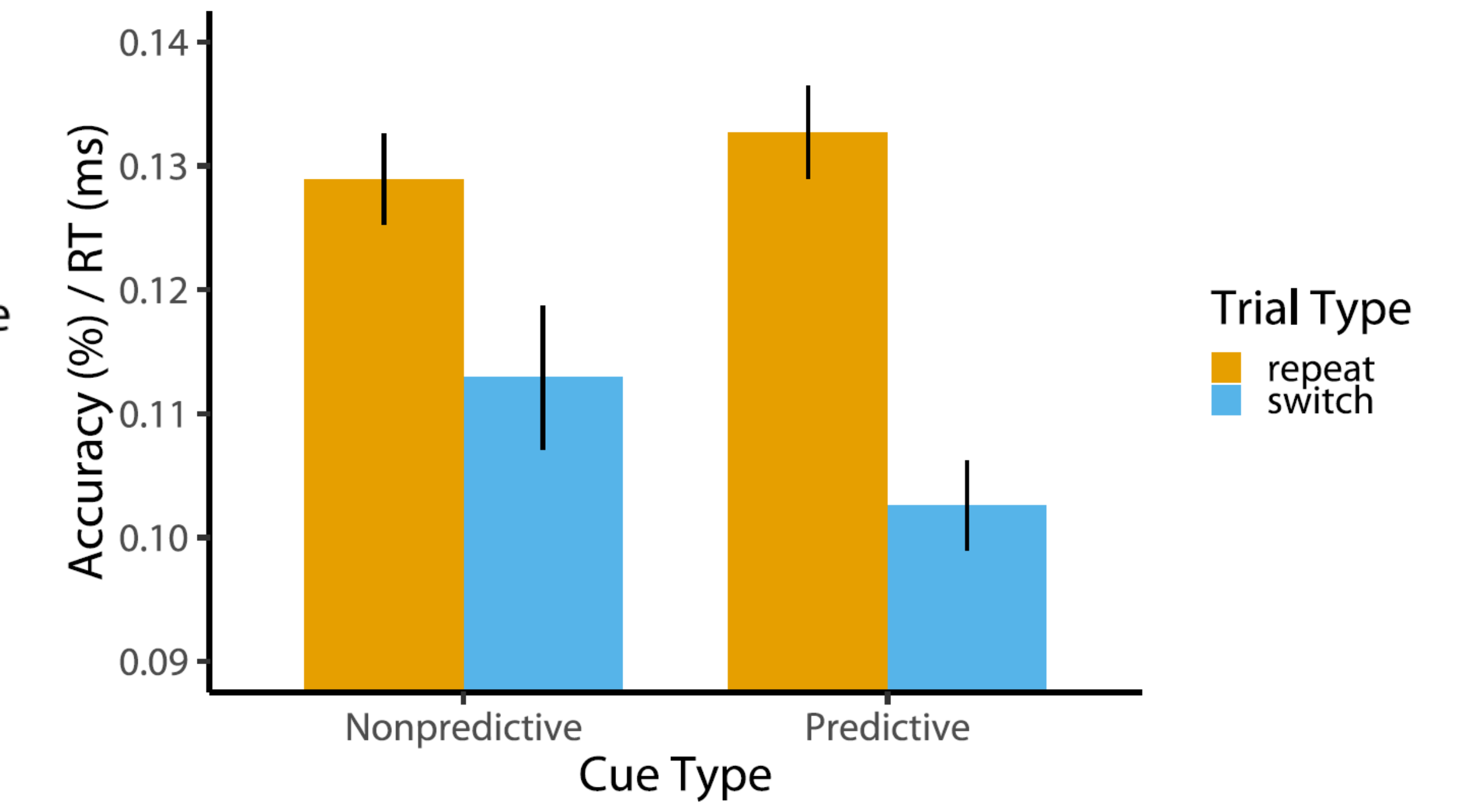
Experiment 1 - Median RT (N = 20)



Context x Trial Type: $F(1,19) = 1.82, p = 0.194, \eta_p^2 = 0.09$

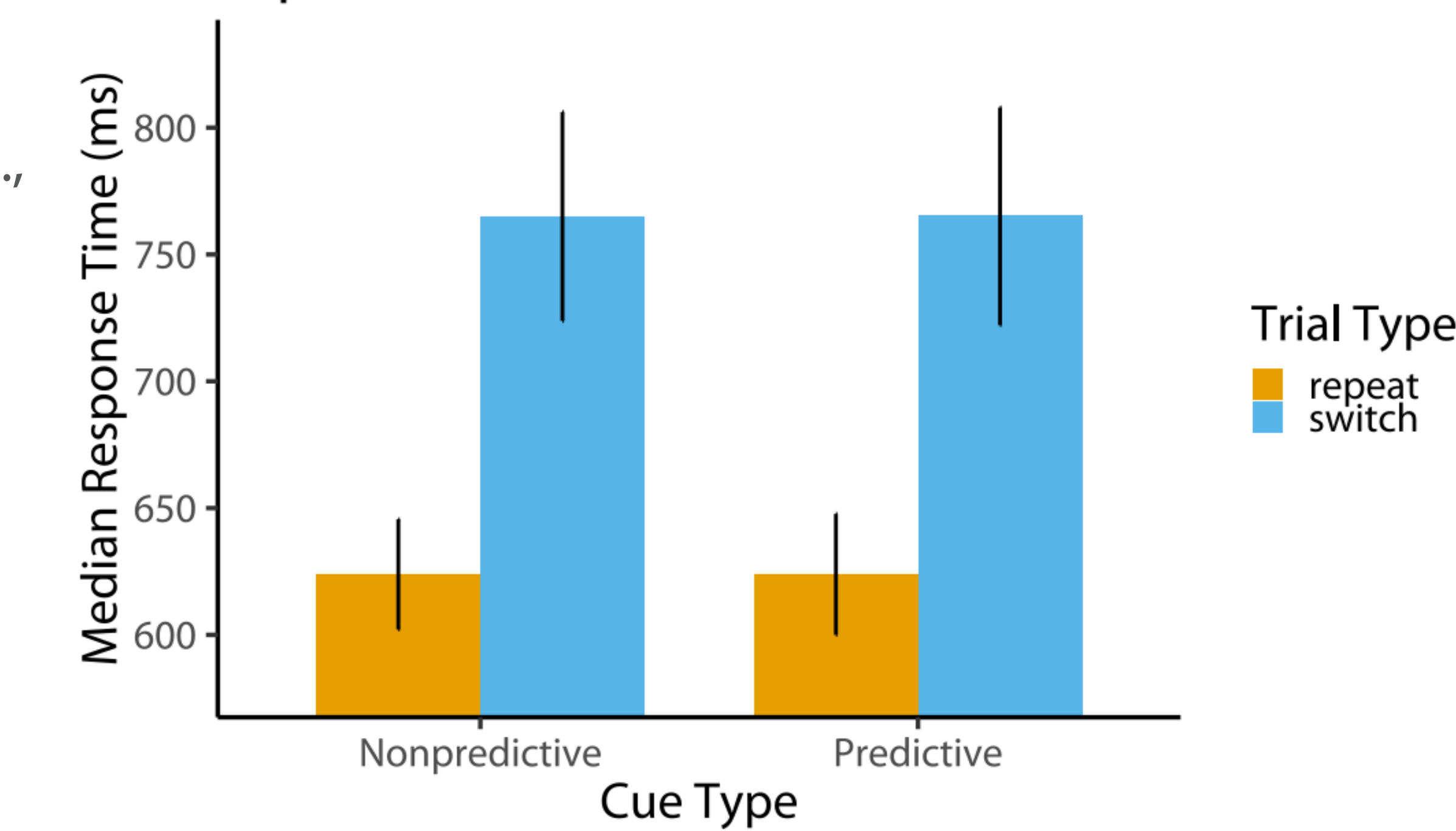
- Sequential bayes factor analysis suggests that data collection is complete; we fail to replicate Farooqui & Manly (2015)
- Equivalence testing suggests that the index is statistically different from, and not equivalent to, zero ($t(19) = 4.78, p = 1.0$; null: $t(19) = 6.71, p < 0.001$).

Experiment 1 - Global Performance Index (N = 20)



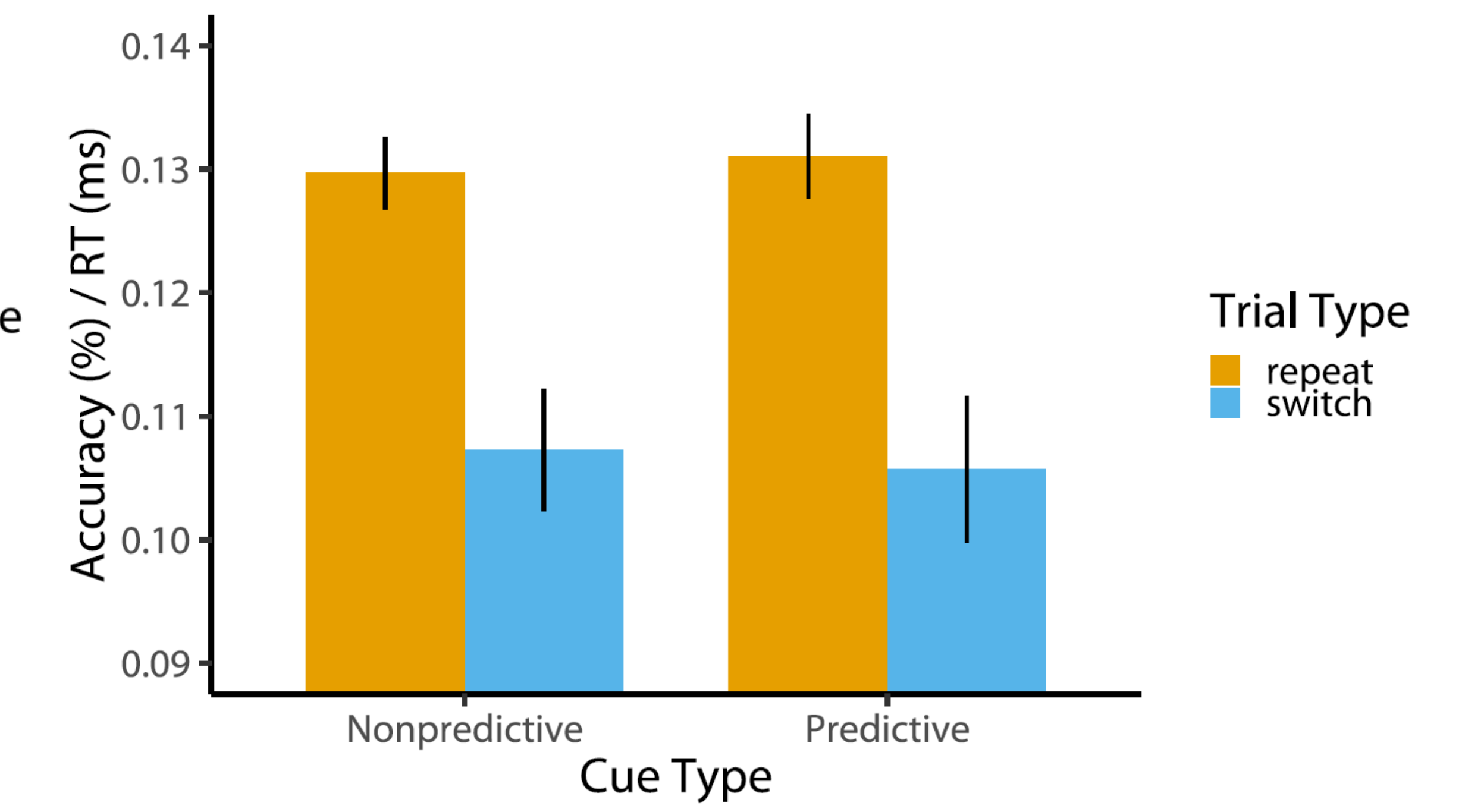
Context x Trial Type: $F(1,19) = 3.31, p = 0.084, \eta_p^2 = 0.15$

Experiment 2 - Median RT (N = 20)



Context x Trial Type: $F(1,19) = 0.01, p = 0.946, \eta_p^2 = 0$

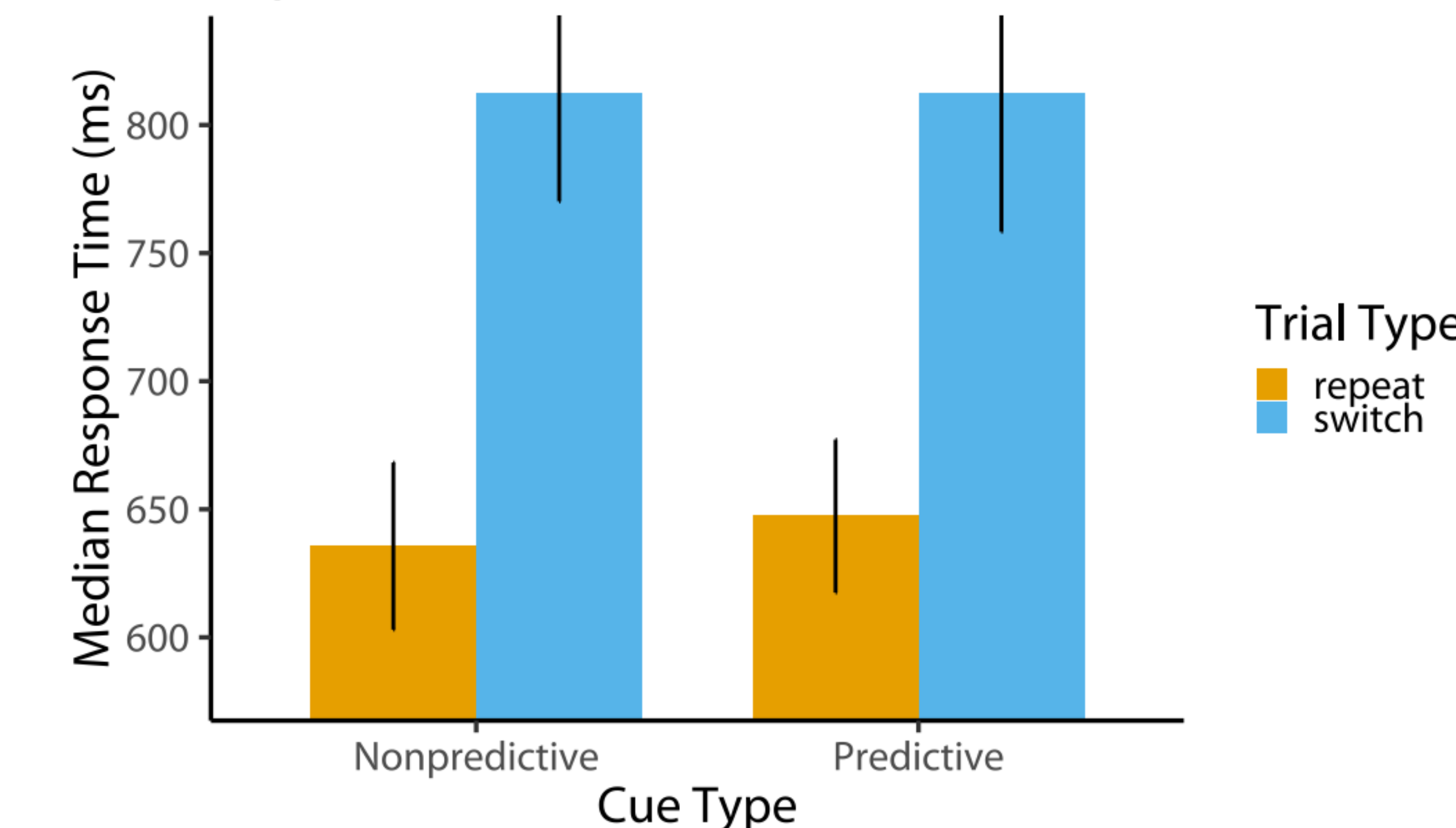
Experiment 2 - Global Performance Index (N = 20)



Context x Trial Type: $F(1,19) = 0, p = 0.985, \eta_p^2 = 0$

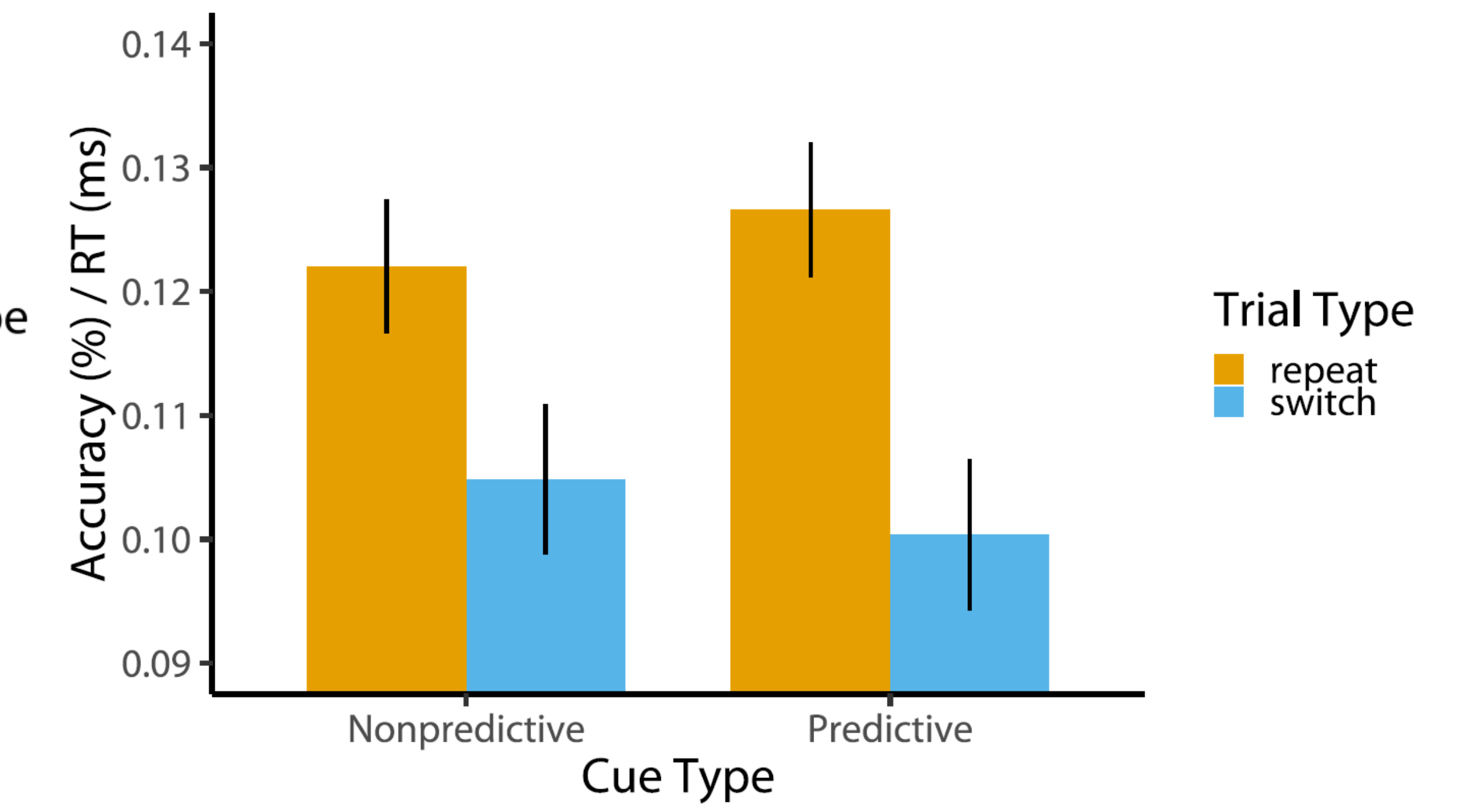
- Sequential bayes factor analysis suggests that we need to collect more participants. However, we may rerun E2.
- Equivalence testing suggests that the index is statistically not different from, and not equivalent, to zero ($t(19) = -0.50, p = 0.310$; null: $t(19) = 1.42, p = 0.172$).

Experiment 3 - Median RT (N = 16)



Context x Trial Type: $F(1,15) = 0.491, p = 0.494, \eta_p^2 = 0.03$

Experiment 3 - Global Performance Index (N = 16)



Context x Trial Type: $F(1,15) = 1.22, p = 0.287, \eta_p^2 = 0.07$

- Equivalence testing suggests that the index is statistically different from, and not equivalent to, zero ($t(15) = 11.62, p = 1.0$; null: $t(15) = 13.34, p < 0.001$).
- Overall, participants do not appear to be using the contextual cues to guide the application of control settings.