

# Evidence Against the Phenomenon of Hemispheric Lateralization in Categorical Perception

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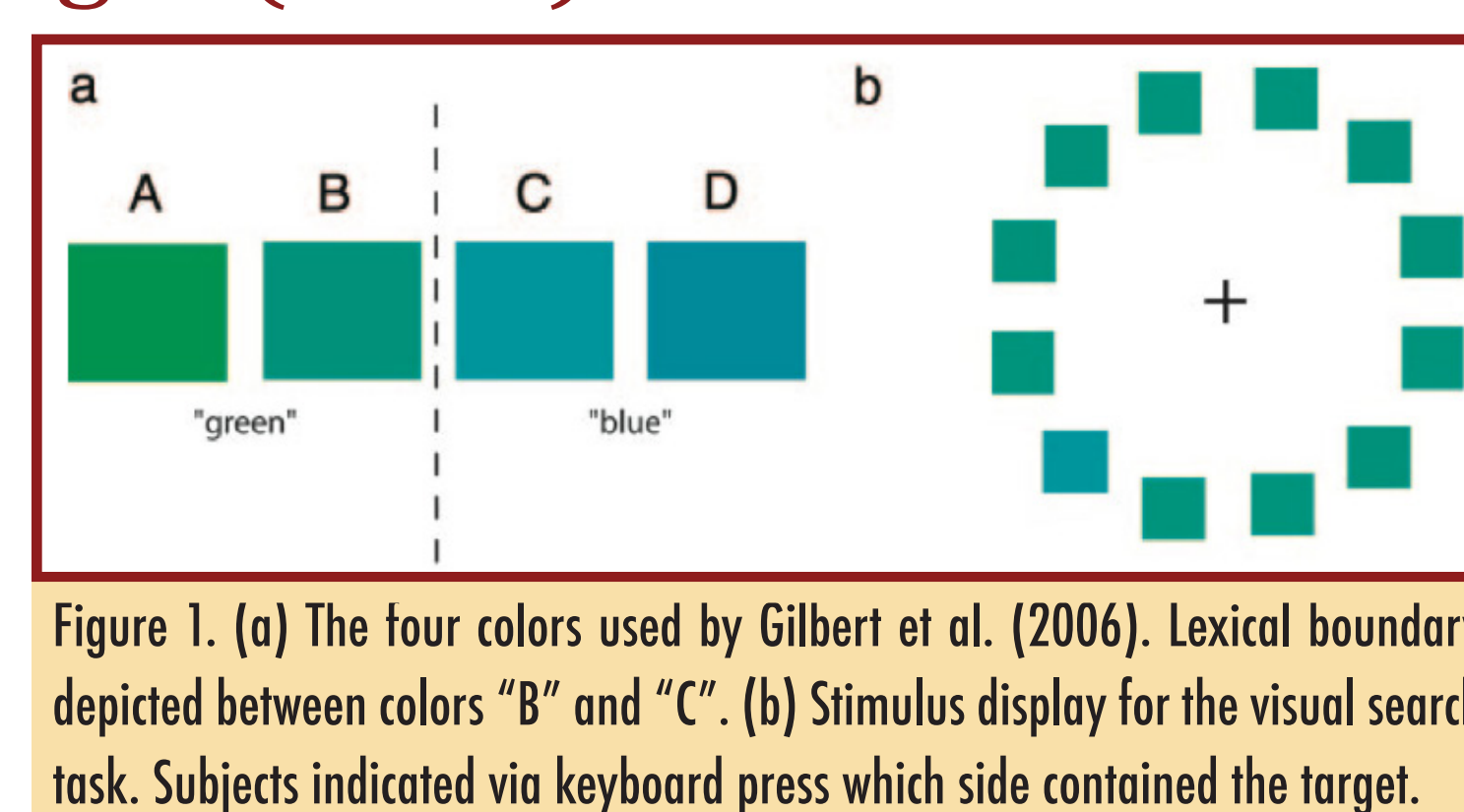
## Introduction

The Sapir-Whorf Hypothesis is a classic theory suggesting that the language we speak impacts how we perceive the world, proposing that language experience shapes even “low-level” perception. Recent research in the area has focused on hemispheric lateralization in categorical (object) perception, finding that people process categories differently in the left and right cerebral hemispheres (LH and RH), theoretically because the LH dominates language processing. Studies have shown that RTs to target stimuli are faster when targets come from a different lexical category than distractors (e.g., cats versus dogs), but significantly more so when targets appear in the right visual field, which feeds into the LH. We sought to further examine these lateralized perceptual processes, by both replicating and extending the original studies (by Gilbert et al., 2006; 2008) across four different experiments.

## Methods

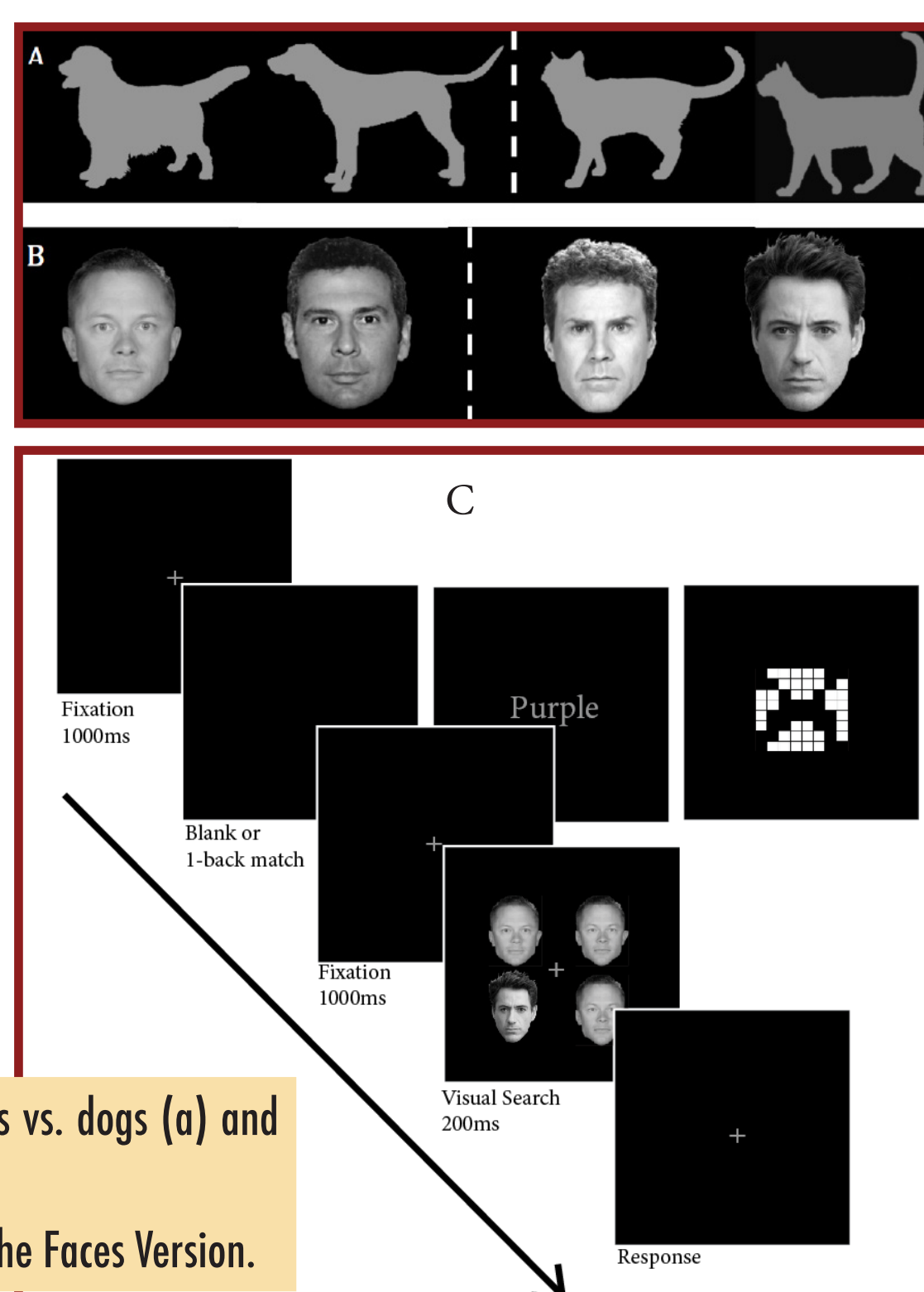
### Gilbert et al.'s original paradigm (2006)

- Stimulus display ring of 12 color squares, 11 of identical color (distractors) and one of unique color (the target).
- Target either within-category or between-category (see Figure 1).
- Display presented for 200 ms; keyboard press to indicate which half of the screen contained the target.
- RTs to targets were faster when target was between-category, but more-so when target was in right visual field (RVF)
- Effect held with secondary visual working memory (WM) interference task, but disrupted by secondary verbal WM task, further implicating the language areas of the brain.
- Paradigm has been used to show hemispheric lateralization both in the categorical perception of colors (2006) and animal shapes (2008).



### Experiment 1

- Exp. 1 compared perception of famous and unknown faces, separately in different visual fields.
- Developed a new but similar paradigm to Gilbert et al. (2008) to test complex stimuli (human faces).
- Used four stimuli instead of 12, to accommodate for increased complexity and difficulty.
- Tested new paradigm with both Animal Shapes Version and Faces Version, to bridge old paradigm and new one.
- Display presented for 200ms; keyboard press indicated which half of the screen contained the target.
- Utilized one-back match tasks to tax verbal WM (using color names) or visual WM (using grids).



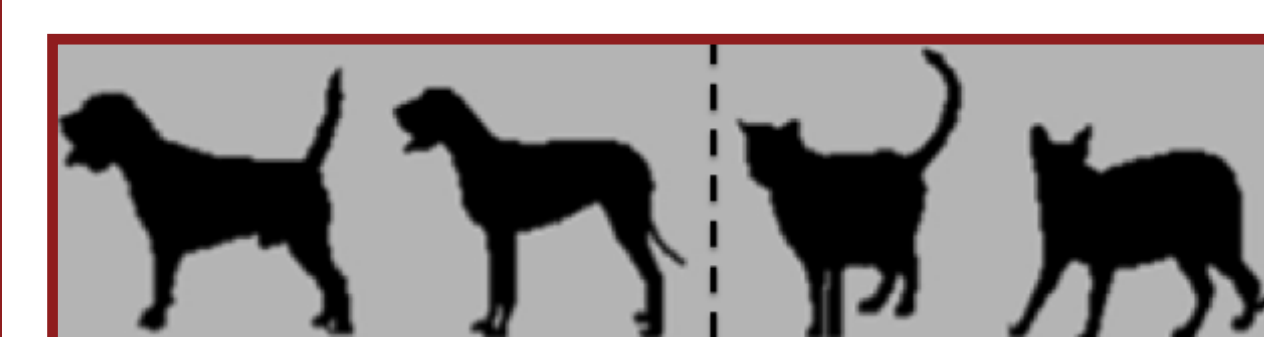
### Experiment 2

- Needed a replication of previous findings, given controversial nature of the Whorf Effect.
- Exp. 2 was a near-direct replication of study done by Gilbert et al. (2008). Only deviation was new, slightly different stimuli, which should be an acceptable change given the theory.
- Followed same paradigm as Gilbert et al.'s (2006) original paradigm using color squares, but with cats and dogs as categorical stimuli.



### Experiment 3

- Exp. 2 did not replicate Gilbert et al.'s (2008) findings. Why? The only deviation made was in the stimuli. Exp. 3 sought to replicate Gilbert et al.'s results.
- Screenshots of Gilbert et al.'s stimuli were used in lieu of the current authors' stimuli.
- Paradigm was identical to Exp. 2 in all other ways.

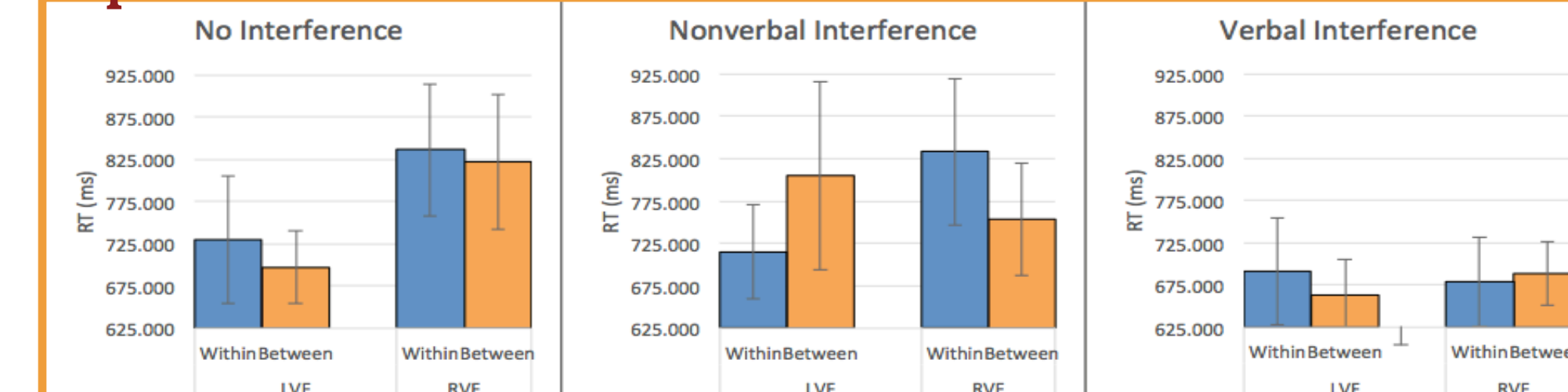


### Experiment 4

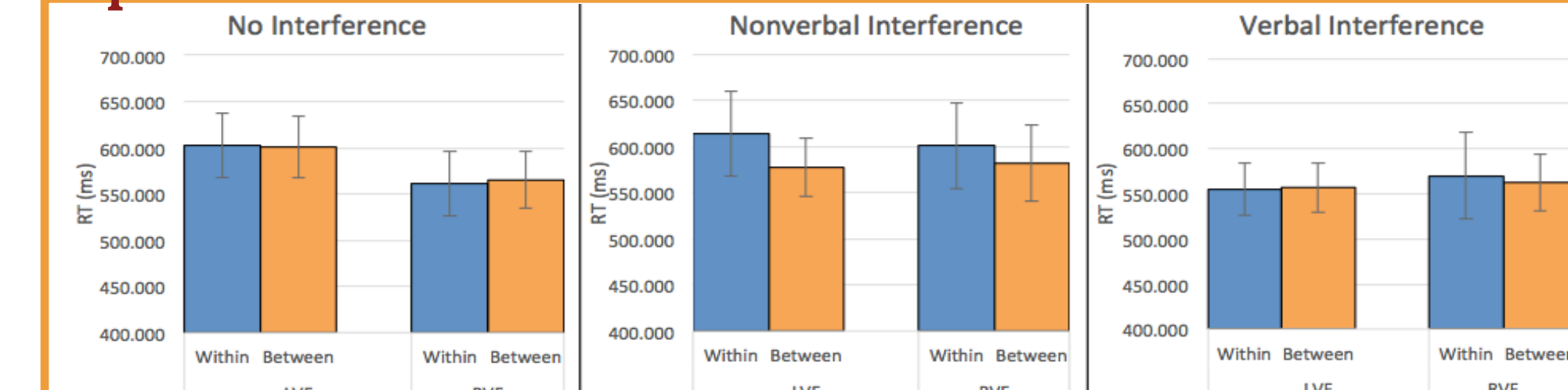
- Again, the replication failed. Are the results of the original study conducted by Gilbert et al. in 2006 are reliable?
- Exp. 4 sought to replicate Gilbert et al.'s original paradigm.

## Results

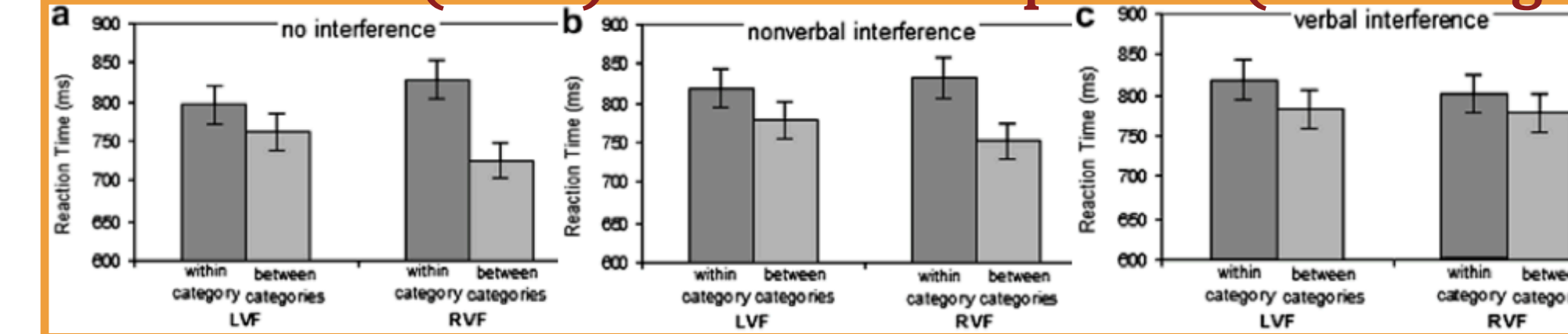
### Experiment 1 - Animals Version



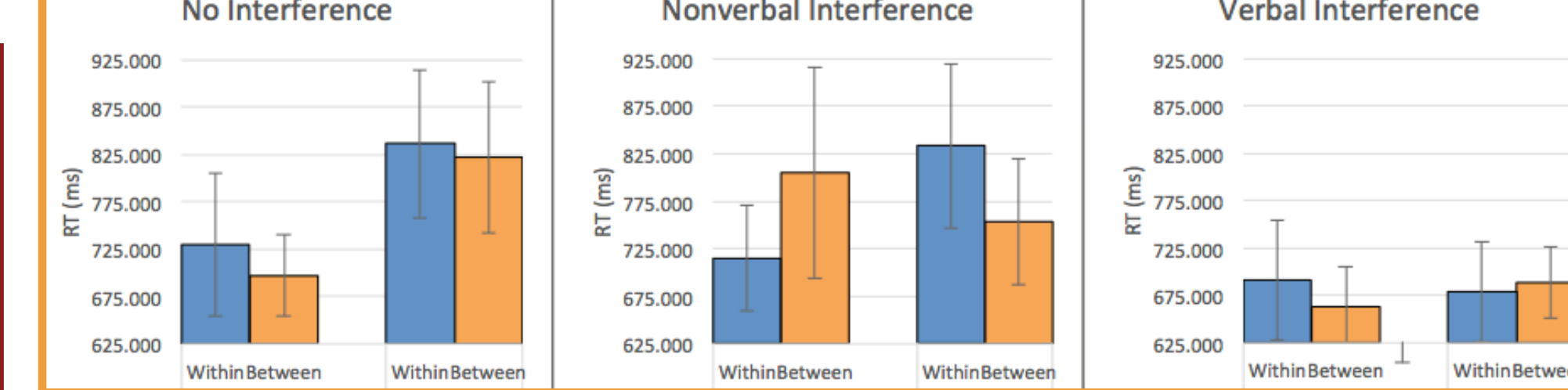
### Experiment 1 - Faces Version



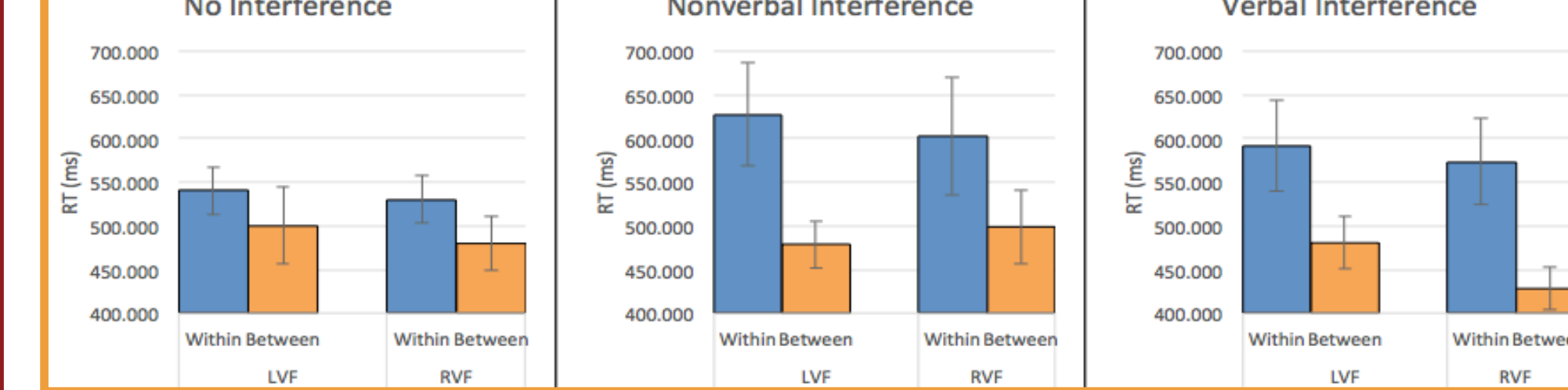
### Gilbert et al.'s (2008) results for comparison (cats & dogs)



### Experiment 2 - Authors' Cat & Dog Stimuli



### Experiment 3 - Gilbert et al.'s Cat & Dog Screenshots

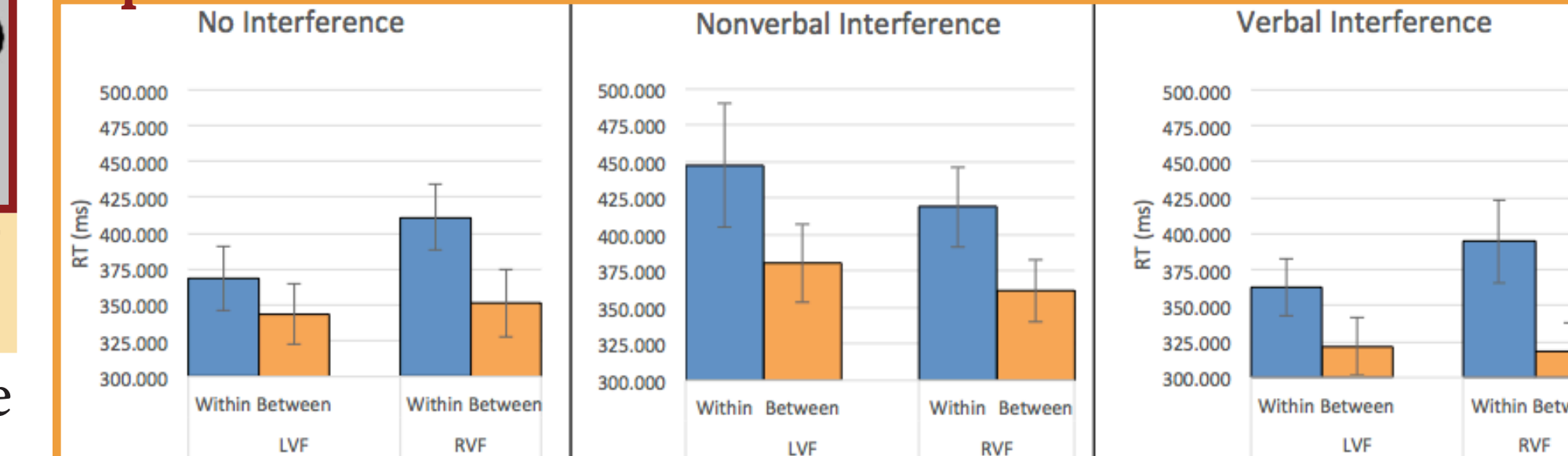


The results of Experiments 1 and 2 were not consistent with those found by Gilbert et al. (2008). For all experiments, we ran a three-way ANOVA [(VF: RVF vs. LVF) x (Category Type: within-category vs. between-categories) x (Interference Type: verbal vs. nonverbal)]. In both versions of Exp. 1, there were no significant three-way interactions, no significant two-way interactions, and no main effects.

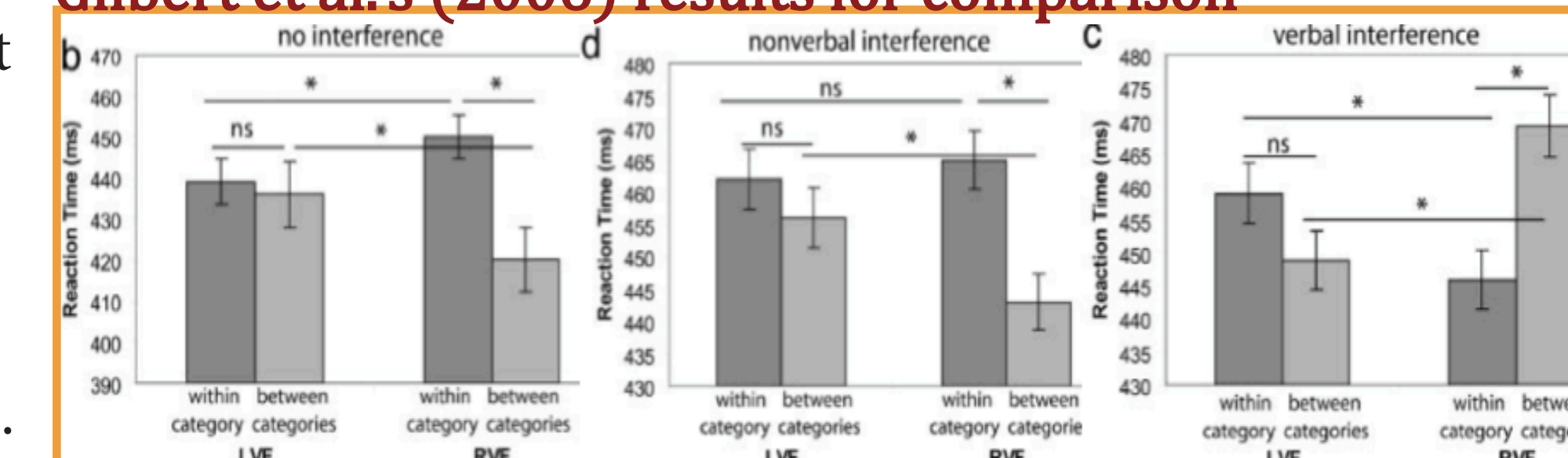
The results of Experiments 2 and 3 were also not consistent with those found by Gilbert et al. (2008). In Exp. 2, there was no significant three-way interaction, nor were there any two-way interactions or main effects. In Exp. 3, there was only a single main effect of Category Type. Importantly, as can be seen by comparing Exp. 3 to Gilbert et al.'s (2008) original data, these results actually did follow the same overall trends as that of Gilbert et al.

Notes: Standard errors are depicted in all of our data, whereas Gilbert et al. (2006 and 2008) use 95% confidence intervals. Accuracy for all experiments was quite high, over 90% on both the visual search tasks and the secondary working memory tasks.

### Experiment 4 - Color



### Gilbert et al.'s (2006) results for comparison



The results of Experiment 4 were also inconsistent with those found by Gilbert et al. (2006). There was no significant three-way interaction or two-way interactions. But there were main effects for Interference Type and for Category. Follow-up two-way ANOVAs showed the replication was successful on the no-interference condition, but not on the nonverbal or verbal interference conditions.

## Discussion

- Exp. 1 showed famous faces did not constitute a lexical category, and our 4-Item paradigm had no Whorfian results. Given subsequent failed replications, these results make sense.
- Exp. 4 achieved similar trends to Gilbert et al., except that secondary verbal WM task did not interfere with the trend. Our effect of category signifies that the experiment was done correctly.
- To implicate the language centers of the brain in the hemispheric lateralization observed in the no-interference condition, disruption of the phenomenon on the verbal interference condition—but not the nonverbal interference condition—was imperative.

- Our power was larger than that of Gilbert et al. Their “significant” differences that resulted in their category/visual field interaction were of 10-20 ms, but the differences observed in Exps. 2, 3 and 4 were of 50-100+ms. **If this Whorf Effect does exist, it should have been detected.**
- Key difference could be the data analysis. Gilbert et al. (2006 & 2008) took trials with RTs outside of two SDs from the individual participant's mean and deleted them. The convention, if this approach is to be taken, is to take trials 2.5 SDs above a participant's mean, and to bring them down to equal 2.5 SDs above the mean, not to delete them. This questionable method could have contributed to their significant results; **their findings may be a Type 1 error.**

## Conclusions

Based on the results of Experiments 2, 3, and 4, we are forced to call into question Gilbert et al.'s (2006 & 2008) previous findings and their implications. The statistical methods used by Gilbert et al. are questionable, and this purported effect of hemispheric lateralization in categorical perception needs further scrutinization. Our next step is to quadruple our sample sizes to increase our power even further, and analyze this data every possible way—at the very least using the methods used by Gilbert et al., as well as more conventional methods—to determine how they got their effects and whether their claims are justified. For the time being, this line of experiments has churned up more questions than it has answered. This “Whorf Effect”, upon which a decade of research has been based, may not exist.