

# Effects of Perceptual and Conceptual Cues in a Response Switching Task

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## ABSTRACT

In the directed response switching (DRS) task, participants kept two conflicting responses active, choosing between responses on each trial. The primary response was word naming, whereas the secondary response was a generic verbal response, “bam.” In previous versions of DRS, we used color as the sole cue for the correct response, potentially allowing people to make decisions about correct responses without fully encoding the stimuli. In the present experiment, we varied perceptual (color) and conceptual (group membership) cues to examine the effect of more complex cues on decision making. We also manipulated the ease of detecting the primary response and secondary response cues. Using response times as the dependent measure, we found a three-way interaction: Altering the nature of the cues lead to dramatic changes in cognitive control performance. Conceptual input exaggerated both the task and discrimination effects, relative to perceptual input.

## BACKGROUND

- Many cognitive control tasks require participants to switch between competing responses.
- Switching between tasks leads to slower responding, relative to performing a single task alone (Jersild, 1927).
- Focus is often on the nature of the tasks, the added manipulations, or the output.
  - Response (Hansen & Goldinger, 2006)
  - Predictability of switch trials (Rogers & Monsell, 1995)
  - Individual differences (Friedman et al., 2008)
  - Nature of the decision (Mayr & Kliegl, 2000)
- In these experiments some stimulus acts to cue the correct response on each trial.
  - Shape
  - Side of the screen
  - Color of stimulus
- What if the cue is **not perceptual** and has to be processed in some other way?

## How does the nature of the cue affect performance in a cognitive control task?

## DIRECTED RESPONSE SWITCHING TASK

- Words appear individually on the screen
- Participants respond to the word based on a cue that is contained within the stimulus
- Cue is randomly assigned, so participants cannot predict the correct response on any given trial.
- Design is easily manipulated to accommodate changes to secondary response, stimuli, and general manipulations.
  - Cue:** perceptual (color) or conceptual (group membership)
  - Task:** single (naming) or dual-task (naming or say “bam”)
  - Discrimination:** how easy it is to discriminate between cues that signal opposing responses - easy (dissimilar) or difficult (similar)

## DESIGN

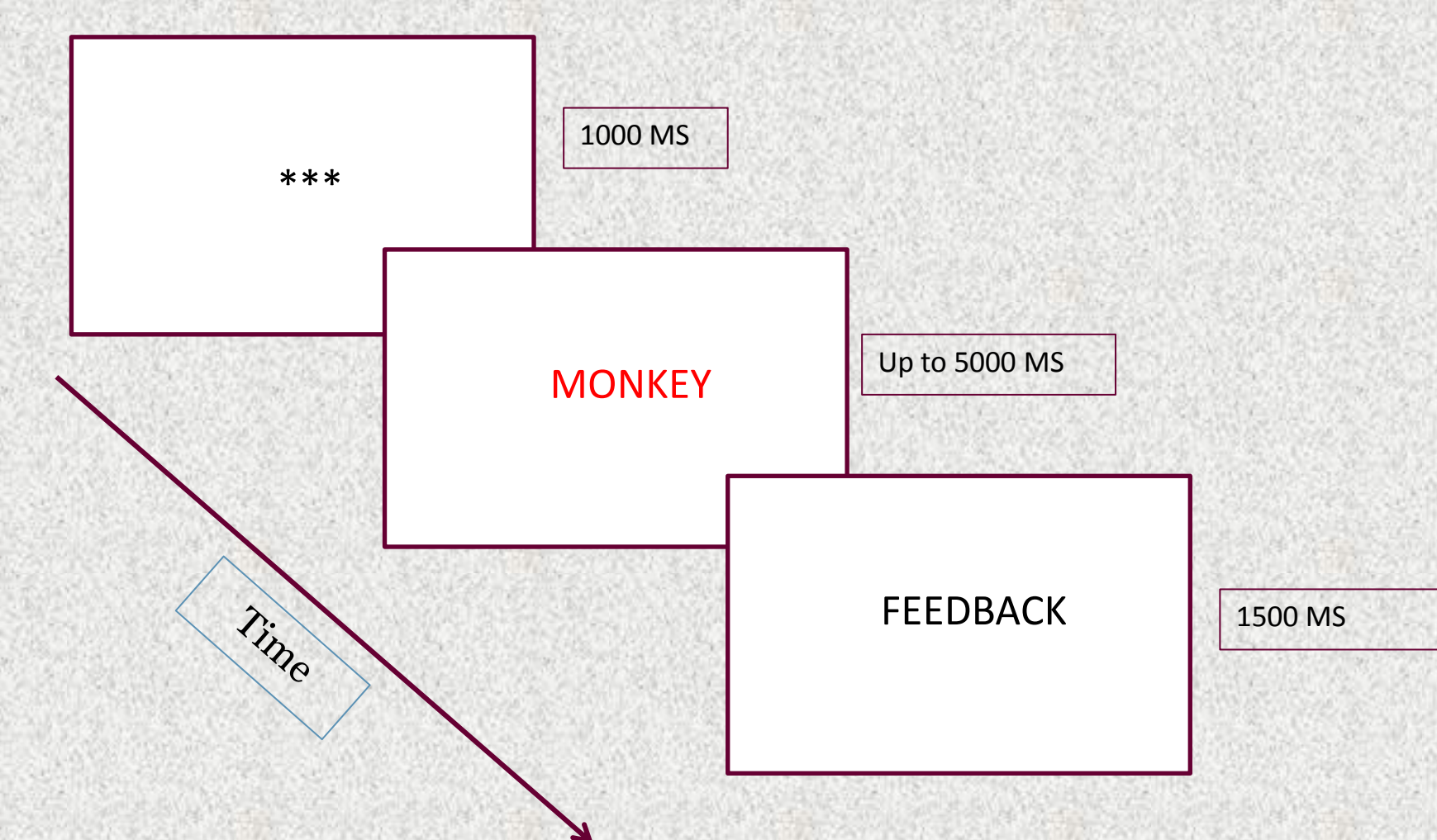
- 2 x 2 x 2 Within-Subjects Design
  - Cue (Perceptual / Conceptual)
  - Task (Name / Bam)
  - Discrimination (Easy/ Difficult)
- 3 Stimulus types:
  - Standard
  - Discrimination
  - Target
- RTs measured by voice key
- Errors documented by a researcher

## STIMULI

- 360 words (45 per condition)
- 15 per stimulus type per condition (see Table)
- Each word appeared in one color and belonged to one of eight categories
- Color was randomly assigned to each word
- Words were selected from various lists and websites
- Words were counterbalanced across conditions

Stimulus Type	Correct Response	Perceptual	Conceptual 1	Conceptual 2
Standard	Name	Blue	Restaurants	Body Parts
Easy / Difficult	Name	Green / Brown	Plants / Birds	Clothing / Drinks
Target	Name / Bam	Red	Mammals	Food

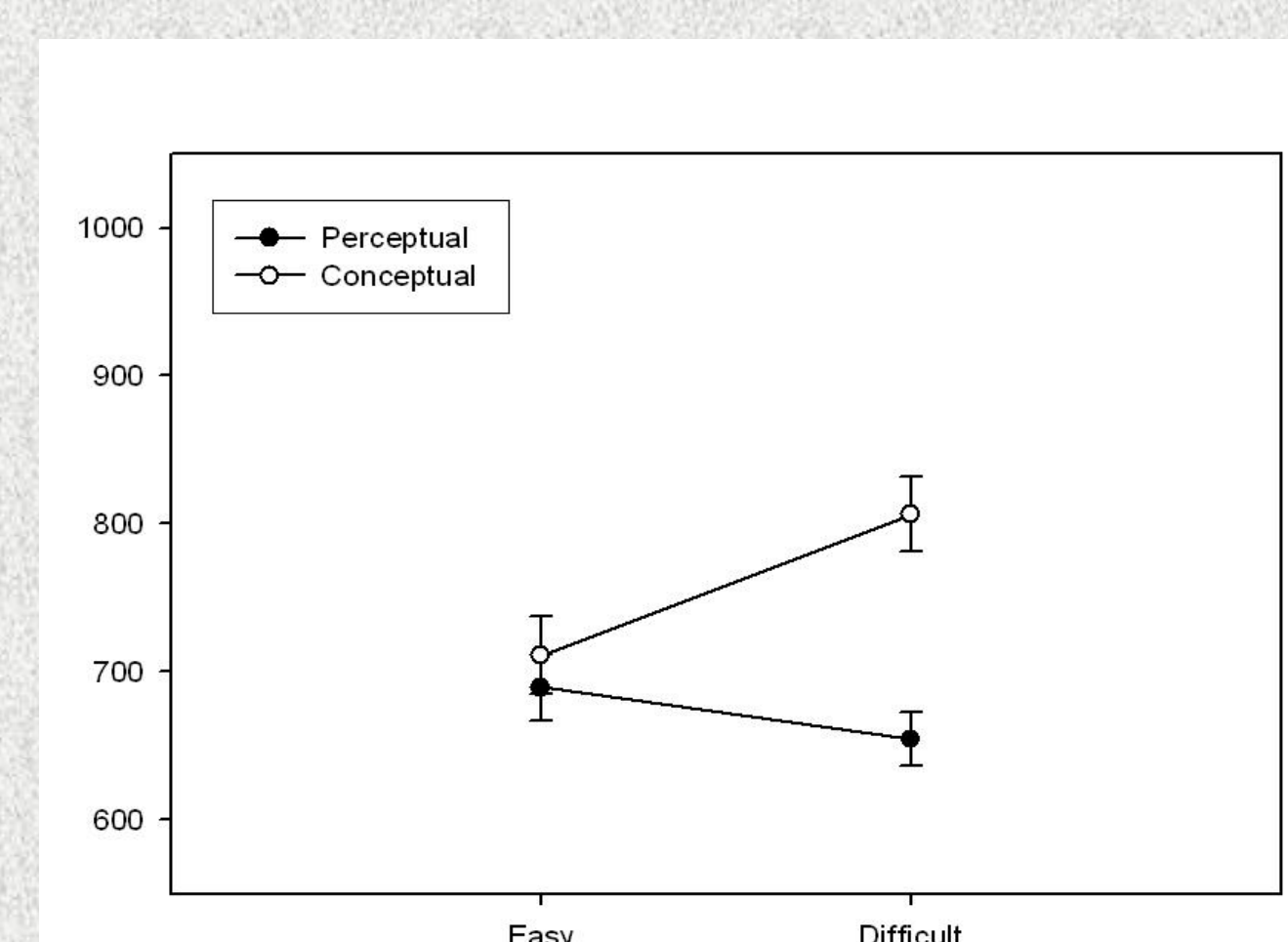
## SAMPLE TRIAL



## RESULTS

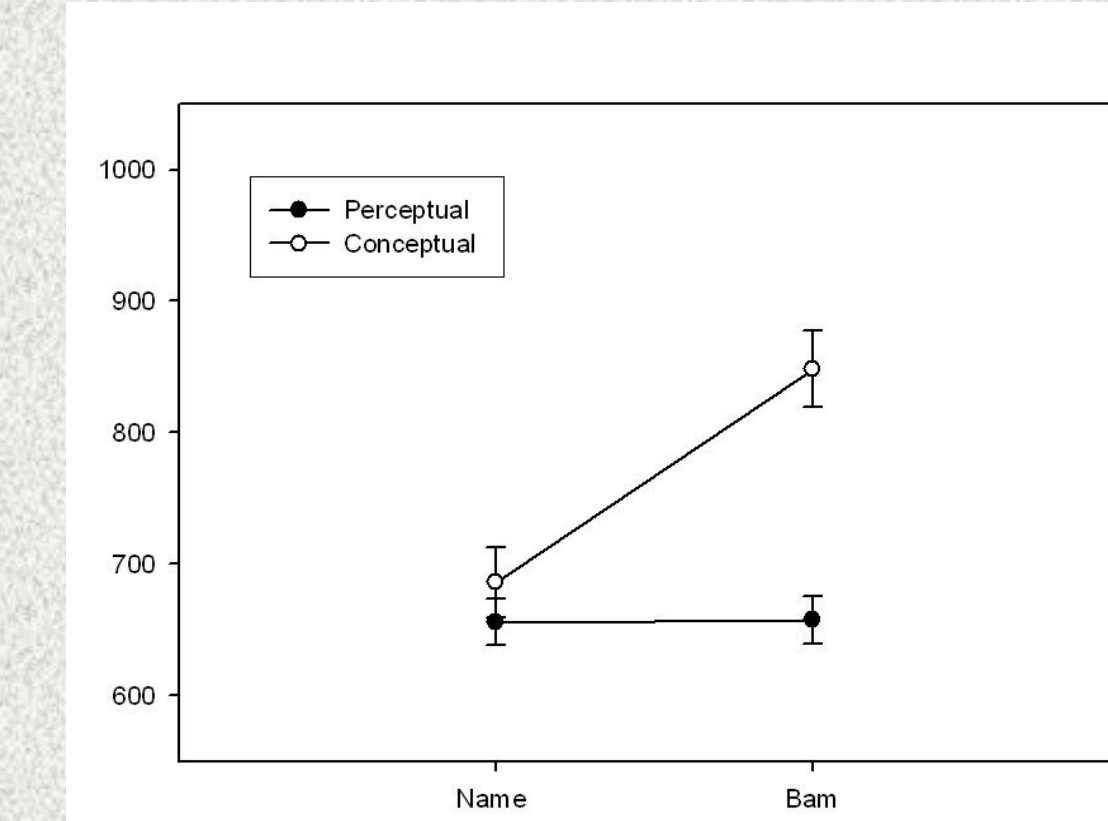
- Generally found main effects of:**
  - Cue:** RTs are faster for Perceptual relative to Conceptual
  - Task:** RTs are faster in Naming conditions relative to Bam
  - Discrimination:** RTs are faster in Easy conditions relative to Difficult (not true for target words)
- Interactions:**
  - Discrimination x Cue:** The discrimination effect is larger for Conceptual cues relative to Perceptual cues.

## DISCRIMINATION

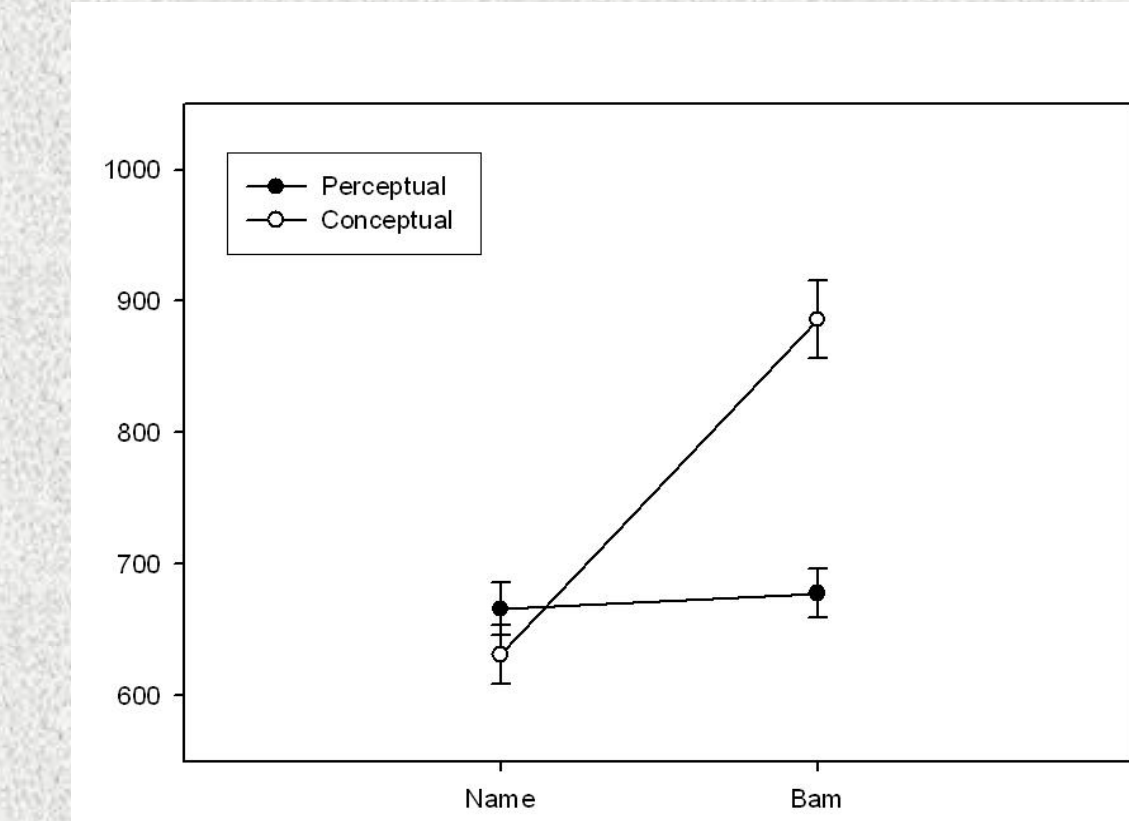


- Task x Cue:** When the cue is perceptual, switching tasks has little effect on performance. When the cue is conceptual, there is a large cost to switching.

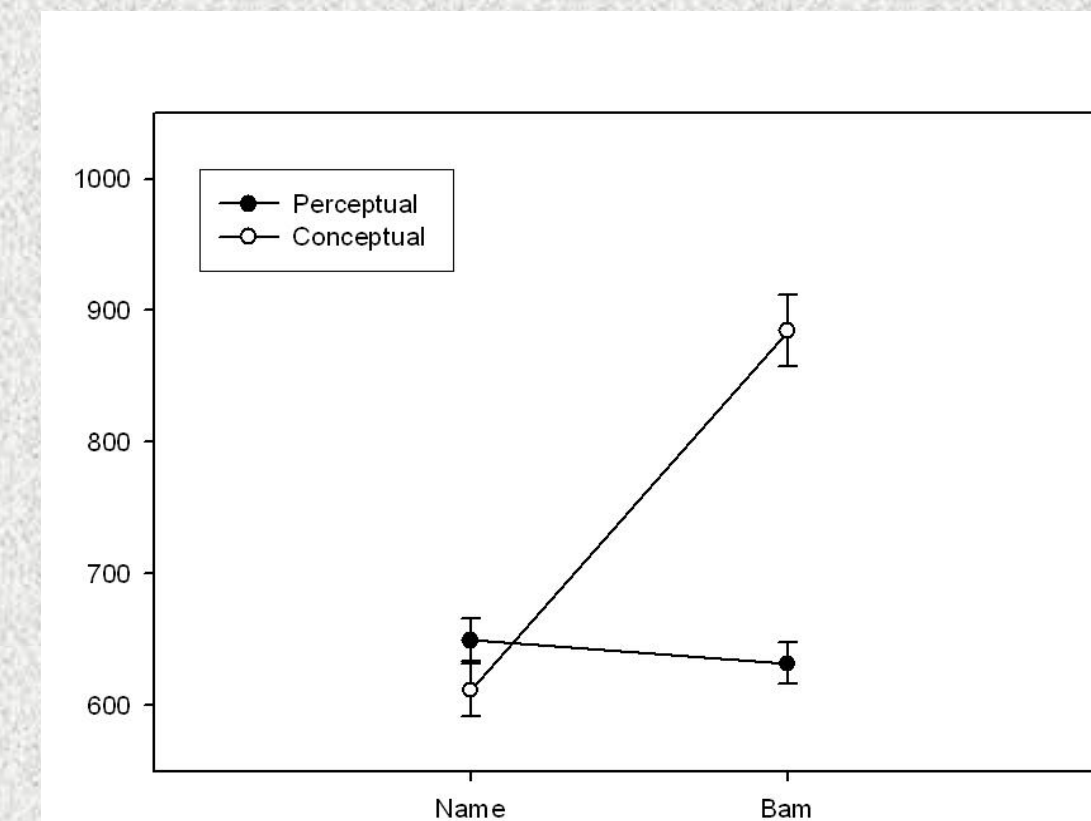
## STANDARD



## DISCRIMINATION

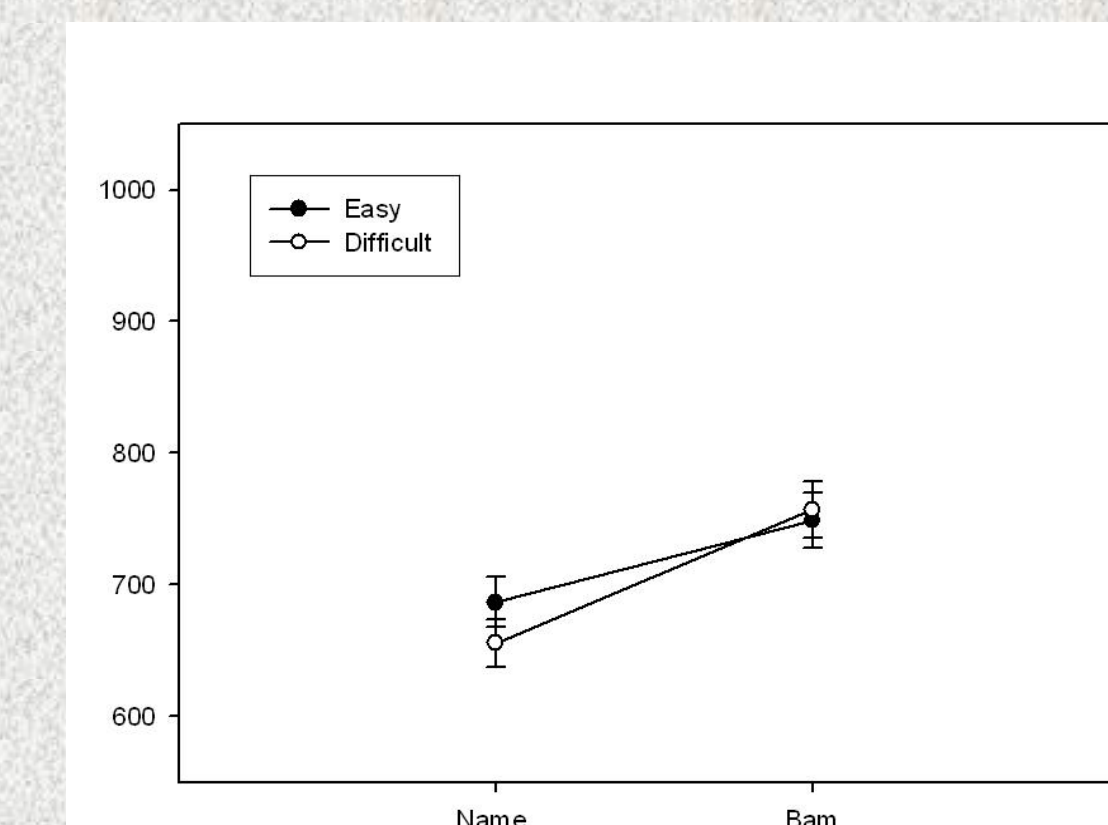


## TARGET

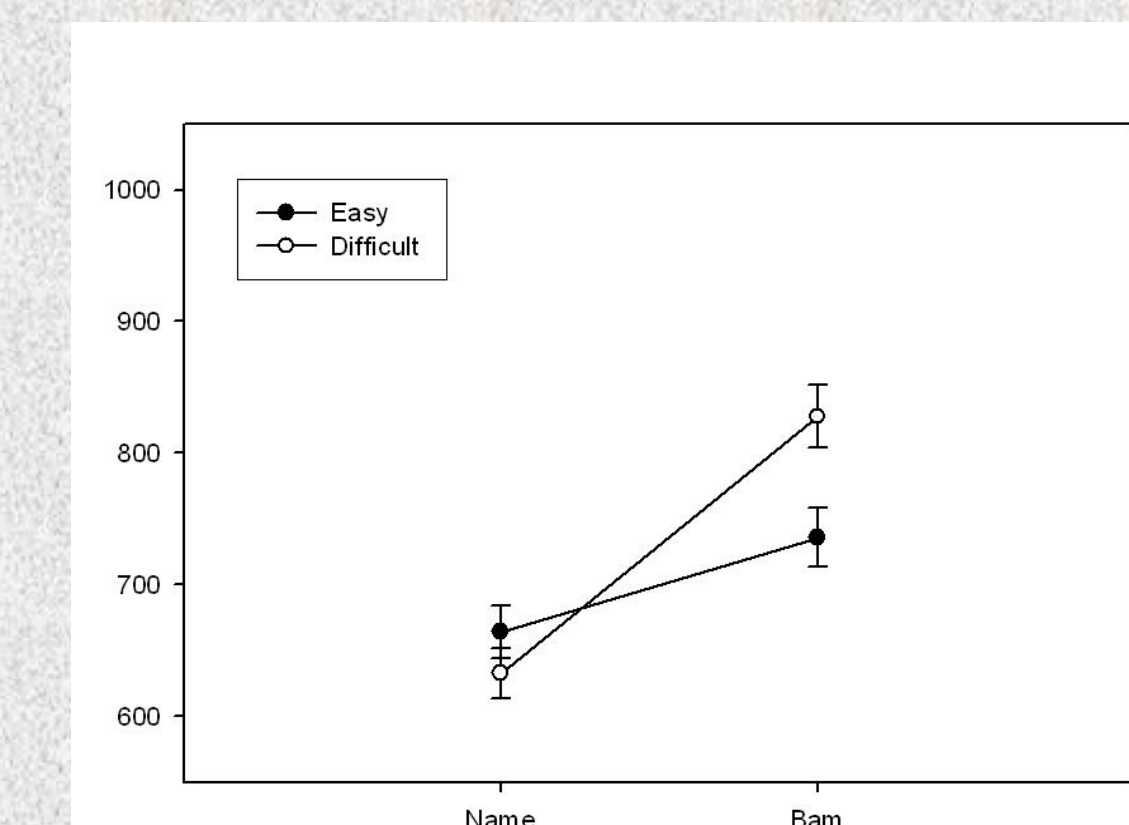


- Task x Discrimination:** Discrimination (usually) has a larger effect when the secondary task must be maintained, relative to when a single response is maintained.

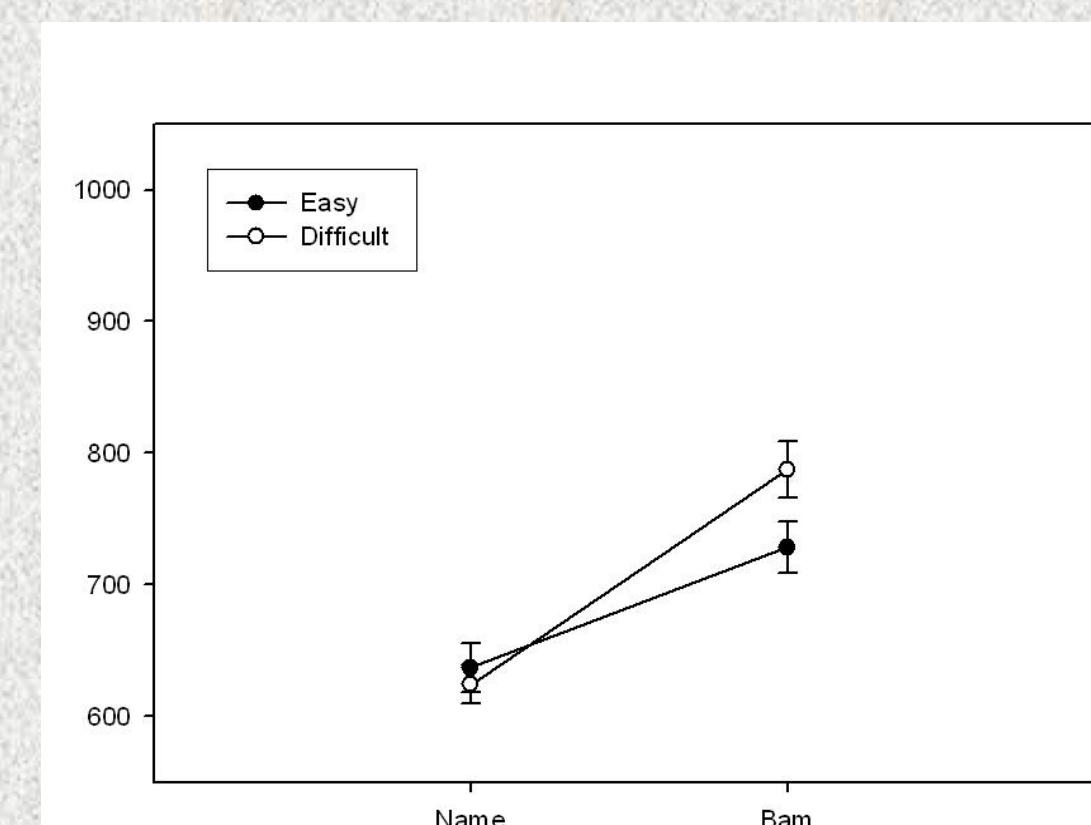
## STANDARD



## DISCRIMINATION

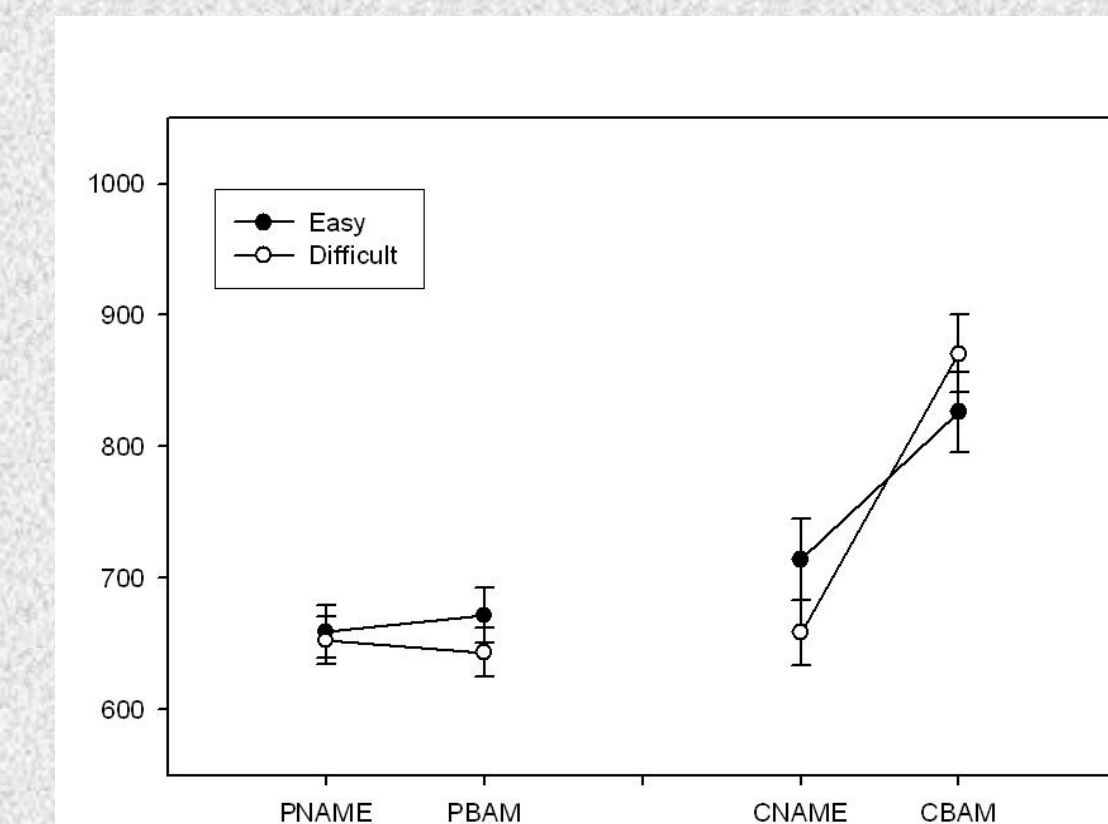


## TARGET

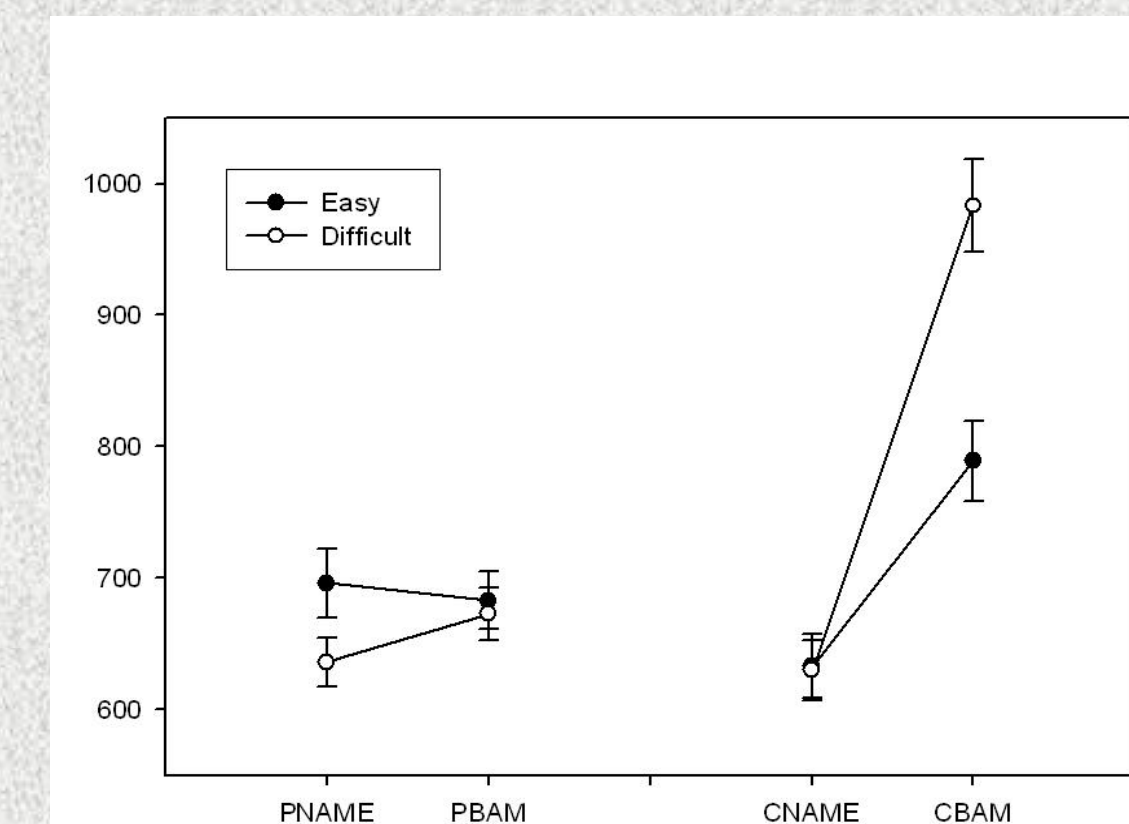


- Cue x Task x Discrimination:** The nature of the Task x Discrimination interaction changes based on the cue signaling the correct response.

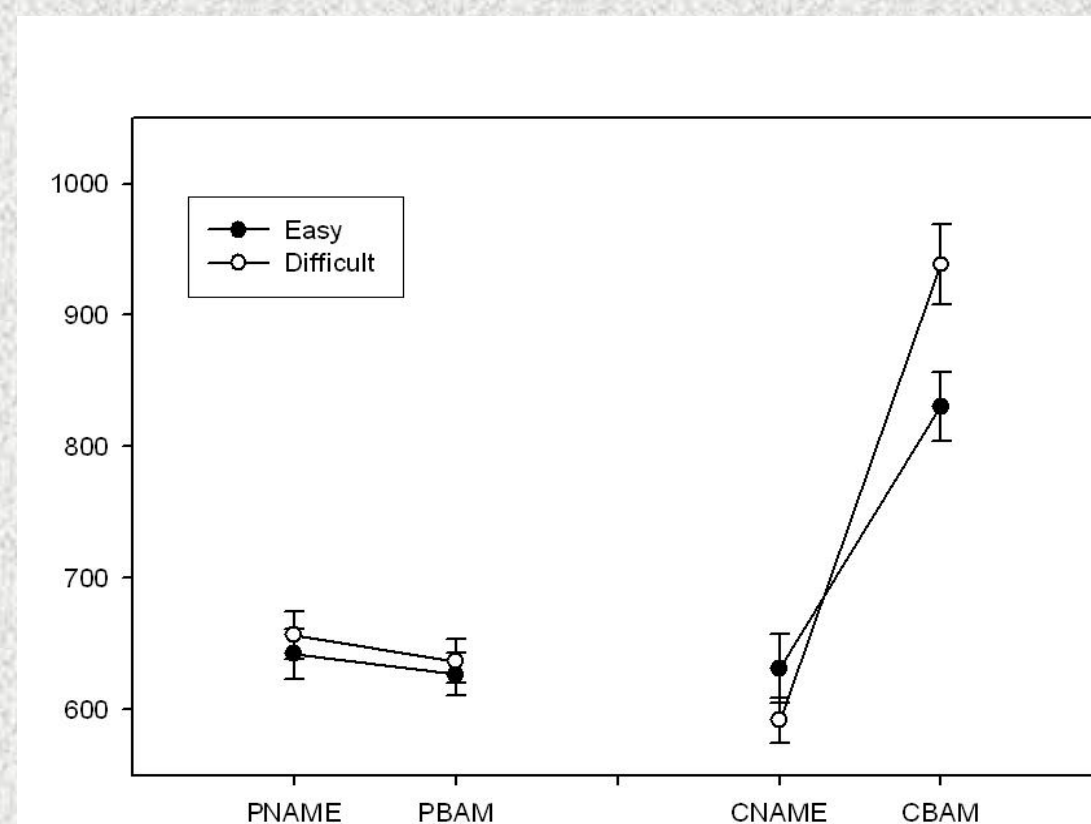
## STANDARD



## DISCRIMINATION



## TARGET



## DISCUSSION

- RTs are longer under the dual-task conditions relative to the single task conditions.
- Responding is slower when the cues are more similar.
- The nature of the cue dramatically impacts performance on cognitive control tasks.
- The cost of switching between tasks is greater for conceptual relative to perceptual cues. (*Task x Cue*)
- The discrimination effect is larger under dual task conditions. (*Task x Discrimination*)
- Discriminating between similar concepts leads to longer RTs relative to similar colors. (*Discrimination x Cue*)
- The Task x Discrimination effect is large for conceptual cues but non-existent for perceptual cues. (*Cue x Task x Discrimination*)

## CONCLUSIONS

- It is not only the nature of the secondary task that matters in cognitive control tasks: The cue that is used to signal the correct response also matters!
- Conceptual cues lead to dramatic increases in RTs when a secondary task needs to be maintained, or even executed.
- Conceptual (semantic) processing slows responding generally relative to perceptual processing, and exaggerates the effects of other manipulations, including discrimination.

## The cue affects the cost!

## REFERENCES

- Jersild, A. T. (1927). Mental set and shift. *Archives of Psychology*, 14, 89.
- Hansen, W. A. & Goldinger, S. D. (2006). The Effects of Working Memory Capacity in a Directed Suppression Task. *Abstracts of the Annual Meeting of the Psychonomic Society*, 11, 111. (Poster presented in Houston, TX.)
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- Mayr, U. & Kliegl, R. (2000). Task-set switching and long-term memory retrieval. *Journal of Experimental Psychology, Learning, Memory and Cognition*, 26, 1124 – 1140.