Investigating the Specificity of Proactive Control in Tasks of Selective Attention

Thomas G. Hutcheon, Maayan Eldar, & Molly Bremner
Bard College, Psychology Program

Cognitive Control

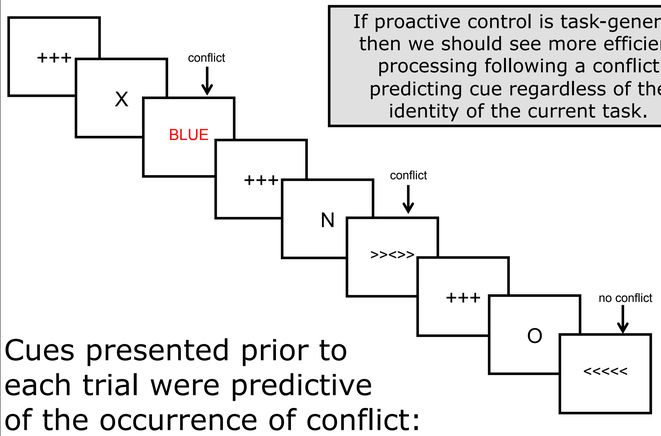
Cognitive control is particularly important in situations where a weaker (but task-relevant) source of information must be selected over a stronger (but task-irrelevant) source of information (Miller & Cohen, 2001).

The efficiency of cognitive control has been shown to vary as a function of conflict (Botvinick et al., 2001). If participants are cued that an upcoming trial is likely to contain conflict, control can be tightened **proactively** such that task-irrelevant information is more efficiently inhibited (Aarts et al., 2008).

To date, this form of proactive control has been demonstrated across a variety of interference tasks (Aarts & Roloefs, 2011; Fernandez-Duque & Knight, 2008). This raises the question as to whether this proactive control is task-general (can be implemented across tasks) or task-specific (can only be implemented within a particular task)?

Proactive Control Across Tasks

In the current experiments, participants randomly switched between the Stroop and Flanker tasks.



If proactive control is task-general, then we should see more efficient processing following a conflict predicting cue regardless of the identity of the current task.

Cues presented prior to each trial were predictive of the occurrence of conflict:

p(conflict|X)=0.75, p(conflict|N) =0.50, p(conflict|O)=0.25

However, cues were predictive of conflict for one task (informative) but not predictive of conflict for the other task (uninformative).

INFORMATIVE STROOP/UNINFORMATIVE FLANKER

Stroop	Flanker
P(conflict|X) = 0.75	P(conflict|X) = 0.50
P(conflict|N) = 0.50	P(conflict|N) = 0.50
P(conflict|O) = 0.25	P(conflict|O) = 0.50

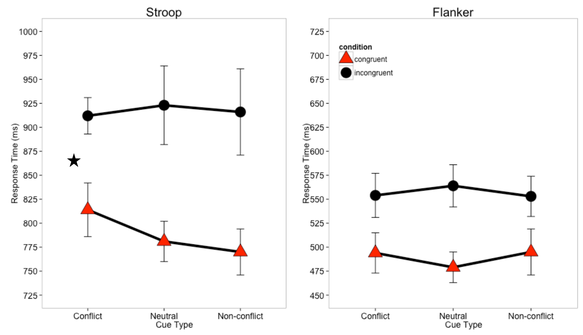
UNINFORMATIVE STROOP/INFORMATIVE FLANKER

Stroop	Flanker
P(conflict|X) = 0.50	P(conflict|X) = 0.75
P(conflict|N) = 0.50	P(conflict|N) = 0.50
P(conflict|O) = 0.50	P(conflict|O) = 0.25

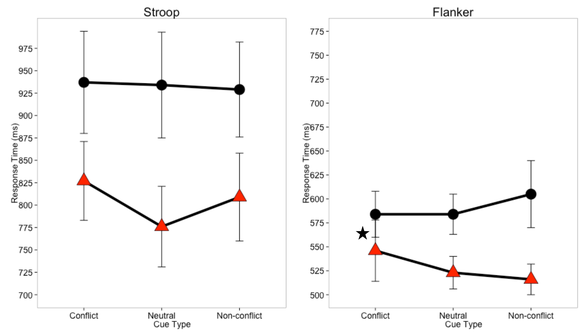
Results

Experiment 1: Switching between Stroop and Flanker task using manual responses (N=32). Each task mapped to a different hand.

Informative Stroop/Uninformative Flanker

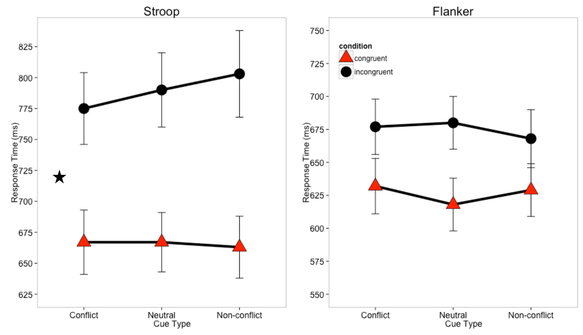


Uninformative Stroop/Informative Flanker

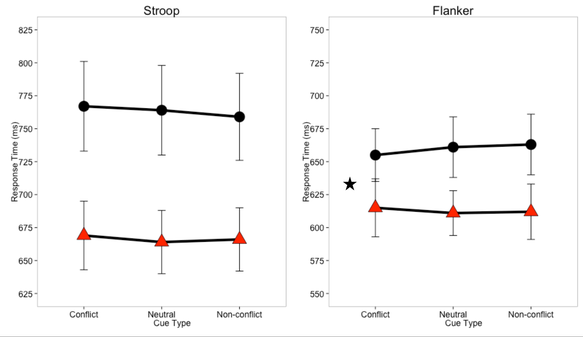


Experiment 2: Switching between Stroop and Flanker using vocal responses (N=30).

Informative Stroop/Uninformative Flanker



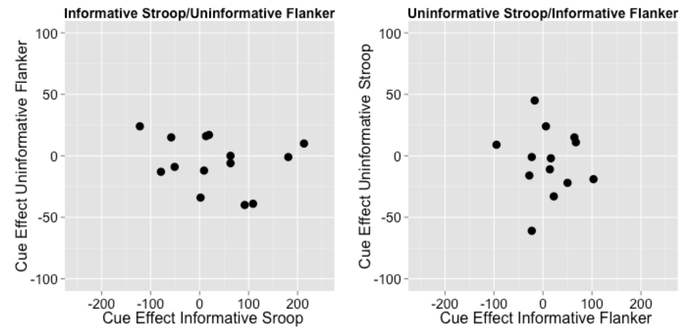
Uninformative Stroop/Informative Flanker



Proactive Control is Task-Specific

In two experiments, participants used cues to proactively adjust control. When cues were informative of conflict in the Stroop task, the size of the congruency effect was reduced in Stroop. And, when cues were informative of conflict in the Flanker task, the size of the congruency effect was reduced in Flanker.

These adjustments in performance were not observed across tasks. Moreover, there was no relationship between the influence of cues in the informative task and the influence of cues in the uninformative task.



Conclusions

In the current set of experiments, we find that proactive control operates in a task-specific manner.

Here, the difference between tasks was highly salient. Future work will investigate the boundaries of proactive control and test whether tasks overlapping on stimulus dimensions demonstrate task-general proactive control (Hazeltine et al., 2011).

Cognitive control is a flexible process that is influenced by experience. Identifying aspects of experience that allow control to generalize across stimuli and tasks is an important issue for future research.

References

Aarts, E., & Roelofs, A. (2011). Attentional control in anterior cingulate cortex based on probabilistic cueing. *Journal of Cognitive Neuroscience, 23*, 716-727.

Aarts, E., Roelofs, A., & van Turrenout, M (2008). Anticipatory activity in anterior cingulate cortex can be independent of conflict and error likelihood. *The Journal of Neuroscience, 28*, 4671-4678.

Akçay, Ç., & Hazeltine, E. (2011). Domain-specific conflict adaptation without feature repetitions. *Psychonomic Bulletin & Review, 18*, 505-511.

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108*, 624-652.

Fernandez-Duque, D., & Knight, M. (2008). Cognitive control: Dynamic, sustained, and voluntary influences. *Journal of Experimental Psychology: Human Perception and Performance, 34*, 340-355.

Hazeltine, E., Lightman, E., Schwarb, H., & Schumacher, E. H. (2011). The boundaries of sequential modulations: Evidence for set-level control. *Journal of Experimental Psychology: Human Perception and Performance, 37*, 1898-1914.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience, 24*, 167-202.