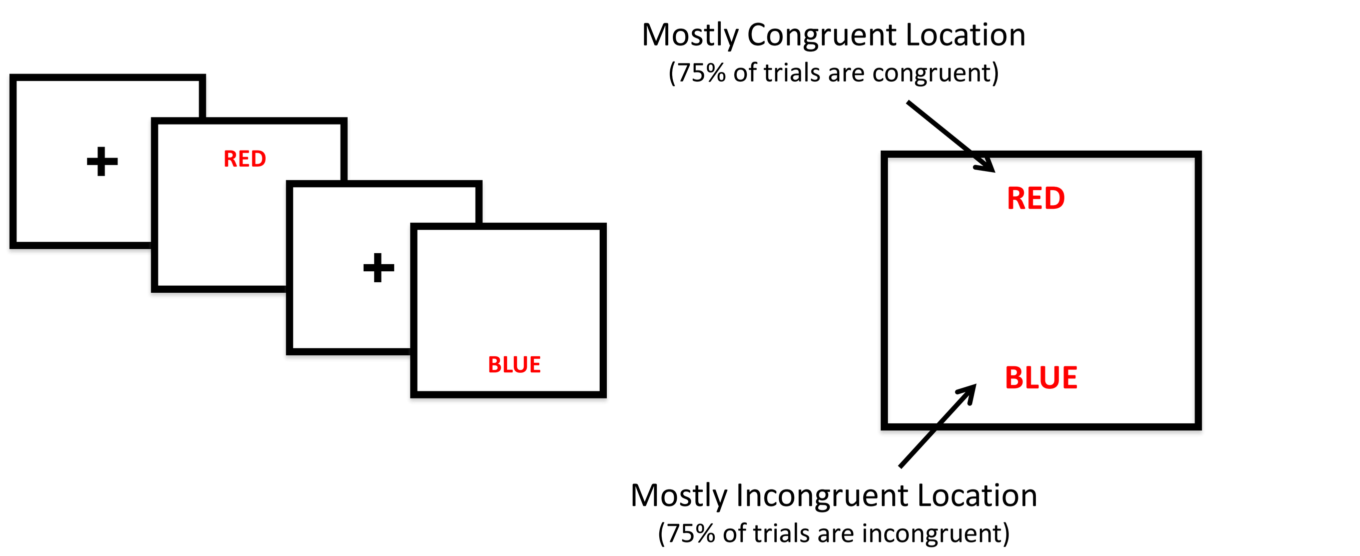
Context-specific contingency learning under low but not high memory load

Bard
A Place to Think

Thomas Hutcheon, Immanuel Zion, Julianne Arnold
Bard College, Annandale-On-Hudson, New York

The Context Specific Proportion Congruent Effect

The context specific proportion congruent (CSPC) effect refers to the reduction in the size of the congruency effect at a location with a high proportion of incongruent trials compared to a location with a high proportion of congruent trials (Crump, Gong, & Milliken, 2006).



Mostly Congruent Location		Mostly Incongruent Location	
Condition	RT (ms)	Condition	RT (ms)
Congruent (C)	659	Congruent (C)	664
Incongruent (I)	796	incongruent (I)	773
Congruency Effect (I-C)	**137**	Congruency Effect (I-C)	**109**
CSPC Effect = 28			

Data from Hutcheon & Zion (in revision)

According to the **stimulus-driven control** account, the CSPC effect reflects variations in the efficiency of cognitive control that are driven by stimulus experience (Bugg & Crump, 2012; Verguts & Notebaert, 2008).

According to the **contingency learning** account, the CSPC effect reflects an associative learning process in which participants use information about the location and the identity of the word to predict the likely response (Schmidt, De Houwer, & Rothermund, 2016).

Representative stimulus list in context-level manipulations

Mostly Congruent Location (Top)		Mostly Incongruent Location (Bottom)	
Stimulus	Number of Trials	Stimulus	Number of Trials
RED	36	RED	12
RED	12	RED	36
YELLOW	36	YELLOW	12
YELLOW	12	YELLOW	36

At the mostly congruent location, word + location is predictive of a response:
P("red"|RED + Top) = 0.75

At the mostly incongruent location, word + location is predictive of a response:
P("yellow"|RED + Bottom) = 0.75

Across several manipulations, stimulus-driven control and contingency learning accounts make similar predictions and have proved difficult to disentangle (Crump, Gong, & Milliken, 2009; Hutcheon & Spieler, 2017; Schmidt & Lemercier, 2019; Spinelli & Lupker, in press).

Context-specific Contingency Learning

In the current experiment, we first tested for the presence of context-specific contingency learning. We used two-item response sets and manual responding as these have been shown to bias participants towards implementing contingency learning (Bugg, 2014).

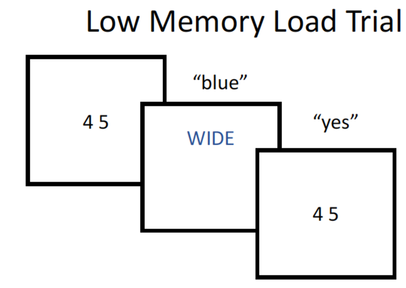
Participants were presented with stimuli where the combination of the location and word were either predictive of the correct response (**high contingency**) or not predictive of the correct response **(low contingency)** trials.

Representative stimulus list for one block of trials in contingency manipulation

Location	Stimulus	# of Trials	Contingency
Top	WIDE	24	High
Top	WIDE	6	High
Top	LOCK	24	Low
Top	LOCK	6	Low
Bottom	WIDE	24	High
Bottom	WIDE	6	High
Bottom	LOCK	24	Low
Bottom	LOCK	6	Low

Participants were also required to maintain either a high or low memory load. This load manipulation has been shown to reduce contingency learning (Schmidt, De Houwer, & Besner, 2010) and we tested whether this would extend to context-specific contingency learning.

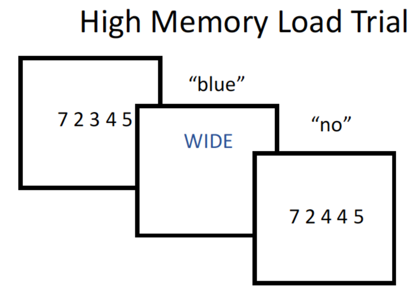
Low Memory Load Trial



Low Memory Load (N=32)				
Contingency	RT	SE	ACC	SE
High	727	13	0.96	0.03
Low	746	12	0.97	0.02
Contingency Effect	19*		-0.01	

*P<0.1

High Memory Load Trial



High Memory Load (N=32)				
Contingency	RT	SE	ACC	SE
High	847	22	0.97	0.04
Low	835	21	0.98	0.05
Contingency Effect	-8		-0.01	

We find evidence for context-specific contingency learning under low but not high memory load. This suggests that context-specific contingency learning might underlie the commonly observed CSPC effect and this memory load manipulation could disentangle the role of contingency and control.

We next applied a memory load component to a context-level manipulation. The presence of a CSPC effect under both high and low memory load would suggest the operation of stimulus-driven control processes. The absence of a CSPC effect in the high memory load condition would imply contingency learning is the primary driver of the CSPC effect.

Looking for the CSPC Effect Across Memory Load

Participants performed a context-level manipulation consisting of two-item sets with manual responding under either high or low memory load.

Low Memory Load (N = 28)					
Mostly Congruent Location			Mostly Incongruent Location		
Condition	RT (ms)	SE	Condition	RT (ms)	SE
Congruent (C)	731	12	Congruent (C)	728	11
Incongruent (I)	802	18	incongruent (I)	784	14
Congruency Effect (I-C)	**71**		Congruency Effect (I-C)	**56**	
CSPC Effect = 15*					

*P<0.10

CSPC effect approaches significance under low memory load.

High Memory Load (N=28)					
Mostly Congruent Location			Mostly Incongruent Location		
Condition	RT (ms)	SE	Condition	RT (ms)	SE
Congruent (C)	920	18	Congruent (C)	866	15
Incongruent (I)	961	19	incongruent (I)	922	20
Congruency Effect (I-C)	**41**		Congruency Effect (I-C)	**56**	
CSPC Effect = -15					

CSPC effect is absent under high memory load condition. Thus, the CSPC effect in this manipulation appears to be driven by contingency learning.

Conclusions

In the current set of experiments we find preliminary evidence for context-specific contingency learning. Moreover, we find that this learning can be blocked by the addition of a concurrent high memory load.

Similarly, we find evidence for a CSPC effect under low but not high memory load. Therefore, contingency learning appears to be driving the observed CSPC effect in this manipulation.

These results suggest that contingency learning processes can operate in context level manipulations. Moreover, the application of the memory load manipulation will be a useful method to clarify the role of control and contingency learning in other related paradigms (Hutcheon & Zion, under review).

References

Bugg, J. M. (2014). Conflict-triggered top-down control: Default mode, last resort, or no such thing? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40,* 567-587.

Bugg, J. M. & Crump, M. J. C. (2012). In support of a distinction between voluntary and stimulus-driven control. *Frontiers in Psychology, 27*.

Crump, M. J. C., Gong, Z., & Milliken, B. (2006). The context-specific proportion congruent Stroop effect: Location as a contextual cue. *Psychonomic Bulletin & Review, 13*, 316-321.

Hutcheon, T. G. & Spieler, D. H. (2017). Limits on the generalizability of context-driven control. *Quarterly Journal of Experimental Psychology, 70*, 1292-1304.

Hutcheon, T. G. & Zion, I. (in revision). Evidence for context-driven control under a concurrent memory load.

Schmidt, J. R., De Houwer, J., & Rothermund, K. (2016). The parallel episodic processing (PEP) model 2.0: A single compuational model of stimulus-response binding, contingency learning, powercurves, and mixing costs. *Cognitive Psychology, 91*, 82-108.

Schmidt, J. R., & Lemercier, C. (2019). Context-specfic proprotion congruent effects: Compound-cue contingnecy learning in disguise. *Quarterly Journal of Experimental Psychology, 72,* 1119-1130.

Schmidt, J. R., De Houwer, J., & Besner, D. (2010). Contingency learning and unlearning in the blink of an eye: A resource dependent process. *Consciousness and Cognition, 19*, 235-250.

Spinelli, G., Lupker, S. J. (in press). Item-specific control of attention in the Stroop task: Contingency learning is not the whole story in the item-specific proportion-congruent effect. *Memory & Cognition.*

Verguts, T., & Notebaert, W. (2008). Hebbian learning of cognitive control: Dealing with specific and nonspecific adaptation. *Psychological Review, 518-525.*