Attention Capture by Distractors Following a Switch in Search Strategy: Evidence for a Break Down of Top-Down Control

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Introduction

Unlike most lab experiments on attention capture, real world scenarios typically require frequent switching between different attentional settings (e.g., drivers watching for a stoplight to change color, checking the speedometer, scanning for pedestrians). Lien, Ruthruff, and Johnston (2010) reported that humans have a remarkable ability to rapidly and fully switch between different search settings (e.g., red to green), with no hint of carryover from previous settings and no capture by irrelevant stimuli. The present study examined whether such impressive flexibility and control is possible even with more complicated attentional switches, differing not only features but in mode –singleton search vs. feature search mode.

S*ingleton search* is looking for a unique object that "pops out" from the display. *Feature search*, however, is looking for a specific feature (e.g., blueness), which might not be salient (Lamy & Egeth, 1994). Both search modes are widely used in the real world, yet seem incompatible. Here, we asked whether switching between them might be especially problematic, weakening attentional control settings and opening the door to capture by irrelevant objects.

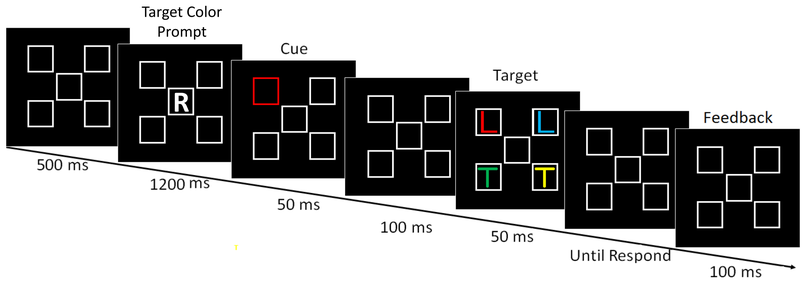
The Present Study

We used a cuing paradigm, with a cue display followed by a target display. Capture by an irrelevant cue was assessed by examining whether response time (RT) was shorter when the target appeared in the same location as the target (the *cue validity effect*).

Cue Display: The cue was always an irrelevant color singleton, whose location was non-informative (25% valid vs. 75% invalid).

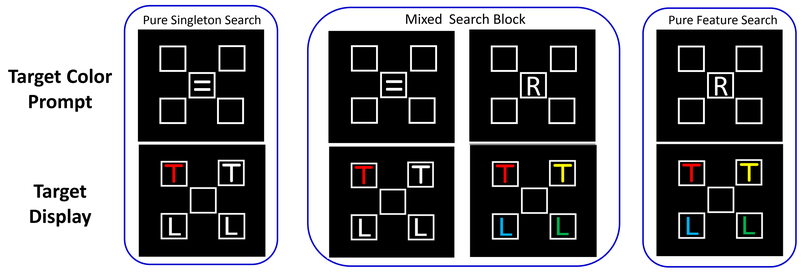
Target Display: Participants identified the only colored letter among white letters (singleton search) or a specific colored letter among three distractor colored letters (feature search). The target displays (identical for all participants) contained two T's and two L's. Participants responded to the target by pressing the key "L" or "T".

Event Sequence:



Target Color Prompt: For singleton search, the prompt was an equal sign. For feature search, the prompt was the first letter of the to-be-searched for color (e.g. "R" for red).

Block Types: Pure blocks of singleton search or feature search, plus mixed blocks of singleton search and feature search.



Predictions

Singleton Search: Irrelevant color singleton cues should capture attention and produce large cue validity effects (both pure and mixed).

Feature Search: Irrelevant color singleton cues should not capture attention in pure feature search blocks. However, if switching between incompatible search modes is challenging, then mixed blocks might show strong capture by irrelevant color singleton cues (especially immediately after a switch in mode).

Experiment 1 (N=44)

We used a fixed AABB sequence in mixed blocks, alternating between runs of two singleton searches and runs of two feature searches.

Design: In feature search,¼ of participants responded to only the red target letter, ¼ responded to green, ¼ to blue, and ¼ to yellow.

Results and Discussion

**p<.05, **p<.01, *** p<.001*

	Pure Block		Mixed Block			
Target	Singleton	Feature	Singleton		Feature	
Transition	Repeat	Repeat	Repeat	Switch	Repeat	Switch
Valid	557	594	614	670	629	693
Invalid	599	599	664	698	642	698
Validity Effect	*42****	*6*	*50****	*29**	*13*	*5*
Switching Cost			*45****		*60****	

As expected, singleton search produced large cue validity effects regardless of the block type and transition type (repeat/switch), *F*s(1,43)≥ 6.34, *p*s<.05. However, the feature search produced very small, non-significant cue validity effects, regardless of block type and transition, *F*s<1.0. These findings suggest that switching between different search strategies does not necessarily weaken attentional control setting.

Experiment 2 (N=44)

We used a random sequence of singleton search and feature search, instead of a fixed alternating AABB sequence, which should make switching even more challenging.

Results and Discussion

**p<.05, **p<.01, *** p<.001*

	Pure Block		Mixed Block			
Target	Singleton	Feature	Singleton		Feature	
Transition	Repeat	Repeat	Repeat	Switch	Repeat	Switch
Valid	544	583	622	644	617	657
Invalid	584	586	655	679	631	680
Validity Effect	*40****	*3*	*34****	*35****	*14*	*23**
Switching Cost			*23***		*45****	

Again, singleton search produced large cue validity effects, regardless of block type and transition type, *F*s(1,43)≥13.28, *p*s<.001. Feature search again produced negligible cue validity effects in pure blocks, as expected, *F*<1.0. In mixed blocks, however, the irrelevant color singleton cue was able to capture attention and produced a substantial cue validity effect following a switch to feature search, *F*(1,43)=4.73, *p*=0.035.

General Discussion

We examined whether the attentional control system is able to rapidly and fully switch between singleton search and feature search. This seemed like a particularly challenging type of switch, yet one that might often be required in many real-world contexts, such as driving a car.

We observed a breakdown in attentional control under these conditions. Whereas irrelevant color singletons could be essentially ignored in pure feature search, they could not be ignored on feature search trials in mixed blocks (at least with random task sequences). The problem was especially noticeable immediately after a switch from singleton search to feature search. This breakdown indicates a limitation in the sharpness of attentional control, under conditions that might be prevalent in the real world.

References

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Lamy, D., & Egeth, H. E. (2003). Attentional capture in singleton-detection and feature-search modes. *Journal of Experimental Psychology: Human Perception and Performance, 29,* 1003-1020.

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