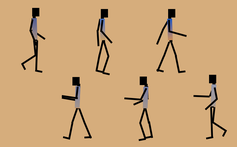
How top-down is perception?

Attentional cycles

in detecting simple events in complex displays



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We are missing top-down gems !

Although top-down and bottom-up processing have been fundamental to perceptual research throughout its history, the overall influence of one or the other in everyday perception is unknown. The body of existing evidence is limited, because the challenges of the complexity of everyday scenes and task behavior have not been appreciated nor measured in most existing experiments.

Complexity is critical: Everyday scenes versus simplicity-biases of experimentation

In natural scenes, stimulus complexity is very high, not only at image levels, but also at the level of possible interpretations (e.g., Tsotsos, 1991). Task complexity is also very high; a wide range of tasks is possible within a scene, varying in content, type, and spatial and temporal scale. The concept of selective attention was identified early in psychological science, motivated by complexity in everyday perception: How do observers select which of multiple possible stimulus streams they will interpret? Complexity may be the primary reason for attention, control processes, and top-down mechanisms (e.g., James, 1890, Kahneman & Treisman, 1984).

Although the bulk of the literature is biased, researchers are beginning to explore complexity, and their results qualify the idea of bottom-up efficiency. Scene categorization is no longer highly efficient when the scene layout varies from trial to trial, with non-relevant objects present in the foreground (Walker, Stafford, & Davis, 2008). Letters are identified efficiently, but not in a "cost-free" manner; the costs of prepatory attentional processes can be observed shortly before identification (e.g., Paap & Ogden, 1981). The capture of attention is greatly reduced when displays start to become complex (Cosman & Vecera, 2009).

Measuring instantiation of a schema

Experimental biases for simplicity go beyond stimulus factors. Researchers usually measure behavior during test periods that are preceded by practice. Yet, attention is set during initial practice periods, and initial portions of the experiment can be very interesting (e.g., Mack & Rock, 1998). The present experiments examine the instantiation of set. The stimuli consist of events — simple, predictable events that changed over time.

Classic schema effects were obtained: Facilitation of *set* events, and inhibition of *other* events until a new set was instantiated via central attention.

References

Cosman, J. D., & Vecera, S. P. (2009). Perceptual load modulates attentional capture by abrupt onsets. Psychonomic Bulletin & Review, 16, 404-410.

James, W (1890). *The principles of Psychology* (Chapter XI: Attention).

Kahneman, D., & Treisman, A. (1984). Changing views of attention and automaticity. In R. Parasuraman, R. Davies, & J. Beatty (Eds.), *Varieties of attention* (pp. 29–61). New York: Academic Press.

Mack, A. & Rock, I. (1998). *Inattentional Blindness.* Cambridge, MA: MIT Press.

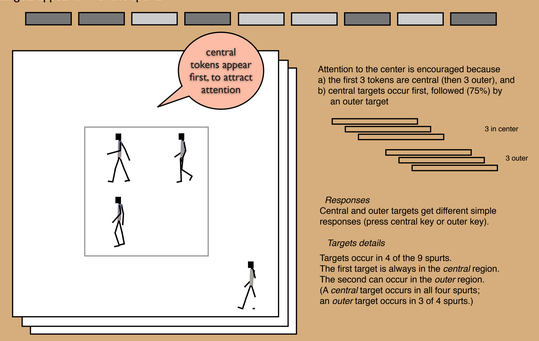
Paap, K. R., & Ogden, W. C. (1981). Letter encoding is an obligatory but not capacity-demanding operation. *Journal of Experimental Psychology: Human Perception and Performance, 7*, 518-527.

Tsotsos, J.K. (1990). Analyzing Vision at the Complexity Level. *Behavioral and Brain Sciences 13*, 423 - 445.

Attentional Set for Efficiency and...

- Attentional set is necessary for optimal perceptual efficiency. Here, a search set (schema) was instantiated, and...
- When the target type suddenly changes ("other task"), there are large costs as a new set is established.
- The costs are large but their duration varies greatly with attention.

Displays: 34 sec stream of token animations
- 54 tokens — 47 distractors, 7 targets
- organized in 9 "spurts" of 3 central tokens and 3 outer tokens
- targets appear in 4 of the spurts



Attention to the center is encouraged because
a) the first 3 tokens are central (then 3 outer), and
b) central targets occur first, followed (75%) by an outer target

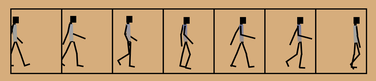
Responses
Central and outer targets get different simple responses (press central key or outer key).

Targets details
Targets occur in 4 of the 9 spurts.
The first target is always in the *central* region.
The second can occur in the *outer* region.
(A *central* target occurs in all four spurts; an *outer* target occurs in 3 of 4 spurts.)

...103 frames in 34 sec trial
(lifetime of one token is 7 frames)

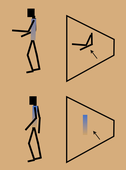
Tokens: 7 frame animations

Distractor token (a "lifetime" of 7 frames ~ 2.3 sec)



Target tokens (the two "types")

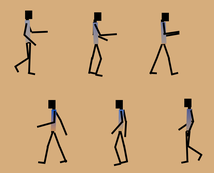
Two "sets":



motion set
look for arms coming together;
if not, ignore
if yes, watch (focus attention and...

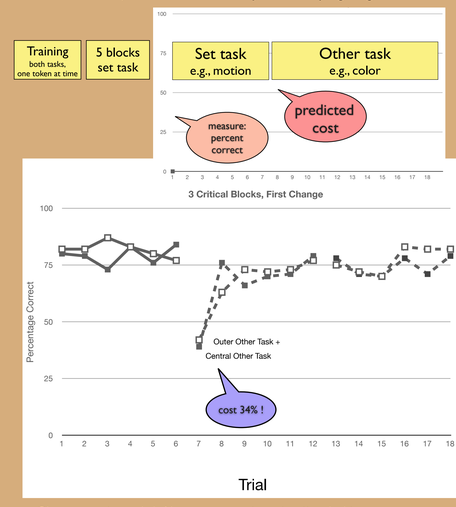
color set
look for colors brightening;
if not, ignore
if yes, watch (focus attention and...

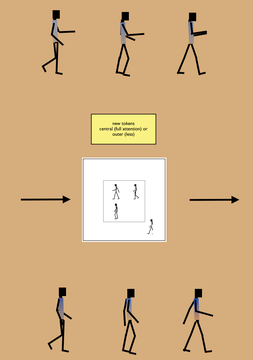
Observers learned both sets at start of experiment
(singly presented tokens; 100% accuracy before continuing)



Experiment 1: Big brief costs when new tokens get full attention

Observers have been set for one task (set task).
Suddenly the task changes both in the central and outer regions (full attention).
Will there be cost, in terms of accuracy of identifying targets?



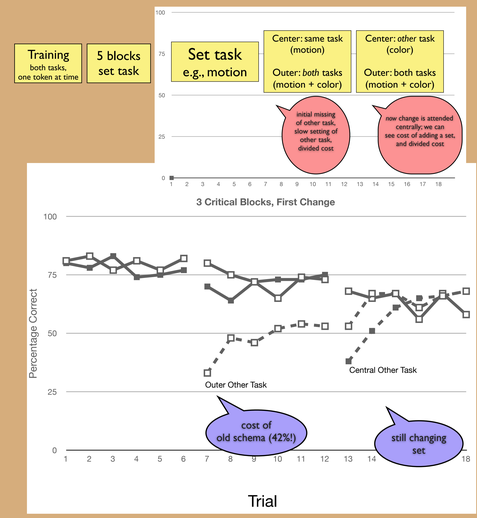


Change cost was brief because new targets attended to.

Will old set stay if new targets more subtle? ...away from central attention?

Experiment 2: Lasting costs when new tokens get weak attention

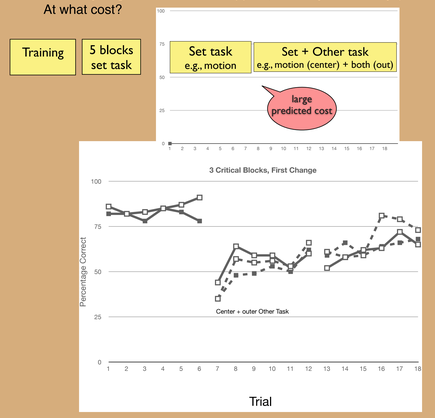
Observers have been set for one task (set task).
Suddenly the task changes but only some tokens in outer regions (weak attention).



Big costs linger (thru 432 tokens!) when new tokens appear away from attention.
More big costs occur when targets presented centrally (trial 13), at attention.

Experiment 3: Big costs for adding a second task set

Observers have been set for one task (set task).
Suddenly targets for both tasks appear, centrally and outerly (full attention).
At what cost?

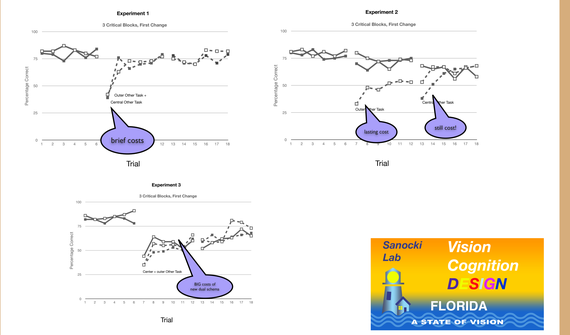


Costs for both tasks (big and long) when 2nd task added to set.

Summary: Big Top-down Effects

Is Perception Top-Down? YES!

Having a prepared schema increases perceptual efficiency by up to 42%!
The schema takes time and attention to prepare.



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