Highly Facilitatory Parallel Processing During Visual Search

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Introduction

- **How does the combination of stimulus features (shape and color) affect the overall search process?**
- Systems Factorial Technology[1] is a nonparametric statistical framework for discriminating serial/parallel, stopping rule, and workload capacity of cognitive processes that combine at least two sources of information
- Our previous work[2] supported parallel models of feature search, but results were less conclusive for conjunctive search

Experimental Design

TARGET PRESENT ON 50% OF TRIALS

Experiment 1: Single-feature search

Four sessions:	3104 total trials per subject
Capacity blocks (2):	92 trials/session; 368 total
DFP block:	592 trials/session; 2368 total

Experiment 2: Conjunctive search

Five sessions:	3040 total trials per subject
Capacity blocks (2):	64 trials/session; 320 total
DFP block:	480 trials/session; 2400 total

Methods

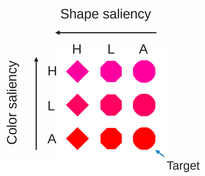
- 15 subjects in each condition
- Compensated $10/session
- First session removed from analysis

Observations Per Subject

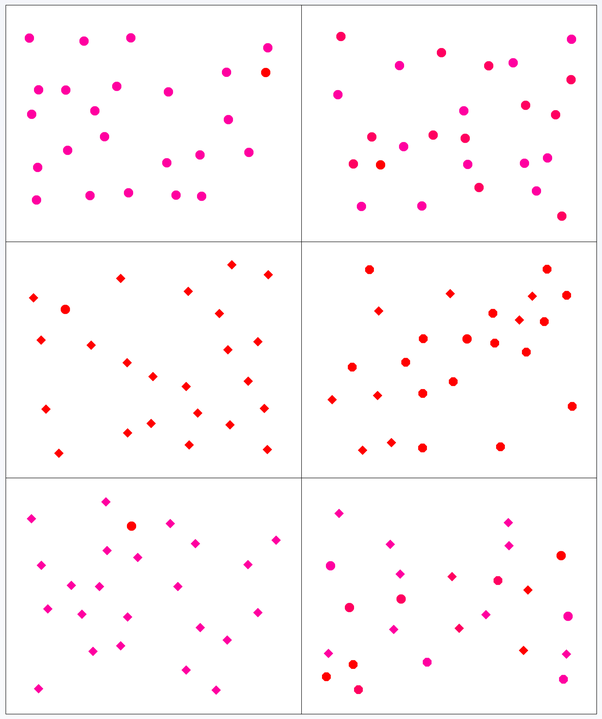
Experiment 1 (single-feature search)		Experiment 2 (conjunctive search)	
Capacity	69	Capacity	64
SIC	111	SIC	120

Stimuli

- 4 capacity conditions
- 16 DFP conditions
- Distractors defined by dissimilarity to target
- Always 24 objects



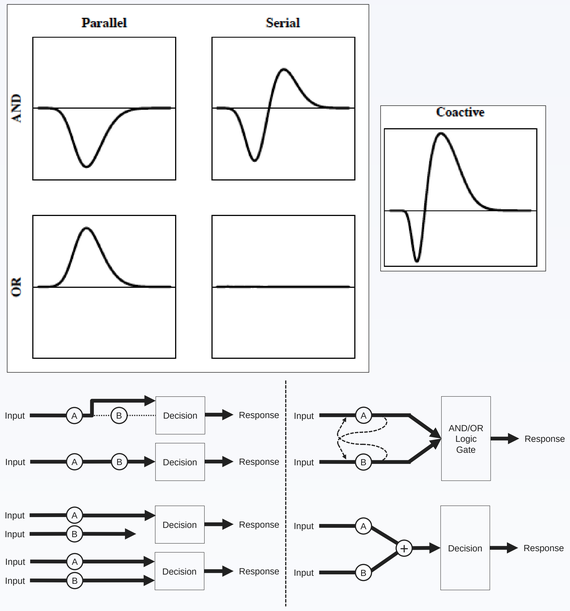
Example Displays



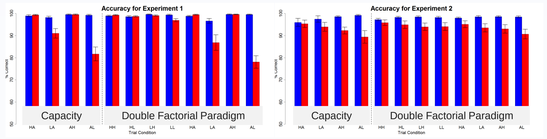
Survivor Interaction Contrast[1,3]

$$SIC(t) = [S_{LL}(t) - S_{LH}(t)] - [S_{HL}(t) - S_{HH}(t)]$$

$S(t) = 1 - CDF(t)$
H:= High Saliency (purple, triangles)
L:= Low Saliency (pink, octagons)

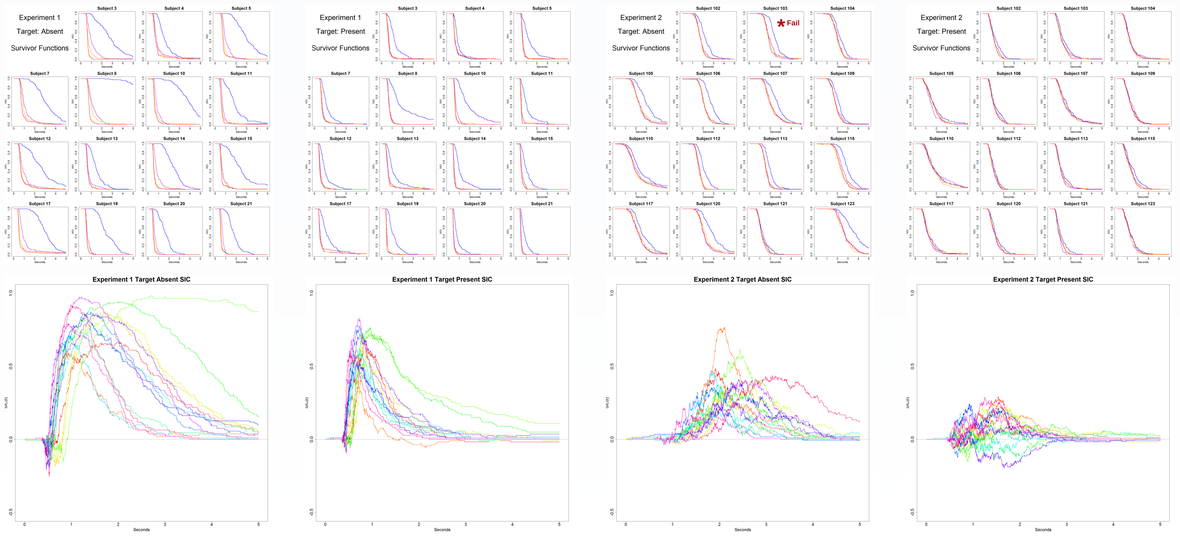


Accuracy



SIC Results Summary[4]

Experiment 1	**Target Absent**	15/15 significantly positive MIC, positive SIC deviation 7/15 significantly negative SIC deviation
	Target Present	15/15 significantly positive MIC, positive SIC deviation No significant negative SIC deviations
Experiment 2	**Target Absent**	14/15 significantly positive MIC, positive SIC deviation No significant negative SIC deviations; 1 failure of SI
	Target Present	No selective influence; unable to interpret

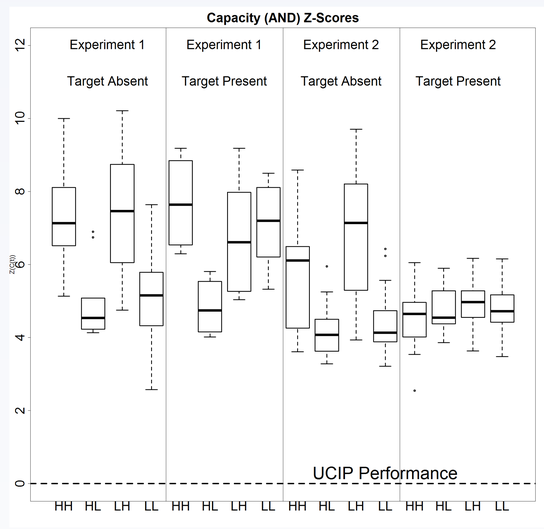


Workload Capacity[1,3]

$$C_{AND}(t) = \frac{K_{color}(t) + K_{shape}(t)}{K_{both}(t)}$$

$C(t) > 1 \rightarrow$ *Super*
$C(t) = 1 \rightarrow$ *Unlimited*
$C(t) < 1 \rightarrow$ *Limited*

$K(t)$:= cumulative reverse hazard function



Conclusions

- Color and shape processing during single-feature and conjunctive visual search is parallel and highly facilitatory, even coactive[5]
- Results constrain parametric process models of visual search
- Future work:
  - Dynamic stimuli and response methods
  - Fused sensor images

References

1 Townsend, J. T., & Nozawa, G. (1995). Spatio-temporal properties of elementary perception: An investigation of parallel, serial and coactive theories. *Journal of Mathematical Psychology*, 39, 321-360.

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3 Houpt, J. W., Blaha, L. M., McIntire, J. P., Havig, P. R., & Townsend, J. T. (2014). Systems factorial technology with R. *Behavioral research methods*, 46(2), 307-330.

4 Houpt, J.W. (2014). A comparison of statistical analyses for the survivor interaction contrast. Talk presented at the 55th Annual Meeting of the Psychonomic Society; Long Beach, CA.

5 Eidels, A., Houpt, J. W., Altieri, N., Pei, L., & Townsend, J. T. (2011). Nice guys finish fast and bad guys finish last: Facilitatory vs. inhibitory interaction in parallel systems. *Journal of mathematical psychology*, 55(2), 176-190.

Acknowledgements

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