TEXTURE DISCRIMINATION WITH SEGMENTATION BUT NOT LOCALIZATION CUES

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INTRODUCTION

Discerning the boundaries of objects embedded within a scene is a prerequisite for object recognition. Although statistical differences can be powerful implicit cues, explicit cues typically enhance image segmentation. Explicit cues such as a frame can act as both segmentation and localization cues. Here, we attempt to distinguish between these influences.

GENERAL METHODS

Stimuli consisted of four 8 x 8 arrays of black and white checks embedded within a same-size random check background.

In Expt. 1, the target array was drawn from one of four image classes and differed from randomness in first-order statistics (LUM), isodipole statistics (EVEN), spatial frequency (1D-corr), or mirror symmetry (SYM). In Expt. 2, the target array had mirror symmetry (SYM). In both experiments, three distractor arrays were colored at random.

Explicit cues were colored in red (vertical bar (VBAR), horizontal bar (HBAR), or an outline (FRAME)) and superimposed on all four arrays (target and distractors). Arrays, along with cues, were positionally jittered in locations about the fixation point.
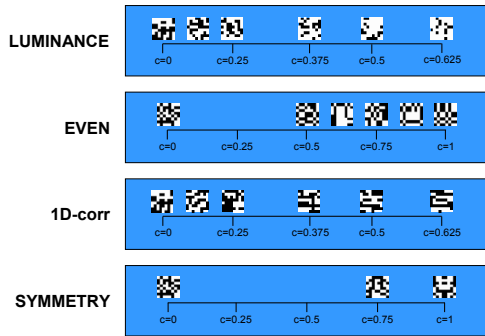
Examples of each image class were generated with a range of statistical structure, "c". For all image classes, the value c = 0 corresponds to randomness. A value of c = 1 corresponds to all-white (LUM), fully-even (EVEN), horizontal stripes (1D-corr), or completely symmetric (SYM). Values of c were chosen to span the range of psychophysical performance, as shown above.

**TASK: Which one of the four arrays is different?**
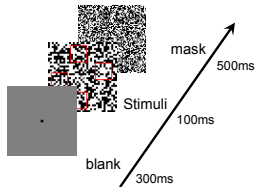
Practiced observers (Expt. 1: N=5; Expt. 2: N=4) were asked to identify the target in a 4-AFC task. Testing sessions consisted of stimuli from a single image class and separate blocks for each cueing condition. Image classes and cueing conditions were randomized and counterbalanced across observers and each observer completed 12 sessions for Expt. 1 and three sessions for Expt. 2. Feedback was given only during an initial practice session preceeding both experiments (1-2 hrs). Stimulus duration in all trials was 100 ms.

Other Details:
Check size: 20 min.
Contrast: 1.0
Luminance: 47 cd/m^2
Cambridge Research VSG2/5 system

LOCALIZATION vs SEGMENTATION

EXPT. 1   Image Classes and Cue Conditions
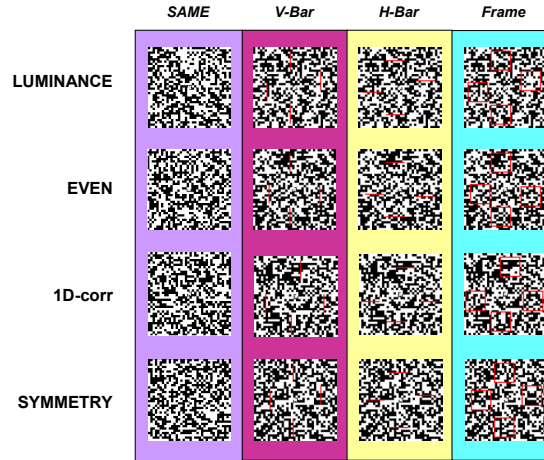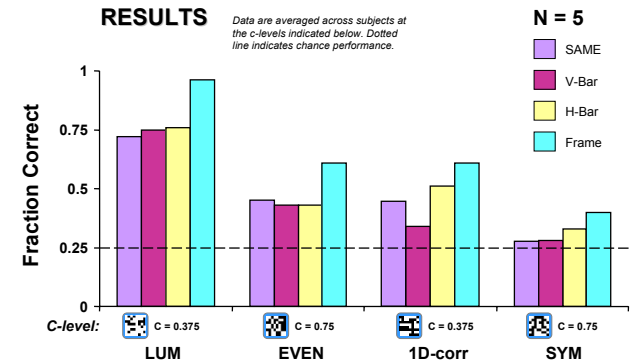

METHODS
N = 5
15,840 trials/Ss
Image Classes
Luminance
Even Textures
1D-correlated
Symmetry
Cueing Conditions
SAME Bkgd (NoCue)
Red Vertical Bar
Red Horizontal Bar
Red Frame

All three cues unambiguously localized the array positions, but only the Frame cue also segmented these arrays from the background.

RESULTS

Data are averaged across subjects at the c-levels indicated below. Dotted line indicates chance performance.

N = 5

➤ Fraction correct for LUM was highest overall; regardless of cueing.

➤ The Frame cue elicited the highest fractions correct for all image classes.

➤ V-Bar and H-Bar conditions localize but don't segment. They do not result in an improved fraction correct for LUM, EVEN, or SYM.

➤ For the 1D-correlated images, H-Bar but not V-bar results in improved performance.

EXPT. 2   Mirror Symmetry and Cue Conditions
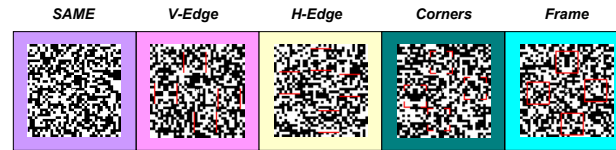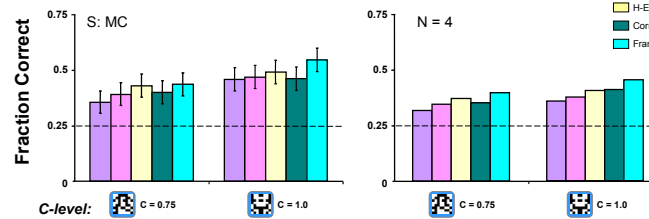

METHODS
N = 4
3,600 trials/Ss
Image Class
Symmetry
Cueing Conditions
SAME Bkgd (NoCue)
Red Vertical Edges
Red Horizontal Edges
Red Corners
Red Frame

RESULTS

For symmetry, a larger effect of cueing on performance was seen for a complete Frame than for cues that provided only partial segmentation (V edge, H edge, or Corners).

SUMMARY & CONCLUSIONS

➤ Symmetry, while visually salient, does not support segmentation by itself. Symmetry detection is improved to a greater degree when the target is surrounded by a cue that fully segments it (Frame), than when the cue provides similarly strong localization but only partial segmentation.

➤ For statistical classes that support segmentation (LUM, EVEN, 1-D corr), additional localizing cues do not improve psychophysical performance.

➤ However a frame, which provides both localization and segmentation cues, improves psychophysical performance across all statistical classes.

➤ The interaction between the orientation of the localizing bar and the orientation of the 1D-corr texture suggests that the cue influences the calculation of image statistics.