A colour-size processing asymmetry in visual conjunction search

Ronald van den Berg[a,c], **Aave Hannus**[b,c], **Jos B.T.M. Roerdink**[a,c], **Frans W. Cornelissen**[b,c]

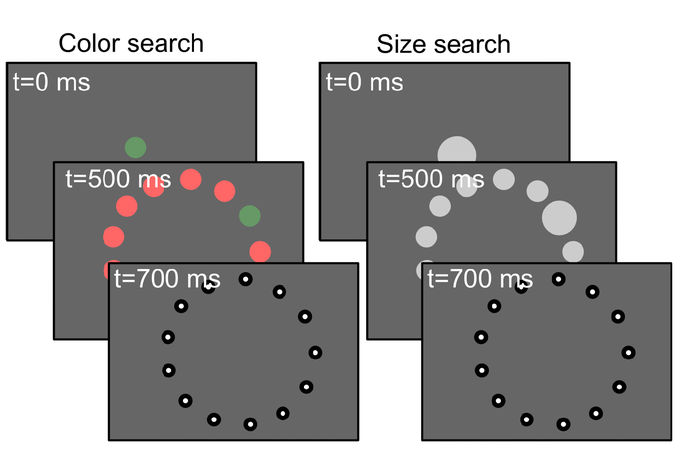
[a]Institute for Mathematics and Computing Science
[b]Laboratory for Experimental Ophthalmology
[c]School of Behavioral and Cognitive Neurosciences

University of Groningen, The Netherlands
r.van.den.berg@rug.nl

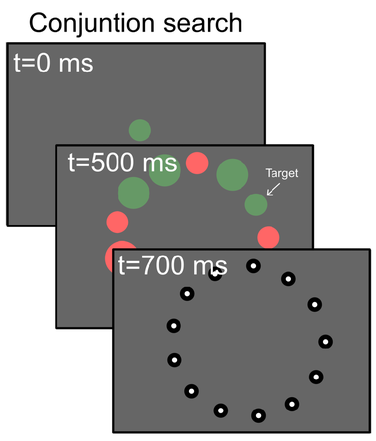
Introduction

Most present theories of visual search assume that individual features are processed independently prior to an integration stage (e.g. [8, 9]). This assumption is at odds with recent physiological findings suggesting the existence of mechanisms tuned to more than one visual modality [4]. In a previous study, we found psychophysical evidence for a color/orientation dependency in visual search [5]. In the present study, we investigate dependencies in the processing of color and size information.

Methods & Materials



(a) Single feature search stimuli



(b) Conjunction search stimulus

Figure 1: *Experiment stimuli (enhanced contrasts)*

Box 1. Correction procedure

To assess absolute performance values and to compare single feature and conjunction search results, we first need to correct for two discrepancies between recorded data and the actual, underlying target selection decisions:

1. ***Differences in guessing rates*** *Due to differences in distractor configurations, the probability of selecting a feature by chance is different in single feature and conjunction search.*
2. ***Target neigbor selection*** *Due to several reasons, a substantial amount of target detections resulted in selection of one of its neighbors, especially in single feature search (see [3] for a plausible explanation).*

The general effect of the correction is a slight vertical shift of performance levels (compare figures 3a and 3b), without the ratios between colour and size performance changing a lot. For a detailed description of the correction procedure, please consult [6].

- **Subjects** Seven volunteers with normal or corrected-to-normal vision
- **Apparatus** Macintosh G4, LaCie 22", Matlab 6.5, Psychophysics Toolbox [1], Eyelink Toolbox [2], Eyelink II
- **Stimuli** Cue (500ms), target and distractors (200ms), mask
- **Task** Fixate at cue and make saccade to target as quickly as possible
- **Procedure**
  1. Single feature search, 10 contrasts (Fig. 1a)
  2. Determine contrasts at which 70% of responses correct (Fig. 2)
  3. Single feature and conjunction search with matched contrasts (Fig. 1)

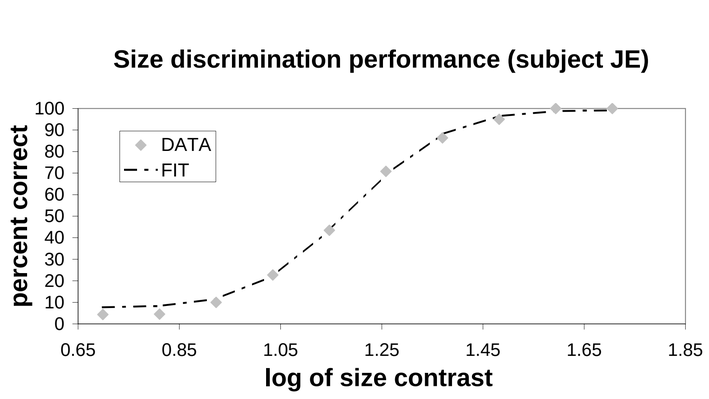


Figure 2: *Discrimination performance as a function of contrast; 70%-correct thresholds are determined by fitting a sigmoid function to the data*

- **Analysis** Determine discrimination performance in single feature and conjunction search for both features and check for interaction effect. Do a correction on the raw data (see Box 1) to assess absolute performance.

Hypothesis

▷ **Hypothesis**
At an early stage, color and size information are processed independently

▷ **Test procedure**

1. determine perceptually matched color and size contrasts for single feature search
2. use these matched contrasts in a conjunction search task

▷ **Falsification criterion**
unequal discrimination performance in conjunction search

Results

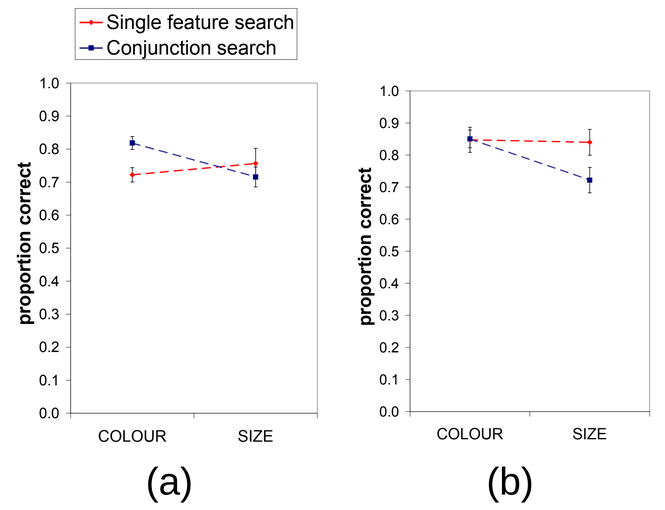


Figure 3: *Performance results derived from (a) uncorrected data and (b) corrected data*

The raw data (Fig. 3a) show an interaction effect between search type and feature, $F(1,6) = 10.209$, $p = .02$. After correction (see Box 1), the following appears:

▷ Colour and size discrimination performance equal in single feature search

▷ Colour discrimination performance remains the same in conjunction search

▷ Size discrimination performance *decreased* in conjunction search

Discussion

▷ Accuracy of size discrimination contingent on whether simultaneous colour search is required as well

▷ Not the other way around

▷ Asymmetry indicates a dependency in processing of visual features

▷ This is at odds with the idea of independent feature processing

▷ Possible explanation: target selection in conjunction search based on visual mechanisms tuned to more than one feature [7]

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