

# Simultaneous colour search renders other object features less salient



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## INTRODUCTION

### BACKGROUND

- Common approach to visualise multidimensional data sets:
  - map data dimensions to separate visual features (e.g., [5, 6, 8]).
  - assumption: features can be judged independently of each other.
- However, dependencies found in processing of visual features [3, 7]
- Colour tends to dominate in visual conjunction search, as found in two of our previous studies [4, 9]:

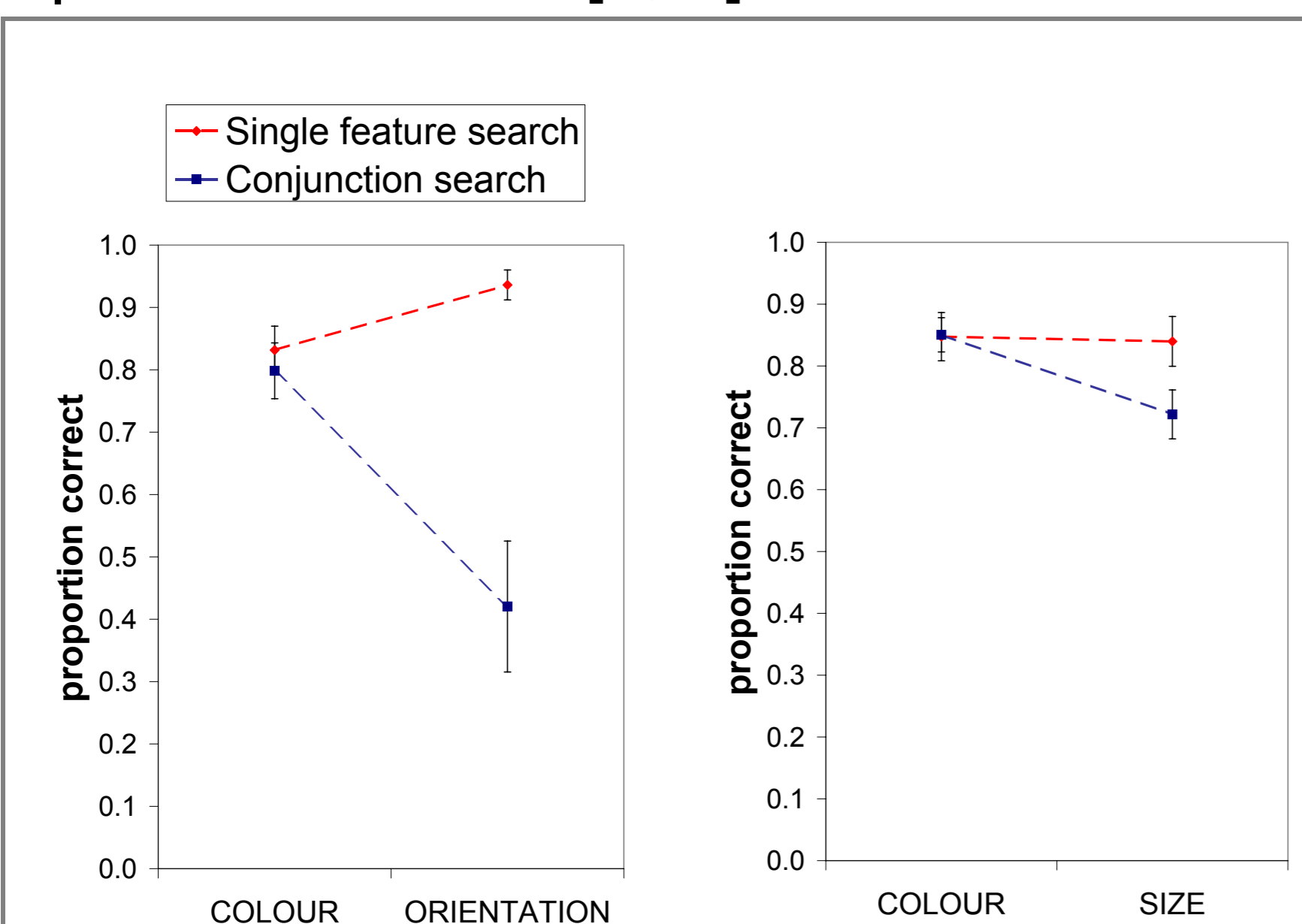


Figure 1: Colour in conjunction search reduces performance for orientation (left) and size (right)

- task: conjunction search with perceptually matched contrasts (Box 1)
- result: simultaneous colour search results in declined performance for orientation and size

- Existence of a feature hierarchy?
- If so, is it a *fixed* hierarchy?

### BOX 1. CONTRAST MATCHING

#### Previous studies

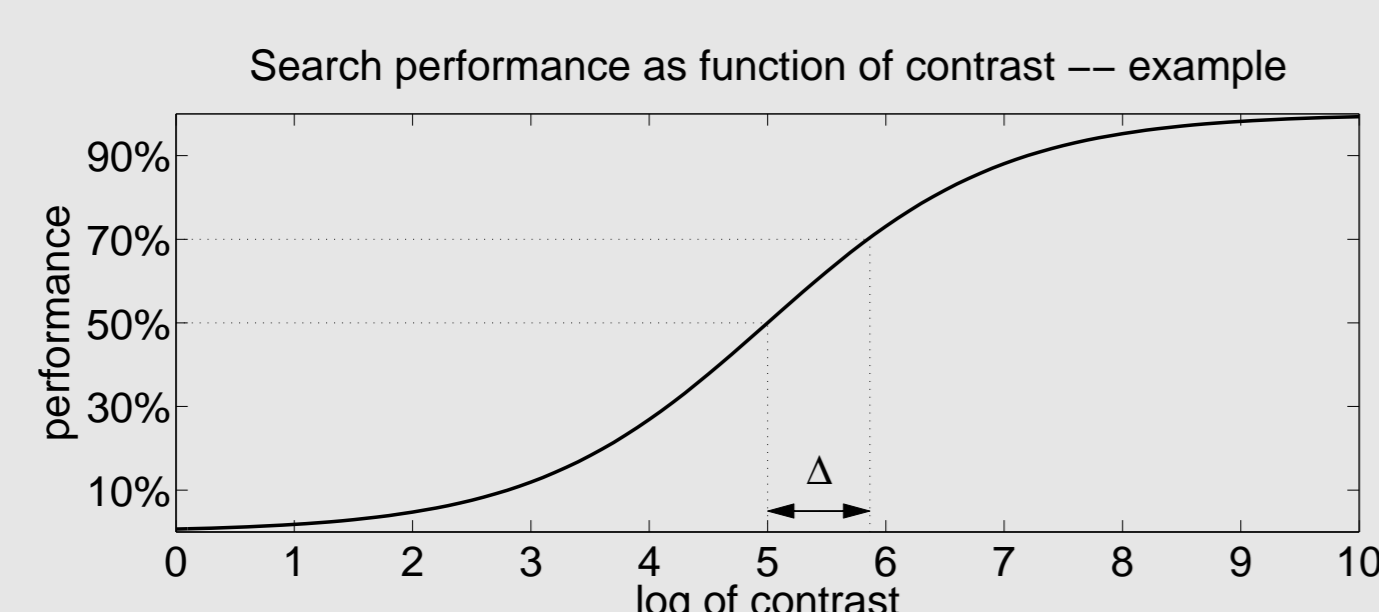
Subjects searched for a target among 12 distractors (stimulus time: 200ms). This task was carried out with 10 different target-distractor contrasts for each feature, providing a sigmoidal contrast-performance curve. Using function fits, we determined perceptually matched colour, orientation, and size contrasts.

#### Current study

Perceptually similar colour and size contrasts for the current experiment were determined by taking the difference between the 70% and 50% correct performance contrasts from the previous studies:

$$\Delta c = \text{colour\_contrast}_{70\%} - \text{colour\_contrast}_{50\%}$$

$$\Delta s = \text{size\_contrast}_{70\%} - \text{size\_contrast}_{50\%}$$



### PRESENT STUDY

- Assess existence of colour/size processing asymmetry in a simplified visualization environment
- Assess relationship between feature contrast and performance
- Approach: track subjects' eye movements during complex conjunction search tasks with varying feature contrasts

## METHODS & MATERIALS

**Subjects** Five volunteers with normal or corrected-to-normal vision

**Apparatus** P4 3.2Ghz PC, LaCie 22", Matlab 6.5, Psychophysics Toolbox [1], Eyelink Toolbox [2], Eyelink II

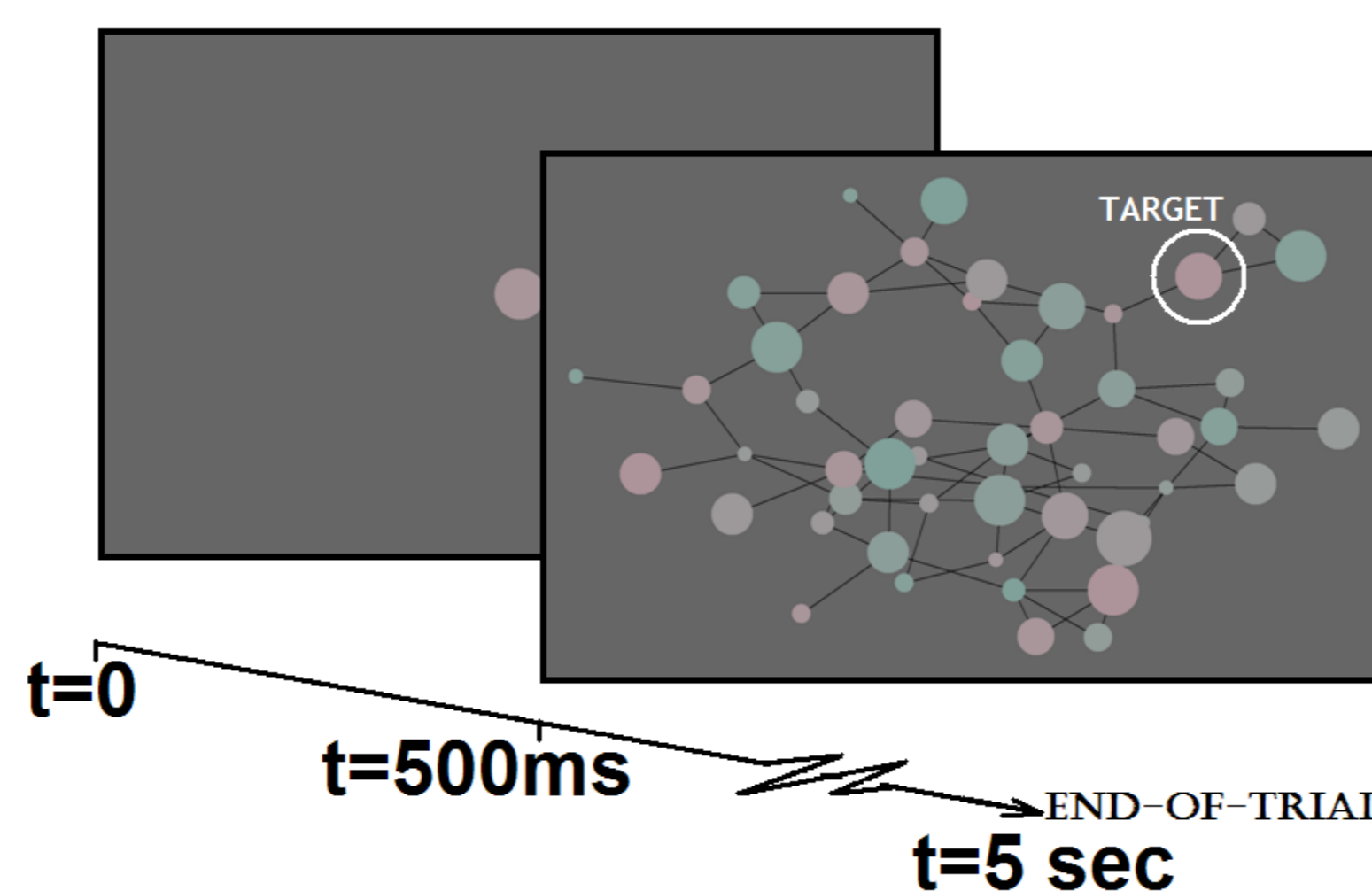


Figure 4: Experiment stimulus

**Stimuli** Cue followed by node-link diagram. All items were randomly assigned one of 10 possible colours and sizes.

**Task** Find the cued item

**Colours & sizes** The distance between every two consecutive colours was  $\Delta c \times C$  and the distance between every two consecutive sizes was  $\Delta s \times S$ , where:

$$\Delta c, \Delta s = \text{default colour and size step}$$

$$C = \text{colour step multiplication factor}$$

$$S = \text{size step multiplication factor}$$

#### Procedure

- Select perceptually similar  $\Delta c$  and  $\Delta s$  (see Box 1)

Track eye movements during:

- Single feature search (SFS), with  $C = S = 1$
- Conjunction search (CS) tasks, with  $C = 1, S = 1$   
 $C = 1, S = 1.5$   
 $C = 1, S = 2$   
 $C = \frac{1}{2}, S = 1$

## RESULTS & DISCUSSION

(Errors are computed as the number of colour/size steps between the colour/size of the target and that of the fixated node)

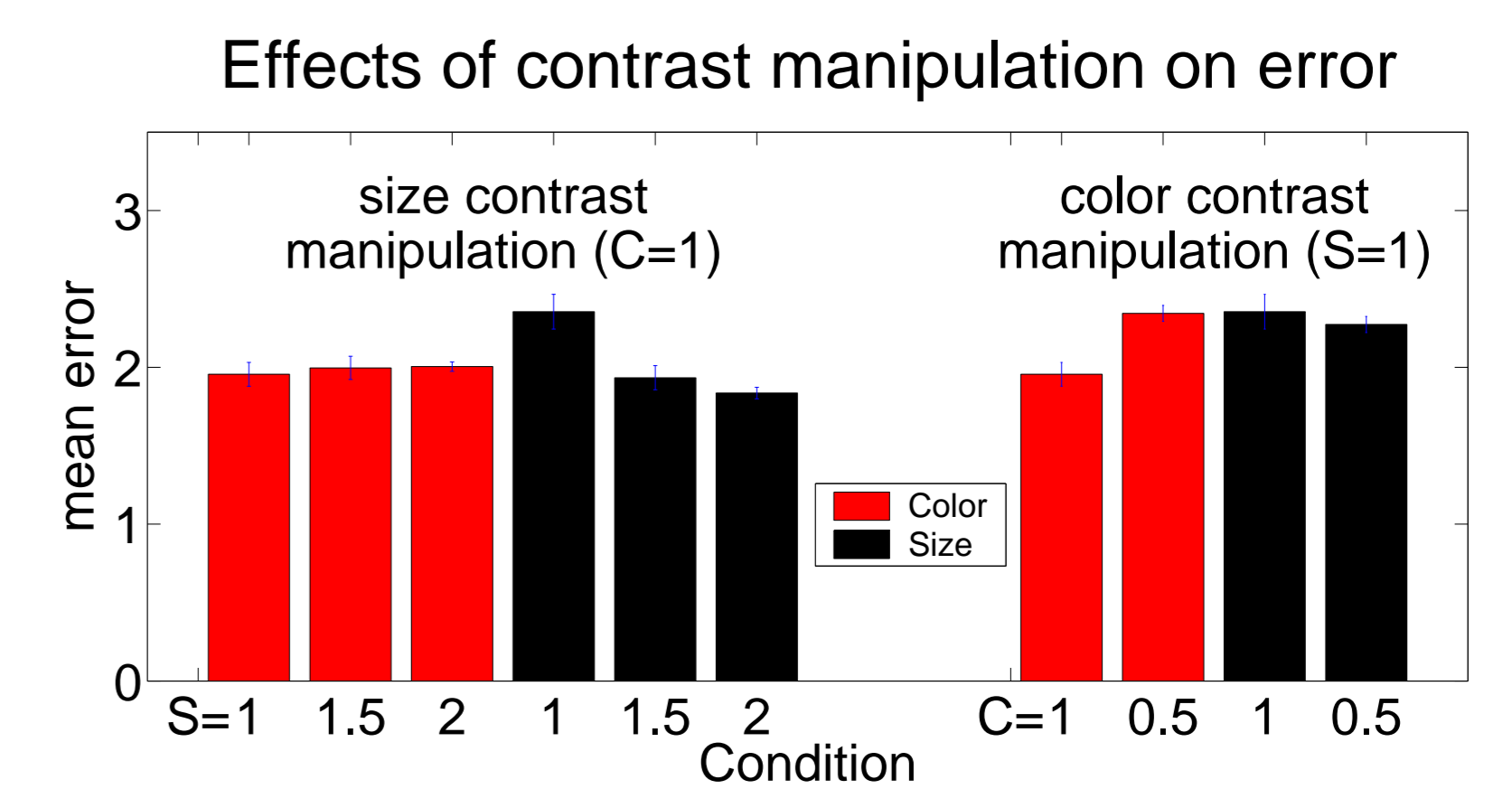


Figure 5: Mean error for different size (left) and different color (right) contrasts.

- Size contrast affects size error, but not color error
- Color contrast affects color error, but not size error

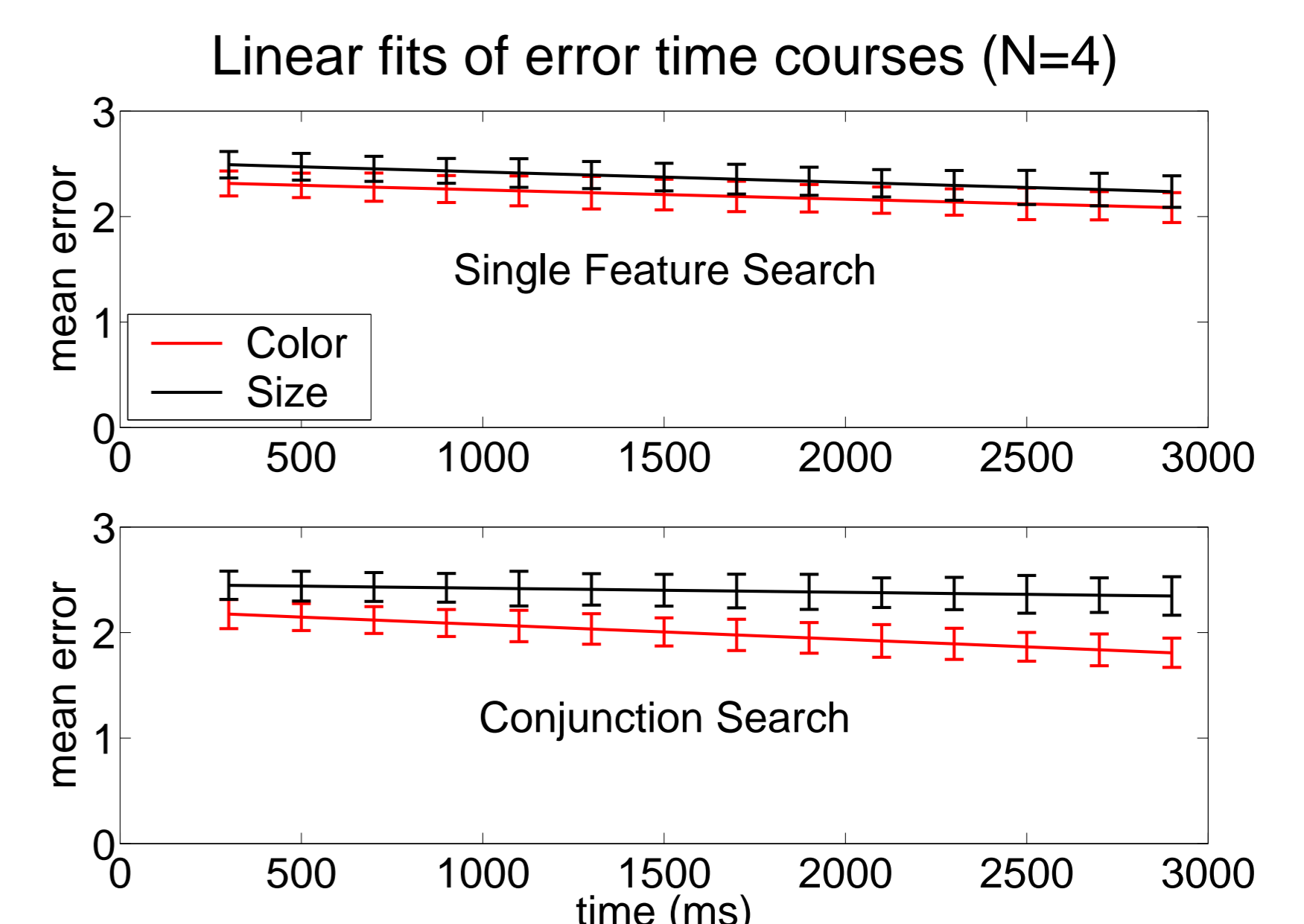


Figure 6: Time courses of colour and size error in single feature (top) and conjunction search (bottom), with  $C=S=1$ . While error is nearly the same in SFS, there is a tendency towards colour in CS.

- Earlier found tendency towards colour dominance in conjunction search also exists in a more complex search task
- It can be compensated for by manipulating feature contrasts
- Hence, feature hierarchies are not fixed and may be adapted to the requirements of a particular visualisation

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