INTRODUCTION

Cardinal models of chromatic discrimination assume that chromatic discrimination is mediated by four mechanisms lying along the cone-opponent axes. For discrimination at test locations intermediate to the cardinal axes, they predict that the discrimination ellipses at these locations are either circular or elongated along one of the cardinal axes. Previously, we presented data showing discrimination ellipses that were elongated along non-cardinal directions [1]. We also found differences between the discrimination ellipses for stimuli chromatically variegated along orthogonal directions in color space at intermediate test locations. A model with eight mechanisms provided a good fit to the data [2]. Here we investigate whether a cardinal model could predict these results by fitting various variants of a model with four and with eight mechanisms to the data.

DATA

Discrimination at the adaptation point

Discrimination away from the adaptation point

References


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MODEL

We fitted a chromatic discrimination model simultaneously to the discrimination data for the disk and the chromatically variegated stimuli averaged across subjects. Each of the M mechanisms has a preferred chromatic direction $\mu_i$ to which its sensitivity is maximal. The excitatory response $E_i$ of mechanism $i$ to an image is computed by projecting the chromatic coordinates $r_i$ and $\theta_i$ of each pixel $j$ of the image onto the mechanism. The sensitivity profile of each mechanism is determined by the tuning width $k_i$ and the sensitivity parameter $s_i$.

1. Excitatory stage

Sensitivity $S_i(\theta)$ of mechanism $i$ to chromatic direction $\theta$:

$$S_i(\theta) = s_i \left| \cos^2(\theta - \mu_i) \right|$$

The excitatory response $E_i$ of mechanism $i$ to the image is given by:

$$E_i = \sum_{j=1}^{N} r_j S_i(\theta_j)$$

2. Response function

$$R_i = g E_i$$

3. Decision variable

The decision variable $D$ is computed using the responses to the comparison image $R_C$ and the responses to the test image $R_T$. Threshold is reached when $D = 1$.

$$D = \left( \sum_{i=1}^{M} |R_i - R_i'|^2 \right)^{1/2}$$

Parameter of the complete model

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CONCLUSIONS

- A chromatic discrimination model based on the cardinal mechanisms predicted discrimination ellipses elongated along directions intermediate to the cardinal directions if the mechanisms were more narrowly tuned than given by a linear combination of cone inputs.
- The discrimination model based on the cardinal mechanisms did not predict the different discrimination ellipses at intermediate test locations for stimuli chromatically variegated along orthogonal directions in color space.
- A discrimination model assuming additional mechanisms along intermediate directions predicted different discrimination ellipses for stimuli chromatically variegated along orthogonal directions in color space without requiring narrowly tuned chromatic mechanisms.