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JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

Chromatic discrimination of textured stimuli

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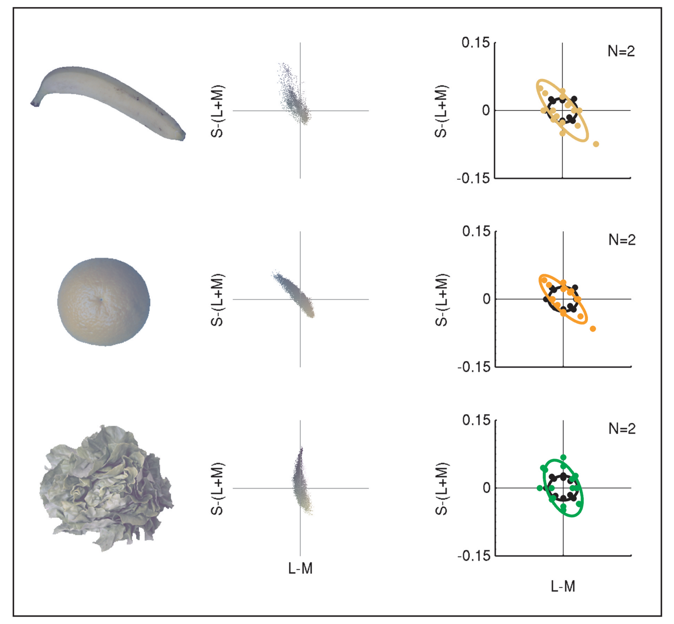
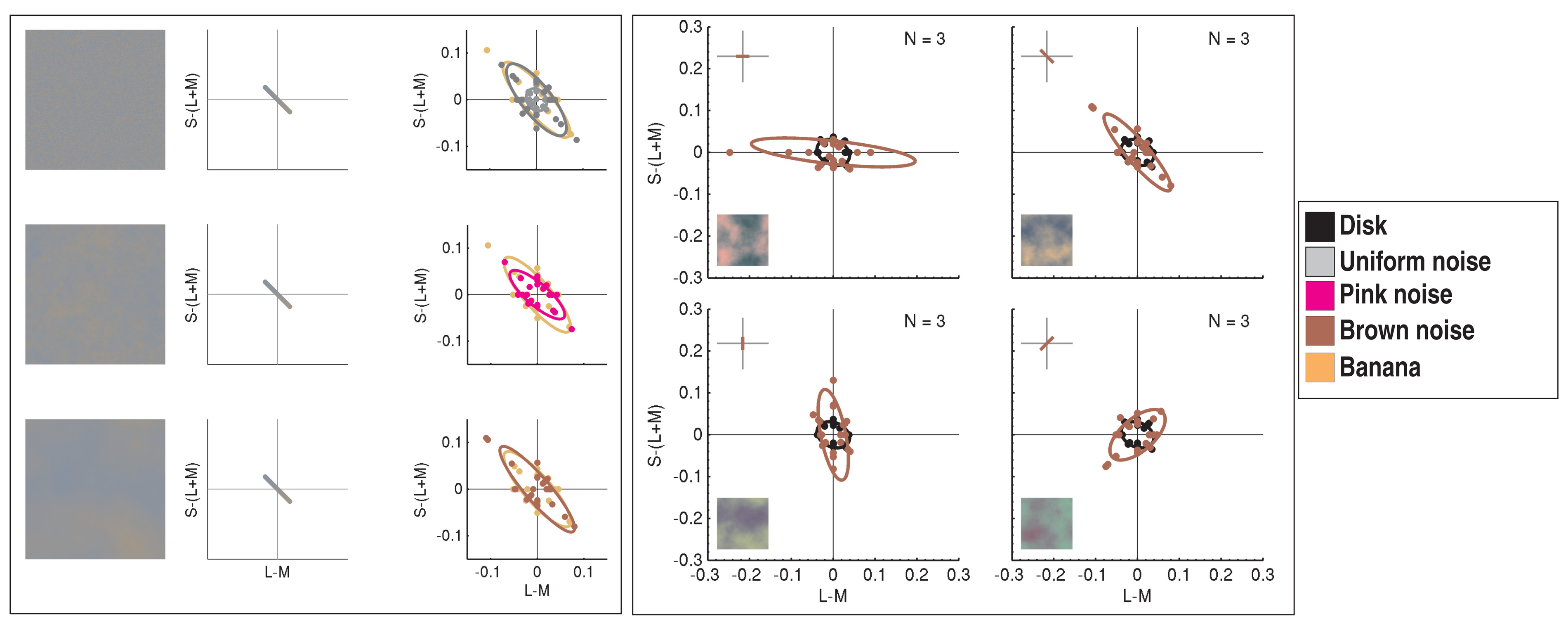
Introduction

In most of the previous studies on chromatic discrimination homogeneously colored patches were employed to assess chromatic discrimination thresholds. Since almost all objects in our environment are not characterized by a single color but have a distribution of different chromaticities we set out to investigate the influence of chromatic distributions on chromatic discrimination.

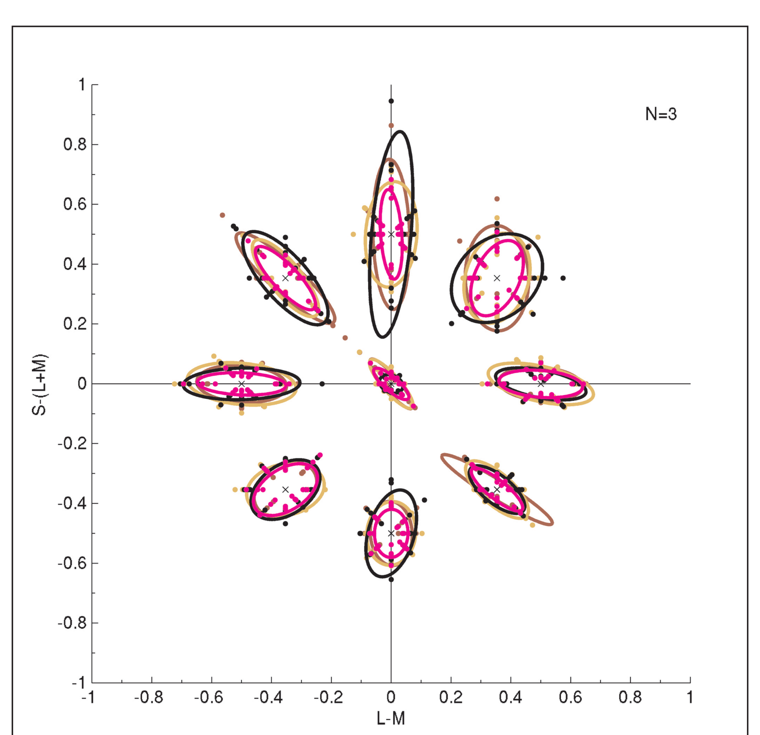
In previous studies (Hansen & Gegenfurtner, VSS 2005) we investigated chromatic discrimination thresholds for natural objects. We found that the chromatic distributions of these objects cause an elongation of discrimination contours compared to the discrimination contours of a homogeneously colored disk. The direction of this elongation approximately coincided with the direction of maximal variation of chromaticities within the stimuli. This effect only occurred when the mean chromaticity of the test stimuli was identical to the chromaticity of the background, i.e. when the test stimuli were presented at the adaptation point.



In subsequent experiments we used synthetic chromatic textures which had different chromatic distributions and different spatial frequency characteristics.



In accordance with the results for the natural objects we found a similar elongation of the discrimination contours in the direction of the chromatic distribution for the synthetic textures. This indicates that the influence of the chromatic distribution is not due to high level vision mechanisms, e.g. memory color.



Thresholds for all stimuli were lowest at the adaptation point. Thresholds increased when the test stimuli were moved away from the adaptation point. At these test locations the discrimination ellipses for the different types of stimuli were similar in elevation and elongation. Most discrimination ellipses were elongated in the direction of the shift away from the adaptation point.

Here we investigate the interplay between the effects of chromatic distributions and adaptation systematically by varying both the distance of the test stimuli from the adaptation point and the amplitude of the chromatic distribution.

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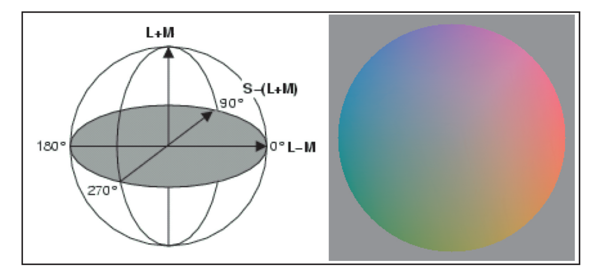
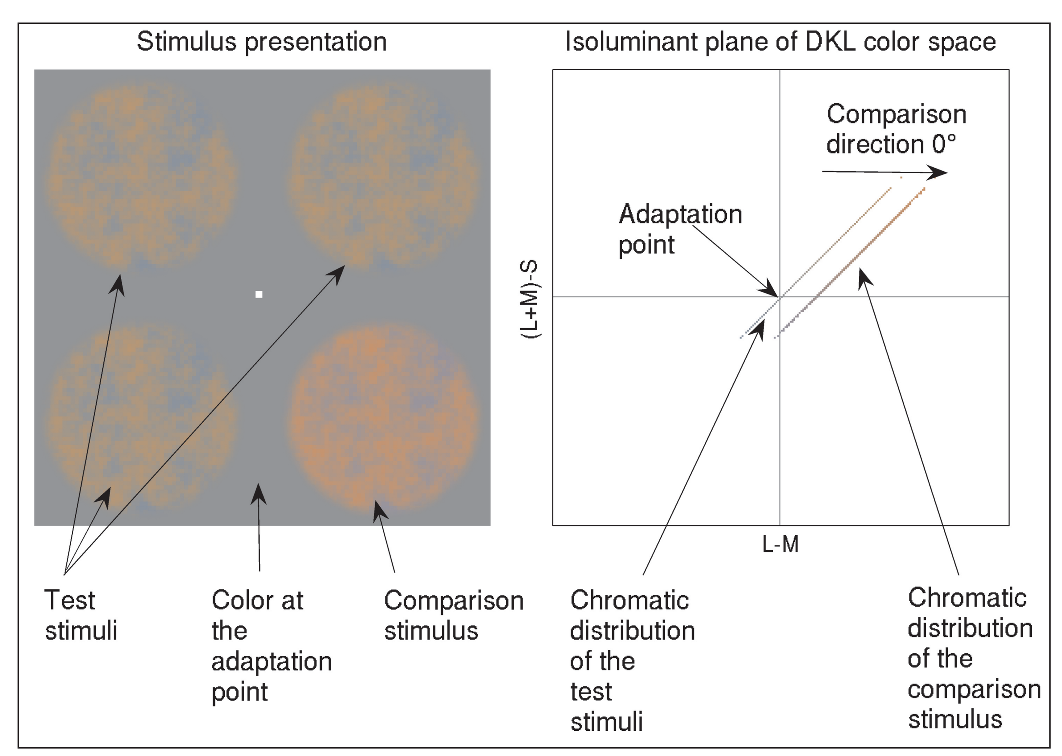
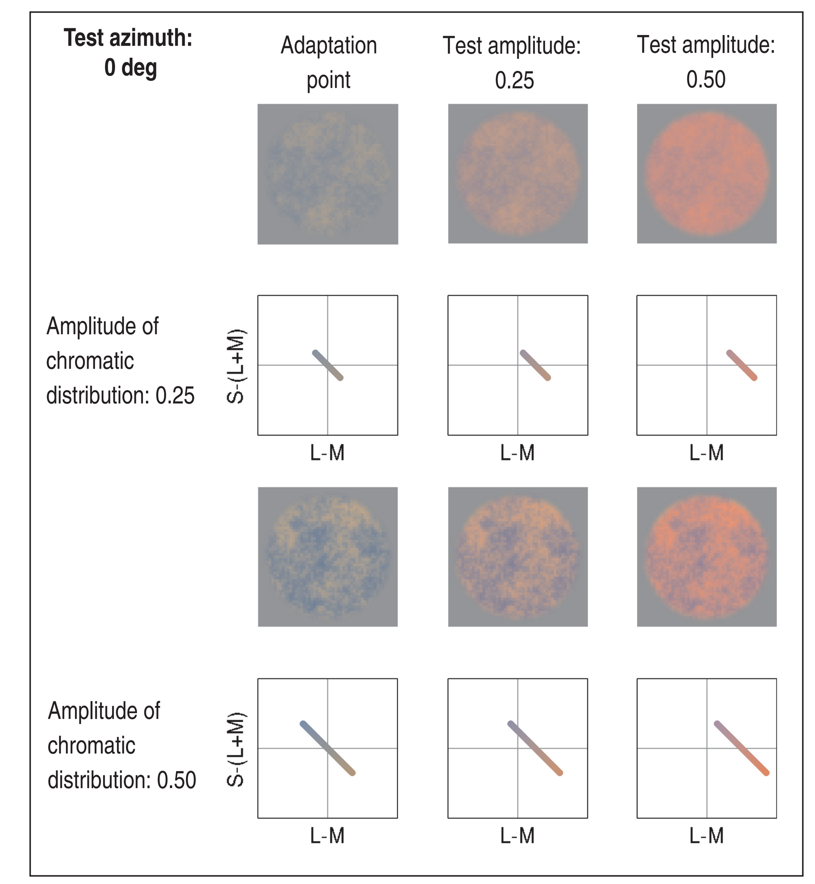
Methods

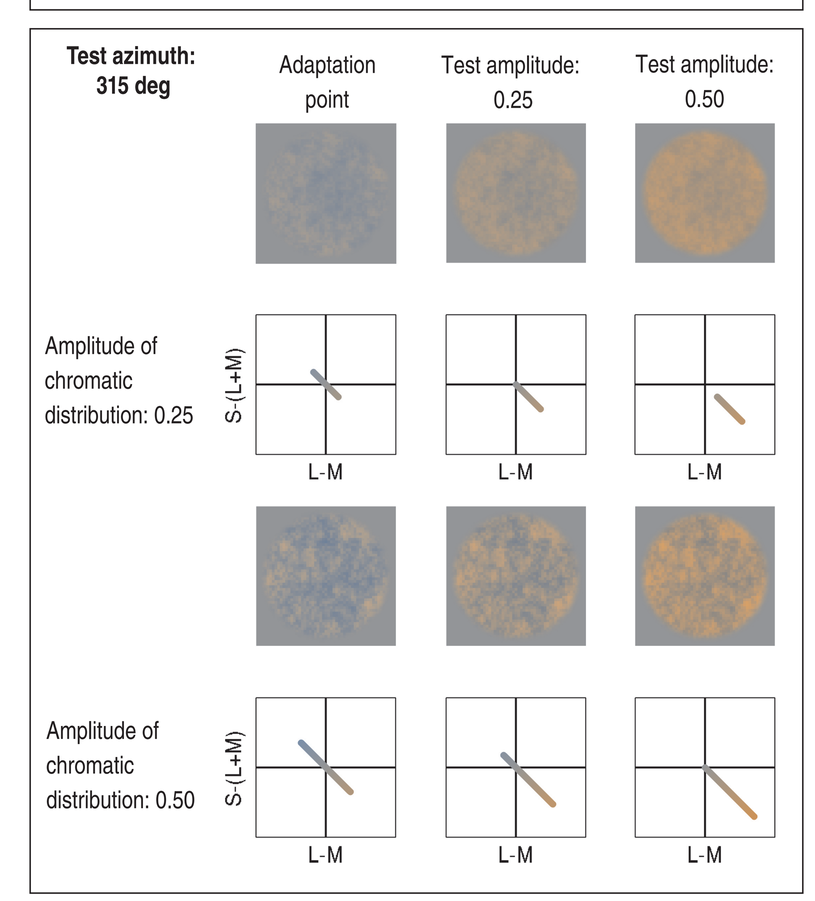
All stimuli were described in the isoluminant plane of the DKL color space which is spanned by two chromatic axes, the L−M axis and S−(L+M) axis. The axes intersect at the white point. Colors along the L−M axis vary between reddish and bluish-greenish. Along the S−(L+M) colors vary between yellow-greenish and purple. Within the isoluminant plane colors are defined by their azimuth and their amplitude. Stimuli were either homogeneously colored disks or pink noise textures. Two different chromaticity distributions were used. Both had an azimuth of 135 deg but differed in their amplitudes. One had an amplitude of 0.25, the other one had an amplitude of 0.5. Discrimination was tested at five test locations which had different distances from the adaptation point (0.05, 0.10, 0.25 and 0.50). This was done for test directions of 0 deg and 315 deg.



In a 4AFC experiment four isoluminant stimuli were presented for 500 ms in a 2-by-2 arrangement. Three of the stimuli were identical (test stimuli) while the fourth one (comparison stimulus) differed slightly in chromaticity. The observers' task was to indicate the position of the comparison stimulus. For each test color, discrimination thresholds were measured along eight different comparison directions (0, 45, 90, 135, 180, 225, 270 and 315 deg) relative to the mean chromaticity of the test stimuli. The chromaticities of the comparison stimulus were varied by a shift of the whole chromatic distribution in the comparison direction. Discrimination thresholds were measured along each of the eight comparison directions using an adaptive staircase method.





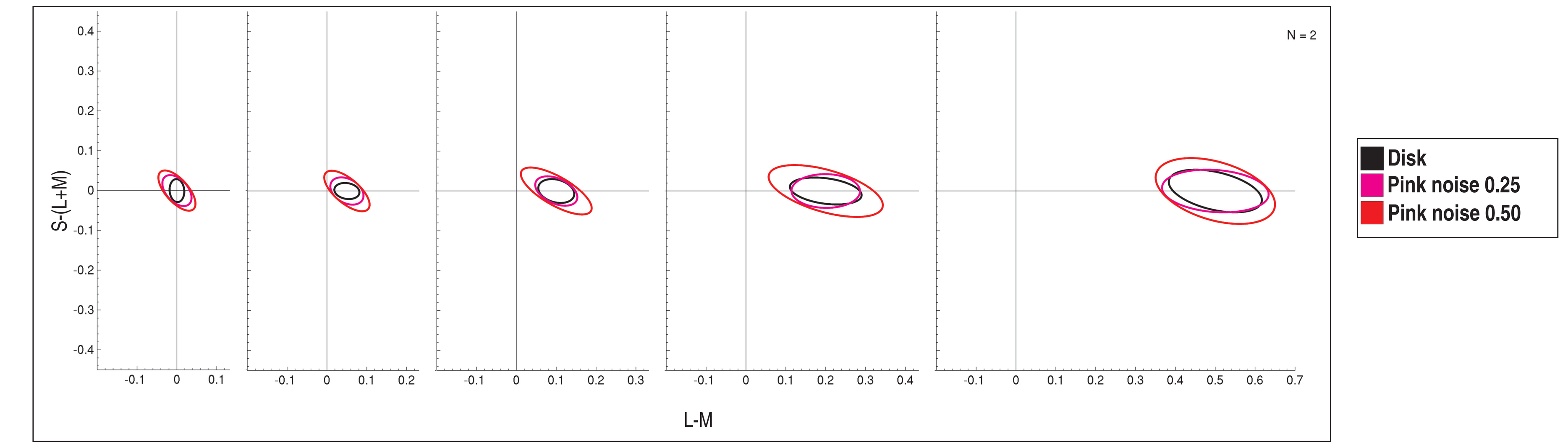


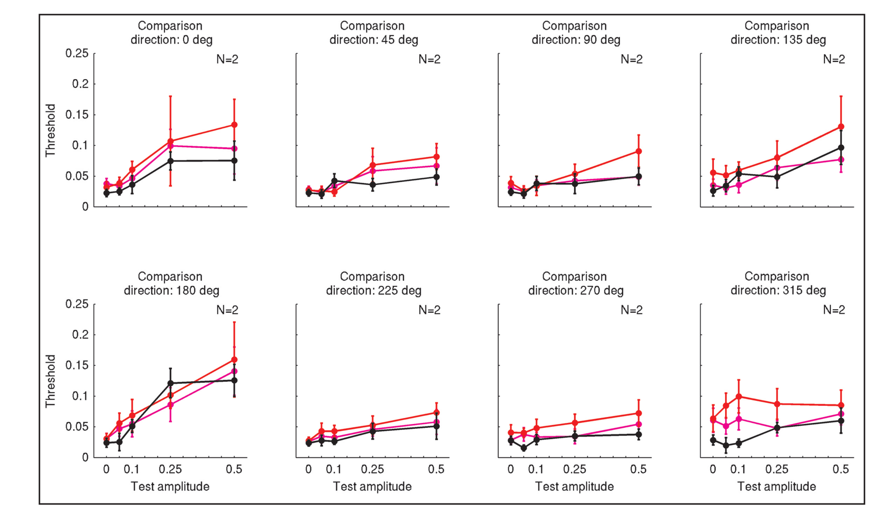
Conclusions

The shape of the discrimination ellipses is determined by the amplitude and direction of both the chromatic distribution and the shift away from the adaptation point. Increasing the distance between the adaptation point and the test color induces an additional modulation of chromaticities causing an increase in thresholds. Depending on the amplitude of the shift, these elevated thresholds outweigh the effect of the chromatic distribution. The results indicate that the effects of the shift away from the adaptation point and the effects of the chromatic distribution are additive.

Results

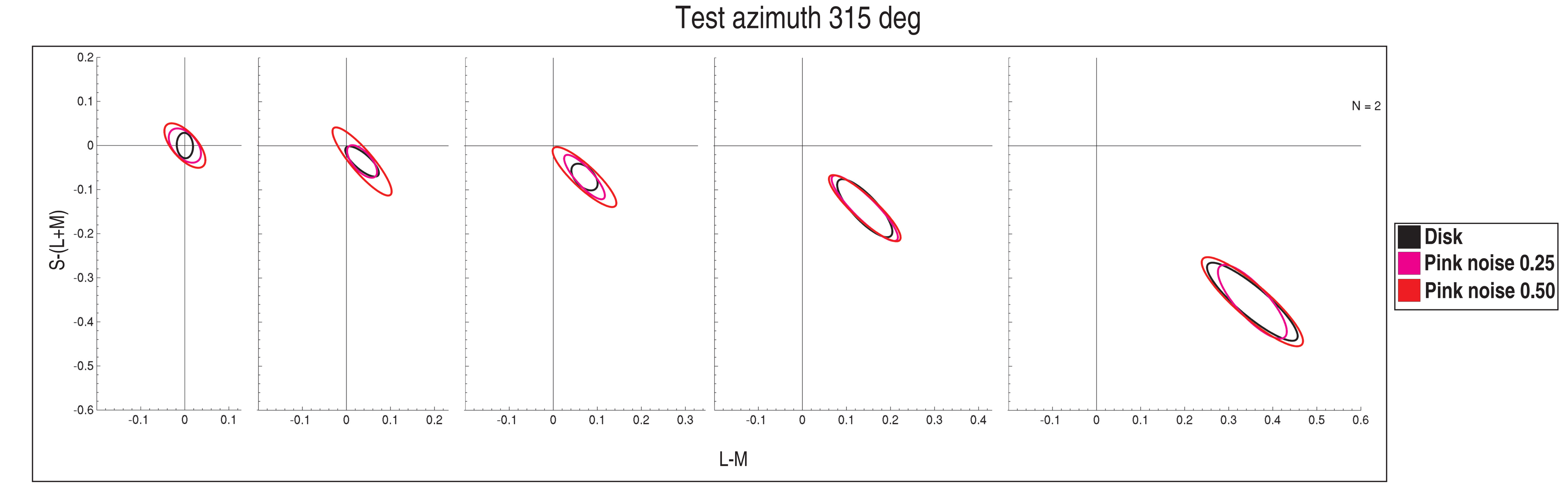
Test azimuth 0 deg

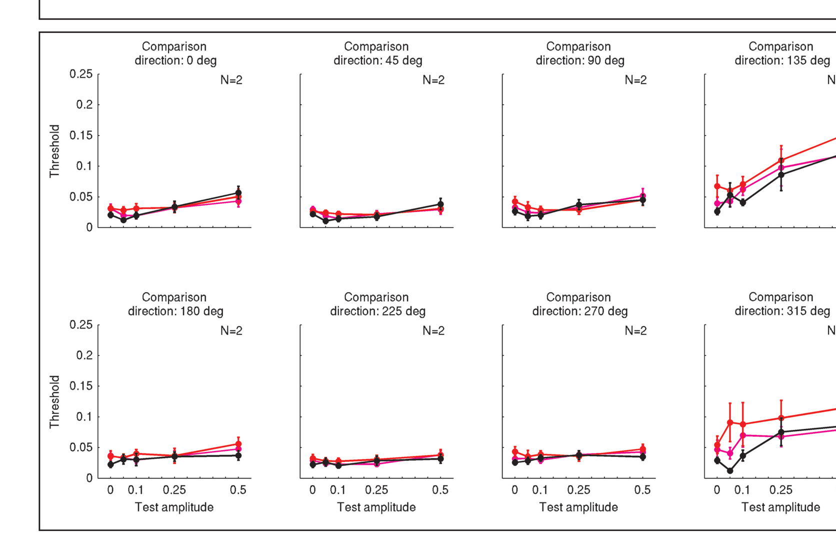




When the test stimuli were shifted into the test direction 0 deg, thresholds in the direction of the shift increased with the distance from the adaptation point. At the adaptation point the discrimination ellipses for the textured stimuli were elongated in the direction of the chromatic distribution. The elongation of the ellipses rotate towards the direction of the shift away from the adaptation point when the thresholds due the shift outweigh the effect of the chromatic distribution.

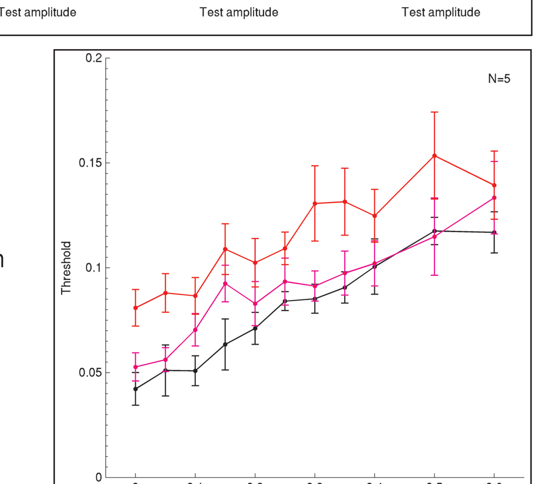
Test azimuth 315 deg





When the test stimuli were shifted in the same direction as the variation of chromaticities in the stimuli, only the thresholds in this direction increased with increasing distance from the adaptation point while the thresholds for the other comparison directions were not affected by the shift.

Average across comparison directions 135 and 315 deg



Averaging the comparison directions 135 and 315 deg (decrements and increments) results for all stimuli in an approximately linear increase in thresholds with increasing distance from the adaptation point. Thresholds for the disk were lowest, and thresholds for the texture with the larger chromatic distribution were highest. This indicates that the two noise component are additive.