# Unmasking the dichoptic mask

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**Previously, it has been shown that dichoptic color-contrast masking can be dramatically reduced by the introduction of task-irrelevant binocular features. It is unclear, however, whether or not the task-irrelevant features need to be matched in the two eyes in order to reduce dichoptic masking. We measured dichoptic masking between target and mask luminance decrement patches and between target and mask isoluminant violet patches. The stimuli were surrounded by a task-irrelevant feature that consisted of a ring of various widths: either a luminance decrement, an isoluminant violet, or an isoluminant red. When the ring was presented to just the target eye—that is, the eye opposite to that of the mask—dichoptic masking was reduced just as much as when the ring was binocular—that is, presented to both eyes. A model that incorporated the combined influence of interocular inhibition from all stimulus components—that is, mask, target, and rings—was found to give a good account of the pattern of dichoptic masking across the full range of conditions.**

## Introduction

Masking occurs when one signal—the mask—inhibits or facilitates the detection of another signal—the target. One form of masking is dichoptic masking, in which the mask is in one eye and the target in the other. When the dichoptic mask is suprathreshold it tends to elevate target thresholds to a greater degree than when the mask and target are presented together in the same eye or together in both eyes (Legge, 1979; Maehara & Goryo, 2005; Meese, Georgeson, & Baker, 2006; Kim, Gheiratmand, & Mullen, 2013; Kingdom & Wang, 2015). Dichoptic masking therefore provides important clues as to the mechanisms of binocular integration, and as the aforementioned references testify, it has been influential in the derivation of models of binocular vision.

The current study is concerned with the detection of chromatic-contrast and luminance-contrast targets under dichoptic-masking conditions, but critically in the presence of task-irrelevant binocularly matched as well as unmatched features. A recent study by Kingdom and Wang (2015) showed that the presence of task-irrelevant binocularly matched luminance-contrast patches dramatically reduced dichoptic masking between chromatic mask and chromatic target patch stimuli. Importantly, the same binocularly matched luminance-contrast patches had little or no effect on conventional chromatic masking—that is, when the chromatic mask and target patches were presented to the same eye(s). Kingdom and Wang argue that the binocularly matched luminance contrasts reduced the interocular inhibition that causes dichoptic masking. In keeping with other studies showing related effects in the *appearance* of stimuli with interocular differences in luminance contrast (Blake & Boothroyd, 1985; Meese & Hess, 2005; Baker, Meese, & Summers, 2007; Buckthought & Wilson, 2007) and chromatic contrast (Kingdom & Libenson, 2015), they proposed the "object commonality hypothesis." This hypothesis states that the presence of binocularly matched features reinforces the interpretation that features that are unmatched in the two eyes originate nevertheless from the same object (see also a somewhat related idea proposed earlier by Baker et al., 2007). Since the unmatched features originate from the same object, Kingdom and Wang argue, it was functionally prudent for the visual system to blend them rather than have them compete. According to this view it is the perceptual blending of the mask and target that reduces dichoptic masking. The object commonality hypothesis has since been invoked to explain other dichoptic vision phenomena, specifically the increase in thresholds for detecting between-eyes differences in hue resulting from

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the addition of binocularly matched luminance contrast (Jennings & Kingdom, 2016).

The question arises, however, whether it is necessary that the task-irrelevant features be matched in the two eyes in order for the reduced dichoptic masking to occur. A literal interpretation of the object commonality hypothesis suggests that they should be so matched. On the other hand, it is reasonable to suppose that the unmasking occurs primarily because the mask is inhibited by the task-irrelevant feature in the opposite eye—in other words, via "masking of the mask." Evidence from Meese and Hess (2005) is supportive: They found that a thin black mask ring in one eye surrounding a target Gabor patch in the other eye reduced the apparent contrast and detectability of the target, albeit to a lesser degree when the ring was presented to both eyes. If such a Gabor patch were to be employed as a dichoptic mask rather than target, one might suppose that its masking effect would be also reduced by a surround ring in the other eye.

The aim of the present study is to determine the relative importance of task-irrelevant monocular versus binocular features for reducing dichoptic masking, and to attempt to model any resulting differential effects. The mask and target stimuli employed here are patches of uniform luminance or chromaticity, and the task-irrelevant features rings placed around them. This protocol differs from that used by Kingdom and Wang (2015), in which the task-irrelevant luminance features were uniform patches that were spatially contiguous with the chromatic mask or target patches. Surround rings have the advantage that one can investigate the potential unmasking effect using chromaticities that are different from those of the chromatic masks and targets; if they were spatially contiguous they would simply blend to form new colors. Our working hypothesis was that as the width of the ring increased, dichoptic masking would decrease. Target thresholds were measured under a range of ring conditions, with rings to neither eye, to both eyes, to the eye containing the target, and to the eye containing the mask. The rings were defined by luminance or chromaticity, and in the latter case with either the same or different chromaticity from the mask and target patches. The mask and target patches were themselves defined by either luminance or chromaticity.

# General methods

## Observers

Four observers participated in the experiments. One was an author (BJJ) and the others were unaware of the purpose of the experiment. All observers had normal or corrected-to-normal (6/6) visual acuity and normal color vision as tested with the Ishihara Color Test (Ishihara, 1972). All experiments were conducted in accordance with the Declaration of Helsinki and the ethics board of the Research Institute of the McGill University Health Centre.

## Equipment

The stimuli were presented on a CRT Sony Multiscan Trinitron G400 monitor, driven by a ViSaGe graphics display system (CRS, Rochester, UK) hosted by a DELL Precision T1650 computer. Custom software was written to generate the stimuli and collect observer responses; this was programmed utilizing the ViSaGe Win32 application-programming interface (C language). The display was gamma corrected using a colorCAL (CRS) controlled via the vsgDesktop software. The spectral emission functions of the red (R), green (G), and blue (B) phosphors were measured using a SpectroCAL (CRS). The CIE xyY coordinates of the R, G, and B phosphors at maximum luminance outputs, in candelas per square meter, were red = (0.62, 0.34, 16.6), green = (0.28, 0.61, 55.4), and blue = (0.15, 0.07, 7.6).

The display was driven at 160 Hz and had a resolution of $800 \times 600$ pixels, giving a pixel size of $\sim 0.47 \times 0.47$ mm. Participants viewed the display through a modified eight-mirror Wheatstone stereoscope, which used four front-surfaced mirrors per eye. Viewing distance along the light path was 100 cm, hence one pixel subtended $\sim 0.027°$ of visual angle. The stereoscope allowed approximately $9.8° \times 12.4°$ of the display to be visible to each eye. Prior to the start of any data collection, the monitor was warmed up for at least 20 min in order to ensure a stable luminance output. During the experiments, observers were seated in a darkened room and their responses were recorded via a Targus AKP10CA keypad.

## Stimuli

Two types of mask-plus-target were employed: an isoluminant violet patch (i.e., an S-cone-isolating increment) and an achromatic luminance decrement patch. Target and mask subtended $\sim 1.1°$ of visual angle. The DKL color space (Derrington, Krauskopf, & Lennie, 1984) was used to define the chromaticity and luminance of the stimuli. The chromatic and luminance axes of the DKL space are defined by combinations of the activations of the long-, medium- and short-wavelength-sensitive cones (L-, M-, and S-cones, respectively), as specified by the cone fundamentals (Stockman, Sharpe, & Fach, 1999; Stockman

& Sharpe, 2000). The chromatic axes are L − M and S − (L + M), which correspond to color directions reddish-cyan and violet-lime, respectively. Chromatic contrast is given by the length of the vector along these axes from the point (0, 0, 0). The luminance axis is defined as L + M + S and corresponds to the luminance- (black–white) isolating direction. The dichoptic mask was always presented with a contrast of 0.1. The surrounding ring contrast was always set to the maximum available contrast in the display in the designated chromatic/luminance direction; in the violet (S-isolating—i.e., $\varphi_{DKL} = 90°$) ring condition the contrast was ~0.84, in the reddish (isolating L − M—i.e., $\varphi_{DKL} = 0°$) ring condition it was ~0.1, and in the luminance ring condition the contrast was −1 (relative to the midgray background)—that is, the RGB phosphors were all set to zero.

Due to individual differences in observers' luminosity efficiency functions, individual isoluminance corrections were determined for each observer (Wyszecki & Stiles, 2000). This was achieved via the use of heterochromatic flicker photometry (Walsh, 1958); observers adjusted an amount of luminance contrast in stimuli isolating L − M or S cones (spatially identical patches to the stimuli employed in the main experiments) until the perception of flicker was nullified or minimized. Ten adjustments were averaged, and the resulting mean luminance corrections were added to the chromatic stimuli to achieve perceptual isoluminance for each observer.

### Procedure and analysis

Luminance- and chromatic-detection thresholds (with and without the dichoptic mask present) were obtained using a two-alternative forced-choice procedure with the method of constant stimuli. The observers' task in all experiments was to report via a key press the position, either above or below fixation, of the target stimulus; the stimulus duration was always 400 ms. The resulting psychometric functions of proportion correct as a function of target contrast were fitted with a Weibull function using the Palamedes toolbox (Kingdom & Prins, 2010), with thresholds estimated at 0.82.

## Experiment 1: Dichoptic masking with binocular surrounding rings

Detection thresholds for chromatic and luminance targets were measured in the presence of a same-color dichoptic mask, as a function of the size of the chromatic- or luminance-defined binocular ring surround ($t$ in Figure 1c). The chromatic target was an isoluminant violet circular patch, whereas the luminance target was an increment relative to the midgray background. Three different ring conditions were used: a luminance ring and two isoluminant ones. The luminance ring was defined as a luminance decrement—that is, black—this induced a luminance increment in contrast into the target patch. Of the isoluminant rings one was violet—that is, the same hue as the chromatic target and mask—and the other reddish—that is, a different hue from the chromatic target and mask. Baseline comparison detection thresholds were obtained in the absence of the mask—that is, the isoluminant or luminance target was presented to one eye while the other eye viewed the midgray background.

For each condition, thresholds were measured for six ring thicknesses (0, 2, 4, 8, 16, and 32 pixels, corresponding to, respectively, 0°, 0.054°, 0.11°, 0.22°, 0.43°, and 0.86° of visual angle). Figure 1 illustrates four example conditions: a luminance mask in the left eye and target in the right eye (below fixation); the same luminance condition but with a thin black binocular ring; a violet target in the left eye (above fixation) and a violet mask in the right eye, both sounded by reddish

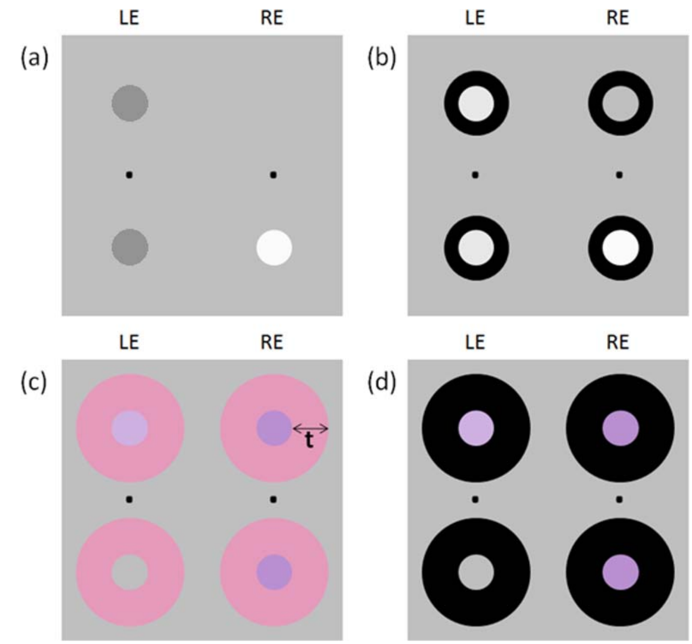


Figure 1. Stimuli used in Experiment 1. Both left-eye (LE) and right-eye (RE) stimuli of the forced-choice pair are shown. (a) Luminance decrement mask/target in the absence of a ring, with LE mask and RE target. (b) Same as (a) but with a narrow black ring. (c) RE violet mask and LE violet target surrounded by thick isoluminant reddish rings (note: Due to chromatic induction, the bottom left gray patch may appear to be colored to the reader). (d) Same as (c) but with black rings. The length of $t$ in (c) specifies ring thickness.

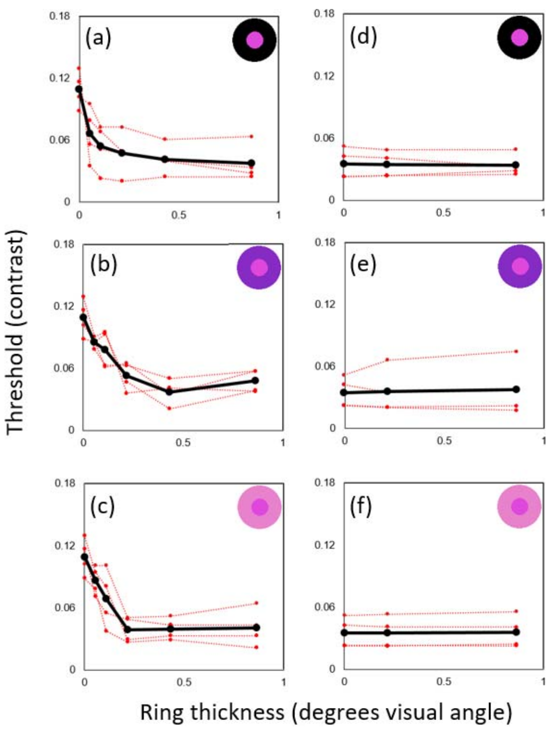


Figure 2. Results from Experiment 1. Detection thresholds as a function of binocular ring thickness for a chromatically defined target and mask. The insert in the top right corner of each panel shows the binocular rings, defined as either a luminance decrement or an isoluminant ring with a violet or reddish hue. The left-hand columns plot the dichoptic mask-present condition with a luminance ring (a), violet ring (b) and reddish ring (c). The right-hand columns the no-mask condition with a luminance ring (d), violet ring (e) and reddish ring (e). The mean data are shown in black, and the individual data in red.

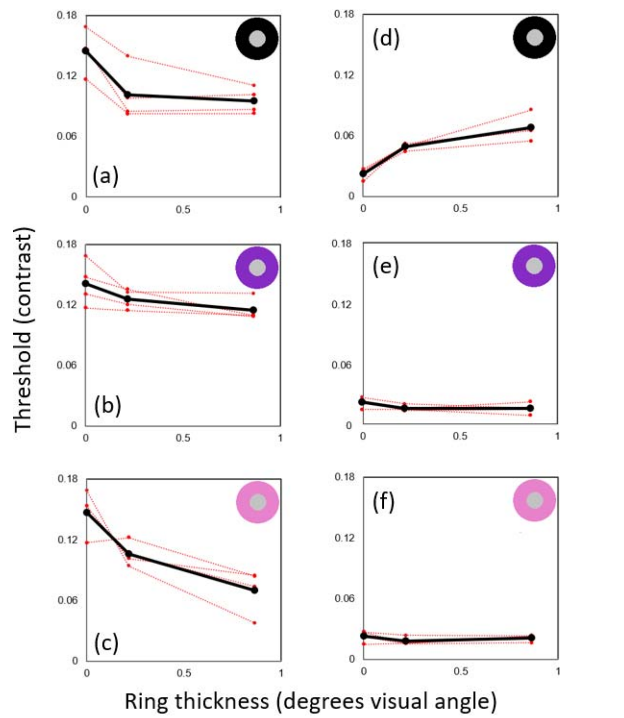


Figure 3. Results from Experiment 1. Detection thresholds as a function of binocular ring thickness for a luminance-defined target and mask. The insert in the top right corner of each panel shows the binocular rings, defined as either a luminance decrement or an isoluminant ring with a violet or reddish hue. The left-hand columns plot the dichoptic mask-present condition with a luminance ring (a), violet ring (b) and reddish ring (c). The right-hand columns the no-mask condition with a luminance ring (d), violet ring (e) and reddish ring (e). The mean data are shown in black, and the individual data in red.

binocular rings; and the same condition except with the target and mask surrounded by black rings.

## Results

Figures 2 and 3 plot thresholds as a function of ring thickness (mean data are in black, individual data are in red). Figure 2 plots the data for the detection of a chromatic violet target, while Figure 3 plots the data for a luminance target. In both figures the rows from top to bottom show rings defined by a luminance decrement; the middle and bottom rows show the two isoluminant ring conditions (violet and reddish, respectively).The left-hand columns (Figures 2a–2c and 3a–3c) show the with-mask condition, and the right-hand columns (Figures 2d–2f and 3d–3f) show the without-mask condition.

The data show that in all conditions, the effect of the dichoptic mask decreases—that is, target thresholds decrease—as a function of ring thickness. The effect is most pronounced for the violet targets. In the absence of the binocular ring (the leftmost points in the graphs), there is a significant difference between the with- and without-mask violet target thresholds, $t(3) = 15.09$, $p = 0.006$. This difference disappears once the ring reaches its maximum thickness; at this point there are no significant differences—black ring: $t(3) = 4.01$, $p = 0.24$; violet ring: $t(3) = 6.37$, $p = 0.070$; reddish ring: $t(3) = 4.26$, $p = 0.21$. For the luminance targets, the difference between with- and without-mask conditions is similarly significant in the absence of the ring, $t(3) = 6.20$, $p = 0.008$. Although the with-mask thresholds are again reduced by the ring, they nevertheless remain significantly different from the no-mask thresholds at maximum ring thickness—luminance ring: $t(3) = 7.88$, $p = 0.004$; violet ring: $t(3) = 3.64$, $p = 0.036$; reddish ring: $t(3) = 3.78$, $p = 0.032$ ($p$ values, here and throughout, are presented for multiple comparisons).

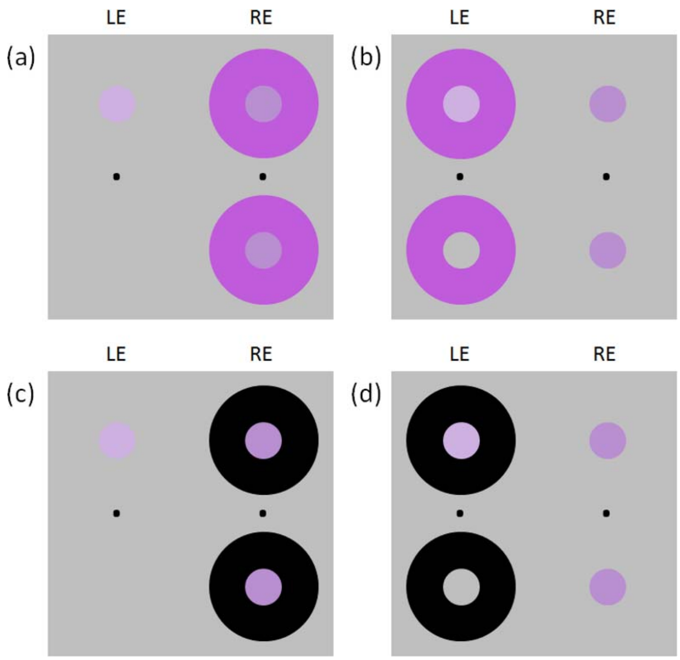


Figure 4. Experiment 2 conditions. Each panel shows the chromatic target in the top location, above fixation, presented to the left eye (LE) and the chromatic mask in the right eye (RE). (a, c) Examples of the rings, defined by either (a) chromaticity or (c) luminance, being presented in the opposite eye to the target. (b, d) Examples of the rings, defined by either (b) chromaticity or (d) luminance, being presented in the same eye to the target.

## Experiment 2: Monocular rings

Experiment 1 shows that binocularly matched surround rings reduce dichoptic masking in patch stimuli, in line with previous results using spatially contiguous binocularly matched features (Kingdom & Wang, 2015). However, the question arises whether it is the *binocular* nature of the surround rings that causes the unmasking. Therefore, we measured dichoptic masking in the presence of a monocular ring with the maximum thickness of 0.86° of visual angle (as with one of the ring conditions in the previous experiment), with violet rings surrounding violet patches, and with black rings surrounding violet patches. Figure 4 illustrates the conditions: monocular violet rings in the mask eye, monocular violet rings in the target eye, monocular black rings in the mask eye, and monocular black rings in the target eye. Note that in Figure 4 the target is shown to be present in the left eye above fixation. The experimental procedure, including the observers' task, was identical to that followed in Experiment 1.

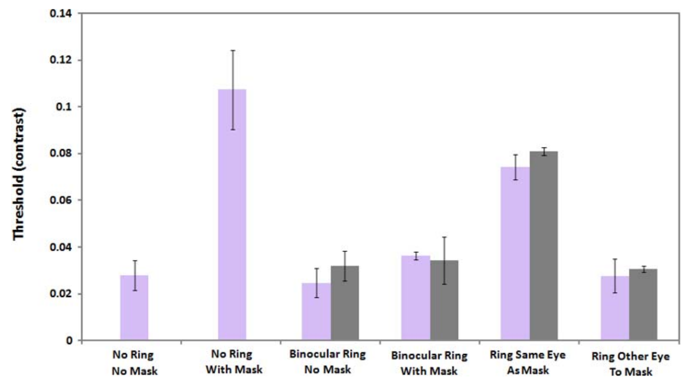


Figure 5. Mean target thresholds from Experiment 1 (first four columns/column pairs) and Experiment 2 (right two column pairs). The first two columns are the no-ring conditions; the remaining four column pairs are the with-ring conditions, with violet bars for violet rings and gray bars for black rings. The middle two columns are binocular ring conditions, and the two rightmost column pairs the monocular ring conditions. The mask is present or absent as labeled. Error bars represent ±2 standard errors.

## Results

Mean data are presented in Figure 5, along with some of the data from Experiment 1 for comparison. Note that all target patches are violet. The first four categories show conditions from Experiment 1. From left to right, the columns represent thresholds when no mask and no binocular rings were present; when the mask was present but binocular rings were absent; when the mask was absent but binocular rings were present; when both mask and binocular rings were present; when a monocular ring was present in the same eye as the mask; and when a monocular ring was present in the same eye as the target. Note that the four rightmost conditions contain two threshold values, with the violet bars representing violet rings and the gray bars black rings.

First, compare the with-mask no-ring condition to the with-mask monocular-ring conditions (second column from the left versus the two rightmost column pairs). The no-ring condition has significantly higher thresholds than both the ring-in-mask-eye and ring-in-target-eye conditions, for both the violet and luminance-decrement rings ($-8.94 < ts < -3.31$, $0.003 < ps < 0.046$). This demonstrates that even with a monocular ring the effectiveness of the mask is reduced, irrespective of whether the ring is presented to the mask or target eye.

Compare next the binocular (no-mask and with-mask) conditions to the conditions with the ring in either the same eye as the mask or the other eye (i.e., middle two column pairs compared to right two column pairs in Figure 5). Thresholds are similar ($ps < 0.05$) for all except the condition in which the monocular ring is in the same eye as the mask, where thresholds are significantly higher for both the isoluminant and luminance ring types ($ps < 0.05$). This shows that the unmasking effect of surround rings is caused also when the ring is present in the other eye to the mask.

## Model

Our proposed model has its basis in Legge and Foley's (1980) model of contrast transduction, given in Equation 1. The equation captures the idea that as contrast $C$ increases from zero, the internal response $R$ is first accelerating or expansive and then decelerating or compressive. The exponents $p$ and $q$ are typically found to lie in the range [2, 5]. The constant $Z$ determines the contrast at which the response switches from being expansive to compressive:

$$R = \frac{C^p}{C^q + Z}. \quad (1)$$

The binocular model uses Equation 1 to define separate left-eye and right-eye responses $\mathrm{LE_{resp}}$ and $\mathrm{RE_{resp}}$. These eye responses are then summed to produce the binocular response. To incorporate the effects of interocular inhibition, inputs from the opposite eye are incorporated into the denominator of each eye's equation, as in many current models of dichoptic masking (e.g., Maehara & Goryo, 2005; Meese et al., 2006; Kim et al., 2013; Kingdom & Wang, 2015), models of the appearance of dichoptic stimuli (Meese et al., 2006; Kingdom & Libenson, 2015), and models of interocular hue- and contrast-difference detection (Jennings & Kingdom, 2016). Here, the inputs from the other eye include the mask, the target, and the rings, the last of which varies in thickness. Accordingly, $\mathrm{LE_{resp}}$ and $\mathrm{RE_{resp}}$ are given by

$$\mathrm{LE_{resp}} = \frac{\mathrm{LE}^p_{\mathrm{signal}}}{\mathrm{LE}^q_{\mathrm{signal}} + \left(\mathrm{LE_{signal}} \times \mathrm{RE}^r_{\mathrm{ring}}\right) + \left(\mathrm{RE_{signal}} \times \mathrm{LE}^s_{\mathrm{ring}}\right) + Z} \quad (2a)$$

$$\mathrm{RE_{resp}} = \frac{\mathrm{RE}^p_{\mathrm{signal}}}{\mathrm{RE}^q_{\mathrm{signal}} + \left(\mathrm{RE_{signal}} \times \mathrm{LE}^r_{\mathrm{ring}}\right) + \left(\mathrm{LE_{signal}} \times \mathrm{RE}^s_{\mathrm{ring}}\right) + Z}. \quad (2b)$$

In each denominator, going from left to right, the terms represent inhibition from the same eye (corresponding to $C^q$ in Equation 1), inhibition from the rings in the same and opposite eyes, inhibition from the mask in the opposite eye, and the constant $Z$ (similar to Equation 1). The middle two terms are weighted by ring thickness ($\mathrm{LE_{ring}}$ and $\mathrm{RE_{ring}}$)—that is, $t$ in Figure 1c.

The binocular model's response is given by the sum of the responses in the two eyes plus an additional

| Experiment | $\mathrm{LE_{signal}}$ | $\mathrm{RE_{signal}}$ | $\mathrm{LE_{ring}}$ (pixels) | $\mathrm{RE_{ring}}$ (pixels) | resp($\mathrm{LE_{resp}}$, $\mathrm{RE_{resp}}$) |
|---|---|---|---|---|---|
| 1 | 0.1092 | 0.1 | 0 | 0 | 0.1090 |
| 1 | 0.0665 | 0.1 | 2 | 2 | 0.0705 |
| 1 | 0.0539 | 0.1 | 4 | 4 | 0.0602 |
| 1 | 0.0475 | 0.1 | 8 | 8 | 0.0508 |
| 1 | 0.0402 | 0.1 | 16 | 16 | 0.0425 |
| 1 | 0.0377 | 0.1 | 32 | 32 | 0.0369 |
| 1 | 0.0349 | 0 | 0 | 0 | 0.0375 |
| 1 | 0.0329 | 0 | 32 | 32 | 0.0320 |
| 2 | 0.0349 | 0 | 0 | 0 | 0.0375 |
| 2 | 0.1092 | 0.1 | 0 | 0 | 0.1090 |
| 2 | 0.0329 | 0 | 32 | 32 | 0.0320 |
| 2 | 0.0377 | 0.1 | 32 | 32 | 0.0369 |
| 2 | 0.0710 | 0.1 | 0 | 32 | 0.0660 |
| 2 | 0.0295 | 0.1 | 32 | 0 | 0.0368 |

Table 1. Model predictions based on measured data from Experiments 1 and 2.

constant $K$, thus:

$$\mathrm{resp}(\mathrm{LE_{resp}}, \mathrm{RE_{resp}}) = \mathrm{LE_{resp}} + \mathrm{RE_{resp}} + K. \quad (3)$$

When the target signal is present, the binocular response must exceed the summed response with no target present by the predicted threshold, thus

$$\mathrm{resp}(\mathrm{LE_{target}}, \mathrm{RE_{mask}}) = \mathrm{resp}(\mathrm{RE_{mask}}) + \mathrm{threshold}. \quad (4)$$

The best-fitting free parameters $p$, $q$, $r$, $s$, $Z$, and $K$ were obtained via a least-squares fitting method and found to be $p = 1.6$, $q = 1.1$, $r = 2.6$, $s = 3.6$, $Z = 0.6$, and $K = 0.03$. These fitted parameters estimated thresholds within two standard errors of the mean measured thresholds. Table 1 outlines the model's threshold estimates resp($\mathrm{LE_{resp}}$, $\mathrm{RE_{resp}}$) for each condition, along with the psychophysically measured responses for comparison. The ring thickness in our model is defined in pixels, but there is a linear relation between these values and the subtended angle: $R_d = 0.0269 \times R_p$, where $R_p$ is the ring thickness in pixels and $R_d$ is the ring thickness in degrees of visual angle.

Figure 6a plots the model predictions (green) along with the measured data (black) for the mask/target condition with black binocular ring and violet dichoptic mask from Experiment 1 shown in Figure 2a. The corresponding no-mask-condition model and data are shown in Figure 6b. Figure 6c shows the model for the no-ring and violet-ring data from Figure 5.

## Discussion

The main findings of the study are as follows:

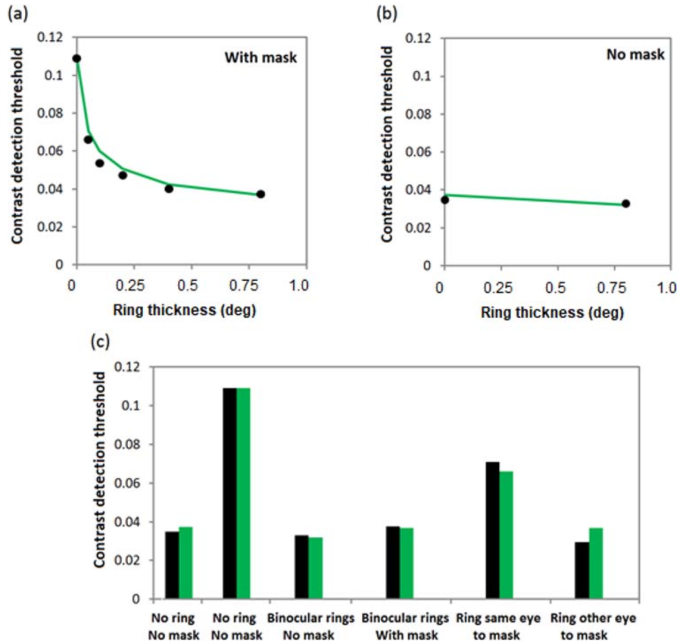


Figure 6. Model fits to the data from both experiments. Data are in black, model predictions in green. (a) Violet mask/target with black-ring data (from Figure 2 showing thresholds as a function of ring width) and (b) the corresponding no-mask condition. (c) Model predictions (green) for all the conditions presented in Figure 5 (black).

- Task-irrelevant binocular rings surrounding mask and target patches reduced dichoptic masking but had little or no effect on target-alone thresholds. A relatively narrow ring (~0.4 of the target-patch diameter) reduced target thresholds to those observed in the absence of the mask (Experiment 1).
- Chromatic- and luminance-defined (i.e., black) binocular rings unmasked both chromatic- and luminance-defined masks. However, our particular chromatic rings were less effective at unmasking dichoptic luminance masks than were luminance rings at unmasking chromatic dichoptic masks. There is hence a two-way chromaticity/luminance interaction (Experiment 1).
- When the task-irrelevant ring was monocular (Experiment 2) and present in the same eye as the mask, a small but significant reduction in dichoptic masking was observed. On the other hand, when the monocular ring was present in the opposite eye to the mask, a strong reduction in mask effectiveness was observed, reducing thresholds to the level produced by the binocular rings.

The results from Experiment 1 extend the findings of Kingdom and Wang (2015), who found that dichoptic masking was reduced with the addition of binocularly matched patches that were spatially contiguous with the mask and target stimuli. We found here that if the binocularly matched features are surround rings, dichoptic masking is similarly reduced. More important, however, are the results from Experiment 2. These revealed that the unmasking effect was not a specifically *binocular* effect; rather, it was caused primarily by the ring in the opposite eye to the mask. We were able to model the differential effects of binocular versus monocular ring unmasking by an extension of a previous model approach that dealt with the effects of binocularly matched features on a variety of dichoptic perception paradigms (Kingdom & Libenson, 2015; Kingdom & Wang, 2015; Jennings & Kingdom, 2016), an approach which was underpinned by the idea that binocularly matched features reduce interocular inhibition. As we noted in the Introduction, the results from these studies were interpreted in terms of the object commonality hypothesis, which asserts that the presence of binocularly matched features reinforces the interpretation that any unmatched features nevertheless originate from a common object. Since the unmatched features originate from a common object, it has been opined (Baker et al., 2007; Jennings & Kingdom, 2016), the visual system tends to blend the disparate features rather than have them compete via interocular inhibition. When this theory is applied to dichoptic masking, it is thus the perceptual blending of physically unmatched features that reduces dichoptic masking.

What then of the object commonality hypothesis in the light of the present findings? As we noted in the Introduction, a literal interpretation of the object commonality hypothesis suggests that the features in the two eyes must be matched in order to perceptually blend any disparate features. We must now conclude that this is incorrect: An irrelevant feature in the eye opposite to the mask produces as much unmasking as do features present in both eyes. Put another way, there does not appear to be a mechanism that reduces interocular inhibition if and only if there are matched features in the two eyes. Rather, unmasking is caused by a generic process of interocular inhibition that takes all comers, as embodied in Equations 2a and 2b.

Is there any way to reconcile the object commonality hypothesis with the present findings? One possible way is via the distinction between a functional role and a mechanism: While the object commonality hypothesis correctly characterizes the functional role played by binocularly matched features in reducing interocular inhibition, it does not characterize the mechanism by which that role is implemented. These results have, however, enabled us to determine more precisely the reasons for dichoptic unmasking from binocularly matched task-irrelevant features.

*Keywords: dichoptic mask, luminance, chromatic*

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