



# Backward masks specifically interfere with Illusory Contours or their Inducers dependent on Timing

B. Dillenburger, and C. Wehrhahn  
MPI for Biological Cybernetics, Tuebingen, Germany



## 1 Introduction

Objects in visual scenes may be only partly visible, rendering the extraction of context-induced Illusory Contours (IC) an essential process in object and scene perception.

Physiological and psychophysical studies show interaction and overlap between real and illusory processes in the first visual areas, suggesting a feedforward-feedback mechanism with the IC being developed first in V2, but fed back to V1. In such a mechanism real lines would interact early with inducers only, but later predominantly with the Illusory Contour.

Real lines are masked best by parallel real lines[2], that also interfere with Illusory Contours[5]. We thus expected strongest masks to be oriented parallel to the inducers if they interact with the inducers, but parallel to the IC if interfering with the illusory percept.

## 2 Methods

### Stimulus

We tested our hypothesis in an orientation discrimination task with an oblique abutting line pattern as inducer.

We designed the stimulus such as to minimize luminance contrast cues. The stimulus was presented in a circular window to which we applied a gaussian filter, thereby blurring the window's border. This prevented subjects from estimating illusory contour orientation by comparing real line length at both sides of the stimulus. Furthermore, contrast information was minimized by presenting inducing real lines at a low spatial frequency (real line distances >14 arcmin).

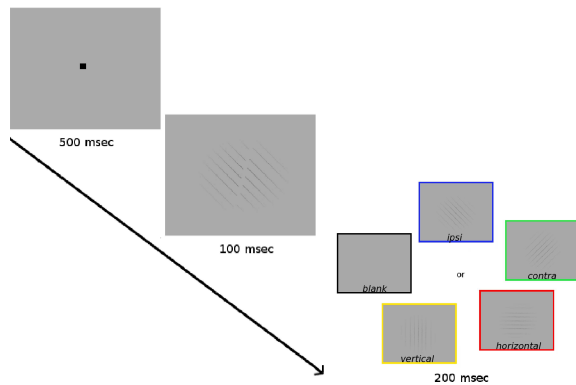


Illusory contours were either induced by directly abutting line patterns, or by line pattern separated by a gap of 4 arcmin width. Illusory contour length was 75 min of arc.

We presented backward mask pattern identical to the inducers, but oriented either the same (ipsi), horizontal, vertical, or oppositely oblique (contra).

### Experiment

Orientation discrimination thresholds for the virtual contour were measured in a 2AFC task.



The stimulus was presented for 100, 125, or 150 msec, followed by a 200 msec mask. Orientation discrimination thresholds for the IC under each masking condition were obtained and compared to an unmasked condition.

### Subjects

Five subjects between 26 and 32 years participated in this experiment. All of them had either normal or corrected to normal vision. Four of the subjects were naive as to the purpose of the experiments.

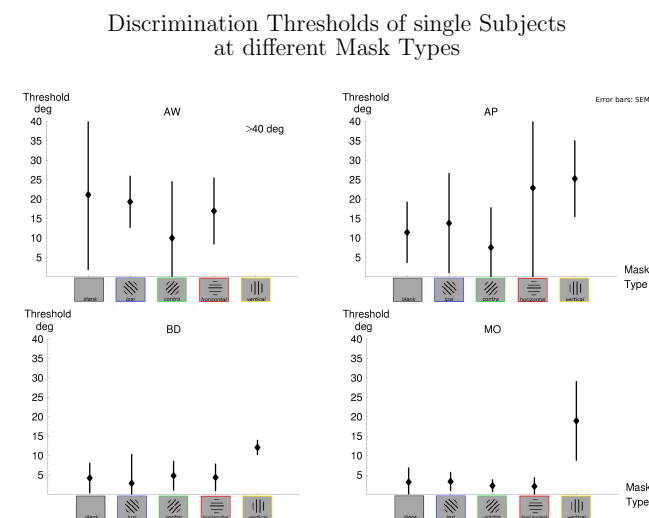
## 3 Orientation dependent Masking of Illusory Contours

### Does Masking specifically interfere with the Illusory Contour or the Inducers?

Illusory contour induction is completed after about 125 msec[5, 1, 4, 6]. We test here whether masking of completed Illusory Contours specifically interferes with the Illusory Contour (mask oriented parallel to the IC) or with the Inducers (mask oriented parallel to inducing lines).

### Individual data sets

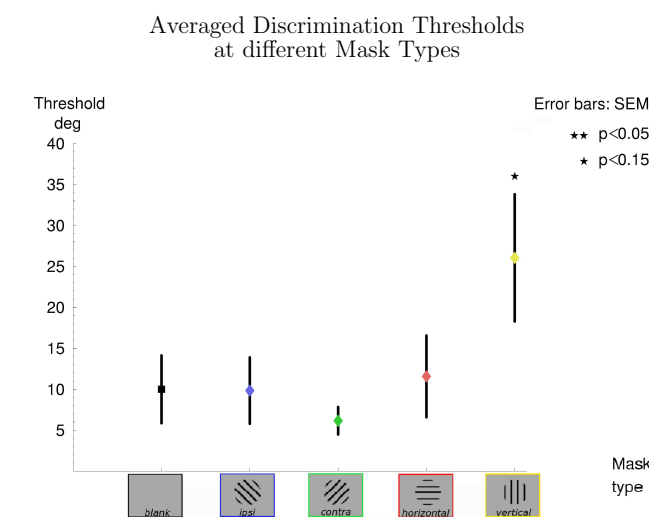
The strength of masking effects at 125 msec presentation time was measured for different mask orientations.



Individual data show high variability, but consistently reveal strong interference by real lines parallel to the illusory contour.

### Average over subjects

Discrimination thresholds of 4 subjects were averaged at each masking condition at a presentation time of 125 msec. Differences to the blank condition were assessed in a paired t-test.



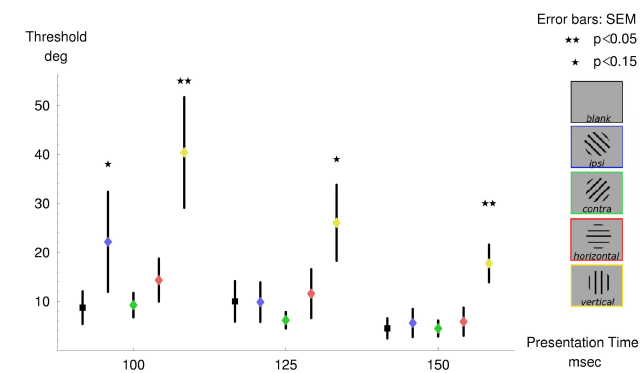
### Masking at 125 msec interferes specifically with Completed Illusory Contours

## 4 Masking changes with Processing Time

### Do Masks affect Inducers and ICs dependent on Timing?

We tested the orientation dependency of the observed interferences at different presentation times (100, 125, 150 msec) of the illusory contour. We expected early on interferences with the inducing processes (i.e. parallel to the inducing lines), but later on with the induced processes (i.e. parallel to the illusory line). Differences between blank and masking conditions at each presentation time were assessed in a paired t-test.

### Averaged Discrimination Thresholds at different Mask Types and Presentation Times

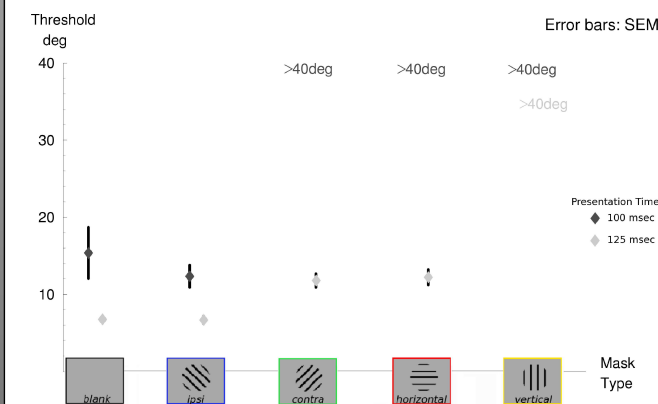


### Induced Illusory Contours are masked from early stages on Inducers are masked only early, during Illusory Contour Induction

## 5 Abutting Lines with and without Gaps behave similar

We measured orientation discrimination thresholds for illusory contour with and without gaps under the different masking conditions at presentation times 100 & 125 msec.

### Averaged Thresholds of No Gap Stimuli at different Mask Types and Presentation Times



No gap stimuli yield results similar to gap stimuli: early on (100 msec) almost every mask pattern interferes, later on only masks parallel to the illusory contour interfere strongly.

Low thresholds in the ipsi masking condition are due a motion effect between in the abutting line stimulus and the following parallel masking pattern, which leads in some subjects to a strongly enhanced percept of the illusory contour.

## 6 Summary

- Backward masking of Illusory Contours with Real Lines is orientation dependent
- Over all, interferences are strongest with Real Lines parallel to the Illusory Contour
- Orientation dependency changes over processing time
  - Early on (<125 msec) masks parallel both to the Inducers and the Illusory Contour were found to be strongest
  - Later on (>=125 msec) only masks parallel to the Illusory Contour were strongest
- Effects are the similar for Contours induced by patterns with and without gap.

## 7 Conclusions

Our results show that real lines can interfere specifically with illusory contours, not only with their inducers. This interference develops over time, with real lines also interfering with the inducing processes early on, but later on masking the illusory contour processes alone.

Previous reports showed differential masking effects depending on time[5, 4]. These effects, with Kanizsa-type stimuli, were contributed by Ringach & Shapley 1996 to local vs. global processes comparable to the inducing vs. induced processes presented here. We therefore suggest that second order contours, like illusory contours of the Kanizsa- and abutting line type, in general are processed by basic mechanisms in the early visual cortex in two steps: first, early processes inducing the illusory contour process, and second, later processes establishing the illusory contour as an independent neural representation, as already shown physiologically by Peterhans & Von der Heydt (1989[3]).

## References

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