EFFECT OF ADAPTATION TO A BRIGHT / DARK FIELD ON THE HERMANN GRID ILLUSION

EFFETTO DELL'ADATTAMENTO A UN CAMPO BIANCO O NERO SULL'ILLUSIONE DELLA GRIGLIA DI HERMANN

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INTRODUCTION

This paper deals with psychophysical research on the perceptual threshold of the Hermann grid illusion (1870). This grid was used by Baumgartner (1960), Sinderman and Piper (1965) and Spillmann (1971) to estimate the size of receptive fields in human subjects. Berbaum and Chung (1981) continued this research by varying the grid. Shepelman, Aschayeri, Baumgartner (1967) investigated neurophysiological responses of the visual cortex in the cat and showed an interaction between receptive and perceptive fields. Jung and Spillmann (1970) have explained the illusion in terms of the interaction of excitatory and inhibitory receptive fields of retinal ganglion cells. Therefore the illusion would be attenuated or eliminated by reducing the influence of the receptive fields after dark adaptation.

Wist (1976) organised a study to find out whether the Hermann grid illusion would disappear or weaken after dark adaptation and if it would return during subsequent light adaptation. He used a three-channel tachistoscope to measure the reaction time for the perception of the grey spots at the intersections of the grid presented in a channel. In a second channel a fixation point was presented and in a third channel a transilluminated adapting field. Each of the initial 20 trials was begun with the exposure of the adapting field for 9 sec. After the initial series of 20 trials, a 10 min. period of dark adaptation was begun. At its termination a second series of 20 trials was initiated but the adapting field was eliminated. At the conclusion of these 20 trials the adapting field was reintroduced for a final series of 20 trials.

Nine students served as subjects and another three served as controls: rather than dark adapting for 10 min., these controls viewed the transilluminated adapting field for 10 min. instead.

Wist found that dark adaptation significantly increased the reaction time for the perception of the spots, while light adaptation had no effect. In fact the dark adapting retina would appear to attenuate the inhibition of the ganglion cells because the illusion disappeared; as the eye recovered from dark adaptation, the illusion reappeared.

The present experiment attempts to verify the hypothesis expressed by Wist, but in a different way because we think it convenient to maintain a constancy of illumination in the different conditions of pre-adaptation to bright or to dark fields to ensure a constancy of adaptation of the receptors for the whole period of the experimental trials.

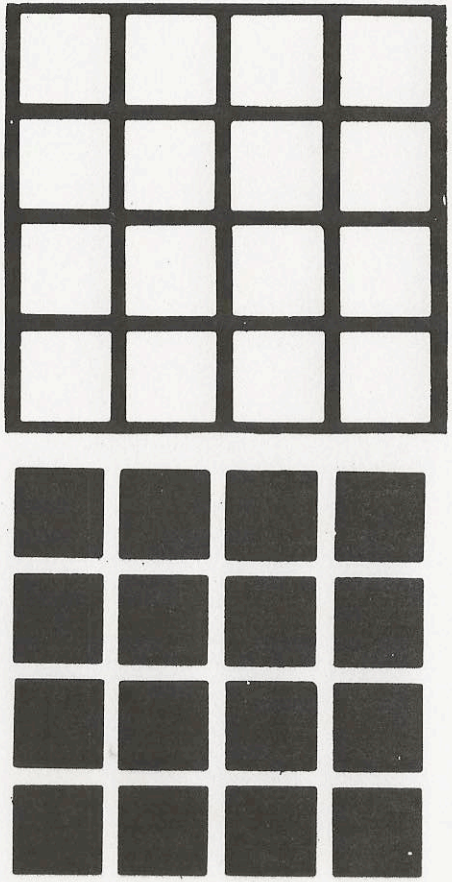
Two type of grids were therefore used, one with black squares on a white background and one with white squares on a black background. The variation of the two grids would show the latency of the responses of the receptive fields with on/off center in relation to a bright/dark field.

EXPERIMENTAL PROCEDURES, MATERIAL AND METHODS

The apparatus used was a Harward tachistoscope mod. T-313-I with three fields. The first field presented the Hermann grid, the second a dark background and the third a bright background.The illumination, identical for the three fields,was by two fluorescent bulbs per field, standard type B4 of 4 Watt 4200K W=.372 and Y=.365 in the ICI chromatic diagram. Two different grids were used as stimuli: one with black squares on a white ground (B/W), the other with white squares on a black ground (W/B).

Fig. 1: The Hermann grids

The illusion consists in the perception of grey spots at the intersections of white bars in the first stimulus situation and of white spots at intersections of the black bars in the second. Contrast of the two grids was .95.
Of course "grey" and "white" indicate only different brightness of the spots. The fields were 90 cm. away from the observer.



DISCUSSION

Luminance of the bright field was .05 Foot Lambert. The visual angle computed on inter-square distance was 1.2 arc. min. Ten subjects were used for the B/W and ten for the W/B grid. The subjects merely had to state whether they observed grey / white spots in each presentation.

The use of a classical psychophysical methodology is supported by the necessity of a more adegua te instrument to threshold determination. The method of limits was used (Guilford, 1954; Manning and Rosenstock, 1968) and the logarithmic temporal scale ranged from 10 to 450 msec. for a total of 20 values. There was an intertrial interval of 9 sec. for adaptation to either the bright or the dark field.

RESULTS

An analysis of variance for repeated measures was carried out. The factory considered were: a) type of grid (B/W or W/B; b) field of adaptation (bright or dark); c) time of exposure to stimulus (20 values). The dependent variable was the percentage of affirmative responses for every presentation.

TAB. 1: table of the ANOVA

	F	df	p
A-Type of grid	21.56	1	.001
B-Field of adaptation	164.98	1	.001
C-Length of stimulus presentation	228.54	19	.001
BC-Interaction	19.22	19	.001

The results are summarized in table 1. The following sources of variability are significant: a) type of grid: affirmative responses for W/B grid

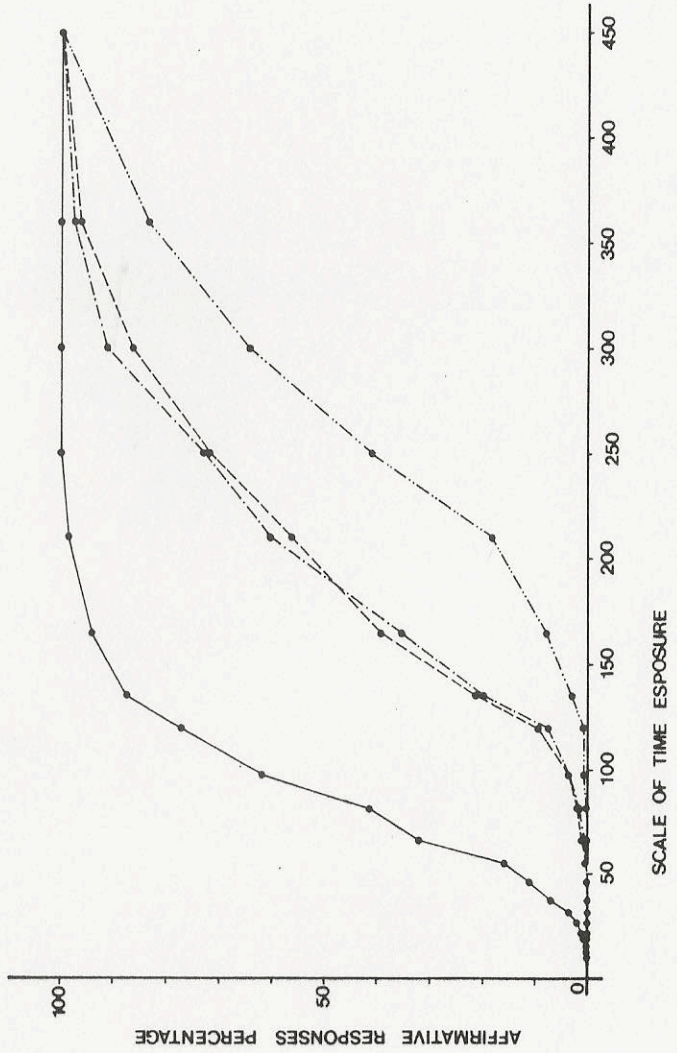
are fewer than for B/W; b) field adaptation: affirmative responses for dark field are fewer than for bright field; c) stimulus presentation time: affirmative responses differ significantly according to presentation times.

Two "t test" for correlate measures were carried out, for the B/W and W/B grids. Affirmative responses for bright field of adaptation were compared with these for dark field of adaptation. The significance ranged from 67 msec. (t_9 = 1,p< .01) to 250 msec. (t_9 = 3.05, p <.02) for the B/W grid; for the W/B grid it ranged from 120 msec. (t_9=2.50, p <.05) to 300 msec (t_9=3.37, p <.01).

DISCUSSION

The results (see fig. 2) indicate how preadaptation to a bright field elicits the Hermann grid effect more clearly than preadaptation to a dark field both for the B/W and W/B grids. Presentation of the two grids requires a longer exposure time in dark field conditions to elicit the illusion of grey/white spots at the intersections. These results fit those obtained by Wist (1976), but also utilize a different methodology (a greater number of subjects, the presentation of two types of grid and a better control of constancy of the illumination conditions). Finally the results may be interpreted and collocated among those obtained by Uttal (1973), Lavin and Costall (1978) and Troscianko (1982) about the problem whether the illusion has a retinal or a central locus. In this experiment it seems that there may be a greater influence of a peripherical mechanism than a central one.

FIG. 2: The figure shows the distribution of affirmative responses for the two types of grid utilized in different conditions of preadaptation (●——● B/W, white field of pread.; ●- - -● B/W, black field of pread.; ●- · - · -● W/B, white field of pread.; ●-·· -·· -● W/B, black filed of pread.)



Riassunto

In questa ricerca viene misurata, dopo adattamento a un campo nero o a un campo bianco, la soglia temporale di percezione delle macchie grigie e bianche alle intersezioni della griglia di Hermann, rispettivamente nelle due versioni: quadrati neri su sfondo bianco e quadrati bianchi su sfondo nero.

I risultati indicano che il preadattamento al campo nero aumenta in modo significativo il tempo di esposizione necessario per vedere l'illusione in tutte e due le griglie. Ciò è in accordo con i risultati di Wist (1976), e indica che lo adattamento alla luce della retina dovrebbe aumentare l'influenza delle cellule gangliari nella determinazione dell'effetto alle intersezioni delle griglie.

Summary

The temporal threshold for perception of grey/white spots at the intersection of the Hermann grid (black squares on a white background and white squares on a black background) was measured after bright or dark field adaptation.

It was found that dark field preadaptation significantly increased the time for display of the Hermann grid for perception of grey/white spots.

Our findings confirm Wist's results (1976) and indicate that light adaptation of the retina would appear to increase the influence of ganglion cells in determining the spot effect at the intersection of the grid.

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