Vision Res. Vol. 30, No. 8, pp. 1253–1255, 1990
Printed in Great Britain.

0042-6989/90 $3.00 + 0.00

LETTER TO THE EDITORS

APPARENT BRIGHTNESS IN COMPLEX DISPLAYS: A REPLY TO MOULDEN AND KINGDOM

QASIM ZAIDI
Department of Psychology, Columbia University, New York, NY 10027, U.S.A.

(*Received* 20 *September* 1989; *in revised form* 2 *January* 1990)

Despite 150 years of research on brightness contrast, we still lack a good general model of the effect of spatial factors on brightness perception. Consequently predictions of apparent brightness in different parts of a complex scene based on current concepts are often inaccurate. Moulden and Kingdom have attempted to give a unified account of two different phenomena of brightness induction, White's effect and grating induction. To evaluate their claims, I have undertaken to examine the nature of White's (1979) effect, and present my analysis below.

In White's effect, the mid-gray test bars that replace the dark strips of a grating apear lighter than test bars of the same mid-gray color that replace light strips. Grating induction refers to the phenomenon whereby a grating is induced in a uniform test field when it is surrounded by luminance or chromatic gratings. The claim of correspondence between White's effect and grating induction seems to be based on their similarity when the test strips are narrow (Fig. 1 in White & White, 1985). Since two phenomena that are quite different, can still be alike in some conditions, it may be more instructive to compare Fig. 1 in White (1979) to Fig. 5d in Zaidi (1989). This comparison shows that for test strips of moderate height, White's effect holds but no grating induction is apparent. If the two effects are affected differently by the same change in spatial parameters, they are unlikely to be the same. It is more probable that grating induction is mainly a manifestation of local edge effects, whereas White's effect is an example of the combined influences on a closed test patch of surrounding sectors of different shapes, sizes and colors.

Figure 1 shows how an effect similar to White's can be studied without the use of grating stimuli. In this figure two small mid-gray rectangles are bounded vertically by white bars in the top panel and by black bars in the bottom panel. The central strips are surrounded horizontally by black bars in the top panel and by white bars in the bottom panel. To most observers, the test patch in the top panel appears darker than the test patch in the bottom panel, similar to the percept in White's original figure. The difference in brightness between pairs of tests, varies as a function of the width of the central strip and the height of the test rectangles. The test patches appear lighter than if they were completely surrounded by white bars, and darker than if they were completely surrounded by black bars, indicating that the apparent induction is some weighted combination of the effects of different parts of the surround. Parenthetically, when the white and black bars are replaced by two complementary colors that are equiluminant with the gray test patches, similar effects are found for pure chromatic induction.

The induced effect in Fig. 1 seems paradoxical if only the parts of the surround that share boundaries with the test are taken into consideration. Therefore, it is important to investigate the role of other parts of the surround. In Fig. 2, two identical mid-gray test squares are surrounded horizontally and vertically by similar black bars. The parts of the surround next to but not sharing a boundary with the test are light gray in the top panel and dark gray in the bottom panel. The test square on the top appears darker than the test square on the bottom, as if the "diagonal" surrounds were inducing opposite contrast. The diagonal part of the surround also has an effect when the test patch is surrounded by both light and dark bars as in Fig. 3. However, in contrast to Fig. 2, the darker diagonals seem to induce darkness and the lighter diagonals lightness. This "assimilation" type of effect is similar to the effect of the diagonal parts of the surround in Fig. 1 and in White's figures. It seems that in a complex display, the total effect of the surround cannot be easily separated into the effects of isolated parts. There is a clear need for more quantitative investigation using such displays.

I am unable to respond to Moulden and Kingdom's claim that their model explains both grating induction and White's effect. No simulation results are provided to show that the model can mimic the percepts described in Zaidi (1989), nor is the description of the model complete enough to generate quantitative predictions for particular stimuli.

Note: The paragraphs above were written in response to Moulden and Kingdom's original letter. Since then, a new paper, Moulden and Kingdom (1989), has appeared in print. In addition, they have chosen to expand their letter. I would like to make four brief points in response to these new developments.

(1) Moulden and Kingdom (1989) point out that for high spatial frequency gratings, the magnitude of the induced grating effect decreases, but the magnitude of White's effect increases. This assertion provides additional support to the point made in the second paragraph of this communication, and weakens the central premise of their letter.

(2) Figure 1 of Moulden and Kingdom's letter successfully isolates White's effect by extracting the relevant patches from White's original stimulus. Figure 1 of this communication was created independently and demonstrates a broader generalization of the original effect.

(3) Moulden and Kingdom have had a chance to respond to my statement about the inadequacy of their explanation for grating induction. In their revised letter, they present only a verbal explanation of the effects demonstrated in Zaidi (1989). This explanation in terms of local mechanisms, will neither account for the quantitative data on distal effects presented in Fig. 4 (Zaidi, 1989), nor explain the reason why the induced percept consists of cohesive gratings for some stimuli and of light and dark patches for others.

(4) A comparison of the simulation in Fig. 2 of Moulden and Kingdom's letter with the percept evoked by Fig. 1, makes it obvious that a number of subsequent stages, including a spatial integration stage, would have to be added to their model for it to be an adequate description of White's effect.

REFERENCES

Moulden, B. & Kingdom, F. (1989). White's effect: A dual mechanism. *Vision Research*, *29*, 1245–1259.

White, M. (1979). A new effect on perceived lightness. *Perception*, *8*, 413–416.

White, M. & White, T. (1985). Counterphase lightness induction. *Vision Research*, *25*, 1331–1335.

Zaidi, Q. (1989). Local and distal factors in visual grating induction. *Vision Research*, *29*, 691–697.

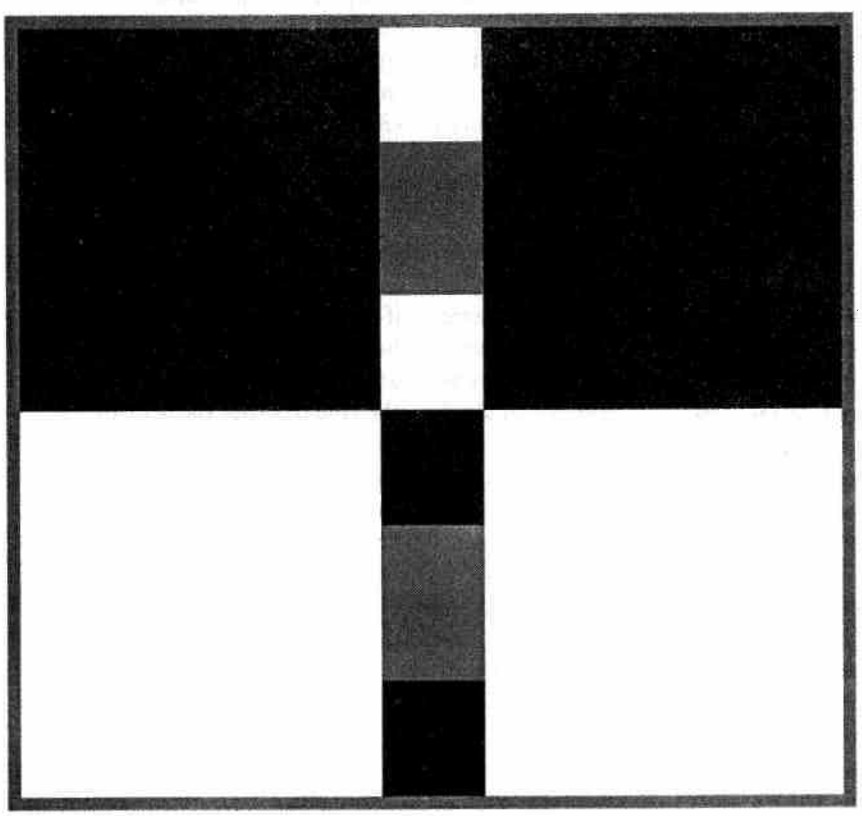

Fig. 1. White's effect with simple stimuli. The two center rectangles are the same mid-gray, but the one on the top appears darker.

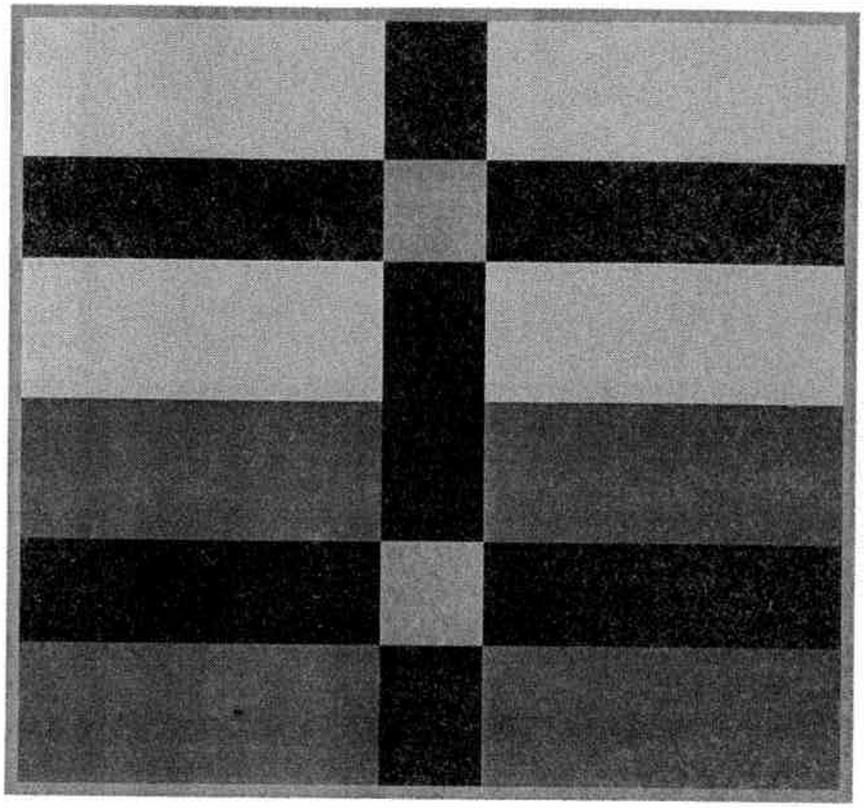

Fig. 2. Induced "contrast" from "diagonal" surrounds. The two center squares are the same mid-gray, but the one on the top appears darker.

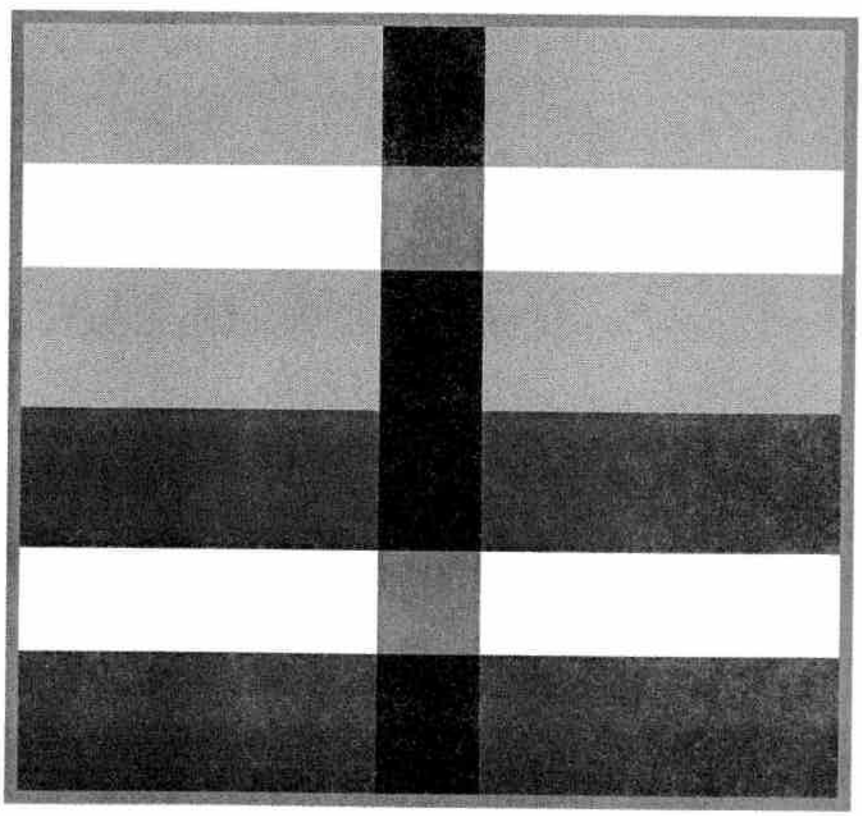

Fig. 3. "Assimilation" from "diagonal" surrounds. The two center squares are the same mid-gray, but the one on the bottom appears darker.