Vision Res. Vol. 27, No. 6, pp. 1041–1043, 1987
Printed in Great Britain.

0042-6989/87 $3.00 + 0.00

RESEARCH NOTE

SATURATION OF THE TILT AFTEREFFECT

MARK W. GREENLEE[1] and SVEIN MAGNUSSEN[2,*]

[1]Neurologische Universitätsklinik mit Abtl. für Neurophysiologie, Freiburg i. Br., F.R.G. and [2]Institute of Psychology, University of Oslo, Box 1094 Blindern, 0317 Oslo 3, Norway

(*Received* 29 *August* 1986; *in revised form* 12 *November* 1986)

Abstract—The tilt aftereffect increases as a logarithmic function of adapting time, reaches saturation after approx 1 hr and decays on a symmetric, logarithmic time-course. This is similar to the time-course of contrast threshold elevation, suggesting that threshold and suprathreshold aftereffects are based on similar type of adaptation processes.

Aftereffects Saturation Psychophysics

An economical theory of spatial aftereffects suggests that the variety of perceptual changes that result from prolonged inspection of high-contrast patterns are based on adaptation in similar or closely analogous mechanisms. Thus a common basis might be found for the orientation and spatial frequency selective elevation of contrast thresholds, the reduction of apparent contrast of suprathreshold stimuli, and the shifts in perceived spatial frequency and orientation (Braddick *et al.*, 1978). However, discrepancies between aftereffects have been occasionally noted (e.g. Magnussen and Kurtenback, 1979; Wolfe and Held, 1981; Parker, 1981; Magnussen and Johnsen, 1986), and it has been suggested that threshold and suprathreshold aftereffects have different origins (Klein *et al.*, 1974; Parker, 1981; Wolfe and O'Connell, 1986). The present note reports evidence for a unitary mechanism.

In a recent experiment (Magnussen and Greenlee, 1985) we measured the growth of the threshold elevation aftereffect well beyond the saturation point during a 3 hr adapting session, and tracked its subsequent decay. We have conducted a similar experiment on the tilt aftereffect, and are now able to compare the time-courses of the complete growth and recovery from continuous adaptation routines for these two aftereffects.

The tachistoscopic arrangement for measuring the tilt aftereffect has been described in several previous papers, most recently by Magnussen and Johnsen (1986). The adapting and test patterns, shown in a scaled-down representation in inset to Fig. 1, were black lines presented on an approx 70 cd/m^2 background with a line/background contrast of approx. 0.9. Changes in perceived orientation were measured by setting the orientation of a micrometer-controlled comparison line C to match a physically vertical test line T, and the tilt aftereffect is the difference between the mean settings before and after adapting to a 12 deg clockwise tilted adapting line A. The test pattern was presented in 1.0 sec exposures, interleaved with either 1.5 sec blanks (for baseline measurements and testing during the decay phase) or 10 sec readaptation periods (for testing during the build-up phase). During adaptation the subject scanned a horizontal fixation bar to avoid afterimages. He was comfortably seated with his head supported by a chin- and forehead rest.

The main experimental session was modelled after Magnussen and Greenlee (1985): after completing 10 baseline settings, the subject initiated a 2–2 $\frac{1}{2}$ hr session of continuous adaptation, interrupted by tests of aftereffect size at 10–30 min intervals. The first readings were collected after 10 min (for S.M.) or 20 min (for M.W.G.), and adaptation was terminated when similar values turned up in three subsequent tests separated by 30 min of continuous adaptation. Five settings were made on each test. During the decay the subject made settings as quickly as possible during the first few minutes and was thereafter tested at regular intervals until the approximate baseline values returned.

*To whom correspondence should be addressed.

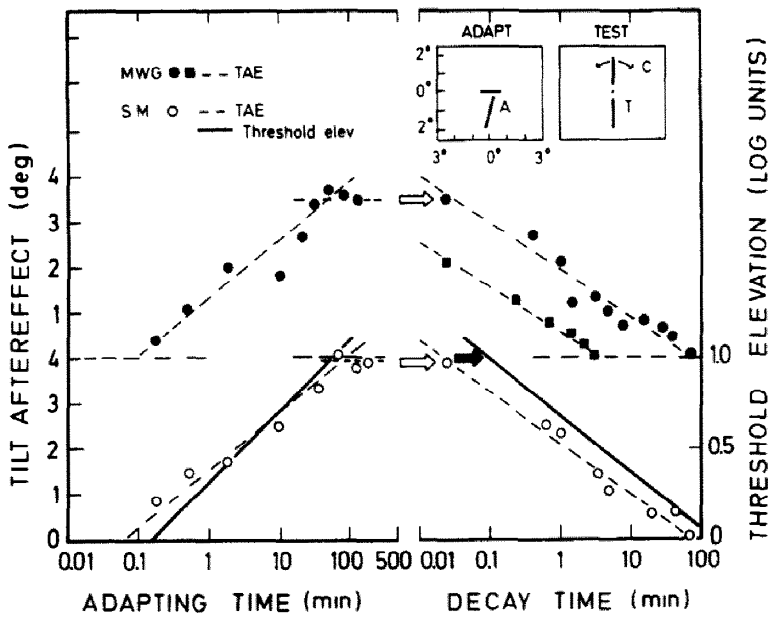

Fig. 1. (a) The build-up of the tilt aftereffect as a function of adapting time. (b) Time course of the aftereffect decay; $n > 5$ except during the early decay phase where data points represent one or two settings only. Squares show decay following 2 min adaptation for M.W.G. Solid regressions lines represent the growth and decay of the threshold elevation aftereffect, reproduced from Magnussen and Greenlee (1985), with the relevant magnitude scale indicated on right ordinate. Inset shows a scaled-down representation of the adapting and test patterns; A—adapting line, C—comparison line; T—test line.

Tilt aftereffects for adaptation times shorter than 10 min (20 min for M.W.G.) were determined in separate sessions; the 10 and 30 sec adapting time results are based on a series of repeated runs with a single exposure of the test pattern.

Figure 1 shows on logarithmic time axes (a) growth and (b) decay of the tilt aftereffect. The results reproduce the main features of the previous marathon experiment on contrast threshold elevation (Magnussen and Greenlee, 1985): first, saturation, as defined by the intercept between the regression lines fitted to Fig. 1(a), occurred after approximately 1 hr adaptation for both subjects. Second, growth and decay prove to be fairly symmetric processes. The settings returned to the baseline values after about 1 hr; There is no evidence in our data for the long-term tilt aftereffect reported by Wolfe and O'Connell (1986) for much shorter adapting times. The most likely explanation for this discrepancy is the differences in adaptation routines: In Wolfe and O'Connell's experiment 3-sec adapting exposures were interleaved with approximate 1-sec test intervals during the complete build-up phase, and there is evidence from other studies suggesting that certain schedules of interrupted adaptation might be more powerful induction procedures (Jameson *et al.*, 1979; Rose and Lowe, 1982; Magnussen and Johnsen, 1986). Third, as reported in several papers (Björklund and Magnussen, 1981; Magnussen and Greenlee, 1985, 1986; Magnussen and Johnsen, 1986) the slope of the decay is independent of adapting time, which implies that adaptation beyond the saturation point does not affect the course of the aftereffect decay.

As S.M. served in both experiments we can compare the time courses of the threshold elevation and tilt aftereffects directly, and in Fig. 1 (lower panel) the regression lines fitted to the contrast threshold elevation data for this subject are reproduced from Magnussen and Greenlee (1985). Considering the differences in stimulus patterns and test exposures in the two experiments (large field gratings vs single lines; 5 vs 1.5 sec test duration) the agreement is remarkable. The present note is thus consistent with the idea that threshold and suprathreshold simple spatial aftereffects are based on similar types of adaptation processes.

Acknowledgements—Supported by Deutsche Forschungsgemeinschaft (SFB 325), the Norwegian Research Council for Science and the Humanities. M.W.G.'s visit to Oslo was sponsored by the Norwegian Telecommunication Research Laboratories.

REFERENCES

Björklund R. A. and Magnussen S. (1981) A study of the interocular transfer of spatial adaptation. *Perception* **10**, 511–518.

Braddick O., Campbell F. W. and Atkinson J. (1978) Channels in vision: Basic aspects. In *Handbook of Sensory Physiology* (Edited by Held R., Leibowitz H. W. and Teuber H.-L.), Vol. VIII, pp. 3–38. Springer, Berlin.

Jameson D., Hurvich L. M. and Varner F. D. (1979) Receptoral and postreceptoral visual processes in recovery from chromatic adaptation. *Proc. natn. Acad. Sci. U.S.A.* **76**, 3034–3038.

Klein S., Stromeyer C. F. III and Ganz L. (1974) The simultaneous spatial frequency shift. A dissociation between the detection and perception of gratings. *Vision Res.* **14**, 1421–1432.

Magnussen S. and Greenlee M. W. (1985) Marathon adaptation to spatial contrast: saturation in sight. *Vision Res.* **25**, 1409–1411.

Magnussen S. and Greenlee M. W. (1986) Contrast threshold elevation following continuous and interrupted adaptation. *Vision Res.* **26**, 673–675.

Magnussen S. and Johnsen T. (1986) Temporal aspects of spatial adaptation. A study of the tilt aftereffect. *Vision Res.* **26**, 661–672.

Magnussen S. and Kurtenbach W. (1979) A test for contrast polarity selectivity in the tilt aftereffect. *Perception* **8**, 523–528.

Parker A. (1981) Shifts in perceived periodicity induced by temporal modulation and their influence on the spatial frequency tuning of two aftereffects. *Vision Res.* **21**, 1739–1747.

Wolfe J. and Held R. (1981) A purely binocular mechanism in human vision. *Vision Res.* **21**, 1755–1759.

Wolfe J. M. and O'Connell K. M. (1986) Fatigue and structural change: Two consequences of visual pattern adaptation. *Invest. Ophthal. visual Sci.* **27**, 538–543.