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# Notes and Comment

## Tilt aftereffect with small adapting angles

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Carpenter and Blakemore (1973) described a model for increasing the orientation tuning of units in the visual cortex. The model assumes that detectors integrate direct input with inhibitory input from neighboring units tuned to different orientations. The distributions of excitatory and inhibitory input are assumed to be Gaussian, and wider and weaker for inhibition than for excitation, so that combining the two inputs yields a "sombrero"-shaped sensitivity profile in the orientation domain. There is physiological evidence for the model (Blakemore & Tobin, 1972; Nelson & Frost, 1978).

This model provides a simple and elegant explanation of the psychophysical phenomenon *orientation contrast* (or the tilt illusion), wherein acute angles are perceptually expanded: When two line stimuli of nearby orientations (10-30 deg apart) are presented simultaneously, their excitatory and inhibitory influences sum so that the distribution of net excitation in the population of orientation detectors is skewed, with peaks shifted to orientations slightly farther apart (Carpenter & Blakemore, 1973). However, the model not only predicts angle expansion at moderate angles. A further implication is that, at very small angles, an inverse effect, angle *contraction*, should be created (O'Toole & Wenderoth, 1977). Unfortunately, this prediction is difficult to test directly because stimulus lines tend to amalgamate at very small angles. But there may be indirect routes: Blakemore, Carpenter, and Georgeson (1971) suggested that the mechanism underlying orientation contrast is also responsible for the well-known tilt aftereffect; specifically, they proposed that it is an aftereffect of lateral inhibition between cortical orientation detectors. The hypothesis is supported by recent experiments (Magnussen & Kurtenbach, 1980a, 1980b), and this led us to look more closely at the tilt aftereffect with small adapting angles.

Method and procedure have been described in detail by Magnussen and Kurtenbach (1980b). The stimuli (Figure 1, inset) were black lines, 1.3 deg long, viewed binocularly in a modified tachistoscope (Scientific Prototype, Model N-1000). Background luminance was approximately 130 cd/m². The subject's task was to set a variable micrometer-controlled comparison line (C) parallel to the apparent orientation of an objectively vertical test line (T). To generate an aftereffect, the subject viewed an adapting line (A) for 5 min, moving his eyes along a horizontal fixation bar to avoid retinal afterimages. After this initial adaptation period, 1.5-sec presentations of the test pattern were cycled with a 10-sec readaptation period until at least five settings were made. Before adapting to each new orientation, five parallel settings of T and C were made, and the aftereffect was defined by the difference between the pre- and postadaptation settings of C. The following adapt-

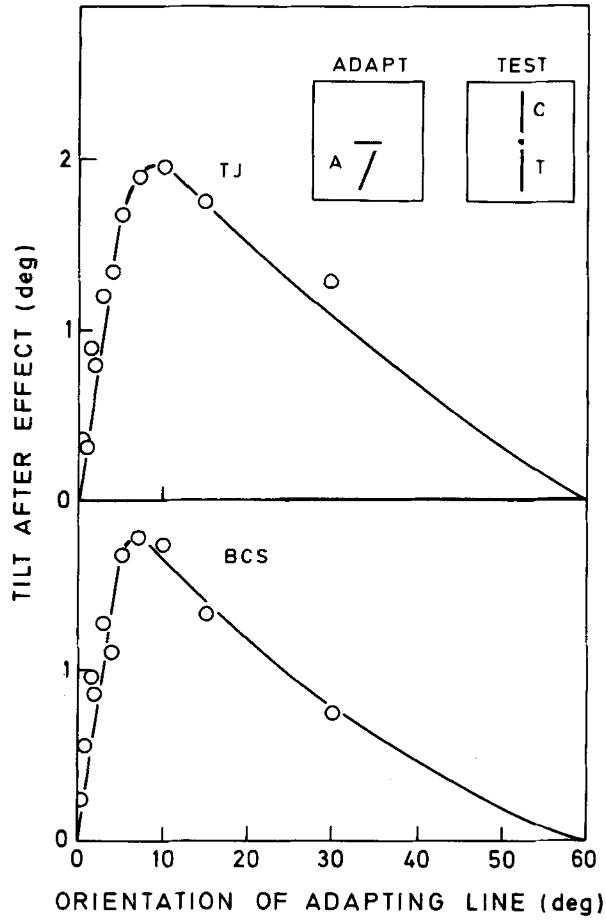


**Figure 1. Tilt aftereffect as a function of the orientation of the adapting line. Results for two subjects. Inset shows stimulus patterns: A, adapting line; C, comparison line; T, test line.**

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ing angles were tested in counterbalanced order: 0.5, 1, 1.5, 2, 3, 5, 7, 10, 15, and 30 deg.

The results for the two subjects tested are shown in Figure 1. They are quite clear: for all angles tested, conventional *negative* aftereffects were observed (i.e., the test line appeared tilted away from the adapting orientation). There is no evidence for an inverse effect, even at the smallest angle tested.

Of course, these results do not invalidate Carpenter and Blakemore's (1973) model or its application to the phenomenon of orientation contrast, but they would seem to imply that the tilt aftereffect, according to this theory, is not determined by the net effect of excitatory and inhibitory influences during adaptation, but it is an aftereffect of the inhibitory component alone. However, taken alone, the results are equally consistent with an explanation in terms of "fatigue" or "habituation" from prolonged excitation in a population of broadly tuned orientation detectors.

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