inactivation of calcitonin by treatments expected to alter the characteristics of calcitonin as a peptide eliminated the ability of calcitonin to inhibit feeding; and (iv) such evidence as we have does not indicate that calcitonin inhibits feeding by producing illness or debilitation. It is therefore tempting to speculate that endogenous calcitonin is involved in the regulation of feeding and appetite, perhaps in certain specific situations such as during infancy, lactation, or calcium-specific hunger (*16*). However, further research will be necessary to determine whether the effects of calcitonin on feeding are merely pharmacological, or whether they mimic an effect of endogenously secreted calcitonin (*17*).

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12. The two groups drank approximately equal amounts on the first exposure to saccharin; 8.3 ± 1.7 ml for the animals that received calcitonin and 8.3 ± 1.2 ml for the animals that received vehicle.
13. As determined by linear regression, the ED_{50} (50 percent effective dose) for inhibition of feeding was 1.86 U/kg administered intraventricularly and 46.3 U/kg administered subcutaneously.
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18. We thank L. A. Bing for technical assistance and J. P. Aldred of the Armour Pharmaceutical Company for comments and suggestions.

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Humans Deprived of Normal Binocular Vision Have Binocular Interactions Tuned to Size and Orientation

Abstract. *A suprathreshold grating presented to one eye elevated the threshold for the discrimination of gratings similar in size and orientation presented to the fellow eye. The magnitude and stimulus specificity of these binocular interactions in human observers with normal binocular vision were similar to those in observers deprived of normal binocular visual experience; however, the latter showed a failure of binocular summation at threshold or subthreshold contrast levels. Whereas strabismus or amblyopia disrupted the normal excitatory interactions between the two eyes, cortical inhibitory binocular connections seem not to have been disrupted.*

Most neurons in the visual cortex of cats and monkeys receive inputs from both eyes. For a given binocular cell, the stimulus requirements (such as size and orientation) are usually similar for the two eyes (*1*). These binocular connections are functionally present at birth, but are refined by concordant binocular experience during a critical period of development (*2*). In contrast, in animals deprived of normal binocular vision through experimentally induced strabismus or monocular form deprivation (resulting from lid closure or anisometropia), most neurons encountered have only a monocular input (*3*). Recent evidence suggests that this reduction in cortical binocularity may be in part the result of synaptic inhibition (*4*).

Several lines of psychophysical evidence have also implied a reduced number of binocular neurons in humans deprived of normal visual experience due to a naturally occurring strabismus or anisometropia. For example, such individuals are frequently stereoblind, display reduced interocular transfer of certain visual aftereffects, and show a failure of binocular summation on visual threshold tasks (*5*). In addition, they retain information concerning the eye of origin under conditions in which normal observers are unable to make reliable distinctions (*6*). On the other hand, it has been suggested from clinical observations that many strabismics in fact show inhibitory binocular interactions; that is, they suppress the input from one eye, and the suppression is most marked for similar stimuli (*7*). We have investigated the nature and extent of binocular interactions in humans deprived of normal visual experience by strabismus, amblyopia, or both. The results show that they have binocular interactions narrowly tuned to size and orientation and similar in magnitude and bandwidth to those found in normal observers.

Observers viewed two matched cathode-ray tube displays in a mirror stereoscope. Each eye was presented with an unstructured 8° circular field with a mean luminance of 10 cd/m^2 (unchanged when test patterns were presented). By depressing a button, the observer initiated a pair of 500-msec trials separated by 1 second. Each trial was delimited by a tone. In both trials, one eye was presented with a background of either a blank field or a grating. A test grating was also presented to the other eye on one of the two trials. Both the background and test gratings could be independently varied in spatial frequency,

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contrast, and orientation. The observer's task was to make a forced-choice temporal discrimination between the two successive trials. If the observer noted any difference between successive stimuli, discrimination of the test grating from the background was scored. The contrast of the test grating was varied according to a staircase procedure to determine the discrimination threshold between the two trials. At least five threshold measures were obtained for each test and background condition (*8*). We tested both normal observers and individuals with abnormal binocular vision (*9*).

Figure 1A shows results of two experiments for an observer with normal binocular vision. The effect of the 2.0-cycle/deg background grating presented to the observer's right eye was to decrease the contrast sensitivity for the discrimination of gratings presented to the left eye in a manner that was specific to the spatial frequency. The greatest decrease in sensitivity was for gratings of the same spatial frequency as the background. Thus, the suprathreshold background grating acted as a mask, reducing contrast sensitivity most for stimuli close in spatial frequency to that of the background. When the background and test stimuli differed in spatial frequency by two octaves or more, however, the background had little effect on the discriminability of the test grating.

Data for an amblyopic observer are shown in Fig. 1B. The contrast sensitivity of his amblyopic eye determined with a homogeneous background was reduced in comparison with that of the normal observer (Fig. 1A), and the peak sensitivity was shifted toward lower spatial frequencies (*10*). In spite of the significant reduction in contrast sensitivity of the amblyopic eye, the effect of the 2.0-cycle/deg background grating presented to the nonamblyopic eye resembled that found in the normal observer.

The masking effect is more easily seen in Fig. 1C, which shows the threshold elevation produced by the 2.0-cycle/deg grating. For both observers, the masking effect of the 2-cycle/deg background was sharply tuned to spatial frequency, with a bandwidth at half strength of about 1 octave. Similar spatial frequency specificity was found over a wide range of background spatial frequencies in both normal observers and in all three observers with abnormal binocular vision. In addition, the dichoptic masking effects were similar even when the background was placed in the amblyopic eye, and the test field in the nonamblyopic eye provided the contrast of the masking background determined with respect to the elevated threshold of the amblyopic observer. These dichoptic masking effects appear to be cortical because (i) they occurred only when the test and background gratings were presented to corresponding areas in the two retinas and (ii)

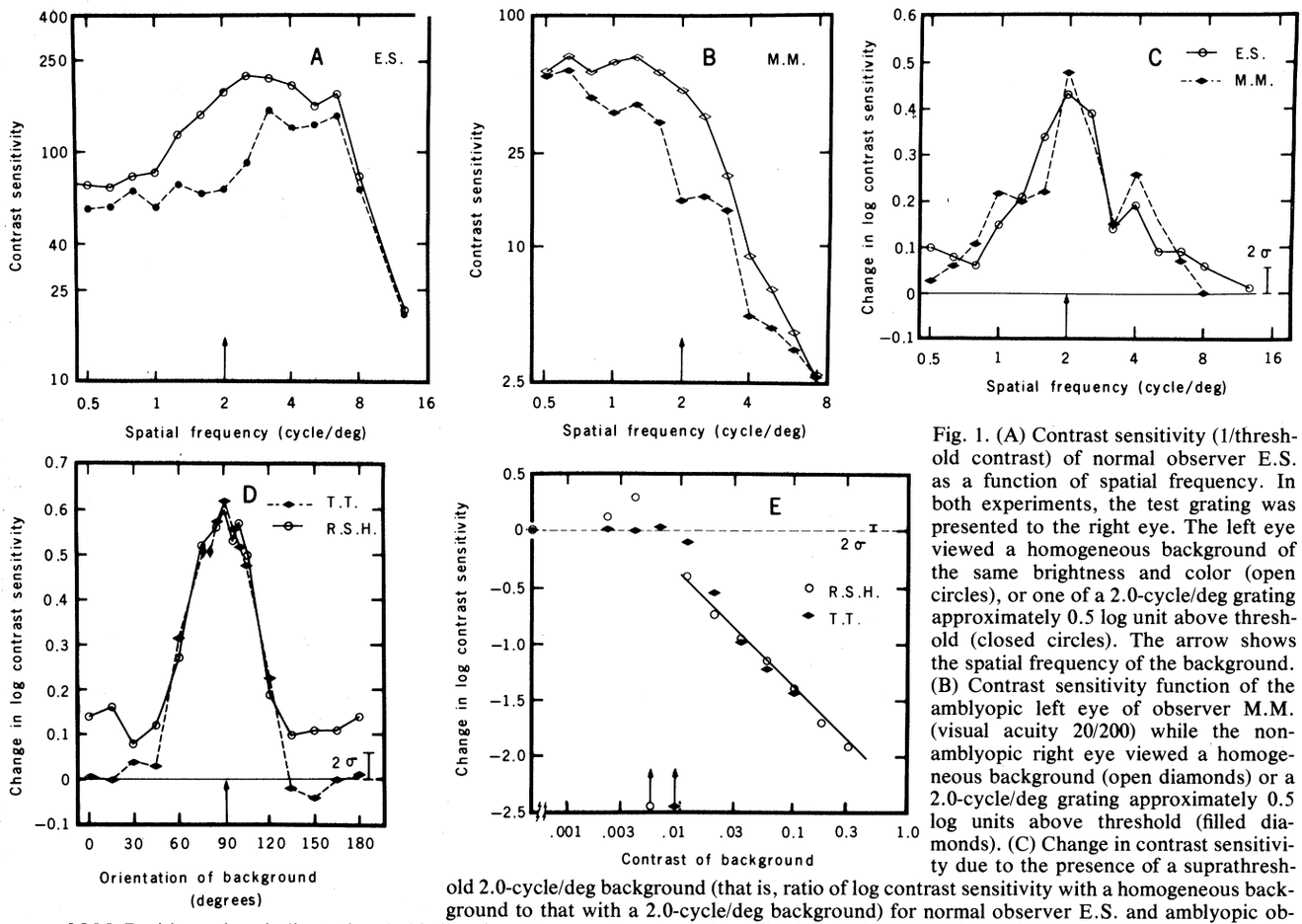

Fig. 1. (A) Contrast sensitivity (1/threshold contrast) of normal observer E.S. as a function of spatial frequency. In both experiments, the test grating was presented to the right eye. The left eye viewed a homogeneous background of the same brightness and color (open circles), or one of a 2.0-cycle/deg grating approximately 0.5 log unit above threshold (closed circles). The arrow shows the spatial frequency of the background. (B) Contrast sensitivity function of the amblyopic left eye of observer M.M. (visual acuity 20/200) while the nonamblyopic right eye viewed a homogeneous background (open diamonds) or a 2.0-cycle/deg grating approximately 0.5 log units above threshold (filled diamonds). (C) Change in contrast sensitivity due to the presence of a suprathreshold 2.0-cycle/deg background (that is, ratio of log contrast sensitivity with a homogeneous background to that with a 2.0-cycle/deg background) for normal observer E.S. and amblyopic observer M.M. Positive values indicate threshold elevation. The error bar shows 2 standard deviations. (D) Change in contrast sensitivity for a 2.0-cycle/deg vertical test grating presented to the left eye as a function of the orientation of a suprathreshold 2.0-cycle/deg background. (The arrow shows the orientation of the test grating.) R.S.H. was a normal observer; T.T. was amblyopic (left eye amblyopic, visual acuity 20/80). The error bar shows 2 standard deviations. (E) Change in log contrast sensitivity for discriminating a vertical 2.0-cycle/deg grating presented to the left eye while the right eye viewed a vertical 2.0-cycle/deg background of different fixed contrast levels. The dashed line shows no change in contrast sensitivity from that determined with a homogeneous background, and the error bar indicates 2 standard deviations. The solid line has a slope of −1 (Weber's law). The arrow with the circle shows R.S.H.'s threshold for detecting the background presented to this right eye. The arrow with the diamond shows T.T.'s threshold for detecting the 2.0-cycle/deg background presented to her nonamblyopic right eye.

they were orientation specific (Fig. 1D). Thus, the maximum threshold elevation occurred when the test and background stimuli were at the same orientation; when the test and background gratings were 45° apart, no masking was evident. Similar interactions occurred when the visual display was limited to restricted retinal regions, including the suppression scotoma. The binocular interactions were also contrast specific. In normal observers, when the test and background were similar in spatial frequency and orientation, a background contrast below threshold lowered the threshold for discrimination of the test grating. Subthreshold summation for dichoptically presented gratings has been described in normal observers by Blake and Levinson (*11*). When the contrast of the background exceeds threshold, however, it acts as a mask, elevating threshold for discrimination of the test grating (Fig. 1E). The increase in threshold has a slope of approximately −1 when plotted against the background contrast (on log-log coordinates). While the masking effects of the background above threshold were similar for these two observers, the observers with abnormal binocular vision failed to show subthreshold summation. The experiment was repeated for a wide range of test and background spatial frequencies from 0.12 to 8 cycle/deg without our finding any evidence for subthreshold summation in the subjects with abnormal visual experience. Thus, although these observers with abnormal visual experience showed inhibitory binocular interactions similar to those seen in normal vision, they failed to show either binocular summation at threshold or subthreshold summation.

The finding of spatially tuned binocular interactions in observers with abnormal binocular vision is surprising even though evidence for binocular interactions in the cortical evoked potentials of humans with strabismic amblyopia that depend on the spatial frequency and contrast of the stimulus has recently been reported (*12*). These findings suggest that in humans deprived of normal visual experience early in life, some binocular neurons escape the profound effects reported in physiological studies of animals reared with induced strabismus, anisometropia, or occlusion. In light of single-unit studies in animals deprived of normal binocular vision, however, the robustness and specificity of the binocular interactions found for humans with strabismus and anisometropia was unexpected. Whereas the failure of binocular summation at threshold and subthreshold summation suggests that it is the excitatory connections which are disrupted, the suprathreshold masking data suggest that the interactions may be inhibitory in nature (interactions not easily seen in single unit recordings) or that binocular interactions in humans deprived of normal visual experience have an elevated threshold and are seen only when the stimuli presented to at least one eye have sufficient suprathreshold contrast (*13*).

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9. We tested three observers with normal binocular vision and three with abnormal binocular vision. All of the abnormal observers were stereoblind. Stereopsis was assessed with the random dot E, the American Optical Vectograph, and the Titmus Stereofly. Although the relationship between interocular transfer of the threshold elevation aftereffect and stereopsis is not clear [R. Hess, *Perception* **7**, 201 (1978)], all observers failed to exhibit any significant interocular transfer of the threshold elevation aftereffect and showed an absence of binocular summation at threshold. For the abnormal observers, the following relevant visual characteristics are provided: T.T. is an anisometropic amblyope (amblyopia due to unequal refractive error) with 20/15 vision in the right eye and 20/80 in the left. M.M. is both strabismic (left eye esotropic) and anisometropic with 20/15 vision in the right eye and 20/200 in the left. For both of these observers, the visual anomaly was noted early in life, but was untreated. R.L. was a congenital esotrope. Surgery was performed at age 18 months. He now demonstrates a 4^{Δ} alternating esotropia and has equal vision in each eye (20/15). All three observers have central fixation in each eye, and only R.L. demonstrates anomalous correspondence. All observers were optically corrected during these experiments.
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Dendritic Growth in the Aged Human Brain and Failure of Growth in Senile Dementia

Abstract. *Golgi-stained dendrites of single randomly chosen layer-II pyramidal neurons in the human parahippocampal gyrus were quantified with a computer-microscope system. In nondemented aged cases (average age, 79.6 years), dendritic trees were more extensive than in adult cases (average age, 51.2), with most of the difference resulting from increases in the number and average length of terminal segments of the dendritic tree. These results provide morphological evidence for plasticity in the mature and aged human brain. In senile dementia (average age, 76.0), dendritic trees were less extensive than in adult brains, largely because their terminal segments were fewer and shorter. Cells with shrunken dendritic trees were found in all brains. These data suggest a model of aging in the central nervous system in which one population of neurons dies and regresses and the other survives and grows. The latter appears to be the dominant population in aging without dementia.*

Aging and senile dementia (SD) (*1*) in the central nervous system have been characterized as processes of deterioration, with both death of neurons in most regions (*2*) and regression of dendrites of the cells that have not yet died (*3*). In cerebral cortex of human aged and senile dementia patients, this regression reportedly progresses in some cells until only stubs of dentrites remain (*4*). We present evidence that, although this regression of dendrites can be seen in some cells,

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