

Table 2. The amino acid incorporating activity of various recombinations of fractions from normal rats and rats treated with methylcholanthrene (MC).

| Source of homogenate fraction |            |             | % of Control* |
|-------------------------------|------------|-------------|---------------|
| Mitochondria                  | Microsomes | Supernatant |               |
| Normal                        | Normal     | Normal      | 100           |
| MC                            | Normal     | Normal      | 122           |
| Normal                        | MC         | Normal      | 112           |
| Normal                        | Normal     | MC          | 125           |
| MC                            | MC         | Normal      | 150           |
| MC                            | Normal     | MC          | 152           |
| Normal                        | MC         | MC          | 144           |
| MC                            | MC         | MC          | 166           |

\* The activity of the control flask containing all normal components was arbitrarily set at 100. Represents average of two experiments. Experimental conditions are the same as system I described in Table 1.

fresh liver. Incubation procedures are described in Table 1.

In the series of experiments with the system containing mitochondria (system I), administration of methylcholanthrene or phenobarbital resulted in average increases of 61 percent (eight experiments) and 163 percent (two experiments), respectively, in the rate of amino acid incorporation into protein (Table 1). In experiments with the microsomal-supernatant system (system II), treatment with methylcholanthrene resulted in an average stimulation of 32 percent (Table 1).

Although all the enzyme systems previously reported to be enhanced by administration of methylcholanthrene are microsomal, the effect on amino acid incorporation is not wholly accounted for by a difference in the microsomes. As is shown in Table 2, each of the homogenate fractions contributed to the increased incorporation rate observed in the preparations from the rats treated with methylcholanthrene. Thus amino acid incorporation was stimulated 12 to 25 percent when only one of the three fractions used was from the treated rats, 46 to 55 percent when two of the three were from treated rats, and 66 percent when all three were from treated rats. Conversely, the effect was reduced but not completely removed by the replacement of any one or two of the fractions from treated rats by the corresponding fractions from normal rats.

One of the later stages of protein synthesis involves the transfer of soluble ribonucleic acid bound amino acid (sRNA-AA) to microsomal protein (10). As shown in Table 1, this is at least one of the steps stimulated by treatment with methylcholanthrene.

The results of the present study demonstrate that treatment with methylcholanthrene stimulates amino acid incorporation into protein whether the amino acid is added free or bound to soluble ribonucleic acid (sRNA). These results, therefore, suggest that this treatment accelerates the rate of protein biosynthesis. Such an action is consistent with the hypothesis that the enhanced enzyme activities previously observed after treatment with methylcholanthrene result from an increased rate of enzyme synthesis. It is noteworthy that ethionine, which is known to inhibit protein synthesis (11), has also been observed to inhibit the stimulatory effect of methylcholanthrene on the enhancement of certain enzyme activities (3, 6).

Confirmation of this hypothesis requires a demonstration of a net increase in newly synthesized enzymes. In the absence of such definitive evidence, alternative explanations of the effect of methylcholanthrene should be considered. It is possible that the increased rate of amino acid incorporation may not be causal to the increased enzymatic activities, but rather another example of a microsomal enzyme system enhanced by methylcholanthrene. A possible mechanism is an increased microsomal membrane permeability resulting in a greater accessibility of microsomal enzyme sites (12).

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## Nonlinear Property of the Visual System at Fusion

**Abstract.** The response of the visual system to intermittent stimulation at rates above the fusion point is generally considered to be independent of frequency, that is, linear with respect to time-average luminance. However, trains of 1000 light pulses per second alternated successively with trains of 500 light pulses per second may be perceived as flickering even though the time-average luminance is the same in each train.

Recent experiments (1) have indicated that the traditional critical flicker frequency (CFF) is at best a special case of a much more general class of visual phenomena relating to temporal visual acuity. A perceptually fused train of light pulses may be reduced to flicker by shortening the duration of every other "on-off" time in the train, an operation which preserves duty ratio and keeps average energy constant. Such an effect suggests that the nature of the visual response may be further illuminated by more extended use of this type of stimulation.

The research reported here involved trains of pulses such as shown schematically in Fig. 1. In this figure, the typical CFF configuration is represented by the top line; square wave pulses are presented successively, with "on" times equal to "off" times. The remaining three lines represent the type of stimulation used in the experiment; two different frequencies of light pulses (standard and variable) presented successively in a continuous sequence. The figure, drawn to scale and pictured as the stimuli appear on an oscilloscope, illustrates the effect obtained with one setting of the standard for three frequencies of the variable train of pulses. Note that, in all cases, each "off" time equals the preceding "on" time.

The standard and variable trains of pulses were generated by two independent circuits, each providing "on" and "off" triggers with continuously variable frequency. The circuits were designed so that duty ratio (proportion of "on" time) remained invariant at 0.5 with changes of frequency. Alternation of the standard and variable trains of pulses was accomplished by switching back and forth between the two circuits. Gating times were controlled by two cascaded time-delay units. The standard train of pulses was generated for a duration determined by the setting of one of the time-delay

units. When this unit shut off, the circuit generating the standard train was stopped, the circuit generating the variable train started, and the second time-delay unit switched on. The end of the second unit's delay stopped the variable circuit, started the standard circuit, and reset the first time-delay unit, and so on. Gating was accomplished with simple logic circuits so that neither the standard nor the variable train of pulses was ever interrupted in the middle of a period—that is, there was an integral number of “on-off” times in all trains of pulses.

The triggers generated by the above circuitry were fed to a d-c generating source to produce intermittent electric square waves which served as the input to a Sylvania R1131C glow-modulator tube. The tube illuminated a spot subtending  $\frac{1}{2}^\circ$  of visual angle with a luminance of approximately 2000 mlam. The luminance of the surround was approximately 22 mlam. All observations were made monocularly.

Gating times were set so that each train contained at least three pulses and had a duration of no less than 40 msec. For each series of measurements the period (“on” time plus “off” time) of the pulses in the standard train was set at a fixed value. The observer then adjusted the period of the pulses in the variable train until a point of fusion was reached. Settings of the standard train periods, ranging from 1 to 18 msec. The output of a photocell illuminated by a second glow-modulator tube permitted continuous monitoring of the stimulus on a Tektronix oscilloscope during the course of the measurements.

The data for three observers are shown in Fig. 2. The coordinates have been labeled in terms of both frequency and period to facilitate interpretation. Each data point represents the mean of ten observations. Inspection of the data for observer DF will illustrate the procedure. With the period of the standard pulses set at 5 msec, the period of the variable pulses is reduced until a value is reached at which the light no longer appears to flicker, in this instance approximately 6.2 msec. The period is then further reduced until a value is reached at which flicker reappears, here approximately 2.6 msec. For this observer, then, with the frequency of the standard pulses set at 200 pulses per second (period, 5 msec), flicker is perceived when the frequency of the variable pulses is less than 161 or greater than

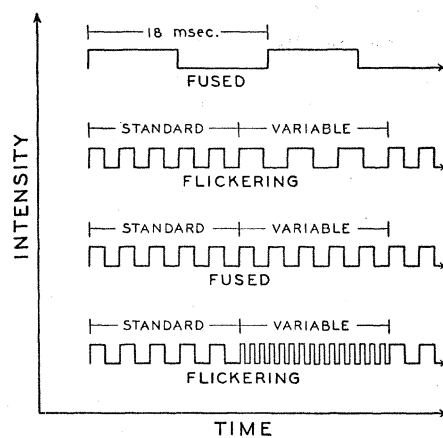


Fig. 1. Schematic representation of intermittent photic stimuli used in this study, drawn to scale.

385 pulses per second. The curves connecting the data points for each observer in Fig. 2 thus enclose a region of fusion. All points outside the boundaries of an observer's curve represent the periods (or frequencies) of alternating trains of pulses which are seen as flicker (the CFF for each observer is represented by the data point lying on the diagonal).

Although smooth curves were not drawn to fit the points, it seems clear

that the best fitting curves would be, throughout their greatest extent, straight lines with a slope of +1, displaced by a constant amount from the diagonal. An estimate of this displacement for a given observer is the average absolute displacement of his data points from the diagonal. For observers, MB, DF, and PM, these values are approximately 0.52, 1.8, and 2.9 msec, respectively.

The curves in Fig. 2 were extrapolated to these values on the coordinates. Such an extrapolation estimates the values which might be obtained by alternating d-c with high-frequency intermittent stimuli of the same time-average luminance. Figure 2 shows further that, for observers DF and MB, flicker is perceived when a train of 1000 pulses per second is alternated with a train of 500 pulses per second. Both trains of pulses, however, have the same time-average luminance and, when viewed in isolation, appear fused. These data do not invalidate the Talbot-Plateau law, but serve only to emphasize that brightness, in the context of this law, implies “steady-state” brightness. Abrupt changes of frequency while time-average luminance remains

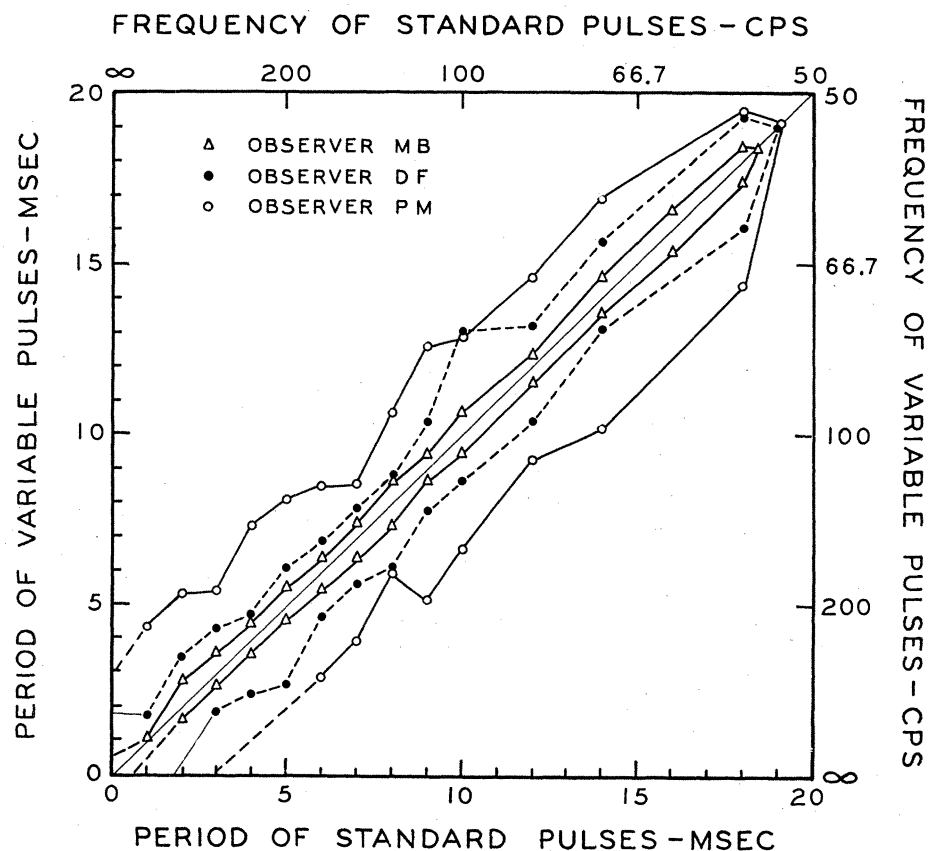


Fig. 2. Fusion as a function of the periods of the pulses in alternating trains of intermittent photic stimuli. Each symbol represents the mean of ten observations.

constant seem to induce an effect analogous to the Broca-Sulzer effect. The linearity of the function with respect to period, however, argues that changes of temporal pattern, rather than frequency, are responsible.

A current model developed by de Lange, Kelly, and Levinson (2) regards the visual system as selectively attenuating the high-frequency components of intermittent stimulation. Such a treatment relies on the linearity implied by the "steady-state" brightness of the Talbot-Plateau law. The data presented in this paper clearly indicate the limited generality of such a model (3).

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### Differential Acuity of the Two Eyes and the Problem of Ocular Dominances

**Abstract.** While it has long been thought that no relationship exists between the eye of greater visual acuity and the eye favored in sighting, the data collected suggest the need for a re-examination of this issue. Sighting-dominance and acuity-dominance were associated. In addition, most individuals tested showed acuity-dominance of the left eye.

In a systematic discussion of types of ocular dominance, Walls (1) differentiated between two which are commonly considered to be independent, namely, sighting-dominance (one eye is consistently aligned with a near

Table 1. The association of sighting-dominance and acuity-dominance in 319 college students.

| Acuity-dominance | Right sighting-dominance | Left sighting-dominance |
|------------------|--------------------------|-------------------------|
| None             | 66                       | 21                      |
| Right            | 76                       | 23                      |
| Left             | 80                       | 53                      |

point when sighting or pointing at a far point) and acuity-dominance (one eye has greater visual acuity than the other). In this laboratory both kinds of dominance were measured in a large sample of college students. This paper reports the frequency of left versus right acuity-dominance and the association of sighting-dominance and acuity-dominance.

Visual acuity was measured with a Bausch & Lomb Ortho-Rater, which measures far acuity and near acuity separately (2). For two subject groups one eye shows greater acuity than the other, that is, acuity-dominance. These groups consist of subjects in which (i) one eye shows greater acuity at both far and near viewing distances and (ii) the eyes show equal acuity at one distance, but differential acuity at the other distance.

In the sample, acuity-dominance of the left eye was more frequent than acuity-dominance of the right eye. This surprising finding was supported by further investigation. Bausch & Lomb, Inc., reported that in many studies in which Ortho-Rater scores were obtained the best mean acuity score has been in the left eye (3). Since testing of the acuity of the left eye follows testing of both eyes together and of the right eye (for both far and near conditions), the possibility of a practice effect favoring higher left eye acuity scores exists. To investigate this possibility, I tested 80 college students, with sequence changed so that the right eye tests were last in each viewing condition and, therefore, any practice effect would favor the right eye. In this sample, as in previously tested ones in which the usual order was used, mean left acuity was greater than mean right acuity, and there were more left acuity-dominant than right acuity-dominant subjects.

The question of an association between sighting-dominance and acuity-dominance was studied by Gahagan, who used a different measure of visual acuity (4). While he concluded that the two dominances are independent,

a trend appeared in his data which could support the opposite conclusion. For those subjects showing acuity-dominance, of 63 right sighting-dominant subjects 54 percent were right acuity-dominant, and of 21 left sighting-dominant subjects 62 percent were left acuity-dominant. A re-examination of Gahagan's published data taken in conjunction with the data from my own studies suggests an association between the two ocular dominances. Table 1 presents the number of subjects showing each combination of acuity-dominance and sighting-dominance. A  $\chi^2$  test of independence was made ( $\chi^2 = 9.59$ ;  $p < .01$ ).

Inspection of Table 1 clarifies the finding of a prevalence of left acuity-dominance. Among right sighting-dominant subjects, right and left acuity-dominance are equally common. However, among left sighting-dominant subjects, left acuity-dominance is considerably more frequent than right acuity-dominance.

These data imply that to the extent that a sample consists of left sighting-dominant subjects, left-acuity would occur in more than half the sample. Further, the data imply that in studies in which there is monocular viewing with the possibility of acuity being relevant, an index of the differential acuity of the two eyes should be obtained, since it can no longer be assumed that left and right acuity-dominance will be equally distributed. In order confidently to generalize from these results it is suggested that (i) populations other than college students be sampled, and (ii) indices of acuity other than Ortho-Rater scores be obtained.

The clear demonstration of a bias favoring left acuity-dominance related to sighting-dominance may assist in the development of a valid conceptualization of ocular dominances and related perceptual events. The basic question of the origin of ocular dominances remains unanswered, and can be expected to remain so barring developmental studies.

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