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BRIGHTNESS AND DISCRIMINABILITY OF LIGHT FLASHES

J. NACHMIAS and R. M. STEINMAN[1]
Department of Psychology, University of Pennsylvania, Philadelphia, Pennsylvania, U.S.A.

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INTRODUCTION

NEITHER the brightness of a patch of light nor the discriminability of luminance differences within the patch are dependent solely on its luminance. Also relevant are other stimulus parameters, such as the area, duration, spectral composition and retinal location of the light patch, as well as the distance, area and luminance of other light patches, and the state of adaptation of the eye. The assumption has frequently been made, often implicitly, that brightness and luminance discrimination both reflect in some simple manner the "sensitivity" or "responsiveness" of the visual system. This assumption suggests that if a change in some stimulus parameter causes a light patch to appear dimmer, luminance discrimination should also be impaired. It also suggests that if two fields appear equally bright, even though they be of unequal luminance, then relative luminance discrimination should also be the same. When these expectations are not fulfilled the practice has been to infer that spatially or functionally distinct features of the visual system are involved.[2]

There is, however, another hypothesis, according to which luminance discrimination is related not to brightness itself but to the relative rate of change of brightness with luminance. One way to state this hypothesis is this: to every level of brightness, no matter how it is brought about, there corresponds a fixed liminal change in *brightness*; whether this fixed brightness change can be produced by the same luminance change depends entirely on whether brightness varies with luminance at the same rate under the conditions being compared. If it is varying more rapidly under condition I than under II, where I and II may be different values of some stimulus variable other than luminance, then the liminal luminance change will be smaller under I than under II, even if the fields appear equally bright.

The following is a more concise statement of the same hypothesis: a brightness match between two fields is not disturbed when the luminance of each is changed by an equally discriminable amount (so long as the changes are neither always nor never discriminated). In this version, the hypothesis is recognizable as a weaker form of Fechner's well-known assumption about jnd's. It asserts not that all jnd's are subjectively equal, but merely that jnd's from the same sensation level are subjectively equal.

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[1] R. M. Steinman is now at the Department of Psychology, University of Maryland, College Park, Maryland, U.S.A.

[2] Several writers have expressed some aspects of this general viewpoint about the relationship between brightness and discriminability. Among them are ONLEY and BOYNTON (1962), and FIORENTINI and TORALDO DI FRANCIA (1955).

This hypothesis has had a curious history. Sometimes it has been assumed to hold almost as an analytic proposition, without need of verification (BAUMGARDT and SÉGAL, 1942–3). At another time it appears to have been verified inadvertently by an investigator who reported that equally bright flashes of different durations are approximately the same number of jnd's above the appropriate absolute thresholds (BILLS, 1920). PITT (1939) tested the hypothesis explicitly, only to reject it because "the number of just noticeable differences between subjective black and subjective white is" not "equal for all adaptation brightnesses". However, as HEINEMANN (1961) has pointed out, Pitt's refutation is not acceptable because it rests on the incorrect assumption that at absolute threshold all stimuli have the same apparent brightness ("subjective black").

The most extensive investigation to date of the second brightness-discriminability hypothesis was undertaken by HEINEMANN (1961). He obtained brightness matches of 1° circular test-fields surrounded by annular inducing fields of various luminances, and also determined luminance increment thresholds within the surrounded test-fields. The findings of this investigation appear to support the hypothesis: "For test-fields of the same apparent brightness, the relative values of the difference thresholds depend on the relative rates at which the apparent brightness of these test-fields changes with their luminance" (HEINEMANN, 1961). Unfortunately, this admirable study contains an important flaw. Although observers matched the brightness of the entire test-field when the fields were presented indefinitely, increment thresholds were determined by superimposing brief (0·2 sec) and small (10 min arc) flashes.

To show the difficulty that arises from this difference in stimulus conditions, let us consider inducing fields of two fixed luminance values, I and II, and let us represent the luminance of a test-field surrounded by I necessary to match in brightness a test-field surrounded by II, as follows:

$$L_{\mathrm{I}} = f(L_{\mathrm{II}}). \tag{1}$$

Now Heinemann's data, in apparent agreement with Fechner's hypothesis, indicates that if ΔL_{I} and ΔL_{II} are equally discriminable increments, equation (2) also holds:

$$L_{\mathrm{I}} + \Delta L_{\mathrm{I}} = f(L_{\mathrm{II}} + \Delta L_{\mathrm{II}}). \tag{2}$$

However, if the duration or area of the increments had been different the values of the corresponding thresholds would also have been different, $k\Delta L_{\mathrm{I}}$ and $k'\Delta L_{\mathrm{II}}$ respectively. If the stimulus conditions under which brightness and discriminability are determined were irrelevant, we might equally well expect equation (3) to hold:

$$L_{\mathrm{I}} + k\Delta L_{\mathrm{I}} = f(L_{\mathrm{II}} + k'\Delta L_{\mathrm{II}}). \tag{3}$$

In general, equations (2) and (3) cannot both be true even if $k = k'$. The hypothesis, therefore, even if true, is likely to fail if applied to data obtained under different stimulus conditions. Consequently, Heinemann's confirmation of the hypothesis is either fortuitous (10 min arc, 0·2 sec increments, give nearly the same results as 1°, indefinite duration increments) or it has even deeper implications about the nature of visual processes.

Clearly, the tenability of Fechner's hypothesis is still in doubt. We performed three experiments in an effort to test it. In experiment I, observers made brightness matches between flashes of different durations. In experiment II, we determined the detectability of bright-line increments in flashes of different durations. In experiment III, we determined the discriminability of small luminance differences in flashes of different durations. These determinations were made in slightly unusual ways so as to eliminate undesirable contaminating factors. Fechner's hypothesis can be legitimately applied to data from experiments I and III because stimulus conditions were the same. It leads us to expect that (to paraphrase Heinemann) for test-fields of the same brightness but different duration, the relative values of equally discriminable luminance changes depend on the relative rates at which the brightness of these test-fields changes with their luminance. Experiment II was performed primarily to provide a concrete instance of the apparent failure of Fechner's hypothesis when it is inappropriately applied. These experiments were also intended to provide data, obtained under comparable conditions, on observers' performance in several tasks involving light flashes of different durations.

METHOD

Apparatus

All experiments were performed on a multi-channel Maxwellian optical system of conventional design which is shown in block diagram form in Fig. 1. Many of its features have been described in a previous publication (NACHMIAS and STEINMAN, 1963). A circular stop, subtending 1° and optically located above a red fixation point, was illuminated briefly through either of two channels in Experiment I. One channel (X) produced a standard flash, 230 or 250 msec in duration and the second channel (Y), which contained the shutter system previously described, produced the variable flash, 13, 26, 52, 102 or 230 msec in duration. Only the second of these channels was used in Experiment III. In Experiment II, a branch of channel Y originating in front of its shutter system could illuminate a nearly vertical slit, 1° by 1·9′. The slit and circular field were optically superimposed. A silent blanketing shutter located in the branch of channel Y blocked light from reaching the slit on "catch" trials.

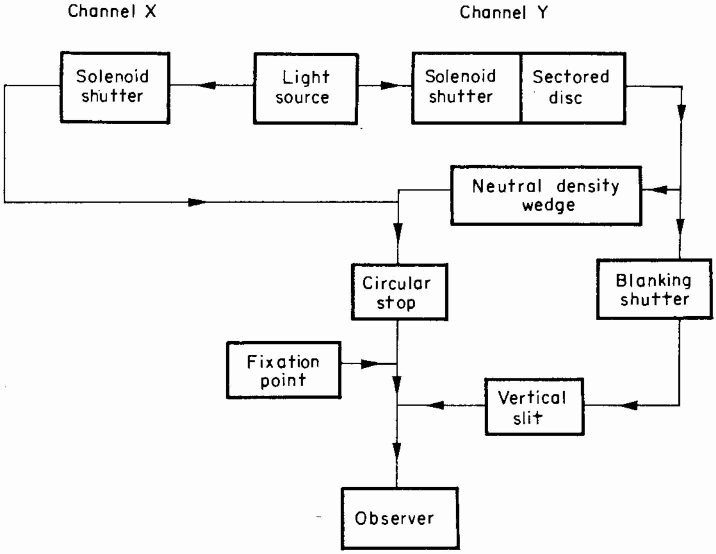


FIG. 1. Block diagram of apparatus.

Observers

Two observers served in all three experiments. One of them (R.S.), who was also the junior author, knew the purpose of the experiment, though not its exact design. Both had considerable previous experience in making a variety of visual observations.

Procedure

Experiment I. Ever since BROCA and SULZER (1902), the brightness of flashes of different durations has usually been evaluated by simultaneous matching, either monocular or haploscopic. Recent work, however, makes it clear that unwanted interactions between flashes are not negligible even with haploscopic procedures (FIORENTINI and RADICI, 1961; KOLERS and ROSNER, 1960). We therefore resorted to successive brightness matching, which was probably last attempted in this connection by MCDOUGALL (1904).

Standard and test flashes followed each other in strict alternation every 10 sec. The duration of the standard was always 230 msec for observer S.L. and always 250 msec for R.S.; its luminance was fixed throughout each block of trials. The duration of the test-flash was fixed throughout each block of trials, but its luminance differed on each appearance. The observer reported whether each flash was brighter or dimmer than its immediate predecessor. Thus each luminance setting of the test-flash yielded two responses. The pair of responses were considered together in determining the direction of change of the test-flash luminance in accordance with the double-staircase method (CORNSWEET, 1962; NACHMIAS and STEINMAN, 1965). For example, within each staircase, the luminance of the test-flash was increased until the occurrence of one consistent response pair indicating that the test-flash appeared brighter: that is, the standard flash was reported to be dimmer than the test-flash and the test-flash was reported to be brighter than the standard.

Two types of daily session were conducted in this experiment. In type A, the luminance of the standard was set at one of several values, and the luminance of the test-flash needed for a brightness match was determined for five different durations of the test-flash. In type B, the standard was set in turn to three different luminance levels separated by 0·5 log mL, and only two durations of the test-flash were used, 52 and 230 msec.

Every session in this and the following experiments began with 15 min of dark-adaptation.

Experiment II. We employed the rating-scale method, devised by signal detection theorists (EGAN *et al.*, 1959), and previously used by us to study absolute visual detection (NACHMIAS and STEINMAN, 1963), to assess the detectability of a line-shaped luminance increment. The observer's task was to discriminate between two types of trials, which were randomly mixed and equally probable. In one type of trial, only the circular field was shown at constant luminance. In the other type, the same circular field was shown, but with a line at constant luminance superimposed on it. The observer used a 6-point rating scale to report which type of trial he believed had just occurred. After each response, he was informed about the type of trial that had in fact been presented.

Trials came every 10 sec in blocks of 33–34. A session consisted of 10–12 such blocks (330–400 trials), in the first half of which one flash duration (either 52 or 230 msec) was employed, and in the second half the other flash duration. For each observer, the luminance of the 1° field at each flash duration was set at the value which had been found in Experiment I to match the apparent brightness of the 1·3 log mL standard flash. L'_A and L'_B will designate these luminances of the 52 and 230 msec flashes, and L_A and L_B all other luminances at these durations.

Experiment III. We decided against using the method of constant stimuli to evaluate discrimination of luminance differences for two reasons: (1) the method is not well enough grounded theoretically at present to enable one to extract a measure of discriminability uncontaminated by response biases or shifts of criterion; (2) it would have been inefficient to have to present the standard on every other trial. We therefore chose a method that resembles the method of single stimuli, and one recently employed by BARLOW (1962a) for a similar purpose. It can be understood most readily as an adaptation of the rating-scale method described above.

In principle, for observer S.L., the situation in this experiment differed in only one respect from that in the preceding experiment: the luminance increment covered the entire 1° field rather than being confined to a 1·9 min arc line. Actually, in each half-session she was presented with a sequence of flashes of constant duration whose luminance was randomly alternated between two values differing by approximately 26 per cent (0·1 log unit). She reported the subjective brightness of each flash (or her confidence that she had just seen the flash of higher luminance) by means of a 6-point rating scale. After each response, she was told which of the flashes had in fact been presented. In this manner, but on different experimental sessions, she was tested on five different values of L_A and L_B in the neighborhood of L'_A and L'_B.

For observer R.S. the procedure differed slightly. The luminance of the flashes presented to him was randomly alternated between three values, differing by approximately 14 per cent (0·057 log units). He also reported the subjective brightness of each flash on a 6-point rating scale. Seven different values of L_A and L_B were tested in this manner.

RESULTS

Experiment I

Figure 2 shows the luminance of the test-flash needed to match in brightness several luminances of the standard flash, as a function of the duration of the test-flash. Each curve therefore represents a different brightness level. The open circles stand for means based on four type B sessions; the closed circles for means based on two type A sessions (observer R.S.) and three such sessions (observer S.L.). The horizontal lines represent the *total range* of between-day variability in type B sessions; these ranges compare quite favorably with those obtained from simultaneous brightness matches of flashes of unequal duration. Observers did not complain of after-images, nor did they find the task difficult, except at the highest brightness level. There, the brightness of a flash appeared to wax and wane markedly, and observers became uncertain as to what would constitute a match. For these reasons, and also in order to minimize adaptation effects, no higher brightness levels were examined.

Our data share many features of those from other studies, notably KATZ's (1964), of the brightness of brief light flashes. Assuming that brightness matches are transitive, we can affirm that to maintain constant brightness the luminance of a flash must be decreased as its duration is increased, though its luminance may have to be increased again if its duration is increased yet further. This last fact is referred to as the Broca–Sulzer effect, or as "brightness enhancement". As BOYNTON (1961) has recently pointed out, "brightness enhancement" is a misnomer. At least within the range of values investigated, less energy is never needed in a longer flash than in a briefer one for the same brightness. The effect is more likely to be due to an "inhibitory" process within long flashes, as BAUMGARDT and SÉGAL (1942–3) have argued, than to an "enhancement" process in 50-msec flashes.

Part of the data of Experiment I is replotted in Fig. 3 in order to emphasize another important point: brightness changes less rapidly with luminance in longer flashes than in shorter ones, even before the Broca–Sulzer effect appears. In this figure, luminances at which 52- and 230-msec flashes matched various standard flash luminances are plotted against each other. Straight lines have been fitted only to the data points from type B sessions, because their relative position is least influenced by between-day variability. The slope of these lines is a direct estimate of the relative change in log luminance at these two durations needed to produce a given change in brightness in the vicinity of $L_B = 1{\cdot}3$ log mL. Its value is 0·67 for both observers. The functions which would fit the data points from type A sessions also appear to be similar for both observers, and to have slopes whose value is never greater than 1·0. Note, however, that the points from the two observers are actually displaced relative to each other. As a result, the value of log L_B at which the Broco–Sulzer effect occurs (i.e. log $L_B >$ log L_A) for observer S.L. is more than 0·5 above that required by R.S.

We chose for further investigation the brightness level defined by a standard flash of 1·3 log mL because the change of brightness with log luminance differs greatly for the two flash durations in the vicinity of this level. The corresponding values of L'_A and L'_B, indicated by arrows in Fig. 3, are 1·46 and 1·27 log mL for observer S.L., and 1·30 and 1·30 log mL for R.S.

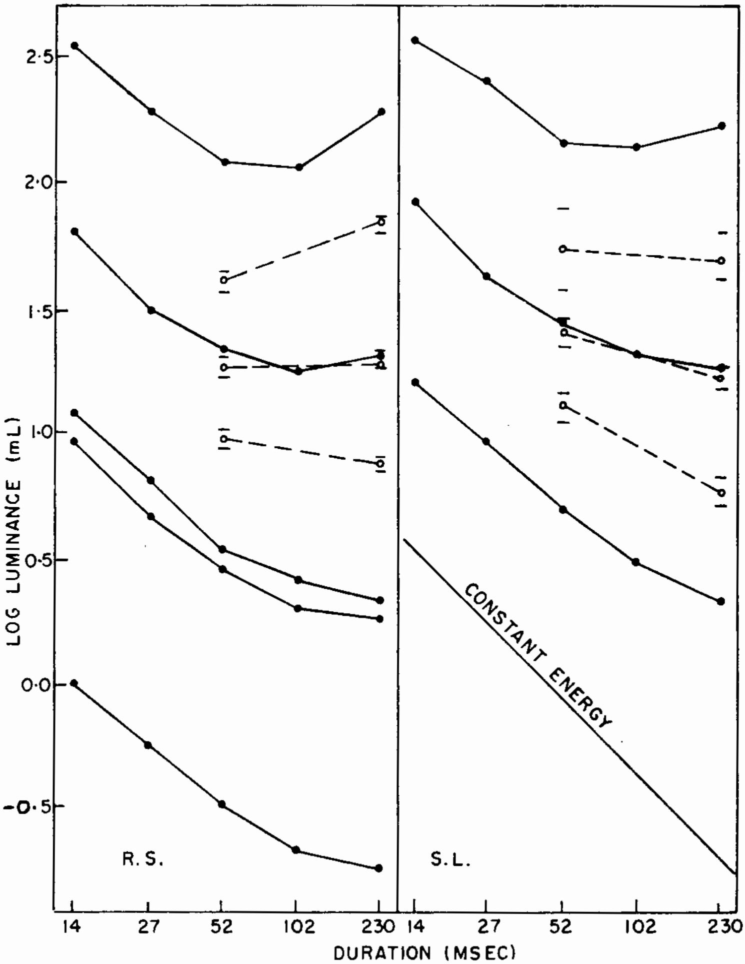


FIG. 2. Combinations of test-flash luminance and duration which match in brightness standard flashes of various luminances. Filled circles—Experiment IA; empty circles—Experiment IB. Horizontal lines above and below empty circles indicate the total range of between-day variability in Experiment IB.

Experiment II

The bright line which the observers had to detect constituted the same relative luminance increment on both the long and the short equally bright flashes, namely $\Delta L/L'_A = \Delta L/L'_B =$ 0·135 for observer R.S. and 0·182 for observer S.L. Figures 4a and 4b are plots of the cumulative proportion of responses of different categories given to flashes with a line present ("hits") against the corresponding proportion of responses given to flashes with the line absent ("false alarms"). For example, the point indicated with an arrow represents the proportion of "line present" trials and the proportion of "line absent" trials when R.S. responded with "6" or "5". All the points in Fig. 4 are means of the proportions obtained in the last four experimental sessions for each observer. The theoretical basis for such R.O.C. curves has been elaborated elsewhere (EGAN *et al.*, 1959; NACHMIAS and STEINMAN, 1963).

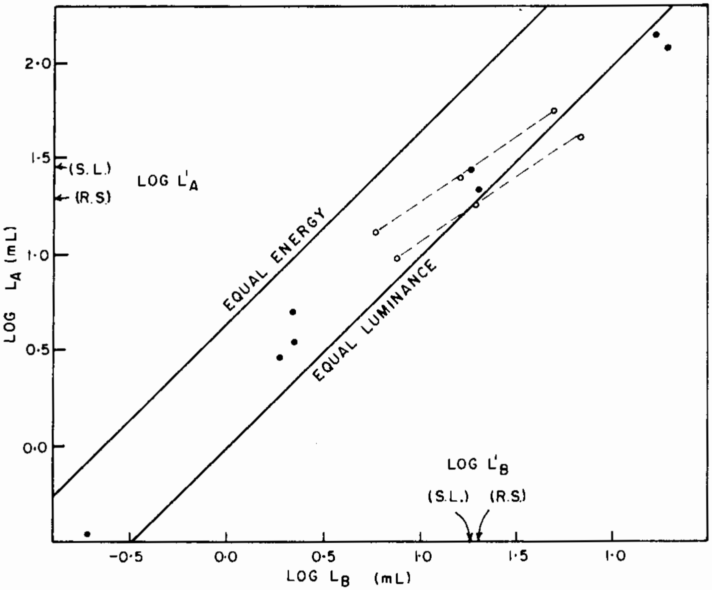
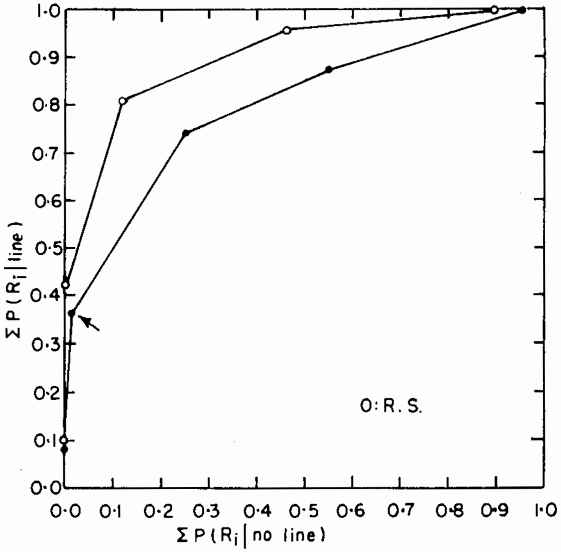
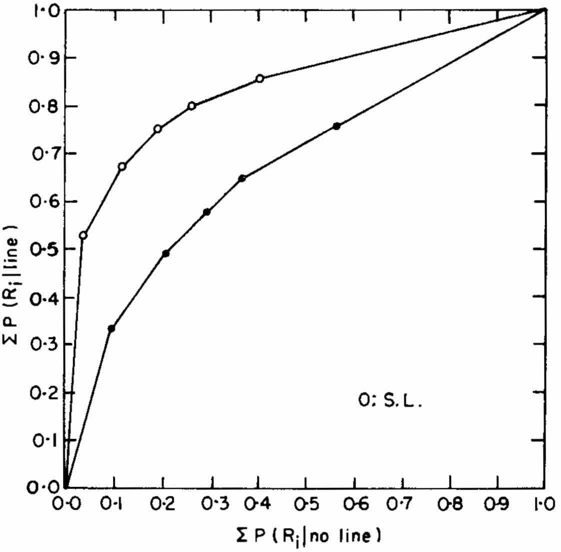


FIG. 3. The log luminance of 52-msec test-flashes which match in brightness standard flashes of various luminances, plotted against the log luminance of 230-msec test-flashes which match the same standard flashes. Filled circles—Experiment IA; empty circles—Experiment IB. The upper data points are from Observer S.L., the lower ones from R.S.

Clearly the same relative luminance increment is more detectable in the longer of the two equally bright flashes. For every response criterion, but especially for intermediate criteria, there are fewer "hits" and more "false alarms" with the 52-msec than with the 230-msec flash. This is true even though, according to experiment I, the same relative luminance change in the entire 1° field would have produced a greater brightness change in the 52-msec than in the 230-msec flash. These considerations might lead one to reject the Fechner hypothesis concerning the relation between brightness and luminance discrimination, were it not for the argument presented at the end of the Introduction. These findings thus lend weight to the assertion made there that the Fechner hypothesis is likely to fail if applied to brightness and discrimination data gathered under different stimulus conditions. Since the detection of a fine line is frequently considered a test of visual acuity, our data also provide another instance in which visual acuity is unequal in equally bright fields of different duration, a point about which there has been some dispute (GIBBINS, 1961; NACHMIAS, 1961).



(a)



(b)

FIG. 4. (a) R.O.C. curves for the detection of a line increment: $\Sigma P(R_i|\text{line})$, the cumulative proportion of "hits" plotted against $\Sigma P(R_i|\text{no line})$, the cumulative proportion of "false alarms". Filled and empty circles refer to 52-msec and 230-msec flashes, respectively. Observer R.S.

(b) R.O.C. curves for the same task. Observer S.L.

Experiment III

In this experiment, the observers had to discriminate between (or recognize) flashes of slightly different luminance. Figure 5 contains R.O.C. curves quite analogous to those in Figs. 4a and b. Corresponding to the "hits" and "false alarms" for those figures are the cumulative proportions of responses of different categories given to the higher luminance, kL'_A or kL'_B, and the cumulative proportions of responses given to the lower luminance, L'_A or L'_B. In the case illustrated in Fig. 5, the value of k was 1·135, the same as that used for R.S. in Experiment II, although there the luminance difference to be discriminated was confined to a 1·9′ line. Contrary to the results of that experiment, however, Fig. 5 shows that here the observer does better with the briefer flashes. That is also what one would predict from Fechner's hypothesis in conjunction with the results of Experiment I.

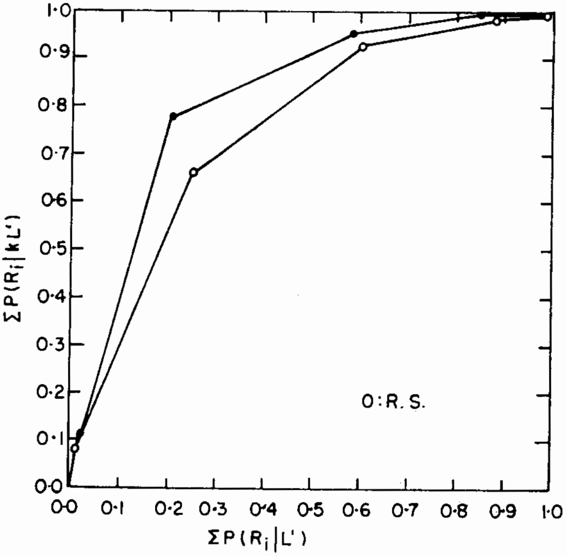


FIG. 5. R.O.C. curves for the recognition of slightly different luminances: $\Sigma P(R_i|kL')$, the cumulative proportion of responses of different categories given to the higher luminance plotted against $\Sigma P(R_i|L')$, the analogous proportion of responses given to the lower luminance. The significance of filled and empty circles is the same as in Fig. 3.

A similar plot of part of S.L.'s data would not be too revealing because in her case log L'_A and log L'_B happen not to have been increased by exactly the same amount. In order to interpret her data, as well as the rest of R.S.'s, and to evaluate quantitatively Fechner's hypothesis, we must consider measures of discriminability (or recognizability) of small luminance differences.

Statistical decision theory, when coupled with an assumption similar to Thurstone's discriminal process, provides one such measure. Let us assume that repeated presentations of the same stimulus give rise to slightly different values along a subjective scale of brightness. The observer establishes several criterial values along the scale, and responds to each stimulus presentation by comparing the elicited brightness to these criterial values. Let us further assume that the frequency distributions of brightness which result when flashes of two luminances are randomly mixed are both Gaussian and of equal variance. Then a quantity, d', can be calculated from rating-scale data such as ours, which represents the difference between the means of the two distributions, with their standard deviation as a unit. d' may be viewed as a discriminability "distance" between the luminances. We are now in a position to consider whether the relative change in log luminance of long and short flashes needed to produce a given discriminability distance equals the relative change needed to produce a given brightness distance.

Table 1 contains estimates of $d'/\Delta \log L$ for every luminance interval tested in Experiment III. The entries are means of four values obtained in different experimental sessions. For observer R.S., only the values obtained by grouping response categories "6", "5" and "4" are listed because on some days one or another category was never given to some flash luminance. The quotient, $Q=d'/\Delta \log L$, rather than d' itself, was used because we were unable, for technical reasons, to produce constant log luminance differences. This procedure assumes that d' is proportional to $\Delta \log L$ in the neighborhood of L'_A and L'_B. The assumption will be justified below.

To test for the effects of luminance level and flash duration on Q, we performed separate analyses of variance (Type I in LINDQUIST, 1956) on the entries for part B and on the row means in part A of Table 1. For both observers the effect of flash duration was significant (observer RS: $F=23{\cdot}105$, $df=1/9$, $p<0{\cdot}001$; observer SL: $F=4{\cdot}985$, $df=1/12$, $p<0{\cdot}05$).

TABLE 1

A. Observer S.L.

Response Categories

Log L — log L′	"6"		"5"		"4"		"3"		"2"		"1"	Row means
						52 msec						
0·22												
		14·30		15·25		16·28		16·05		15·25		15·43
0·12												
		11·73		12·20		13·33		13·63		13·30		12·84
0·00												
		13·58		14·55		15·58		15·90		14·48		14·82
−0·10												
		10·60		11·15		10·75		10·58		10·83		10·78
−0·21												
Column means		12·55		13·29		13·74		14·07		13·47		(13·44)
						230 msec						
0·21												
		11·93		12·23		12·78		13·10		11·80		12·37
0·11												
		11·43		13·53		13·68		13·13		13·73		13·10
0·00												
		13·33		12·33		13·78		12·43		12·23		12·82
−0·11												
		8·63		8·90		9·65		10·13		9·48		9·36
−0·20												
Column means		11·33		11·75		12·45		12·20		11·81		(11·91)

B. Observer R.S.

Log L — log L′	52 msec	230 msec
0·16		
	19·83	20·00
0·11		
	18·03	13·93
0·06		
	32·39	26·74
0·00		
	34·09	25·96
−0·06		
	26·08	25·88
−0·11		
	26·00	18·25
−0·15		
Means	(26·07)	(21·79)

Mean estimates of $Q=d'/\Delta \log L$ as a function of response criterion and luminance level. Entries in each row are based on responses to flashes of the luminances listed immediately above and below that row. To calculate the entries in each column of Part A of the table, all the response categories to the left of it were grouped together, as were all the categories to the right of it. For Part B, response categories were grouped in only one way: "6", "5", and "4" *vs* "3", "2", and "1".

Neither the main effect of luminance level nor the interaction between the two main effects approached significance. The fact that luminance level has no effect on Q substantiates an assumption made previously, namely that d' is proportional to $\Delta \log L$ in a small region around L'. On the other hand, the significant effect of flash duration is in agreement with expectations from Fechner's hypothesis when applied to the results of Experiment I: the rate of change of discriminability with log luminance is greater for 52-msec flashes than for 230-msec flashes. However, it is not sufficiently greater. The ratios of the grand means of Q_A to the grand means of Q_B (numbers in parentheses in Table 1) serve as estimates of the relative change of log luminance at 52 and 230 msec needed to produce a given discriminability "distance". The values of these quantities should be 0·67; instead their values are 0·83 and 0·89 for observer R.S. and S.L., respectively.

Before commenting on this quantitative discrepancy between theoretical predictions and data, we must consider one striking feature of Table 1. Quite consistently, the entries in the outermost columns tend to be smaller than those in the intermediate ones. The effect of response criterion cannot be similarly demonstrated in the summarized data from observer R.S., for reasons stated above. However, it was quite evident in data from individual sessions. There is little doubt that in Experiment III estimates of d' varied non-monotonically with response criterion.

DISCUSSION

Altogether, the results of these experiments do not support the Fechner hypothesis about brightness and luminance discrimination, at least not quantitatively. This failure does not necessarily imply that the hypothesis is incorrect. There are other possibilities that must be considered.

First of all, the observers' tasks in Experiments I and III were not quite comparable. In the former, they judged the relative brightness of successive flashes; in the latter, they tried to identify flashes of slightly different luminance. The failure may be due to the fact that the two kinds of judgments were not based entirely on the same internal events. Therefore, a discriminability measure based on a method like that of constant stimuli may prove more successful.

Secondly, the observers may have been guessing on a certain proportion of the trials in Experiment III. Since for each observer the values of $\Delta \log L_A$ were nearly equal to those of $\Delta \log L_B$, this guessing tendency may have had the effect of making their performance with long and short flashes spuriously similar. In this connection, it is interesting to note that the stabler, more experienced observer, R.S., behaved more in accord with the Fechner hypothesis.

A final reason for not rejecting the hypothesis is that the discriminability measure we employed may have been defective, as is indicated by the dependence of d' on response criterion described in the last section.[3] If flashes of any two fixed luminances generate internal effects that are normally distributed, then d' should either be independent of response criterion or should vary monotonically with it, depending on whether the standard deviations of the two distributions are the same or different. The data from Experiment II, like those from similar experiments on absolute and increment detection (Swets *et al.*, 1961; Nachmias and Steinman, 1963), are compatible with the assumption that the standard

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[3] Estimates of discriminability based on a very different kind of theory, Luce's choice theory (Luce, 1959) also vary non-monotonically with response criterion.

deviation of the distribution generated on "line present" trials is greater than that of the distribution generated on "line absent" trials. However, in Experiment III, d' varied non-monotonically with response criterion. So far as we know, this kind of result has not been reported before, though some work by BARLOW (1962b) may have the same implications. This surprising finding raises several unsettled possibilities: (1) statistical decision theory cannot be applied in this way to luminance discrimination; (2) it can be applied but the underlying distributions are non-normal; (3) the variation of d' is due to some unknown artifact introduced by the rating scale method when employed to study luminance discrimination.

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Abstract—Three experiments were performed to test the hypothesis that for equally bright flashes of different duration, equally discriminable luminance differences are subjectively equal. The hypothesis received qualitative support from the finding that it takes a smaller difference in the log luminance of brief flashes (52 msec) than of longer ones (230 msec) to produce either a given difference in brightness or a given discrimination performance. Contrary to the hypothesis, however, the log luminance difference of 52-msec flashes relative to that of 230-msec flashes is smaller for equal brightness differences than for equal discriminability.

Résumé—On a fait trois expériences pour essayer l'hypothèse selon laquelle, pour des éclairs également brillants de différentes durées, les différences de luminance également discernables sont subjectivement égales; l'hypothèse reçoit un appui qualitatif dans le fait qu'il faut une plus petite différence dans le log de la luminance des éclairs brefs (52 msec) que des plus longs (230 msec) pour produire soit une différence donnée de luminosité, soit une performance donnée de discrimination. Toutefois, contrairement à l'hypothèse, la différence des log luminance des éclairs de 52 msec comparés à ceux de 230 msec est plus petite pour d'égales différences de luminosité que pour une discrimination égale.

Zusammenfassung—Es wurden Experimente durchgeführt, um folgende Hypothese zu prüfen: für gleich helle Blitze verschiedener Dauer sind gleich unterscheidbare Leuchtdichteunterschiede subjektiv gleich. Diese Hypothese wurde qualitativ gestützt durch die Beobachtung, dass bei kurzen Blitzen (52 msec) ein geringer Unterschied im Logarithmus der Leuchtdichte genügt, um einen gegebenen Helligkeitsunterschied oder eine gegebene Unterscheidbarkeit zu erzeugen als bei längeren Blitzen (230 msec). Im Gegensatz zu dieser Hypothese jedoch ist für 52-msec-Blitze relativ zu 230-msec-Blitzen, der Unterschied im Logarithmus der Leuchtdichte für gleiche Helligkeitsunterschiede kleiner als für gleiche Unterscheidbarkeit.

Резюме—Были проведены три серии экспериментов для проверки гипотезы, по которой считается, что для одинаковых по яркости вспышек света различной длительности, равно-различимые разности яркостей, кажутся субьективно равными. Гипотеза находит качественное подтверждение, поскольку для того чтобы получить либо данное различие по светлоте, либо же данную характеристику различения нужна меньшая разница в логарифме яркости коротких вспышек (52 мсек), по сравнению с более длительными вспышками (230 мсек). Противоречит зтой гипотезе, однако, то, что логарифм разности яркостей вспышек длительностью в 52 мсек по отношению к таковому же для вспышек в 230 мсек меньше для равных светлотных разностей, чем для равной различимости.