C. H. AMMONS

reproduction of visually perceived forms.
91)
*ull.*, 1917, 14, 322-323. (662)
factometric technique and some results. *J.*
8)

*Perceptual and Motor Skills*, 1966, 22, 635-644. © Southern Universities Press 1966

# EFFECT OF STIMULUS RANGE, DURATION, AND CONTRAST ON ABSOLUTE JUDGMENTS OF VISUAL SIZE[1]

W. R. GARNER, GEORGE KAPLAN,[2] AND C. DOUGLAS CREELMAN[3]

*The Johns Hopkins University*

*Summary.*—Two experiments on absolute judgment of visual size were carried out with variations in stimulus range of size, exposure duration, and contrast. The results indicate that the effects of all three variables are interchangeable within limited values of each, in the sense that their effects are simply additive. Thus they can be considered to form a common class of energic variable within limited conditions. Stimulus range has an additional effect over and above these mutual effects, however, in a manner which suggests that it influences judgmental factors as well as receptor factors in absolute judgment.

In an experiment concerned with the effect of correlated dimensions (redundancy) on visual absolute judgment, Eriksen and Hake (1955b) found that discrimination accuracy, measured in bits of information transmission, increased considerably when one or two dimensions were varied along with an original one in a correlated fashion. Garner and Lee (1962), in an analogous experiment requiring judgment of patterns of Xs and Os, found no gain due to the addition of dimensions. In this latter experiment, however, the stimuli were presented at low contrast; furthermore, stimulus duration was varied and found to have a large effect.

This result led Garner (1962, p. 209) to suggest that a discrimination gain due to dimensional redundancy might not occur with very short exposure duration. In a test of this idea, Garner and Creelman (1964) confirmed the original Eriksen and Hake finding but found that the short durations they used had no appreciable effect on discrimination accuracy. These authors suggested that the discrepant results concerning the deleterious effect of limited duration might be due to different factors being responsible for errors in the two different experimental situations. They specifically distinguished between receptor-limiting factors and judgmental or response-limiting factors.

In a more explicit analysis of this problem, Garner (1965) argued that there should be a class of variables all involving energy relations in the stimuli which should be mutually operative in producing receptor-limited perception. Stimulus duration is just one such variable, and certainly stimulus contrast and the

[1]This research was done under Contract Nonr-4010(03) between the Office of Naval Research and The Johns Hopkins University. This is Report No. 14 under that contract. Reproduction in whole or in part is permitted for any purpose of the United States Government.

[2]Now at Cornell University.

[3]Post-doctoral Fellowship No. MH-12,140 from the National Institutes of Health, U. S. Public Health Service. Now at the University of Toronto.

spacing between adjacent stimuli (or the total stimulus range) are other variables governing energy relations between stimuli. It seems possible, then, that whether duration has an effect on absolute judgments should depend on whether the total energy limitation is sufficient. Certainly the fact that the only appreciable effect of duration in such experiments was found by Garner and Lee with stimuli presented at low contrast suggests that such an interrelation between energic variables does exist.

*Purpose of Experiments*

The present experiments investigated further the effect of limited duration on accuracy of absolute judgment of visual size, specifically by determining the interrelating effects of duration, contrast, and stimulus range on judgmental accuracy. In simplest form, such an interrelation would be manifested by an interchangeability of these three factors in their effects on discrimination. These experiment were designed to determine whether such an interchangeability exists.

## General Method

Two different experiments are reported here, but since the methods for both are identical in most respects, the common aspects will be described first.

*Stimuli*

*Ss* made absolute judgments of squares differing in area, using response numbers corresponding to the ordinal size of each square. The stimuli were projected onto a ground-glass screen from behind, and appeared as dark squares against a brighter surround. The range of sizes constitutes one experimental variable.

*Apparatus*

The basic apparatus and its dimensions are described in detail by Garner and Creelman (1964). As before, *S* viewed the presented stimulus through a 10-ft. tunnel and a reduction box, at the back of which the stimulus appeared. Unlike the previous experiment, however, here the stimulus was projected onto a ground-glass screen from behind the reduction box, with the duration of the exposure controlled by a shutter mounted on the projector. Incandescent lights behind the ground-glass screen provided a constant background illumination on the screen against which the dark squares (with additional surround) were projected. Stimulus contrast was adjusted by setting the aperture stop on the shutter of the projector, thus varying the brightness of the additional projected surround. The constant background brightness was approximately 60 apparent foot-candles.

*Subjects*

All *Ss* were male students, either graduate or undergraduate, at Johns Hopkins University. They were paid an hourly rate for participating in the experiment.



*Procedure*

Stimuli were presented a
warning bell sounded 3 sec. b
citation, *S* wrote his response
who then told him the correct
Each *S* was used for an a
n block of 50 randomly select
tion, after which a different e
beginning of the experiment,
judgments, and he was given
ments with a new stimulus ra
sible stimuli whenever any c
These procedures were intende

EXPERIME

*Experimental Conditions*

Three ranges of size and
binations. The durations we
sizes were used per set, and
1.85 in. on a side in steps of
from 0.485 in. to 2.100 in., in
and *Large*, from 0.17 in. to 2
2.28 in. Stimulus contrast (
100%.

Each of six *Ss* received
terbalanced across *Ss* by using
*S*. Durations were randomly
judgments under each conditi
separately for each *S* and each

*Results and Discussion*

The average information
condition are given in Tabl
though in the expected direc

INFORMATION TRANS
T

| Duration (sec.) | |
|---|---|
| .040 | |
| .020 | |
| *M* | |

*Note.*—Each information transm

*Procedure*

Stimuli were presented at the rate of approximately one every 7.5 sec. A warning bell sounded 3 sec. before each presentation. After each stimulus presentation, *S* wrote his response on a sheet of paper and also called it out to *E*, who then told him the correct response.

Each *S* was used for an approximately 1-hr. session in a day. In a session, a block of 50 randomly selected sizes was used for a given experimental condition, after which a different experimental condition was introduced. Before the beginning of the experiment, each *S* was given 2 hr. practice in making area judgments, and he was given another hour of practice before beginning judgments with a new stimulus range. In addition, *S* was shown the full set of possible stimuli whenever any change in experimental conditions was introduced. These procedures were intended to minimize practice effects.

## Experiment I: Range and Duration

*Experimental Conditions*

Three ranges of size and two exposure durations were used in all six combinations. The durations were 0.02 and 0.04 sec. Twenty different stimulus sizes were used per set, and the stimulus ranges were: *Small*, from 0.71 in. to 1.85 in. on a side in steps of 0.06 in., giving a total range of 1.14 in.; *Medium*, from 0.485 in. to 2.100 in., in steps of 0.085 in., giving a total range of 1.615 in.; and *Large*, from 0.17 in. to 2.45 in., in steps of 0.12 in., giving a total range of 2.28 in. Stimulus contrast (total surround vs darker square) was greater than 100%.

Each of six *S*s received all 6 experimental conditions. Ranges were counterbalanced across *S*s by using a different one of the six possible orders for each *S*. Durations were randomly selected within *S*s and ranges. Each *S* made 600 judgments under each condition. Information transmission in bits was calculated separately for each *S* and each condition.

*Results and Discussion*

The average information transmissions for the six *S*s for each experimental condition are given in Table 1. The effect of duration is very small, even though in the expected direction. The effect of stimulus range of size is quite

TABLE 1
Information Transmissions for Three Stimulus Ranges and Two Durations in Exp. I

| Duration (sec.) | Stimulus Range | | | *M* |
|---|---|---|---|---|
| | Small | Medium | Large | |
| .040 | 1.94 | 2.21 | 2.50 | 2.22 |
| .020 | 1.88 | 2.16 | 2.48 | 2.17 |
| *M* | 1.91 | 2.18 | 2.49 | 2.19 |

*Note.*—Each information transmission is the mean, in bits, for 6 *S*s.

great, however, with an increase of 0.58 bit obtained when the stimulus range is doubled.

This increase is less than the theoretical maximum of 1.0 bits which could come from a doubling of the range of sizes (Garner, 1962, p. 73), but it is entirely in line with the difference due to size range found by Alluisi and Sidorsky (1958). On the other hand, it is much greater than the difference found by Eriksen and Hake (1955a). The discrepancy in results is almost certainly due to the method of doubling the range of sizes. In the present experiment and in the Alluisi and Sidorsky experiment, the middle size was kept constant and the range was doubled around that. In the Eriksen and Hake experiment, the lowest size was kept constant, a method which keeps the end-anchoring effect constant for both ranges at one end.

The purpose of this particular experiment was to determine whether duration would have an effect on information transmission if the basic discrimination task were made more difficult by decreasing the range of stimulus sizes. These results showed that the decreased range did make the task substantially more difficult, but that the loss of information transmission produced by a decreased range could not be offset to any extent by an increase in duration. Thus the effect of range *per se* was not of primary interest. Rather, we needed to know that the decreased range did produce a more difficult discrimination, so that we could be sure that the previous Garner and Creelman result, showing no effect of duration, was not due to their use of a discrimination condition so easy that decreased duration was irrelevant.

The next experiment was designed to check this finding under conditions of extreme stimulus degradation by using stimuli of very low contrast.

## Experiment II: Range, Duration, and Contrast

### *Experimental Conditions*

This experiment involved combinations of three experimental variables. Two ranges of size were *Large* and *Small* from Exp. I; four exposure durations were 0.01, 0.02, 0.04, and 0.10 sec.; three contrasts were *High* (10%), *Medium* (5.6%), and *Low* (3.2%). Ten different stimulus sizes were used for each stimulus range, by using the even numbered stimuli from Exp. I. Thus the interstimulus spacing was doubled for each range.

Each of four *S*s received all 24 experimental conditions. Range was counterbalanced in an ABBA order for each *S* (two *S*s each way), and contrast was counterbalanced within each *S* and each range. Durations were randomly arranged within the other conditions. Two *S*s made 400 judgments under each combination of experimental variables, and two *S*s made 250 judgments under each.

*Calculation of information transmission.*—Information transmission was computed separately for each *S* and each condition. In this experiment, unlike



Exp. I, some very low values of infor
which makes the sampling bias of sor
estimated with the Miller-Madow c
transmission is zero. There is no bia
its maximum. There is no known cor
transmissions between zero and maxi
bias by using a linear relation betwee
calculated bias for a true transmission
transmission. This procedure is certai
rection at all, since the bias is sizable
per stimulus, for example, the bias is

A further complication occurred
for one *S* were destroyed by vandalism
sumption that all interactions were z
tained differences from the other thr
cases for this one *S*, with a correction
The assumption of no interaction will
affect the basic conclusion of the experi

### *Results and Discussion*

The results of this experiment are
data averaged across *S*s. In addition,
ried out on the individual corrected i
tive summary of this analysis is shown
accounted for by each experimental va
along with percentage of variance for i
action term involving *S*s.

*Interchangeability of effects.*—Th
attempts to answer is whether stimulus
common such that their effects are int
formation transmission is lowered by a
back to its original level by an increa
terms, this is to ask whether all main ef
account for the major portion of the
Table 2 makes clear that they do. The
ulus variables are all substantial and to
variance, while all four interactions i
account for only 3.54% of the variance
tion these three stimulus factors can
effects.

This result is in clear contrast to th
Garner and Creelman. It appears that t

Exp. I, some very low values of information transmission were obtained, a fact which makes the sampling bias of some importance. The sampling bias can be estimated with the Miller-Madow correction (Miller, 1955) when the true transmission is zero. There is no bias when the information transmission is at its maximum. There is no known correct way of estimating bias for information transmissions between zero and maximum, but for these data we estimated the bias by using a linear relation between bias and true transmission, between the calculated bias for a true transmission of zero and a zero bias for a true maximum transmission. This procedure is certainly more acceptable than making no correction at all, since the bias is sizable at low transmissions. With 25 judgments per stimulus, for example, the bias is 0.23 bits for a true transmission of zero.

A further complication occurred in that data records for seven conditions for one *S* were destroyed by vandalism. These values were estimated on the assumption that all interactions were zero, by using average experimentally obtained differences from the other three *S*s and applying them to the missing cases for this one *S*, with a correction for his average information transmission. The assumption of no interaction will be seen to lead to little error and does not affect the basic conclusion of the experiment.

*Results and Discussion*

The results of this experiment are shown in graphical form in Fig. 1, with data averaged across *S*s. In addition, a complete analysis of variance was carried out on the individual corrected information transmissions, and a descriptive summary of this analysis is shown in Table 2. The percentage of variance accounted for by each experimental variable and their interactions are shown, along with percentage of variance for individual differences and a pooled interaction term involving *S*s.

*Interchangeability of effects.*—The major question which this experiment attempts to answer is whether stimulus range, duration, and contrast operate in common such that their effects are interchangeable, so that, to illustrate, if information transmission is lowered by a decrease in contrast it can be brought back to its original level by an increase in duration. In analysis of variance terms, this is to ask whether all main effect variances are important and together account for the major portion of the variance due to experimental variables. Table 2 makes clear that they do. The three main effect variances for the stimulus variables are all substantial and together account for 65.41% of the total variance, while all four interactions involving just stimulus variables totally account for only 3.54% of the variance. Thus to a very good first approximation these three stimulus factors can be considered interchangeable in their effects.

This result is in clear contrast to the results of Exp. I and to the results of Garner and Creelman. It appears that the previous failures to find interchange-

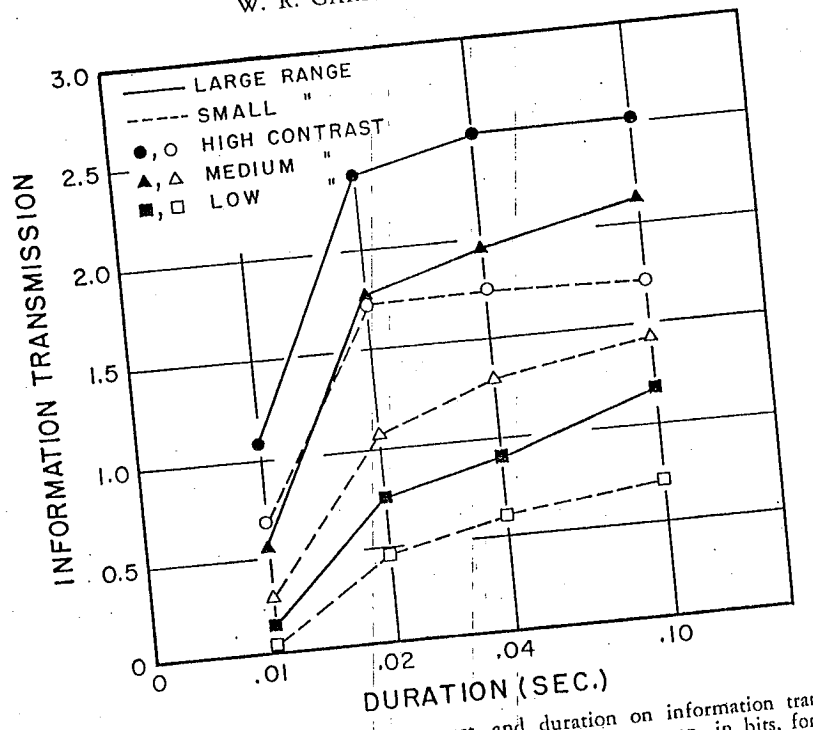



FIG. 1. Effect of stimulus range, contrast, and duration on information transmission for absolute judgments of size. (Each plotted point is the mean, in bits, for 4 Ss in Exp. II.)

ability, or to find any effect of duration, were due to the lack of sufficient overall stimulus degradation, which was produced in the present experiment by the use of low contrast.

*Lower limits to interchangeability.*—The interaction effects indicate the

TABLE 2

PERCENTAGE OF VARIANCE ACCOUNTED FOR BY THE DIFFERENT EXPERIMENTAL VARIABLES OF EXP. II

| Variable | % Variance | *df* |
|---|---|---|
| Range (R) | 8.26 | 3 |
| Duration (D) | 26.08 | 2 |
| Contrast (C) | 31.07 | 3 |
| Subjects (*S*) | 21.51 | 3 |
| R × D | 0.76 | 2 |
| R × C | 0.86 | 6 |
| D × C | 1.85 | 6 |
| R × D × C | 0.07 | 69 |
| *S*-interactions | 9.54 | 95 |
| Total | 100.00 | |



extent to which simple additive interc
are very small in this experiment. No s
actions are given because there are logi
actions must be real and larger, with a

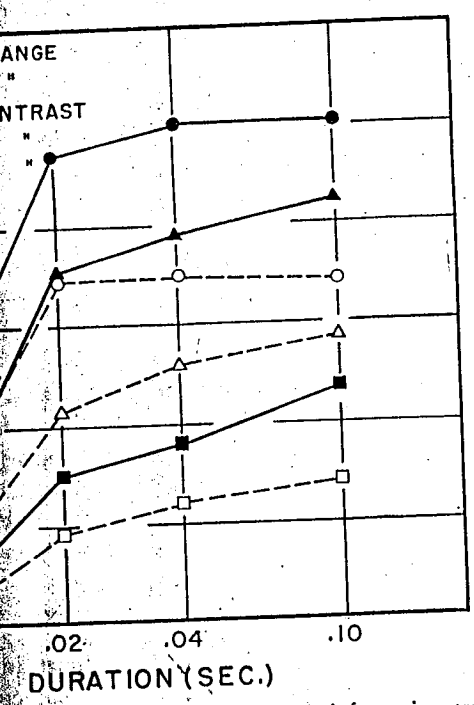
Clearly any one of these stimulus
either or both of the other two. For ex
be no effect of either duration or stimu
there can be no effect of the other tw
analysis of variance terms, that there n
experimental variables. A semblance o
Fig. 1, where the effect of stimulus ra
lowest contrast.

In similar fashion, the triple intera
cause if any one of the variables is ope
action between the other two.

*Upper limits to interchangeability*
mation transmission which must produ
certainly some over-all limit to informati
situation, regardless of the number of st
concept of a limiting channel capacity
ments have shown. But the limit produ
simple interchangeability of effects cann
so once again there is a logical basis f
small for these data, must be larger in th

In effect, in this experiment we fo
ulus variables within which simple addi
but the small interactions we obtained
extended the range of experimental co
simply wanted to determine that there is
does occur. It is therefore improper t
conditions that it will occur for all possi

*Judgmental factors with range.*—
tinct and duration shown in Fig. 1 sugg
larger values of contrast, have a commo
tion, i.e., they might have a common
seems to relate to duration differently,
that at high contrast and large range, d
0.02 sec. If contrast is decreased, how
formance up to at least 0.10 sec. Supp
stimulus range instead of contrast. Th
duration, rather, it appears simply to de
ing its shape.




ange, contrast, and duration on information transmis-
e. (Each plotted point is the mean, in bits, for 4 *Ss*

duration, were due to the lack of sufficient over-
h was produced in the present experiment by the

*ngeability.*—The interaction effects indicate the

TABLE 2

CCOUNTED FOR BY THE DIFFERENT EXPERIMENTAL VARIABLES OF EXP. II

| % Variance | *df* |
|---|---|
| 8.26 | 1 |
| 26.08 | 3 |
| 31.07 | 2 |
| 21.51 | 3 |
| 0.76 | 3 |
| 0.86 | 2 |
| 1.85 | 6 |
| 0.07 | 6 |
| 9.54 | 69 |
| 100.00 | 95 |



extent to which simple additive interchangeability does not operate, and they are very small in this experiment. No statistical significance tests for these interactions are given because there are logical factors which indicate that the interactions must be real and larger, with a wider range of stimulus conditions.

Clearly any one of these stimulus variables can limit the effectiveness of either or both of the other two. For example, if there is zero contrast, there can be no effect of either duration or stimulus range, and if stimulus range is zero, there can be no effect of the other two variables. Such limitations mean, in analysis of variance terms, that there must be interactions between all pairs of experimental variables. A semblance of this type of interaction can be seen in Fig. 1, where the effect of stimulus range is least at the shortest duration and lowest contrast.

In similar fashion, the triple interaction must be real at limiting cases, because if any one of the variables is operating at zero level, it will prevent interaction between the other two.

*Upper limits to interchangeability.*—There are upper limitations to information transmission which must produce interactions as well. There is almost certainly some over-all limit to information transmission for any given judgmental situation, regardless of the number of stimuli to be judged. In other words, the concept of a limiting channel capacity must have some validity, as many experiments have shown. But the limit produced by a channel capacity does mean that simple interchangeability of effects cannot occur when the limit has been reached, so once again there is a logical basis for arguing that the interactions, though small for these data, must be larger in the general case.

In effect, in this experiment we found a range of values for the three stimulus variables within which simple additivity (or interchangeability) does occur, but the small interactions we obtained would have been much larger if we had extended the range of experimental conditions. We did not do so because we simply wanted to determine that there is a range within which interchangeability does occur. It is therefore improper to argue from these limited experimental conditions that it will occur for all possible values of the stimulus variables.

*Judgmental factors with range.*—The nature of interaction between contrast and duration shown in Fig. 1 suggests that these two variables might, with larger values of contrast, have a common upper limit for information transmission, i.e., they might have a common channel capacity. The stimulus range seems to relate to duration differently, however. Notice in Fig. 1, to illustrate, that at high contrast and large range, duration has practically no effect beyond 0.02 sec. If contrast is decreased, however, longer durations do improve performance up to at least 0.10 sec. Suppose, on the other hand, that we decrease stimulus range instead of contrast. This change does not produce an effect of duration; rather, it appears simply to depress the entire function without changing its shape.

Garner and Creelman pointed out that judgmental factors as well as receptor-limiting factors affect information transmission with large numbers of stimulus alternatives. It may well be that the stimulus range plays a dual role in this task. As range (and thus stimulus spacing) is increased, the limits of improvement in accuracy or discrimination based on energic aspects could be reached, but the assistance provided the observer in judgmental aspects of the problem could continue to increase as range is made even greater. In any case, in the present experiment the stimulus range of judged size appears to operate both as an energic variable (thus having interchangeable effects with duration and contrast) and also as a variable affecting judgmental accuracy.

## The Nature of the Interchangeability

In this paper we have used the term interchangeability to refer to the mutual effects which two or more stimulus variables can have. We have deliberately used a term with such non-specific connotations about the nature of the mutual effects to avoid complications temporarily, but also because the exact nature of the interchangeability is less important than showing that these variables can operate as a single common class.

The analysis of variance model is one based on linear additive effects, so with a variance analysis the simplest way to answer our question about mutuality of effects was to determine how much of the total effect could be predicted by assuming simple additivity of the main effects of the separate factors. At first glance, additive interchangeability is a little surprising, because in most sensory discrimination research multiplicative functions have been found rather than additive. Some caution needs to be expressed concerning the interpretation of either an additive or a multiplicative interchangeability conceptualization in this situation.

First, it should be remembered that the dependent measure we are using is information transmission, and it is a logarithmic measure of discrimination in absolute judgment. So additivity of such a measure can be interpreted as multiplicativity with regard to the underlying variables, since the taking of logarithms changes multiplication to addition.

Second, most laws of sensory discrimination involve multiplication of actual physical values of the stimulus, such as intensity times duration, or duration times area, in visual discrimination. But the multiplicative model can be with regard to derived values (or weights) for each level of duration, contrast, range, etc., and need not be with regard to the physical measures of duration and contrast, or simple functions of these parameters. Thus to interpret these results as indicating a simple underlying multiplicative interchangeability of physical parameters is not legitimate, since the analysis only shows that there exists for each level of each stimulus variable a value which can be used as a multiplier. It does not show that any particular functions of the actual durations and contrasts are the multipliers.



Third, the multiplicative model may
general model for such processes. Garn
model, in which

$$IT = \tfrac{1}{2} \log_2 [V$$

$IT$ is information transmission and $V'(\overline{S})$
the inherent discriminability of the stimu
normalized error term.

The term $V'(\overline{S})$ is a multiplicative f
criminability in the given situation, of wh
(three experimental factors plus individual

If $V'(\overline{S})$ is large compared to the un
reduce to simple additivity of the $IT$ me
series of multipliers is the same as to add
compared to the unit normal error, a simple
mission measures is no longer appropriate.

This general model was used to fit th
cative parameter was estimated for each le
transmissions were then computed from th
ns a fit which used only the main effects
seems highly likely that the model describe

Nevertheless, we have presented data
it is just as parsimonious (the same numb
the data in either case); because there is no
at low values of information transmission;
concept of analysis of variance is more wid

## Conclusi

The necessity for distinguishing betwe
factors in this type of absolute judgment ex
Myers, and Grant (1955) had shown that d
on the accuracy of radial location of a stimu
Thus they had shown that factors other thar
limit accuracy of localization. Garner and C
mental accuracy could be improved by the a
mension, even when increasing the duration
such effect. And the first experiment report
range of judged sizes can improve judgment
where duration has no such effect.

These experiments all suggest that facto
of the judged stimuli (the energic variables)
factors such as redundant stimulus dimensions

Third, the multiplicative model may be only an approximation to a more general model for such processes. Garner and Lee actually present a general model, in which

$$IT = \tfrac{1}{2} \log_2 [V'(\overline{S}) + 1]. \qquad [1]$$

$IT$ is information transmission and $V'(\overline{S})$ is an hypothetical variance related to the inherent discriminability of the stimuli. The added factor of 1 is a unit normalized error term.

The term $V'(\overline{S})$ is a multiplicative function of all factors which affect discriminability in the given situation, of which there are four in our experiment (three experimental factors plus individual differences).

If $V'(\overline{S})$ is large compared to the unit normal error, then this model will reduce to simple additivity of the $IT$ measures, since to take logarithms of a series of multipliers is the same as to add them. If, however, $V'(\overline{S})$ is small compared to the unit normal error, a simple additive model for information transmission measures is no longer appropriate.

This general model was used to fit the data of Exp. II. A single multiplicative parameter was estimated for each level of each variable, and information transmissions were then computed from these. The fit to the data is as good as a fit which used only the main effects from the analysis of variance, and it seems highly likely that the model described in Eq. [1] is quite acceptable.

Nevertheless, we have presented data in analysis of variance form because it is just as parsimonious (the same number of parameters are estimated from the data in either case); because there is no real difference in the models except at low values of information transmission; and because the simple additivity concept of analysis of variance is more widely understood.

## Conclusion

The necessity for distinguishing between judgmental factors and receptor factors in this type of absolute judgment experiment is quite clear. Leibowitz, Myers, and Grant (1955) had shown that duration and brightness had no effect on the accuracy of radial location of a stimulus if the stimulus was seen at all. Thus they had shown that factors other than energic properties of the stimulus limit accuracy of localization. Garner and Creelman (1964) showed that judgmental accuracy could be improved by the addition of a correlated stimulus dimension, even when increasing the duration of the stimulus to be judged had no such effect. And the first experiment reported here showed that increasing the range of judged sizes can improve judgmental accuracy, again under conditions where duration has no such effect.

These experiments all suggest that factors which affect the basic visibility of the judged stimuli (the energic variables) function entirely separately from factors such as redundant stimulus dimensions and range of stimulus sizes, which

affect only the judgmental process. The second experiment reported here shows that such a simple conclusion is not valid, because there are conditions under which stimulus range can function interchangeably with the variables of duration and contrast. For example, if judgmental accuracy is decreased by a reduction of stimulus range, it can be brought back to its original level by an increase in duration and contrast, at least within limited values of these. Still further, Lockhead (1966) has shown that the addition of a redundant stimulus dimension can be used to offset a loss in discrimination produced by a decrease in stimulus energy, again within limited conditions.

Thus there are factors which can primarily affect judgmental accuracy and appear to operate independently of factors which produce receptor limitations. But these same factors can be interchanged with receptor-limiting factors, so the two processes are not entirely independent. The primary distinguishing characteristic of the factors which affect judgmental accuracy is that they continue to function under conditions where purely energic variables no longer have any effect. Thus there is a hierarchy of factors affecting accuracy of absolute judgment: first, there are factors which produce receptor limitation, and these will have effects on accuracy only when total energy limitations are fairly severe; then there are factors which affect judgmental processes, and such factors can operate both when there are receptor limitations and when there are no receptor limitations.

## REFERENCES


ALLUISI, E. A., & SIDORSKY, R. C. The empirical validity of equal discriminability scaling. *J. exp. Psychol.*, 1958, 55, 86-95.

ERIKSEN, C. W., & HAKE, H. W. Absolute judgments as a function of stimulus range and number of stimulus and response categories. *J. exp. Psychol.*, 1955, 49, 323-332. (a)

ERIKSEN, C. W., & HAKE, H. W. Multidimensional stimulus differences and accuracy of discrimination. *J. exp. Psychol.*, 1955, 50, 153-160. (b)

GARNER, W. R. *Uncertainty and structure as psychological concepts.* New York: Wiley, 1962.

GARNER, W. R. Data presentation. In F. A. Geldard (Ed.), *Communication processes (Proceedings NATO Symposium on Human Factors, Washington, 1963).* New York: Pergamon, 1965. Pp. 44-49.

GARNER, W. R., & CREELMAN, C. D. Effect of redundancy and duration on absolute judgments of visual stimuli. *J. exp. Psychol.*, 1964, 67, 168-172.

GARNER, W. R., & LEE, W. An analysis of redundancy in perceptual discrimination. *Percept. mot. Skills*, 1962, 15, 367-388.

LEIBOWITZ, H., MYERS, N. A., & GRANT, D. A. Radial localization of a single stimulus as a function of luminance and duration of exposure. *J. Opt. Soc. Amer.*, 1955, 45, 76-78.

LOCKHEAD, G. The effects of dimensional redundancy on visual discrimination. *J. exp. Psychol.*, 1966, in press.

MILLER, G. A. Note on the bias of information estimates. In H. Quastler (Ed.), *Information theory in psychology.* Glencoe, Ill.: Free Press, 1955. Pp. 95-100.


*Accepted February 28, 1966.*

*Perceptual and Motor Skills*, 1966, 22, 645-646. © So

# POINTS OF VIEW IN THE PERCEPT
# EXPRESSIONS OF EMOT

W. BRUCE HASLAM AND DARHL
*Brigham Young University*

*Summary.*—65 *Ss* rated each of 20 facial emoti
ential scales. An obverse factor analysis was compl
yielded dimensions of viewpoint associated with the
sions of emotion. Six of seven significant dimension
by significant correlations of the individual coefficien
other personality variables.

In interpersonal situations each individual provides cu
guiding the course of their interactions. Facial expressions
emotions of others. A number of studies have been perfor
of judgments of facial expressions of emotions (7, 8, 9, 13)
are easier to judge accurately than others and that *Ss* vary
emphasis in research on the perception of others has shif
accuracy of such perceptions to concern with the processes
made (2). The present research studied relationships bet
characteristics and his perception of expressed facial emot
different facial expressions of emotion, and the data were
determine factors which represent idealized points of view
of the facial expressions. The obtained points of view were
with several personality measures obtained from *Ss*.

*Method.*—Sixty-five psychology students at Brigham Y
*Ss* rated 20 facial emotions on each of 20 semantic differenti
facial emotions were selected from a series of facial expressio
and Schlosberg (6). *Ss* indicated their sex, age, class in co
average, and they completed a number of personality measur
as to the extent to which it involved the study of human
Scale, measuring authoritarianism (1) and the Negative Cal
Pedersen (11) to assess acquiescent response set were admini
Tolerance-Intolerance of Ambiguity Scale (3), the Social
Category Width Scale (12), and the Personality Inventory
disposition (emotional instability), rhathymia (happy-go-lu
(introspectiveness), cooperativeness, extraversion, and neurotic

Twenty ratings on the semantic differential were made
emotions, yielding a total of 400 ratings for each *S*. These
matrix of correlations between *Ss*, which was analyzed using a
over individuals (4). The significant factors were rotated, an
lent points of view in the perception of facial emotions.
factors, intercorrelations were obtained between the individual
on each resultant factor and *Ss*' personality data.

*Results.*—The factor analysis resulted in 37 unrotated fa
total variance. Factor I accounted for 51.1% of the varianc
accounted for 4.7%, 4.0%, 3.9%, 3.4%, 2.9%, and 2.8% o
The first seven factors were retained for rotation.