# EFFECTS OF PRACTICE ON ESTIMATES OF ADAPTATION LEVEL

by

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# EFFECTS OF PRACTICE ON ESTIMATES OF ADAPTATION LEVEL

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# PREFACE

A great deal has been written and published by psychologists about the many phenomena underlying the judgment process. Adequate quantification has been lacking in most descriptions of such phenomena as the effects of anchor stimuli and contextual stimuli; the asymmetry of judgments of a series of stimuli; the effects of an observer's personal experiences before the experiment; and the observer's adjustment to new stimuli. Adaptation level theory as originated by Helson (1947) appears to offer the most promise for quantified description and explanation for judgment phenomena.

This study represents a small part of the research involving the judgment process and scaling techniques being conducted at Oklahoma State University. It is hoped that this study will contribute to a better understanding of the principles underlying judgment.

Deepest and most sincere gratitude and appreciation are extended to Dr. W. W. Rambo for his most valuable guidance and assistance in this study. Also, indebtedness is acknowledged to Dr. H. K. Brobst and Dr. R. J. Rankin for their assistance and counsel.

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# EFFECTS ON PRACTICE ON ESTIMATES OF ADAPTATION LEVEL

Adaptation level theory as originated by Helson (1947) has been an attempt to account for the many phenomena involved in judgment. As set forth by Helson (1959) all behavior including judgment consists of acts of adjustment to external and internal forces. Quantitative treatment of organization and patterning of behavior is possible since it is dependent upon the adjustment level of the organism to the conditions confronting it at any time. Thus, Helson postulates that all behavior centers about the adaptation level which depends upon interaction of all stimuli confronting the organism, and between present and past stimulation. Since all dimensions of present and residual stimuli are pooled to form a single level to which all responses are referrable, this level is called adaptation level.

While the concept may be considered an intervening variable, it differs from many intervening variables in being operationally defined in stimulus terms (Helson, 1959). Tresselt (1948) was able to successfully evaluate the effects of previous experience by using 36 professional weight lifters and 36 professional watchmakers as subjects. The results showed that the means of weights that professional weight lifters called "medium" were systematically higher than those for students. The means of weights judged "medium" by the watchmakers were not very different from those of the students.

Every response represents in varying degree either a positive, neutral, or negative adjustment of the organism. Every response continuum then contains a neutral or transitional region corresponding to the adaptation level of the organism. The significance of this neutral region is illustrated by a study by Bishop (1940) who found that school teachers and college students ordered asocial acts essentially the same as prison inmates, but the point at which the groups separated good from bad acts differed importantly. The individual raters own position determined whether the items were rated near the favorable or unfavorable ends of the scale.

Stimuli operative in all behavior and which pool to form adaptation level are divided into three general classes: (1) the stimuli in the immediate focus of attention; (2) all other stimuli immediately present and forming a background or context for focal stimuli; and (3) residual effects of all pertinent past experiences and constitutional and organic factors. Adaptation level is approximated as a weighted log mean of all stimuli affecting the organism. Following Helson's general principle, we have an equation in logrithmic form (Guilford, 1954).

$$\log A_e = m \log A_p + n \log A_c + e \log \overline{S}_i$$

Where log:

$A_e$ = adaptation level as determined empirically.

$A_p$ = adaptation level at the time the experiment begins, where the subscript stands for "past".

$A_c$ = adaptation level that would be set up by the contextual stimuli only, where the subscript stands for "contextual".

$\overline{S}_i$ = a geometric mean of the series of judged stimuli.

m, n, and e = weights to be applied to the logrithms of the stimulus effects $A_p$, $A_c$, and $\overline{S}_i$, respectively, their sum being unity.

Where the influence of past experience and/or contextual stimuli are regarded as negligible either or both terms $A_p$ and $A_c$ may be dropped from the equation. For example, if past experience is regarded as negligible, we have:

$$\log A_e = n \log A_c + e \log \overline{S}_i$$

with the requirement $n + e = 1$, we may solve the two simultaneous equations in order to obtain an estimate of the magnitude of these weighting constants. Hence, once $A_e$ is obtained, one is in a position to assess the relative importance of standard stimuli and the judged or series stimuli to the judgment distribution generated by the subject. As weights m and n approach zero, e approaches 1.0, and the adaptation level $A_e$ becomes the geometric mean of $S_i$.

Presumably, the adaptation level for a particular judgment scale would be established upon the first presentation of a stimulus series and remain unchanged should the same stimulus series be repeatedly presented for judgment. In his discussion of scale formation and revision, Guilford (1954) states that the observer goes through a period of adjustment on any scale and that adjustment is a phenomenon of learning. Thus, if a presentation of a series of stimuli is defined as a trial, the first trial would yield extremely variable responses and with succeeding trials, learning would proceed until responses are fairly stable. Adaptation level, itself, then, must change as learning takes place during repeated trials. Whatever changes may take place among variables influencing the observer's adjustment during formation of a judgment scale, adaptation level by definition must also change.

Helson (1959) recognizes that adaptation level is influenced by the learning process. He views learning as the modification of behavior resulting from experience or practice and as a matter of relative contributions of residuals and present stimulation. He regards the structure of insight learning versus mechanical learning as relative contributions of focal and contextual stimuli on the one hand versus residual stimuli on the other hand. This provides a convenient explanatory system, but is deficient from a quantitative consideration. The quantitative aspects of the theory have been limited to situations where influence of past experience have been completely ignored, assumed to be negligible, or at any rate, not expressed quantitatively. For instance, the general approach to adaptation level has been averaging the responses and computing regression of average responses on the log mean of the stimulus values. Such averaging tends to obscure immediate past experience variables that define the dimensions of the judgment task.

It is the purpose of this study to demonstrate the change in adaptation level over repeated trials and to make a quantified description of that change in order to predict adaptation level on any particular trial during scale formation. Adaptation level estimate will be obtained from an extended series of trials and a function will be fitted to these data in an attempt to develop a quantitative expression describing the regression of adaptation levels over trials.

# METHOD AND PROCEDURE

SUBJECTS: The subjects were 108 undergraduates who were enrolled in sections of Introductory Psychology, Oklahoma State University. Approximately 75 percent of the subjects were women.

MATERIALS: The stimulus material used in this study was groups of dots 9/32 inches in diameter which were drawn in black india ink on a $3\frac{1}{2}$ x $5\frac{1}{2}$ inch white field. The patterning of the dots on each card was determined unsystematically.

For each judged stimulus series, there were nine cards on which appeared 5, 7, 10, 13, 18, 24, 32, 45, or 65 dots. For each deck of judgment cards, each of the nine dot groups was reproduced five times with an attempt being made to vary unsystematically the patterning of dots each time the group was reproduced, therefore, the series stimuli in each deck consisted of 45 cards.

PROCEDURE: One of the difficulties associated with a study of this type is the rapidity of scale formation. Tresselt and Volkmann (1942) and Tresselt (1947) demonstrated the tendency of judgments to stabilize after four to six responses. The usual procedure of adaptation level theory defining a trial as a complete series of stimuli tends to obscure the changes that take place in formation of the judgment scale. In order to show the changes taking place in scale formation, this study employs a latin square design. This procedure permits definition of a trial as a complete series of stimuli, but by summing across columns, the complete series is represented by the first stimulus card presented all subjects.

The study employed nine groups each containing twelve randomly assigned subjects. The arrangement was such that for each of the groups, every nine trials represented a complete presentation of the series. Each subject was presented five complete series, a total of 45 stimuli. Each group was randomly assigned a series order of stimuli based on a latin square design so that each stimulus card was presented in one of the groups in each of the nine positions in the series, i.e. each of the nine stimulus cards was presented once and only once in each of the nine ordinal positions. By summing across columns (groups), the entire stimulus series was represented upon each card presentation in each of the nine groups. For example, the presentation of the first stimulus card to each group yields a complete stimulus series with each of the nine stimulus cards represented in one or another of the nine groups. Similar design was used by Tresselt (1947). Further support is given to averaging responses across subjects by Tresselt and Volkmann (1942). Included, then, in each cell of the latin square was the average response made by twelve subjects. The regression of the average responses on the log of the stimulus values was then determined. The reader should be aware that this regression analysis extended across the nine groups.

The assumption is also made in using a latin square design that the form of the function is independent of serial order. Support for this assumption was found in an unpublished study by Rambo (1962). The design was essentially the same as used in this study. Exceptions were that the subjects were given nine response alternatives instead of seven and although the stimulus cards were similar to those used in this study, a different serial order of presentation was used. Results indicated that a function similar to that obtained in the present study quite adequately fit the data.

Subjects were brought into the experimental room and were asked to look down a viewing tube 12 inches long which connected with the viewing aperture of a Tachitron model tachistoscope. This viewing tube was mounted in a 36 x 33 inch plywood partition which obscured the experimenter and experimental materials from the direct view of the subject. Instructions were read aloud by the experimenter while subjects read the instructions which appeared on the viewing screen of the tachistoscope. Details of the instructions may be found in the Appendix. Subjects were instructed to judge along a seven category scale, the numerousness of the dot groups which were exposed on the viewing screen of the tachistoscope. Cards were exposed for a . 1 second and there was an approximate 5 second interval between successive exposures.

Two cards containing groups of numbers were presented prior to presentation of the experimental series to familiarize the subjects with the exposure rate and need to attend carefully. Subjects were instructed not to attempt judgment on the two practice trials. Each subject received a booklet on which appeared one seven category scale for each judgment. Three of the categories, i. e. the center and the two extremes, were appropriately labeled very large, very small, and average and the subjects responded by checking the category which was judged appropriate for the stimulus exposed. The subjects were instructed to regard labeled categories merely as indications of scale direction and not meaning they should be checked more or less frequently than unlabeled categories.

Criteria for rejection of data were: (1) failure to check a scale; (2) more than one check on a scale; (3) checks on lines dividing categories rather than within categories; and (4) obvious inversions of scale values on five or more scales or on a number of successive scales which would indicate the subject may have skipped a scale, thereby placing scale values in inappropriate order, or had failed to understand instructions.

## RESULTS

In the analysis of the data, the usual operations of fitting a line to the regression of the average responses on the log of the stimulus magnitudes for each of the forty-five stimulus card presentations were carried out. It will be recalled that by average responses is meant that each cell of the latin square represents the average of twelve responses, also in going across groups each of the forty-five presentations represents a complete series of stimulus values. From each of these trials, an estimate was made of the adaptation level, therefore, these values might be best interpreted as a composite or group adaptation level.

The procedure used for solving for adaptation level follows that outlined by Guilford (1954) which involves an equation derived from the Michels and Helson (1949) modification of the Fechner Law. The Fechner logrithmic relationship of stimuli in determining adaptation level being consistent with Helson's principle of using geometric means in his equations.

In order to apply Helson's general equations to empirical data, it is necessary to assume that from judgments we have psychological values of R on an interval scale. In this study, a seven category scale was used for judging numerousness of dots with arbitrary scoring weights of one to seven assigned to response alternatives. The neutral response being 4.00.

The equation used:

$$AL = \frac{R_a - a}{b}$$

where

AL = adaptation level or that level of X that yields an average response of 4.00.

$R_a$ = the psychological scale value corresponding to the neutral judgment. In this study, 4.00.

a and b = regression constants.

The resulting forty-five adaptation level estimates were plotted against trials. This plot is presented in Figure 1. The rapid acceleration over the early trials and then a gradual leveling off or stabilization will be noted from this plotting.

Inspection of the general trend of this plotting suggested that a hyperbolic function should be appropriate for the data. In this case, a plot of the reciprocals of trials and adaptation levels should yield a linear trend. Therefore, if a straight line could be fitted to the data, and this fit appeared adequate, then this could imply that a hyperbolic function was appropriate for the data. The general form of the equation for ordinary hyperbolas is:

$$Y = \frac{X}{a + b\ X}$$

This equation may also be written:

$$\frac{1}{Y} = a \frac{1}{X} + b$$

and is linear in 1/Y and 1/X, the reciprocals of Y and X; and a plot of the reciprocals yields a straight line. In this case, a is the slope of the reduction line and b is the intercept.

Solution for the constants yielded values a = .0483 and b = .0472 so the equation for the reduction line becomes:

$$\frac{1}{Y} = .0483 \frac{1}{X} + .0472$$

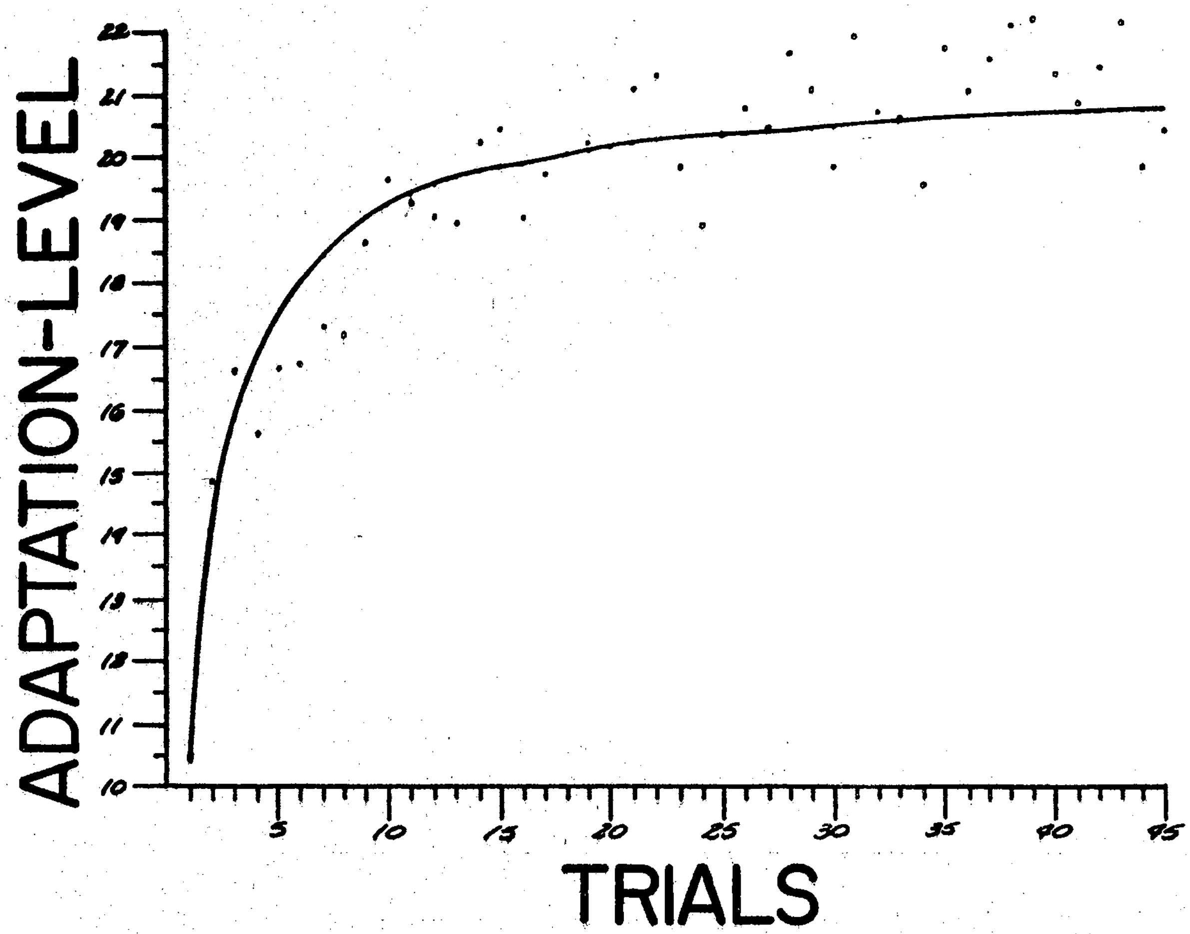


Figure 1

Expected adaptation level curve superimposed on plots of obtained estimates of adaptation level and trials.

This equation reflects a least squares linear function for the data transformed into reciprocals of X and Y, however, these constants transformed into the hyperbolic equation in X and Y do not provide a least squares estimate. Assessment of the adequacy of the straight line for the reciprocal data can nevertheless be used as support for the hyperbolic transform. Part of this assessment consisted of testing the regression constant to determine whether it deviates significantly from a line with zero slope. A t test is used with n - 2 degrees of freedom. For the present regression weight, it was found that the data was significant at the .001 level. Therefore, we may conclude that adaptation level does change significantly over trials. In order to demonstrate the closeness of fit for the reduction line a Pearson r was computed the square of which is the index of determination. This value reflects the proportion of variance shared by X and Y. For the present data, this index had a value of .92 indicating a rather close fit.

The equation for the hyperbolic curve is:

$$AL = \frac{X}{.0483 + .0472X}$$

Predicted adaptation level values (AL) were computed for each of the forty-five trials by using the above equation. These values may be found in Table I and compared with obtained adaptation level estimates. As an index of goodness of fit, a standard error of estimate was computed and found to be .867.

For hyperbolic curves, the Y asymptote is given by 1/b, in this study 21.19. Since adaptation level estimates become fairly stable at this point, this value may be regarded as an estimate of overall adaptation level. Adaptation level according to Helson's theory, i.e. ignoring contextual stimuli and residual effects, would be the geometric mean of the stimulus values. This was found to be 17.85.

TABLE I

THEORETICAL AND OBTAINED ADAPTATION LEVEL VALUES FROM FORTY-FIVE JUDGMENTS

| Trials | $AL_o$ | $\hat{AL}$ | $(AL_o - \hat{AL})^2$ |
|---|---|---|---|
| 1 | 10.50 | 10.47 | .00 |
| 2 | 14.88 | 14.02 | .74 |
| 3 | 16.59 | 15.90 | .62 |
| 4 | 15.60 | 16.87 | 1.61 |
| 5 | 16.64 | 17.59 | .90 |
| 6 | 16.63 | 18.10 | 2.16 |
| 7 | 17.31 | 18.48 | 1.37 |
| 8 | 17.23 | 18.78 | 2.40 |
| 9 | 18.63 | 19.02 | .15 |
| 10 | 19.64 | 19.22 | .18 |
| 11 | 19.29 | 19.38 | .01 |
| 12 | 19.06 | 19.52 | .21 |
| 13 | 18.99 | 19.64 | .42 |
| 14 | 20.26 | 19.74 | .27 |
| 15 | 20.45 | 19.83 | .38 |
| 16 | 19.01 | 19.91 | .81 |
| 17 | 19.71 | 19.98 | .07 |
| 18 | 20.04 | 20.05 | .00 |
| 19 | 20.22 | 20.10 | .01 |
| 20 | 20.18 | 20.16 | .00 |
| 21 | 21.07 | 20.20 | .76 |
| 22 | 21.32 | 20.24 | 1.17 |
| 23 | 19.85 | 20.28 | .18 |
| 24 | 18.98 | 20.32 | 1.80 |
| 25 | 20.39 | 20.35 | 1.08 |
| 26 | 20.77 | 20.38 | .15 |
| 27 | 20.48 | 20.41 | .00 |
| 28 | 21.61 | 20.44 | 1.37 |
| 29 | 20.54 | 20.46 | .01 |
| 30 | 19.84 | 20.49 | .42 |
| 31 | 21.95 | 20.51 | 2.07 |
| 32 | 20.69 | 20.53 | .03 |
| 33 | 20.60 | 20.55 | .00 |
| 34 | 19.54 | 20.57 | 1.06 |
| 35 | 21.70 | 20.58 | 1.25 |
| 36 | 21.03 | 20.60 | .18 |
| 37 | 21.55 | 20.62 | .86 |
| 38 | 22.06 | 20.63 | 2.04 |
| 39 | 22.13 | 20.64 | 2.22 |
| 40 | 21.36 | 20.66 | .49 |
| 41 | 20.89 | 20.67 | .05 |
| 42 | 21.47 | 20.68 | .62 |
| 43 | 22.10 | 20.69 | 1.99 |
| 44 | 19.77 | 20.70 | .86 |
| 45 | 20.40 | 20.71 | .10 |

## DISCUSSION

In a study by Tresselt and Volkmann (1942) each of the one-hundred and twenty subjects made one judgment of heavy, medium, or light upon each of twelve weights. The order of presentation was such that the twelve weights were lifted with equal frequency in each of the twelve serial positions, from the first weight lifted to the twelfth. It was found that the frequency of medium judgments in the first ordinal position were widely distributed. By the time the subjects had lifted four weights, however, their medium judgments were much less widely distributed. When the fourth and twelfth positions were compared, it was found that the data of the fourth position were no more widely distributed than those of the twelfth. The responses would appear to have stabilized well by the fourth position.

Tresselt (1947) used a similar design to study the effects of practice on scale formation. Groups were given varying numbers of practice trials with weights varying in magnitude for each group, and after a time lapse were required to judge the series of weights in a manner similar to the study above. The frequency distribution of judgment of medium narrowed considerably at the sixth position indicating stability of responses at this point.

The present study is consistant with these findings in that the scale tended to stabilize early. It is doubtful, however, that complete stability occurs as early as the fourth or sixth trial. Inspection of the plotting of adaptation level estimates and trials in this study reveals that the curve tends to flatten, indicating stability of response, at about the tenth to the twelfth trials. It is possible that this might be a function of the number of response alternatives made available to the observers. The present study used a scale of seven response alternatives as compared with three used in the weight lifting studies.

In comparing the data resulting from the present study with that reported by Tresselt (1947), it is apparent that these data vary a great deal less. Graphs for each of her experimental groups show that with continued stimulation and judgment the mean weight judged medium, approach the center of the stimulus-range, but that the approach is not a smooth and steady process. Extremely irregular trends are apparent and for some groups curve inversions occur, particularily after the sixth serial position. Differences in regularity of curves of the two studies may be due to the fact that she used only part of her data, namely, mean stimulus judged medium while this study utilized all data. Basis for comparison of these studies exists, in that by representing the center of the judgment scale by the mean weight judged medium, she is approximating adaptation level as described by Helson (1947). It will be recalled, however, that the adaptation level as computed in the present study utilized regression techniques which include all observations.

This study is fundamentally oriented toward the learning variables that influence adaptation level. Since Noble (1954) and Thurstone (1919) were able to effectively use the hyperbolic functions to describe learning phenomena, it was felt that some support is given to selection of the hyperbolic function for this study. This does not, however, conclusively demonstrate that the variation noted among the observations is to be attributed entirely to learning. It only offers one source of support.

Adequacy of fit of the hyperbolic function to these data is indicated by the standard error of estimate of .867 and a correlation, r = .96, which is significant at the .01 level.

It is felt that the quantitative procedures used in the present study to estimate a stable adaptation level offer an interesting extension to adaptation level theory. The usual procedure under Helson's adaptation level theory has been determination of adaptation level estimates as weighted log means of stimuli impinging upon the organism. The stimulus classes generally included in this weighted log mean equation are focal, contextual and residual or past experience stimuli. This procedure is open to some difficulty since previously it has been difficult to obtain a notion of relative weight carried by these classes of stimuli and to obtain estimates of the change in these weights over trials. It is suggested that the asymptote of the adaptation level estimates, as indicated in this study, may be a better estimate of stable or terminal adaptation level by taking into account the learning process in addition to the situational stimuli. It is granted that the adaptation level will not remain static, but will fluctuate as a result of the constantly changing stimulus situation. It is, however, of considerable theoretical interest to be able to estimate the terminal adaptation level value.

Support is found for this study from an independent study by Rambo (1962). The two studies, while independent, employed the same design with important exceptions of differing response alternatives and serial order of presentation, produced virtually the same results. In fact, Rambo's data were even more adequately accounted for by the hyperbolic function.

These findings suggest further study into the shift of adaptation level at various points in the trials by shifting the magnitude of the stimulus series, thus relating learning to situational stimulation. It is suggested that the focal stimuli in themselves, produce an anchoring effect in form of the central tendency phenomenon. In this light, it would be of interest to study the effects of systematically varying a standard stimulus in both magnitude and frequency of presentation.

## SUMMARY

One-hundred and eight subjects were divided randomly into nine groups of twelve each. Each subject was presented a deck of stimulus cards on which appeared varying numbers of black dots. The stimulus cards were presented for .1 second and the subjects were instructed to judge the numerousness of each of the dot groups on a seven category response scale.

Each deck of stimulus cards consisted of five series of nine dot groups. A latin square design was employed wherein each of the nine groups was randomly assigned a different serial order of stimulus values, i.e. each stimulus was presented to one of the groups in each of the nine ordinal positions in the series. By using a latin square design, a single presentation to all nine groups represented the entire series of stimuli and was defined as a trial. Thus, a total of forty-five trials was involved and adaptation level estimates were computed across columns (groups) for each trial. This procedure permitted demonstration of changes occurring by trials during formation of the judgment scale.

Adaptation level estimates and trials were plotted and it was determined that a hyperbolic function would fit the data. Reciprocals of adaptation level estimates and trials were plotted yielding a reasonable approximation of a straight line fit. Goodness of fit was demonstrated by a standard error of estimate of .867.

Results indicate that adaptation level is a changing phenomenon during scale formation and can be predicted on any particular trial. The

asymptote of adaptation level estimates is a prediction of overall adaptation level, which may prove to be more accurate than usual computational procedures by accounting for learning in scale formation as well as stimuli present in the situation.

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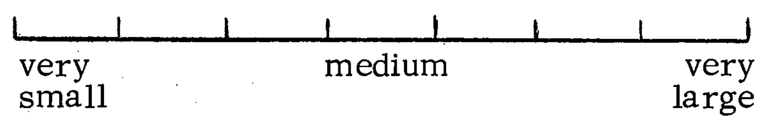
# APPENDIX

## INSTRUCTIONS

(Card 1)

I am going to flash on this screen a series of cards on which will appear groups of dots. The cards will vary in terms of the number of dots making up each group, and I want you to judge the number of dots in each group. In order to make your task easier, you will be provided with a series of categories which you may use to express your judgments. These categories form a judgment scale which is presented below.




(Card 2)

When a card appears, I want you to judge the category which best accounts for the number of dots in the group. On the sheets that you have in front of you, there appears one of these category scales for each judgment you will be asked to make. Express your judgments by putting a check mark in the category which you feel best describes the numerousness of the dot group.

The fact that only three of the categories are labeled does not mean that these categories should be used more or less frequently than the unlabeled ones. These labels merely show the direction in which the scale runs.

When a card appears, check the category that most closely corresponds with your judgment - then move down to the next response scale.
(Card 3)

I am now going to present a few practice cards on which will appear groups of numbers. This is to acquaint you with the exposure rate that will be used. There is no need to write down judgments for these practice cards.

You will see from these trials that you will have to attend carefully or you will be unable to see the stimuli.
(Card 4)

1. Before each card is presented, I will signal you with the number of the scale that you should be using. Make sure that you put ONLY ONE judgment on each scale, and make sure the scale that you check corresponds with the number I read.

2. Put down the first response that comes to you. Do not think a long while about each judgment.

3. Do not erase after you have made a response.

4. Place your check mark in the middle of the category you select and not on the line separating the categories.

5. Be careful that you place only one check mark on each scale.

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