# INDIVIDUAL DIFFERENCES IN VISUAL FIGURAL AFTER-EFFECT

by

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A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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August 1960

TABLE OF CONTENTS

TABLES

I

## INTRODUCTION

In an article on binocular perspective, Verhoff (1925) made passing mention of his observation that if the centre of a bent line were viewed "steadily with one eye for a short time" and the eye then fixed on a straight line, the latter appeared bent in the opposite direction. Verhoff suggested that this effect might be due to "unconscious mental comparison" of the second line with the after-image of the first.

Gibson (1933) found that Ss who had worn lenses which made verticals appear curved remarked, on removing the glasses, that verticals now appeared curved in the opposite direction. Gibson and his co-workers (Gibson, 1937a, 1937b, 1937c, 1939; Vernon, 1934; Radner and Gibson, 1935) named this illusion the tilted line effect. They showed that it was limited to the previously stimulated portion of the visual field, that its appearance was not prevented by the use of one eye for the inspection stimulation and the other for the test stimulation, and that similar distortions appeared in kinesthesis.

Kohler and Wallach's (1944) monograph argued that these illusions could be included in a broader class of events which the authors called "figural after-effects." In general terms, figural after-effect is the effect of a previous stimulus on the perception of a subsequent stimulus. It commonly involves comparison of responses to stimulation of a receptor area before and after a period of continuous stimulation of that area. If the second response shows that the stimulus has been subjectively distorted or has become subjectively less intense, or more distant, figural after-effect is said to have occurred.

Individual differences in this illusion were mentioned as incidental findings by several authors (e.g., Hammer, 1949; Prentice, 1950; Kohler, 1951; Fox, 1951; Krauskopf, 1954; Seagrim and Grenot, 1956). The theoretical importance accorded the effect as an index of cortical processes led to the investigation of individual variations as possible correlates of a variety of constitutionally determined traits. It was hoped that the figural after-effect response might serve as an index of some underlying brain-action variable.

However, individual response measurement requires tests which meet accepted criteria of reliability, internal consistency, and discriminability. If the testing instruments have unknown or inadequate psychometric properties, the results of their use cannot be interpreted clearly. Laboratory techniques of unknown psychometric worth have most often been used in differential figural after-effect studies. Some authors (e.g., Spitz and Lipman, 1960) have made sure of the reliability of their methods, but attempts at standardization have extended no further.

The present thesis describes the construction, standardization, and validation of a test of visual figural after-effect. An investigation of the relationship between visual figural after-effect scores and several questionnaire variables is reported. Finally, the theoretical implications of individual variation in the figural after-effect are discussed.

## II

## TERMS AND METHODS

The stimulus to which responses are given is usually called the test object or T-object; the source of continuous stimulation to which no immediate response is made is termed the inspection object or I-object. The two stimulus-response intervals are known as the pre- and post-inspection test periods or T-periods: the interval of continuous stimulation is referred to as the inspection period or I-period. Test periods are usually untimed and are of only a few seconds' duration. Inspection periods are timed and may be as brief as a fraction of a second or as long as five minutes.

Suppose, for example, that a S views from a distance of 6 feet, a test object composed of two small circles of equal size centered five inches to the right and left of a fixation point (see Appendix for illustrations). He reports that the circles appear alike (pre-inspection T-period). He then views, during a 60-second inspection period, an inspection object consisting of one large circle centered five inches to the left of the fixation point. When the test object is again fixated (post-inspection T-period), the retinal area stimulated by the left test circle will lie within the area formerly stimulated by the inspection circle. A report from the S that the left test circle appears paler, smaller, or further away than the right test circle indicates the presence of figural after-effect.

The procedure just described, which is one of the two usual techniques of measuring the visual effect, may be called the judgment method. A second procedure, that of adjustment, involves the setting of a variable test figure to correspond in size or position with a standard test figure, before and after an inspection period. The difference between the two settings represents the magnitude of the effect.

The adjustment technique gives a quantitative measure of the effect. The judgment procedure, on the other hand, only allows the effect to be scored present if the response changes in the expected direction and absent if there is no difference between the pre- and post-inspection judgments. If, as sometimes occurs, the difference between the two responses is not in the expected direction, the change may be scored either as zero or as a minus quantity. There is no convention for scoring these reverse effects.

The after-effect in kinesthesis is most often measured by an adjustment technique known as the Klein and Krech method (Klein and Krech, 1952). It involves estimation of the width of a test object held between the thumb and forefinger, before and after a period of continuous stimulation of the same thumb and forefinger. The difference between the pre- and post-inspection adjustments indicates the magnitude of the illusion. Estimations are made by finding on a tapered comparison object, the point which is subjectively equal in width to the test object.

Auditory figural after-effects have been reported but have received little attention. Since individual differences in the auditory effect have not been investigated, its methodology will not be discussed.

## III

## HISTORICAL REVIEW

### A. Theories of Figural After-effect

Kohler and Wallach (1944) interpreted the figural after-effect in terms of their well-known field theory, in which they assume that the visual cortex acts as a homogenous electrolytic conductor of excitation. When a figure current has been aroused in a cortical area, that area is temporarily in a state of heightened resistance to further stimulation. Therefore a second figure-current will be deflected from the previously excited cortical area. Because of isomorphism between cortical excitation locus and percept, the second figure will be perceived as deflected from the locus of the first figure.

The only major alternative to this satiation theory was outlined by Osgood and Heyer (1952). Their system, like that of Kohler and Wallach, assumed a cortical area of increased resistance induced by stimulation of the retina and causing displacement from that area of a subsequent stimulus pattern. Osgood and Heyer, however, deduce this area of increased resistance from assumptions about a great many separately firing neural units, while Kohler and Wallach base their deductions on the concept of the cortex as a homogenous conductor.

Kohler and Wallach's theory has been criticized by Luchins and Luchins (1953), who argue that it is not consistent with other tenets of Gestalt theory, particularly the law of Prägnanz. This law states that perception changes the stimulus in the direction of maximum simplicity, clearness, and regularity. Thus, for example, a slightly irregular circle tends to be perceived as regular; a not-quite-straight line as straight. However, a figure which stimulates a satiated cortical area may be distorted in the opposite direction -- a perfect circle may be perceived as irregular, or an objectively straight line as uneven.

Experimental evidence against Kohler and Wallach's theory was offered by Lashley, Chow, and Semmes (1951), who showed that the perceptual responses of two Rhesus monkeys were not impaired by the insertion of gold pins into the visual cortex nor by the placing of strips of gold foil over the visual area. Satiation theory would predict that such operations should distort perception by disrupting the normal flow of figure currents.

Osgood and Heyer's system, commonly called the "statistical theory", has led to little significant research, and there has been no attempt to design a crucial experiment between statistical and satiation theories. Deutsch (1956) has argued against the adequacy of the logic of statistical theory and the accuracy of the neurological concepts on which it is based. A study by Hochberg and Hay (1956) suggests that physiological nystagmus, a central concept in statistical theory, is not necessary for the formation of figural after-effects.

Kohler and Wallach's monograph remains the most comprehensive description and the most influential interpretation of the effect. The tendency to take these authors' definitions as "givens" may lead to confusion over some aspects of the illusion. For instance, they define the figural after-effect in terms of changes in apparent locus, apparent brightness, and/or apparent distance of objects. However, no attempt has been made to investigate the equivalence of these three changes, and it is not known whether they are correlated within individuals.

Both satiation and statistical theories deal only with the visual effect. Kohler and Dinnerstein (1947) describe a similar illusion in kinesthesis but do not interpret it. Kohler (1951) stated, "I do not yet know how our interpretation of pattern vision is to be applied to other modalities..." (p. 241). Since Osgood and Heyer make use of physiological nystagmus in their system, statistical theory could be extended to kinesthesis only with revisions, if at all. The common name applied to the visual and kinesthetic illusions, and some similarity in the operations which produce them, may overemphasize their comparability.

B. Parametric Studies

Figural after-effect responses are modified by changes in various stimulus parameters. Information on the influence of such item-content variables as meaningfulness, complexity, or brightness contrast, which is relevant to a later section describing a multi-item visual figural after-effect test, will be reviewed in detail. Validation studies of the test will involve manipulation of time factors; therefore previous investigations into the influence of inspection-time length and inspection-test interval length will be described. Parametric information on the kinesthetic effect is scant and will not be mentioned in this review.

Only a few studies deal with item-content parameters. Largest effects are usually produced when the inspection object is about twice as large as the test object (Sagara and Oyama, 1957). The former authors have also shown that, in vision, a test object the same size as the inspection object usually appears smaller after inspection -- a finding that neither satiation nor statistical theories predict. Vernon (1934) found that the tilted-line effect was not lessened by the substitution of a meaningful figure for the line. Marquart (1954) reported that simple abstract figures produced larger effects than slightly more complex figures. When figure and ground differ in intensity, greater intensity differences do not produce greater effects (Walthall, 1946; Freeburne and Hamilton, 1949). Hochberg and Triebel (1955) found that stimuli differing only in hue produced no figural after-effect responses. Day (1959), on the other hand, found no difference in the frequency of responses to brightness-same and brightness-different stimuli. The latter author quotes a personal communication from Kohler who stated that he, too, obtained after effects with brightness-same stimuli. Both Day and Kohler prepared their stimuli by cutting out and mounting the figures. It is possible that fine, irregular shadow-lines around the edges of the figures might be sufficient to produce the effect. As Hochberg and Triebel do not describe the construction of their stimuli the importance of this factor cannot be assessed. Neither field nor statistical theories predict the occurrence of figural after-effects in response to brightness-same stimuli.

Evidence on inspection-period variations is ambiguous. Hammer (1949) employed I-periods of 5 to 160 seconds and found that although a measureable effect occurred after 5 seconds, its size increased with I-periods of up to about 60 seconds. On the other hand, Sagara and Oyama (1957) reviewed several Japanese studies and concluded that when judgment was immediate I-periods of as little as one second produced effects as large or almost as large as much longer periods.

Three studies varied the inspection-test interval. The first (Bales and Follansbee, 1925) did not employ fixation and did not report significance figures. The authors interpolated 30 and 60 second intervals during which the Ss read or fixated a dot on a white card. Immediate judgment produced largest effects. Scores decreased under interpolated-interval conditions in the following order: 30 seconds reading, 30 seconds fixation, 60 seconds reading, 60 seconds fixation. Hammer (1949), in two experiments, reported significance data for differences between the smallest intervals (0 and 5 seconds) and the largest (150 and 180 seconds). Her graphs show a steady decrease for intervals between these significantly-different extremes. Intervals were filled with uncontrolled visual activity (first study) and inspection without fixation of a white surface (second study). These two types of interpolated activity did not appear to have differential effects. Sagara and Oyama (1957) show diagramatically the size of the effect as a function of inspection period length and interpolated interval length. Long inspection periods produced effects which were not initially greater, but which dissipated more slowly, than those produced by short inspection periods. Neither significance data nor information on interpolated-interval activity is given. Thus there is no conclusive evidence on the smallest interval required to produce a response decrement nor on the interval-activity most conducive to a response decrement.

C. Individual Differences in Psychophysics

Studies designed to obtain information about differential figural after-effect responses have generally assumed that some underlying variable which might be called "figural after-effect proneness" was reflected. This orientation separated such studies from differential investigations of other psychophysical tasks. However, it will be argued in a later section that this separation is not necessary. Therefore a review of individual differences in various psychophysical responses will precede the description of studies concerned only with differential figural after-effect responses.

Cattell (1893) pointed out that the method of determining jnd which allows a "same" category (a method often used in figural after-effect studies) produced large response variations which did not necessarily indicate the S's capacity for sensory discrimination, but might be partly determined by the S's concept of his own accuracy -- "his general knowledge of his error of observation" (p. 289).

Thorndike and Woodworth (1901) showed that performance on specific discrimination tasks could be improved by training, but that the transfer of improvement even to apparently similar tasks was limited.

Seashore (1939) developed various auditory measures. He found negligible correlations among logically related auditory responses, and showed that specific functions could be improved by training. These findings led him to argue against a consitutional basis for the individual differences which he obtained. He offered instead a "work methods" hypothesis -- that individuals developed specific methods of making perceptual judgments, and that these methods were alterable by training.

More recently, Gibson (1953) reviewed the evidence concerning the effect of special training on a variety of perceptual responses. Although her discussion is limited to experimentally-controlled short-term practice, the generally positive results of such training suggest that informal long term and/or early learning probably plays a part in the development of differences in perceptual response.

Klein (e.g., Holtzman and Klein, 1954) has commented on the theoretical importance of individual differences in psychophysical tasks: "Individual differences in psychophysical response are considered the outcome of "preferred" forms of cognitive regulation -- "preferred" in the sense that they are the organism's typical means of resolving adaptive requirements... " (p. 105).

Vernon (1955) has discussed individual differences in perception in terms of Bartlett's definition of schemata, which she quotes as "... an active organization of past reactions or past experiences, which must always be supposed to be operating in any well-adapted organic response..." (p. 181). Referring this concept to psychophysics, Vernon says, "It has been assumed that in such experiments, the abilities of the sense organs to respond to and discriminate stimuli are being measured. ...But appropriate schemata are nevertheless operating in the construction of the percepts. For they will vary greatly between different observers with different degrees of sophistication and training..." (p. 183).

Material used in much of the recent work on perception has been ambiguous or effect-laden, and more complex than in the simple psychophysical situation. The assumption is made (e.g., Bruner, 1957) that perceptual processes found by these methods also operate in the perception of less complex stimuli. However, there has been little recent interest in differences in response to simple stimuli.

This brief review shows that individual differences in psychophysical response tend to be reliable but highly specific, improveable by training but showing little transfer. They have most often been explained in terms of past experience. At least three authors (Cattell, Vernon, Seashore) argue against the notion that response differences reflect constitutional differences in discriminatory ability. Their stand is supported by the fact that many perceptual responses can be made more accurate by practice.

## D. Tests of Figural After-effect

Tests of figural after-effect have made use of either judgment or adjustment methods. However, many specific techniques have been developed, and none has been standardized. Several authors have reported reliability estimates for their measures, but no other psychometric information has been given for any technique. As a later section will deal with the construction of a visual figural after-effect test, some previously used visual tests will be described in detail.

Wertheimer (1954) devised the following technique: The I-figure, which consisted of three oblongs (above, below, and to the right of fixation), was presented for one minute. The T-figure (two small squares on each side of fixation) was then viewed for five seconds. If figural after-effect occurred, the two test squares on the left looked farther apart than the two on the right. After the T-figure was removed, Ss were given a pack of nine cards and told to choose the card which seemed most similar to the T-figure. Each card showed a more or less distorted drawing of the figure. Distortions were arranged in a series, with the card representing the objective appearance of the T-figure in the middle of the pack. Three trials were given in each session, and the numbers of the three cards chosen were averaged to give a score. If the S chose either of the two extreme cards, or if he varied by more than three cards on the three trials, he was dropped from the group. Sixteen of the normal and schizophrenic Ss tested with this method were retested after one month. The rho obtained was .82.

This method is open to several objections. First, the test requires retention of both instructions and memory of the T-figure while the comparison cards are being examined. Second, lack of a pre-inspection test period leads to the inclusion of constant errors in the figural after-effect score. Third, memory of the T-figure might be complicated to an unknown degree by reduction of the effect during the decision period. Fourth, discarding Ss who varied by more than three cards within one session may have eliminated variable responders and produced a deceptively stable group. Fifth, the orderly presentation of the comparison cards may have led schizophrenic Ss to respond to the position rather than the appearance of the cards. Finally, groups of significantly different mean figural after-effect scores were combined in the reliability retest. Reliability within either the normal or the schizophrenic group might have been considerably lower.

Wertheimer (1955) devised another visual procedure which corrected some of the flaws mentioned above. His method required the adjustment of a variable test bar to a position subjectively equidistant from fixation with a fixed test bar, before and after a period of inspection. This method yielded a test-retest rho of .60 after a one-week interval.

Eysenck (1955b) and Rechtschaffen (1958) reported Hoyt reliability estimates derived from analysis of variance. Eysenck obtained estimates of .94 to .77 for kinesthetic scores. However, Rechtschaffen points out that since none of the measures from which the estimates were derived could be considered independent of each other, spuriously high correlations would be expected. The latter author, using a bar-adjustment method of measuring the visual effect, obtained a Hoyt coefficient of .52. Inter-correlations among three trials were .25, .12, and .27.

Spitz and Lipman (1960) determined the reliability of the visual bar-adjustment technique and the Klein and Krech kinesthetic procedure, by means of test-retest tetrachoric coefficients. Although the tetrachoric estimate should be numerically equivalent to the Pearson r, it is up to 50% more variable (Guilford, 1950). It was used with these data in order to reduce the influence of some extreme scores obtained on the visual test. Reliabilities obtained were:

| | | |
|---|---|---|
| Group I, | visual, 20 minute interval | .73 |
| Group II, | " 5 " " | .66 |
| Group I, | kinesthetic, 5 minute interval | .34 |
| Group II, | " 20 " " | .74 |

Additional reliability estimates for kinesthetic measures are the retest correlation of .34 obtained by Lipman and Spitz (1959) for 80 retarded Ss after a three week interval, and Knudson's (1957) low and mainly non-significant retest correlations for 13 schizophrenics after a four week interval.

In summary, the visual and kinesthetic effects have been shown to be stable only for short periods of time and with dichotomized score distributions. Where high reliability estimates were reported, they were found to be based on unsatisfactory test methods, doubtful statistical procedures, or retest after a short interval. No technique has been standardized, and there is no evidence that different methods of measuring the effect in the same mode are correlated. Normative data is lacking, as is information on the discriminative power of the various tests. Until more extensive test data is obtained, differential studies involving the figural after-effect must be ambiguous.

## E. Theories of Differential Figural After-effect Responses

Individual differences in figural after-effect were first discussed by Klein and Krech (1952). These authors attempt to include the kinesthetic effect in field theory. They assume that any neural activity heightens resistance in the area stimulated and deflects subsequent activity from that area, and that neural activity resulting from tactual stimulation will determine perceived width through its "intensity or sheer 'amount'" (p. 132). Stimulation by the inspection object will decrease the intensity of excitation produced by the test object and thus reduce its perceived size, in proportion to the amount of inspection-period stimulation. However, the size of the illusion will also be a function of the individual's characteristic rate of cortical transmission. Those with rapid conductivity will build up little resistance during the I-period and will show small figural after-effects; those with a slow rate of conductivity will accumulate a large amount of resistance and will show large figural after-effects. The authors suggest that metabolic variations may account for these hypothetical differences in cortical conductivity.

Wertheimer and Wertheimer (1954) attributed figural after-effect differences to a "cortical modifiability" variable. They point out that both satiation and statistical theories involve physico-chemical changes in the cortex. These changes must be related to metabolism; therefore size of figural after-effect should be related to various metabolic measures. Wertheimer and Wertheimer suggest that the generality of their construct will make possible its integration into any theory of the effect which finally gains acceptance.

Eysenck (1955a, 1955b, 1957) relates figural after-effect to the Hullian concept of reactive inhibition. On the basis of Pavlov's observations of experimental neurosis, Eysenck postulated that individual differences due to the "properties of the physical structures involved" (1955a, p. 34) exist in the inhibitory process. He then hypothesized that strong reactive inhibition, extraversion, and hysteria would be related, as would weak reactive inhibition, introversion, and dysthymic disorders. Reasoning that the reactive-inhibition concept might apply to various perceptual responses, Eysenck predicted that figural after-effects should vary in the same way as other indices of reactive inhibition. In other words, he proposed that the variable underlying figural after-effect differences was susceptibility to accumulation of reactive inhibition.

These three constructs -- cortical conductivity, cortical modifiability, and reactive inhibition -- comprise the most important attempts to account for individual differences in the effect. All assume that the individual response is a direct index of a general property of neural functioning.

These general constitutional variables imply positive intermodal correlations. A positive relationship between visual and kinesthetic measures was reported by Wertheimer (1955). On the other hand, negligible visual-kinesthetic correlations have been reported by Lipman and Spitz (1959), Spitz and Lipman (1960), and McEwan and Roger (1960). Lipman and Spitz, who employed reliable techniques, found that none of the eight correlations computed between visual and kinesthetic scores reached significance. These results suggest that a general physiological variable may not be useful in accounting for individual differences in the figural after-effect.

## F. Correlations with Other Variables

Wertheimer and Wertheimer (1954) predicted that figural after-effect scores, as well as correlating intermodally, should be related to various measures of metabolic rate. Wertheimer (1955) tested this prediction by determining relationships among visual and kinesthetic figural after-effects, simple reaction time, sensory-motor co-ordination, BMR, thyroid function, capillary structure, and mesomorphy. Correlations were computed, but only test-retest rhos for the first four variables were reported. Wertheimer states that "all but one of the remaining 26 intercorrelations, though not statistically significant, were in the predicted direction" (p. 71). A positive relationship among most of the variables was obtained when above and below median positions for each pair of variables were compared. It is probably accurate to say that these results show an inconclusive trend in the predicted direction. Three studies (Wertheimer, 1954; Wertheimer, 1955; Wertheimer and Jackson, 1957) showed significant differences between normal and schizophrenic groups on both visual and kinesthetic effects. However, as Wertheimer himself points out, the factors accounting for these differences may be non-metabolic. Maier (1957) found an analysis of variance failed to differentiate kinesthetic scores for hospitalized psychotic and non-psychotic patients, suggesting that hospitalization rather than psychoticism might underlie Wertheimer's results.

Eysenck predicted that figural after-effects should correlate positively with measures of extraversion and should differentiate hysterics from dysthymics. He found only a non-significant trend in the predicted direction when tested by a two-tailed criterion (Eysenck, 1955). Maier (1957) found that kinesthetic scores were positively related to a measure of reminiscence but did not differentiate diagnostic groups. Rechtschaffen (1958) found negligible correlations among visual after-effect scores, reminiscence scores, and Guilford R-scale scores in a sample of college students. Roger and McEwen (1960) found no correlation between the Maudsley Personality Inventory extraversion scores and kinesthetic scores in a normal sample. Lipman and Spitz (1959) found that in a sample of retarded adolescents high and low kinesthetic scorers obtained significantly different scores on a reactive inhibition measure. There is thus some evidence that kinesthetic figural after-effects are positively related to reactive inhibition measures -- perhaps because of the motor component in the Klein and Krech method of measuring the kinesthetic effect. Predictions relating either visual or kinesthetic scores to personality traits or diagnostic categories have not been confirmed.

Although Klein and Krech (1952) expressed the hope that a variety of perceptual and learning measures might be related to figural after-effects, they made no specific predictions. Their own investigation of kinesthetic effects in the brain-injured yielded negative results by a two-tailed criterion. Jaffe's (1954) study of a sample of brain-injured veterans confirms these negative findings. Further evidence against a difference between normal and brain-injured groups was reported by Spitz and Blackman (1959) who found that although retarded adolescents scored lower than normals on a kinesthetic measure, subgroups of brain-injured and ideopathic defectives did not differ from each other. Petrie, Collins and Solomon (1958, 1960), whose discussion of differential "satiability" appears to be based on the Klein and Krech position, have reported a relationship between kinesthetic figural after-effect, pain tolerance, and tolerance for sensory deprivation.

G. Summary of Differential Studies

Lacking a standard technique, investigators have constructed a variety of devices which may or may not yield correlated measures. The adjustment technique, which provides a quantitative reading, has been most popular in differential studies.

Interpretations of response differences must take into account the modality tested: intermodal correlations have been mainly non-significant. Predictions of relationships between figural after-effects and other variables must state the modality in which the after-effect is to be tested. Until information is available concerning the correlation of various after-effect measures within the same modality, the possibility will remain that score distributions are specific to the method, as well as the modality used.

No relationships between figural after-effects and other variables have been firmly established, although various trends have been noted. It is not possible to decide whether the generally non-significant correlations reported above are due to flaws in the methods of measurement or to a real lack of relationship.

The following sections describe further studies of figural after-effect response differences. The first reports on the after-effect inducing properties of various visual stimuli; the second outlines the standardization of a test constructed on the basis of information obtained in the first study; the third discussed validation problems and reports validation studies; the final experimental section involves correlation of the test with questionnaire variables. These sections will be followed by a theoretical discussion of individual differences in the figural after-effect.

# IV

## FIGURAL AFTER-EFFECT RESPONSES TO VARIED STIMULI

Introduction:

The stimulus items in the great majority of visual figural after-effect studies have been simple abstract figures clearly different in brightness from an unpatterned ground. Little attention has been given to item-content parameters, although such information is essential for the construction of a multi-item test.

The aim of the present study, therefore, was to determine whether frequency of reports of visual figural after-effect were related to complexity of the stimulus figures, meaningfulness of the stimulus figures, and nature of the figure-ground relationship. Results are discussed in terms of their implications for previous work and for the construction of a visual figural after-effect test.

Materials:

The stimulus figures (see appendix for illustrations) were mounted or drawn on 14 x 20 inch white dull-finish 16-ply cardboard. The fixation point was an India ink dot approximately 1/8 of an inch in diameter in the centre of each card. All inspection figures were approximately 6 inches in diameter and were centered 5 inches to the right or left of the fixation point. Test cards contained two objectively equal figures centered 5 inches to the right and left of fixation. Test figures were approximately 3 inches in diameter and were identical in all other respects with their corresponding inspection figure. The inspection figures are described below.

1. Simple abstract figure: solid black circle on white ground.
2. Complex abstract figure: solid black nonsense figure on white ground.
3. Simple meaningful figure: solid black elephant silhouette on white ground.
4. Complex meaningful figure: black-and-white matte finish photograph of a face on white ground.
5. Familiar three-dimensional figure: 50-pack of a well-known cigarette brand on white ground. Test figures were two 20-packs of the same brand.
6. Simple abstract figure on patterned ground: outline circle and cross-hatched background pattern drawn in India ink.
7. Simple abstract figure on ground of similar brightness but different hue: solid circle of Munsell 2.5 blue, 5.2/6 on ground of Munsell 2.5 red, 4.8/6.
8. Simple abstract figure on ground of same brightness but different hue: solid circle of Munsell Neutral 4.8 on ground of Munsell 2.5 red, 4.8/6.

Brightness-same cards were prepared from "Color-Vu" papers Nos. 64, 147 and 195 (suggested by the Munsell Color Company). As in Day's study, figures were cut out and glued to their grounds. (Hochberg and Triebel do not describe the method of construction of their figures.) According to Day, the specific hues used in construction of the figures are not important.

Subjects:

Four small study-groups of male and female undergraduates in Introductory and Developmental Psychology were tested. Classroom presentations were made one week apart for eight weeks. Since the same stimulus was presented to all groups on any given week, and since the N's were small, scores from all four groups were combined for each stimulus card. The N's of these combined groups varied from week to week: the smallest combined N was 37 and the largest 51 (see Table I). At the end of the series Ss were queried about their knowledge of the illusion, and not reported familiarity with it.

Procedure:

Ss viewed the test card for 5 sec., then indicated on an answer sheet whether the two test figures appeared the same size, or whether one appeared larger than the other. The I-card, displaying one large figure to the right or left of the fixation point, was then viewed for 45 sec., and was followed immediately by another 5 sec. presentation of the test card. Ss again indicated whether the test figures appeared equal or whether one appeared larger than the other. The order of presentation of inspection figures was: left, left, right, right, left, left, left, right. Normal classroom lighting was used.

Exact instructions were:

"Each of the cards I'm going to show you has a black dot in the centre. The cards will also have other figures on them, but I want you to fix your eyes at once on the black dot in the centre and not look away.

"The first card has two figures on it. Keep your eyes on the dot in the centre and without looking away from it, decide which figure is larger or whether they're both the same size.

"Now check the appropriate box for item I.

"The next card has just one figure on it. Again, fix your eyes immediately on the dot in the centre and don't look away. You don't have to make any judgment about this card -- just look at it steadily. You'll see it for a longer time than the last one. Then when I take it away I will show you another card with 2 figures on it. Again, I want you to look at the dot in the centre and without looking away decide which figure is larger or whether they are both the same. You will see the second card for just a few seconds, so make your decision quickly.

"Now check the appropriate box for item no. 2."

Responses were scored in three categories: reported change of perceived relative size of the test figures in the expected direction (figural after-effect); reported change in the non-expected direction (reverse effect); and report of no change (no change). The expected direction of change was, of course, decrease in the perceived size of the test figure on the same side as the inspection figure.

Results:

The frequencies obtained are shown in Table I.

To test the significance of the inter-stimulus differences shown in Table I, chi2 tests were performed on the combined categories of change (figural after-effect plus reverse effect) vs. no change; and figural after-effect vs. no figural after-effect (reverse effect plus no change). These frequency combinations were made in order to eliminate small cell values in the chi2 tables. The chi2 values of 6.92 and 5.29 did not reach significance (P's .3 and .5, respectively).

If the inspection figures had no systematic influence on the perception of the test figures, as many changes should occur in the reverse as in the expected direction. This random distribution of frequencies, tested against the total reported frequencies of figural after-effect and reverse effect, yielded the highly significant chi2 of 129.6 (P .001). Thus the absence of differential responses to the stimuli cannot be attributed to failure to obtain any systematic effect from the inspection figures used.

Discussion:

These data were collected by group testing in a classroom setting and may not be free from artifact. However,

TABLE I

Response Frequencies

| | Figural After-effect | Reverse Effect | No Change | N |
|---|---|---|---|---|
| Simple abstract | 26 | 0 | 14 | 40 |
| Complex abstract | 28 | 6 | 17 | 51 |
| Simple meaningful | 20 | 5 | 15 | 40 |
| Complex meaningful | 20 | 2 | 15 | 37 |
| Familiar 3-dimension | 20 | 2 | 12 | 34 |
| Patterned ground | 21 | 1 | 27 | 49 |
| Similar brightness | 22 | 3 | 13 | 38 |
| Same brightness | 27 | 2 | 19 | 48 |
| Total | 184 | 21 | 132 | 337 |

the fact that figural after-effect responses did not become more frequent as the series progressed suggests that the Ss were not learning the "correct" response to the stimuli. Problems related to the construction of brightness-same cards were discussed above (Section III). The possibility that fine shadow lines at the boundaries of brightness-same figures are able to produce figural after-effect responses as frequently as maximum-contrast figures is, while hardly plausible, a point for further investigation. Meanwhile, the brightness-same cards may be used as stimuli emperically equivalent with the other figures described in this study.

Marquart (1954) found simple figures more effective than slightly more complex figures. Her I-cards consisted of two figures, one on each side of the fixation point. One of each pair was less complex than the other. Thus the relative effects of the two I-figures, rather than the absolute effects of either, were compared in Marquart's study. The present experiment dealt with the presence or absence of a size change induced by a single I-figure and is therefore not comparable to Marquart's. Complex figures may produce effects as frequently, but less intensely, than simple figures.

The size ratios of Hochberg and Treibel's (1955) study were less likely to produce figural after-effects than were those used in the present experiment (Sagara and Oyama, 1957). Hochberg and Triebel reported that no figural after-effects were elicited by brightness-same cards. However, brightness-same cards might produce smaller effects than those not equated for brightness. Such a size difference might result in a low frequency of reports under the unfavorable Hochberg and Triebel conditions, but might be revealed only by quantitative scoring under the more favorable conditions of the present experiment. This interpretation is strengthened by Day's (1959) comment that several Ss spontaneously mentioned a greater intensity of effect under brightness-different than brightness-same conditions.

Summary:

Eight tests of figural after-effect were administered at one-week intervals to undergraduate study groups. The stimuli varied in complexity, meaningfulness, and figure-ground differentiation. The frequencies with which reports of figural after-effect were elicited did not differ significantly. Therefore stimuli varying within the limits employed in this study may be treated as equivalent items in the construction of a test of visual figural after-effect.

# V

## A TEST OF VISUAL FIGURAL AFTER-EFFECT

### Introduction:

The study reported in Section IV indicates the limits in which stimuli may vary while remaining equivalent in their response-eliciting properties. On the basis of this information, a multi-item test was assembled. The construction and standardization of this test was the aim of the present study.

### Materials:

A general description of item construction was given under this heading in the previous section. Inspection figures are described below in order of presentation, which was so arranged that the I-figures appeared alternately to the right and left of the fixation point. Seven of the items used in the previous study were retained; one, the "patterned ground" stimulus, was dropped because of its atypical response pattern (see Table I). Each of the seven new items was constructed within the limits of variation used in the previous study. Illustrations of the items will be found in the Appendix.

Inspection figures in order of presentation were as follows:

1. Complex abstract figure: solid black nonsense figure on white ground.
2. Figure and ground of similar brightness but different hue: solid circle of Munsell 2.5 blue, 5.2/6 poster-paper mounted on ground of Munsell 2.5 red, 4.8/6.

3. Simple abstract figure: solid black circle on white ground.

4. Complex meaningful: black-and-white matte finish photograph of a man's face on a white ground.

5. Simple abstract: outline circle drawn in black India ink on white ground.

6. Simple meaningful: solid black elephant silhouette on white ground.

7. Figure and ground of same brightness but different hue: solid circle of Munsell Neutral 4.8 poster-paper mounted on a ground of Munsell 2.5 red, 4.8/6.

8. Familiar 3-dimensional: 50-pack of a well-known cigarette brand on white ground. Test figures were two 20-packs of the same brand.

9. Complex abstract: solid black nonsense figure on white ground.

10. Simple meaningful: clock faces drawn in India ink on white ground.

11. Complex meaningful: black-and-white glossy-finish photograph of a woman's face on white ground.

12. Simple abstract: outline tri-angle drawn in India ink on white ground.

13. Simple meaningful: solid black butterfly silhouette on white ground.

14. Simple abstract: solid black square on white ground.

Subjects:

Scores were obtained from a sample of 92 normal, young adult Ss, of whom 28 were student teachers, 35 were student nurses, and 29 were night-school students, YMCA and YWCA residents, and University Placement referrals. Differences among the mean scores of these three subgroups were not significant ($F = .82$). The difference between the 58 females and 34 males in the sample also fell short of significance, although males tended to score higher ($t = 1.96$, $df = 90$). None of the Ss questioned showed any familiarity with the effect.

Procedure:

The test was administered individually. Before and after a 45 sec. I-period, Ss were shown the test card and asked whether the two test figures appeared the same size, or whether one appeared larger than the other. Exact instructions were:

"I'll be showing you a series of cards (indicating where the cards would be placed). Each of the cards will have a black dot in the centre, and as soon as I show you a card, I want you to look directly at the dot and not look away as long as the card is before you. There will be other figures on the cards as well, and I'll be asking you questions about the size of some of these figures. But they'll be questions you can answer easily without looking away from the dot.

"Here's the first card (placing the test card before the S). Look at the dot, and without looking away from it, tell me whether the two figures look the same size or whether one looks slightly larger than the other.

"I won't be asking you any questions about this card (placing the I-card before the S); I just want you to look at it steadily (45 sec.).

"Look at the dot (placing the T-card over the I-card, in order to position it exactly). Do the two figures look

the same size, or does one look slightly larger than the other?
"Now close your eyes for a few seconds, to rest them. I'll tell you when to open them again. (Approximately 12 sec.)."

Ss were asked to close their eyes between items in order to facilitate dissipation of the effects of the previous I-card, and to standardize visual experience in the intervals between items. After the first few cards were presented, most Ss responded without being questioned. At intervals during the subsequent items they were reminded to fixate the dot at all times. Total testing time was about 20 min. Ss were seated approximately 6 ft. away from the cards. As testing was done in four different locations, such factors as seating arrangements, general stimulus background, and illumination, could only be kept approximately constant. However, the non-significant F among the sample subgroups suggests that such variations in the testing situation had no significant effect on the scores.

Scoring:

A difference between the two responses indicating that the relevant test figure appeared smaller after than before the I-period was scored "1". Reports of no change, or change in the reverse direction, were scored "0". The range of possible scores was thus zero (no figural after-effects reported) to 14 (figural after-effect reported on every item). The effect of this method of scoring on some response configurations requires comment.

First, consider the case in which the S gives a pre-I response of "right smaller" to an item whose I-figure is to the right of the fixation point. In this situation the item can only be scored "0", since a post-I report of "right smaller" would represent no change from the pre-I judgment. It is possible that in some of these cases the right-hand T-figure appeared even smaller after the inspection period than before, and that therefore some instances of figural after-effect are scored "0".

Second, consider the case in which the S gives a pre-I response of "right smaller", and a post-I response of "same", to an item whose I-figure is to the left of the fixation point. Although the post-I judgment corresponds to the objective test-card appearance, it represents a change in the expected direction from the pre-I judgment and is therefore scored "1". It is possible that in some of these cases the post-I judgment merely represents correction of an initially erroneous judgment rather than a distortion by the I-figure, and that therefore some instances of no effect are scored "1".

Third, it was decided in the interest of simplicity to score reverse changes as "0" rather than "-1", treating the reverse scores as error rather than systematic variation. Reverse visual effects have been reported only rarely in the literature (e.g. by Smith, 1952, 1954). Out of the total number of 1288 responses given by the 92 Ss on the test, only

53 of the responses were reversals: these were distributed randomly among the 14 items (chi2 = 17.9, df = 13, NS); suggesting that these responses can in fact be treated as error variation.

These methods of dealing with these special problems of scoring are essentially arbitrary: no precedent exists for their solution. The methods used are justified only by the satisfactory results of psychometric analysis of the scores.

Results:

The Kuder-Richardson reliability estimate was .82. Test-retest reliability, obtained on an N of 37, with 3 - 10 day intervals, was also .82. The average score was 6.95. Range of scores was 0 - 14. That the shape of the distribution is approximately rectangular is indicated by a coefficient of discrimination of .99 (Ferguson, 1949).

Validity coefficients on the individual items were obtained by a non-parametric statistic which yields a rank-biserial correlation between item and total test (Bryden, 1960). The formula for this "scalability coefficient" is

$$Ci = 1 - [2Rp - P(P + 1)/PQ]$$

where Rp is the sum of the total-score ranks of all subjects obtaining a score of "1" on item i, P is the number of subjects obtaining a score of "1" on that item, and Q is N - P. Table II gives difficulty indices (P/N) and scalability coefficients for each item.

TABLE II

VALIDITY COEFFICIENTS AND DIFFICULTY INDICES

| Item | Validity Coefficient | Difficulty Index |
|---|---|---|
| 1. Nonsense figure | .56 | .43 |
| 2. Blue on red | .50 | .53 |
| 3. Black circle | .66 | .55 |
| 4. Matte photograph | .79 | .45 |
| 5. Outline circle | .67 | .38 |
| 6. Elephant silhouette | .70 | .54 |
| 7. Gray on red | .78 | .48 |
| 8. Cigarettes | .73 | .47 |
| 9. Nonsense figure | .54 | .46 |
| 10. Outline clocks | .57 | .54 |
| 11. Glossy photograph | .71 | .59 |
| 12. Outline triangle | .53 | .43 |
| 13. Butterfly silhouette | .48 | .52 |
| 14. Black square | .78 | .58 |

All validity coefficients are significant beyond the .0001 level. The mean difficulty index is .49. The fact that there is little variation in the difficulty levels of the various items confirms the finding of the previous study that such items function equivalently in producing figural after-effect responses.

Discussion:

The results obtained in this study indicate that stimulus material of the type employed elicits reliably discriminable individual differences in response. The problem of determining whether these differences indicate differential susceptibility to the figural after-effect phenomenon will be discussed in the next section.

The meaning of the term, "visual figural after-effect" commonly includes changes in perceived brightness and distance as well as size. These responses have been subsumed under one name because they may be elicited by the same inducing operation: they are not, however, known to be inter-correlated. Moreover, it has not been shown that different techniques of measurement applied to the same modality produce correlated inter-individual differences. The measures obtained by the test described in this section are not necessarily correlated with those obtained by other, logically similar, methods. It is probably unnecessary to repeat that intermodal correlations have not been found and cannot be assumed.

Strictly controlled administration conditions which eliminated variations in distance of viewer from card, illumination, and length of rest period between each item would probably give higher reliability estimates than those reported here. However, if use of a test under non-laboratory conditions is envisaged, reliability estimates obtained under these conditions are most informative.

Summary:

A 14-item test of visual figural after-effect was administered to a standardization group of 92 Ss. Data reported on the psychometric attributes of the test indicate that reliability, item validity, and discriminability are adequate for differential measurement.

# VI

## VALIDATION OF THE FIGURAL AFTER-EFFECT TEST

### Introduction:

The test described above discriminates individuals reliably. Is it possible to determine the nature of the variable (s) represented by this response pattern? Since there is no external criterion of "susceptibility to figural after-effect" against which to evaluate the test, the item content and the test's relationship to the theoretical construct "figural after-effect" must be examined.

It may be argued that each item fulfils an operational definition of a figural after-effect inducing situation -- employing an inspection period, fixation on the part of the S, conventional scoring, etc. It may also be pointed out that the initial study with items of the type used in the test provides additonal support for the validity of each item considered separately. However, since the items are combined into one test which provides an overall score, analysis of individual items cannot be a sufficient validating procedure for the test as a whole. In the terms of Cronbach and Meehl (1955), content validity cannot be definitely established.

Is it possible to apply a construct-validation procedure to the test? Construct validity has been most carefully considered in terms of highly general and theoretical concepts such as "anxiety" or "drive level" (e.g., Jessor and

Hammond, 1957); and involves the demonstration that a particular test is predictably related to other observable indices of the hypothetical construct in question. For instance, Spence et. al. have offered evidence that the Manifest Anxiety Scale is an index of drive level by showing more rapid conditioning among high than among low scorers (e.g., Spence and Farber, 1953).

The two main theories of figural after-effect -- field and statistical -- are identical in their postulation of a cortical area of reduced excitability which is produced by the inspection period and which produces distortions in subsequent perception. Thus an essential part of the construct is the relationship between the inspection period and the post-inspection judgment. In other words, a change in inspection and/or judgment conditions should produce a change in response. Demonstration that such a change occurs would provide one line of evidence for the construct validity of the test.

On the basis of studies reviewed above (Section III), it was decided that length of inspection period and length between inspection and judgment were crucial aspects of figural after-effect induction, although information on the specific effects of these stimulus variables was ambiguous.

The following predictions were made:

a) Reduction of the I-period from 45 seconds to 5 seconds will produce a moderate but significant mean score decrement.

b) Insertion of a 30 second interval between inspection period and post-inspection test period will produce a significant mean score decrement (a 30 second interval was estimated to be the smallest interval likely to produce a measurable decrease).

c) Insertion of a 90 second interval between inspection period and post-inspection test period should produce a significant mean score decrement. (According to previous work, a 90 second interval reduced visual figural after-effect to approximately zero).

The testing of these three predictions is described below.

Subjects:

Group I: Introductory psychology students (14), graduate nursing students (12). Total 26, male 10, female 16.

Group II: Introductory psychology students (18), graduate nursing students (4). Total 22, 9 male, 13 female.

Group III: Introductory psychology students (11), student nurses (4). Total 15, 7 male, 8 female.

None of these Ss served in more than one group; and none had been tested previously.

Procedure:

Group I: Inspection period reduced from 45 sec. to 5 sec. Administration standard in all other respects.

Group II: A 30 sec. interval filled with fixation of dot on white card was interpolated between inspection period and judgment. Administration standard in all other respects.

Group III: A 90 sec. interval filled with repetitive writing of digits 1 - 100 was interpolated between inspection period and judgment. Administration standard in all other respects.

Results:

Group I: Mean score, 5.07. This score is significantly different from the standardization-group mean ($t = 2.28$, $P = .05$, 2-tailed test).

Group II: Mean score, 6.68. This score is not significantly different from the standardization-group mean ($t = .36$, NS).

Group III: Mean score, 3.06. This score is significantly different from the standardization-group mean ($t = 10.04$, $P = < .01$, 2-tailed test).

Discussion:

All differences are in the direction predicted. As expected from previous studies, the reduction of the I-period in Group I produced a significant but moderate decrease in mean score.

Groups II and III involved manipulation of the inspection-judgment interval. The fact that the 30 sec. period (a guess at the minimum interval likely to produce significant reduction in mean score) did not produce a significant mean decrease is not inconsistent with the literature cited in Section III and therefore not invalidating to the test. Group III was tested after negative results had been found with the 30 sec. interval. The 90 sec. period was chosen as the interval length after which, according to both Hammer and Sagara and Oyama, figural after-effects approximated zero. The sizable decline in mean score under this condition is therefore consistent with the literature.

In summary, the test has been shown to be sensitive to variations both in inspection-period length and in the inspection-judgment interval.

It will be noted that the activity in the interpolated interval differs in Group II and Group III. Fixation of a white card was chosen as an activity which should introduce as few variables as possible other than the time lapse itself. However, under the 90 sec. interval condition of Group III, it was felt that Ss would be unable to fixate continuously over the 14 items and interpolated intervals. Digit-writing was therefore substituted for fixation. The question of which combinations of time-lapse and interpolated activity tend to produce greatest decrements is an important one, and one which would require rather extensive investigation for a satisfactory answer. As theory makes no clear predictions here, and previous studies tell very little, the problem is not crucial to the construct validation of the test. However, the importance of this problem to the construct is recognized, although its scope is beyond the aim of the present study.

These studies show that mean test scores vary predictably with variations in testing procedure. How much does this information tell us about individual differences in response under any one condition? Can it be assumed that because groups differently treated register different mean scores, individuals who obtain different scores under the <u>same</u> conditions are registering different degrees of the variable in question? It seems clear that the variable(s) invoked to account for group differences under different conditions need not be the same as those invoked to account for individual differences under any one condition. In other words, a distinction must be made between the elicitation of a phenomenon by a testing procedure, and the measurement of individual variations in the phenomenon by the testing procedure. It is possible to demonstrate the first (e.g., by group differences under different conditions) without having demonstrated the second. In order to reason from one to another, it is necessary to show either a) that individual responses are determined only by the relevant stimulus condition, or b) that the degree to which other variables affect the response can be measured. In short, it is necessary to validate the response pattern under any one set of conditions against a theoretical concept of these differences which is sufficiently well-founded to permit rejection of the test in the case of negative results. There is no theory of individual differences in the figural after-effect which permits a validation of the individual response-pattern.

Thus, the group-differences method of establishing validity is one in which negative results would provide strong evidence against the test's validity, but positive results give only the gross information that grouped scores reflect appropriate changes contingent upon changes in the stimulus situation (this point is recognized by Cronbach and Meehl, p. 287). Validation of the construct as a variable rather than as a phenomenon requires either an adequate theory of individual differences or an external criterion.

Thus, it can only be inferred that because the test elicits the figural after-effect phenomenon, individual response differences are differences in individual susceptibility to figural after-effect. A later section (VIII) will argue that this inference leads to an over-simplified concept of the factors operating in the test situation. Meanwhile it may be said that the present test shows face and content validity and has the added support of high internal and retest consistency. For the purposes of the study to be reported in the next section, it was assumed that the individual differences which were being reliably discriminated by the test were in fact differences in figural after-effect.

Summary:

The application of construct validation to the test was discussed, and three such validation studies reported. The limitations of this method of validation were pointed out.

# VII

# CORRELATION OF TEST SCORES WITH QUESTIONNAIRE RESPONSES IN NON-PATIENT GROUPS

## Introduction:

Theoretical interpretations of individual differences in the figural after-effect were reviewed in Section II. The most ambitious approach was proposed by Eysenck, who suggested a linear relation, mediated by reactive inhibition, between the "extraversion-introversion" continuum and figural after-effect scores. Several studies failed to confirm this prediction.

Two considerations indicated that Eysenck's hypothesis had not been conclusively disproved. First, the methods of measuring figural after-effect in previous studies were unstandardized and of doubtful reliability. Second, the concept of introversion-extraversion is a highly general one: figural after-effects might be correlated with one or more of the specific components of this construct and yet might be unreliably related to a global extraversion measure.

The following hypotheses were therefore tested:

a) Visual figural after-effect scores correlate positively with questionnaire measures of extraversion.

b) In a test which derives extraversion as a second-order factor, visual figural after-effect scores correlate positively with one or more of the specific factors from which the extraversion score is obtained.

Materials:

The test described in Sections V and VI was used to test visual figural after-effect. Questionnaires used were the Maudsley Personality Inventory (MPI), the Heron Two-part Questionnaire, the Cattell 16-Personality Factor Test (16-PF), and the Army Beta Intelligence Exam.

The MPI consists of two scales of 24 items each, chosen to measure the factorially independent dimensions of introversion and neuroticism. Correlations between the two scales in normal samples approximate zero. Both split-half and retest reliabilities average in the .80's. The test was developed by Eysenck out of his factorial study of the two dimensions (Eysenck, 1959).

The Heron Two-Part Questionnaire was designed for measurement of neuroticism and introversion in the normal population. The scales, named "maladjustment" and "sociability", have internal consistency reliabilities of .81 and .74; and correlate .64 and .80 with the corresponding MPI scales (Heron, 1956).

The 16-PF measures sixteen primary factor-traits from which are derived two second-order factors named anxiety and introversion. An outline of the development of the test is given by Cattell (1957); and a critique and research bibliography by Buros (1959). Reliability and item-validity figures are mainly in the .80's and .90's. The second-order factors correlate significantly with MPI neuroticism and introversion scales (Eysenck, 1959). The 16-PF is available in three forms. Cattell recommends the use of the three forms combined in order to obtain maximum reliability. This was done in the present study.

In addition to the scores required to test the predictions stated above, several correlations were made on an emperical basis. These estimated the relationship between figural after-effect scores and: age, neuroticism (MPI), maladjustment (Heron), specific 16-PF factors not contributing to the introversion score, and Beta IQ.

Subjects:

Group I: Student nurses at Verdun Protestant Hospital (20).

Group II: Night school students (9), student nurses (15), McGill undergraduates (4), YMCA residents (10), YWCA residents (2). Total 40, 20 male, 20 female. Age range 17-41 yrs. Three of these Ss had also served in Group I.

All figural after-effect scores from both groups were included in the final analysis of the standardization data.

TABLE III

Correlation Coefficients, Group I and Group II

Group I

| Test | | | r. |
|---|---|---|---|
| MPI | a) | extraversion | .32 |
| | b) | neuroticism | .004 |
| Heron | a) | sociability | -.20 |
| | b) | maladjustment | .10 |
| Beta Intelligence Quotient | | | -.19 |

Group II

| 16 PF Test | | | r. |
|---|---|---|---|
| a) | Factor A: | schizothymia | -.08 |
| b) | Factor B: | intelligence | .12 |
| c) | Factor C: | ego strength | .25 |
| d) | Factor E: | submissiveness | .28 |
| e) | Factor F: | surgency | .09 |
| f) | Factor G: | superego strength | -.40xx |
| g) | Factor H: | adventurousness | .27 |
| h) | Factor I: | sensitivity | -.26 |
| i) | Factor L: | paranoia | -.08 |
| j) | Factor M: | conventionality | -.24 |
| k) | Factor N: | sophistication | .20 |
| l) | Factor O: | guilt | -.29 |
| m) | Factor Q1: | conservatism | .07 |
| n) | Factor Q2: | dependency | -.06 |
| o) | Factor Q3: | exactitude | -.002 |
| p) | Factor Q4: | drive tension | -.11 |
| Age | | | .34x |

| | |
|---|---|
| Anxiety | -.19 |
| (Weighted sum of sten scores of factors Q4, O, Q3-, C-, L, and H- ) | |
| Introversion | -.13 |
| (Weighted sum of sten scores of factors M, F-, A-, Q2, Q1, and H-) | |

xx P = .01
x P = .05

Procedure:

Group I: MPI, Heron, and Beta were administered and correlated with figural after-effect scores.

Group II: The 16-PF was administered. First and second order factor scores were correlated with figural after-effect scores. Scattergrams were drawn for each correlation. Age was correlated with figural after-effect scores.

Results:

Correlation coefficients are given in Table III.

Group I: All correlations were NS.

Group II: Only two of the 19 correlations were significant. As at least one significant correlation would be expected by chance, no interpretative significance was attached to these results. Inspection of scattergrams gave no indications of a curcilinear relationship between any of the variables.

Discussion:

The results of this study confirm previous negative findings. Neither of the two predictions tested received even equivocal support. Correlations with introversion measures approximate zero; correlations with factors contributing to 16-PF introversion are also uninterpretably low.

Nor does the additional correlational information obtained on an emperical basis suggest alternate hypotheses.[1] The correlation between age and figural after-effect is probably due to the fact that the older Ss tended to be male, and males show a strong though non-significant tendency to score higher than females (see Section V). Kohler and Dinnerstein (1947) reported a non-significant trend toward larger kinesthetic scores inthe older Ss; however, Maier (1958) failed to confirm this trend in an all-male group. It is doubtful that there is any reliable relationship between age and figural after-effect scores in young adult groups.

The negative results of Group I might be attributed to restriction of range in a rather homogenous group of student-nurses, were it not for the fact that equally negative results were found in Group II, which was heterogenous in all variables tested.

In this study, lack of significant findings cannot be attributed to unreliability of any of the tests used.

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[1] The correlation between figural after-effect and 16-PF factor G, "superego strength", is significant at the .01 level. Ss who scored high on this factor tended to obtain low figural after-effect scores. While this relationship can be attributed to chance, another interpretation is possible. Factor G involves statements related to careful, self-controlled, planful, correct, cautious behavior. Ss high on this factor might give careful, considered answers to the figural after-effect test, prolonging the judgment time and thus allowing the effects to dissipate before responding.

Only two alternatives arise: a) the hypotheses tested were incorrect, or b) one or more of the measuring devices do not measure the constructs specified in the prediction. It is relevant to the second alternative that Eysenck arrived at his introversion-figural after-effect prediction by way of reactive inhibition. This link has not been conclusively demonstrated: either visual or kinesthetic after-effects might be related to reactive inhibition but not to questionnaire measures of introversion. The possibility the figural after-effect test scores are measuring something other than "figural after-effect proneness" will be considered in more detail in the following section.

<u>Summary</u>:

Questionnaire variables were correlated with visual figural after-effect test scores, and negative results obtained. The implications of these negative results were discussed.

# VIII

## THEORETICAL CONSIDERATIONS

All current explanatory hypotheses of the figural after-effect phenomenon seem to agree that the inspection period results in a cortical area of reduced excitability which in turn causes a distortion in the post-inspection perception of the test figure. While speculative, this explanation seems to account fairly well for the existence of the effect itself.

The discovery of stable individual differences in the figural after-effect response does, however, present a separate problem, the problem of how such individual differences may be interpreted. They have been thought to reflect individual variations in the hypothetical area of reduced excitability in the cortex. The question arises, however, if this interpretation is necessary, or even reasonable, if it is supported by available evidence, and if there is an alternative approach. These questions are considered in the present Section.

The concepts used to explain figural after-effect response differences have been: cortical conductivity (Klein and Krech, 1952), cortical modifiability (Wertheimer, 1954), and reactive inhibition (Eysenck, 1957). These constructs are not clearly defined and definite predictions cannot be made from them. All three do imply that there should be a positive relationship between figural after-effect responses in one sensory modality and figural after-effect responses in another sensory modality. Wertheimer suggests that the magnitude and duration of the figural after-effect is metabolically determined. He predicts that a large figural after-effect in one modality should be accompanied by a large figural after-effect in another modality, since both responses would be influenced by the same metabolic process. Similarly, Klein and Krech hypothesize that figural after-effect differences are due to individual variations in the rate of cortical transmission. This hypothesis, too, implies that a large figural after-effect in one modality should be accompanied by a large figural after-effect in another modality. Eysenck, in relating such diverse responses as figural after-effect, speed of conditioning, and neurotic symptoms, clearly implies the existence of a general factor: thus his construct, too, would predict correlation between responses obtained from different modalities.

Reliable tests of visual and kinesthetic figural after-effects however have yielded negligible correlations (e.g., Spitz and Lipman, 1960). Spitz and Lipman conclude that their findings constitute strong evidence against existing theories of individual differences in the figural after-effect response. They comment, "If one argues that this lack of intercorrelation may be attributed to the specific operations employed, then it becomes necessary to explain why one set of operations is a more valid test of theory than other operations" (p. 184).

There are certain difficulties involved in validating tests of figural after-effect (see Section VI). If no obvious operational flaws appear in the testing procedures, however, the results obtained from these procedures may be accepted until further validation data are available. As the methods of Spitz and Lipman appear operationally adequate, their data may be accepted as offering evidence against current theories of individual differences in the effect.

The evidence against concepts previously used in interpreting individual figural after-effect differences is not conclusive; but it is strong enough to suggest that consideration of alternative approaches might be profitable. The approach outlined in this Section speculates on the role of learned response tendencies in producing individual differences in the figural after-effect response. This approach will be discussed mainly in the context of normal Ss responding to the visual judgment situation.

The present approach does not attempt to explain stable differences in figural after-effect response in terms of variations in the hypothetical cortical area of reduced excitability. It seems reasonable to ignore the probable presence of these variations in accounting for stable differential response in the figural after-effect situation. The proximal inspection stimulus is undoubtedly modified by temporary fatigue conditions, variations in background stimulation, shifts in fixation, and so forth. These proximal differences in turn should lead to variations in the properties of the cortical inhibition area supposedly produced by the inspection stimulus. These differences should vary however within, as well as between, individuals; and should thus contribute to error variance in test scores rather than to reliability.

The visual judgment method is essentially the same as the psychophysical technique for determining a just-noticible-difference between objectively different stimuli. Thus, the post-inspection presentation of the test figures is equivalent to the psychophysical situation in which the S compares two figures of different size and reports them "same" or "different". There is only one point of contrast: in the post-inspection presentation the experimenter does not know how great a difference exists for the S between the two test figures. The two do produce different central effects, however, and the S may or may not be able to discriminate between these differences in his verbal response. It need not be assumed that the two test figures have produced identical cortical effects even if a particular S indicates inability to discriminate by reporting "the same".

In terms of this description, the problem of accounting for individual differences in figural after-effect becomes a special case of the more general problem of explaining individual differences in any psychophysical task and, in fact, in any perceptually based judgment. Literature reviewed in Section III showed that individual differences in most perceptual responses were highly specific, reliable, and alterable by training. Most frequently they were accounted for in terms of the individual's learned modes of response.

If the figural after-effect situation can be equated with other psychophysical tests, we may speculate that some form of past experience may account for individual differences in the effect. In other words, differences in the response may be a function of the Ss' past perceptual experience. Negligible correlations between visual and kinesthetic scores and between figural after-effect scores and general personality variables thus become intelligible. One would not expect experiential factors to produce similar response tendencies for a variety of tasks. Such an interpretation permits relating figural after-effect differences to a broad range of phenomena and also permits consideration of the non-stimulus aspects of perceptual judgment.

The discussion so far has dealt only with comparison judgments, i.e. the type of judgment required in the test described in this Thesis. The same reasoning however may be applied to the adjustment-situation. Let us consider the Klein and Krech kinesthetic testing method. The large number of reverse responses obtained from this method has been thought to be due to some atypical effect of the inspection-period stimulation. The present approach would consider such reversals as adjustments within the equivalence range of the S's perception. As such, they may be looked on as indications that no change in the test object has been perceived following the inspection period.

In the adjustment-situation, then, individual differences in both pre- and post-inspection adjustments may be due to learned differences in Ss' perception of equivalence. If this is so, the variance of adjustment scores should not be significantly different after the inspection period than it was before it. Tentative conformation for this hypothesis was found by the present author in a minor unpublished study. A comparison was made of the variances before inspection with those after 60 second and 120 second inspection periods for 18 Ss tested on the Klein and Krech apparatus. These Ss were tested in a study of the effects of dexedrine on kinesthetic figural after-effect. Group I consists of the first testing for each S without dexedrine. Group II consists of the first test given each S, whether under dexedrine or not. These data are clearly not ideal for testing the present hypothesis, and are quoted only as a tentative indication that the inspection period has little effect on the variance of scores.

Variances were as follows:

| | | | |
|---|---|---|---|
| Group I: | Pre-I $s^2 = 1.05$ | 60 sec. I $s^2 = 1.12$ | 120 sec. $s^2 = 2.18$ |
| Group II: | Pre-I $s^2 = 2.08$ | 60 sec. I $s^2 = 1.63$ | 120 sec. $s^2 = 1.84$ |

The post inspection variance increases in Group I, and decreases in Group II, are non-significant (t-test for correlated variances). Such results suggest that an explanation which accounts adequately for the pre-inspection response variability may also be applied to the post-inspection spread of responses. It is suggested that experiential factors may account for both.

The approach suggested here implies that differences in figural after-effect scores should relate to the Ss' degree of sophistication in making discrimination judgments similar to those called for by the testing procedure. This sophistication might be attained either by special training or by informal, long-term experience. It might also be expected that individuals whose adjustment to the environment has involved disproportionate use of one sensory modality might report figural after-effects more frequently than individuals with normal experiences when tested in that modality. For example, deaf individuals might learn to make finer-than-average visual discriminations: if this is so, they would be expected to report visual figural after-effects more frequently than normal individuals.

## Summary

Current explanations of individual differences in the figural after-effect response have been examined critically. An alternative approach was suggested. This approach compared the figural after-effect testing procedure with other psychophysical testing situations, and speculated on the possibility that individual differences in all such situations might be based on learned response tendencies. Some implications of this orientation were mentioned.

# IX

## SUMMARY AND CONCLUSIONS

Individual differences in visual figural after-effects were investigated through the construction of a test of visual figural after-effect, determination of its psychometric characteristics, and consideration of the problems involved in its validation and its use in correlational studies. A theoretical approach to these individual differences was suggested.

The studies described in this Thesis may be summarized as follows:

a) The figural after-effect inducing properties of varied stimuli were determined. Equivalence was found among the stimuli used.

b) A 14-item test of visual figural after-effect was constructed and standardized. The test was found to be reliable and discriminating.

c) Three validation studies were carried out. Results were in the predicted direction. Validation of the test as a measure of "susceptibility to figural after-effect" however was not established.

d) Correlation of the test with questionnaire variables yielded negative results.

e) The theoretical interpretation speculated on the possibility of accounting for individual differences in figural after-effect responses in terms of learned perceptual organization.

On the basis of this material, it is concluded:

a) Individual differences in figural after-effects may be categorized with individual differences in other psychophysical responses.

b) Individual differences in psychophysical responses, including figural after-effect responses, are best accounted for in terms of past experience.

c) The responses of individuals to figural after-effect stimuli may be reliably discriminated; it has not been shown, however, that these responses reflect only the influence of the inspection period.

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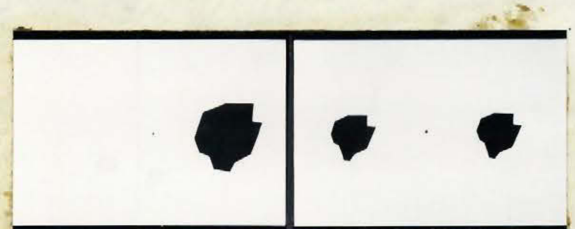
# APPENDIX

## Illustrations of Test Items (Test and Inspection Figures)

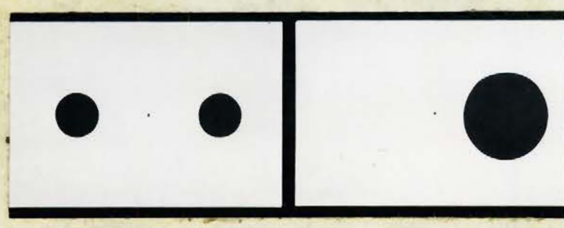
### In Order of Presentation

Note: Photographs of Items 2 and 7 were not included because of brightness distortions in the prints. Instead, swatches of the papers used to construct these Items were shown.



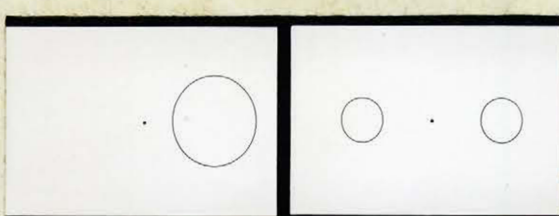
Item 1. Complex abstract.

Item 2. Figure and ground of similar brightness but different hue: samples of colors used. Design same as Item 3.

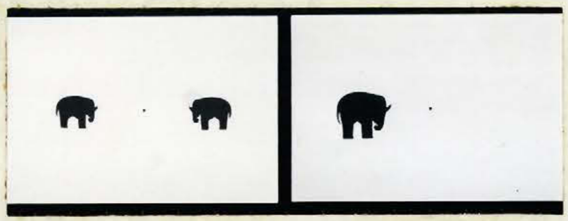


Item 3. Simple abstract.

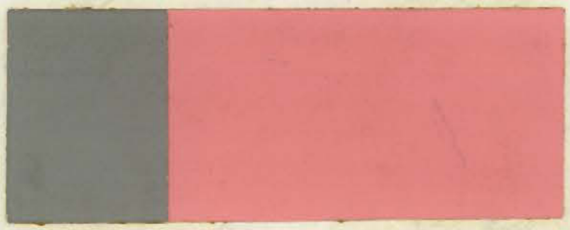
Item 4. Complex meaningful.



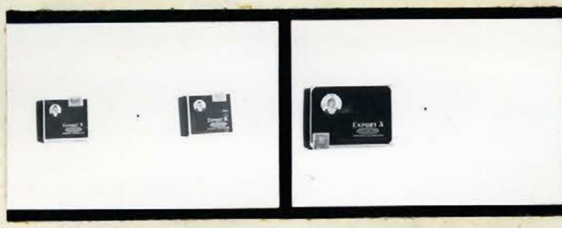
Item 5. Simple abstract.



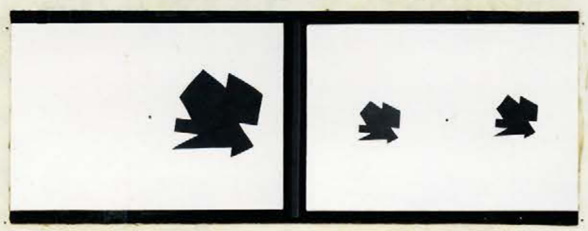
Item 6. Simple meaningful.



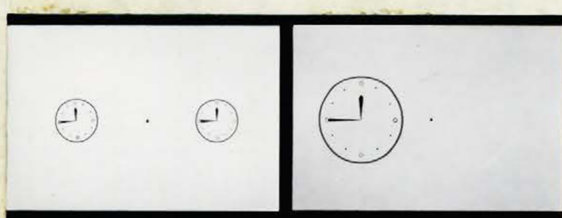
Item 7. Figure and ground of same brightness but different hue: samples of colors used. Design same as Item 3.



Item 8. Familiar three-dimensional.

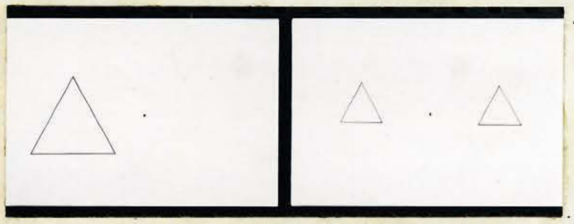


Item 9. Complex abstract.



Item 10. Simple meaningful.

Item 11. Complex meaningful.



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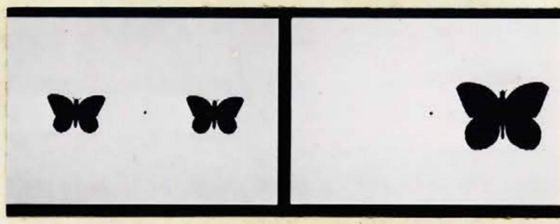
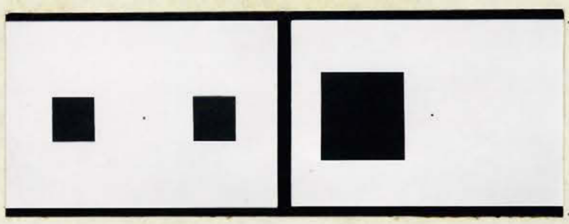


Item 13. Simple meaningful.



Item 14. Simple abstract.