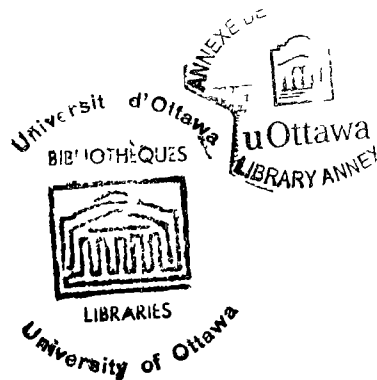


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SENSORY AUGMENTATION:
A POSSIBLE EXTENSION OF THE EYENCKIAN THEORY
OF INTROVERSION-EXTRAVERSION

by Bertram T. Rotman

Thesis presented to the School of
Psychology and Education of the
University of Ottawa as partial
fulfillment of the requirements
for the degree of Doctor of
Philosophy



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CURRICULUM STUDIORUM

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TABLE OF CONTENTS

| Chapter | page |
|--|------|
| INTRODUCTION. | vii |
| I.- REVIEW OF THE LITERATURE. | 1 |
| 1. Origins of the Eysenckian Theory and its Related Studies | 1 |
| 2. Satiation and Inhibition Theories | 8 |
| 3. Studies Concerning Introversiion-Extraversiion and Reactive Cortical Inhibition | 14 |
| II.- EXPERIMENTAL DESIGN | 27 |
| 1. The Sample Population | 27 |
| 2. The Psychophysiological Apparatus | 28 |
| 3. The Psychological Tool | 32 |
| 4. The Experimental Procedures | 36 |
| 5. Methods for Analyzing the Data | 43 |
| III.- PRESENTATION AND INTERPRETATION OF RESULTS. | 51 |
| 1. Test-Retest Reliability | 51 |
| 2. Statistically Determining the Augmenter and Reducer | 54 |
| 3. Correlations of Variables Being Studied | 60 |
| 4. Discussion of Results | 64 |
| SUMMARY AND CONCLUSIONS. | 70 |
| BIBLIOGRAPHY. | 72 |
| Appendix | |
| 1. SCATTERGRAMS OF TEST-RETEST ESTIMATION SCORES. | 74 |
| 2. MEASURES OF CENTRAL TENDENCY AND VARIABILITY FOR ESTIMATION SCORES AND <u>MPI E</u> SCORE | 77 |
| 3. <u>ABSTRACT OF Sensory Augmenters: A Possible Extension of the Eysenckian Theory of Introversiion- Extraversiion.</u> | 78 |

LIST OF TABLES

| Table | page |
|--|------|
| I.- Cut-Off Scores Derived from Individual Estimates and Group Mean Scores Used to Determine Augmenters and Reducers at the 95% and 99% Levels of Probability in the Kinesthetic, Auditory and Visual Modalities. | 57 |
| II.- Frequency of Augmenters and Reducers in the Kinesthetic, Auditory and Visual Modalities, Based on Cut-Off Scores Derived from Individual and Group Mean Estimates at Both the 95% and 99% Levels of Probability | 59 |
| III.- Computed r and z Values for Estimation Scores in the Three Modalities of Kinesthesia, Audition and Vision as Well as the <u>MPI F</u> Scale | 62 |
| IV.- Measures of Central Tendency and Variability for Estimation Scores and <u>MPI E</u> Scale for the Sample Made up of 127 Male Subjects | 77 |

LIST OF FIGURES

| Figure | page |
|--|------|
| 1.- Schematic Diagram of Apparatus Measuring Auditory After-Effect. | 30 |
| 2.- Schematic Diagram of Apparatus Measuring Visual After-Effect. | 33 |
| 3.- Scattergram of Test-Retest Estimation Scores for Kinesthesia. | 74 |
| 4.- Scattergram of Test-Retest Estimation Scores for Audition | 75 |
| 5.- Scattergram of Test-Retest Estimation Scores for Vision. | 76 |

INTRODUCTION

Many studies have been published which discuss the personality dimension of introversion-extraversion and its psychoneurological correlates stemming from the reactive cortical inhibition theory. Attempts have been made to link objective test results as determined by a questionnaire-type task with behaviour which was said to be neurological in character. Much of the work done in this area leaves the reader both speculating and confused.

According to Eysenckian theory, individuals should show estimation scores in a specific direction, that being underestimation of stimuli in relation to established basal estimates, i.e., a point of subjective equality. This amount of reduction over a specified number of trials is used as one of a number of physiological criteria in establishing personality traits of an individual. One of the major assumptions made by Eysenck is that all people tend to reduce their estimates of standard stimuli in relation to original estimates made.

Recently, however, a study, mainly interested in investigating tolerance to pain and ability to stand sensory deprivation, reported individuals who did not show estimation scores in the expected direction. Subjects were observed

increasing their estimates of a standard stimulus over a given number of trials and were labelled as augmenters.

The reported findings intrigued this writer and initiated an inquiry as to why Eysenck, in his theory, failed to account for these response types. This dissertation then, is an attempt to discover if augmentation is a statistically significant and reliable phenomenon in a population and to investigate this psychoneurological event as a possible correlated factor in the personality dimension of introversion-extraversion. This study was designed to investigate the after-effects phenomenon in the three modalities of kinaesthesia, audition and vision.

Chapter one presents a review of the literature concerned with the origin of the Eysenckian theory and the related physiological constructs of reactive inhibition and satiation. It also presents the primary article in which Eysenck states and explains his basic postulate. Finally, this chapter surveys relevant works in the area of the inhibition theory and its relation to the personality dimension of introversion-extraversion, and states the hypotheses to be investigated.

The following chapter describes the population selected for this study, the instruments used to measure sensory estimations, and the objective criterion for the

personality variable under study. A description is also given in this chapter of the experimental procedures as well as the statistical techniques used in handling the data.

Chapter three presents the results of this experiment and attempts a discussion of them in relation to the hypotheses being tested. Lastly, the significance of the findings are considered and from this suggestions for further research are made.

CHAPTER I

REVIEW OF THE LITERATURE

This chapter presents Eysenck's theory of the introversion-extraversion personality dimension, based on the psychoneurological phenomenon of reactive inhibition. It also reports on pertinent studies regarding the inhibition theory and other related areas. Section one deals with the origin of Eysenck's theory and its related studies. Section two presents theories concerned specifically with the phenomenon of satiation and inhibition, as well as the confusion and differences of opinion in this area. Section three deals primarily with the inhibition theory and its relation to the personality dimension of introversion-extraversion.

1. Origins of the Eysenckian Theory and its Related Studies.

The finding of McLeod¹ showing that introversion-extraversion is strongly based on an inherited disposition,

¹ H. McLeod, "An Experimental Study of the Inheritance of Introversion-Extraversion", unpublished doctoral dissertation, University of London, 1954, quoted by H.J. Eysenck, "Cortical Inhibition, Figural After-Effect, and Theory of Personality", in Journal of Abnormal and Social Psychology, Vol. 51, No. 1, July 1955, p. 94-106.

for Eysenck,² suggests that the search for a causal factor responsible for extraverted behaviour should be concentrated on properties of the central nervous system, especially the cortex. It seems unlikely that peripheral factors could be responsible for the great and complex differences observed between extraverts and introverts. Eysenck³ proceeds under the assumption that from the testing of two groups, one comprised of hospitalized neurotics and the other non-hospitalized normals, the test differences would provide an outside criterion of neuroticism and that test differences between hysterics and dysthymics would provide a criterion of introversion-extraversion.

In turn, Eysenck⁴ has interpreted his introversion-extraversion continuum⁵ on the basis of a cortical predisposition in the individual which causes an inhibition of the response process to successive stimulation. Also it should be noted that conditionability and learning are said to be related inversely to the amount of cortical inhibition,

2 H.J. Eysenck, "Cortical Inhibition, Figural After-Effect, and Theory of Personality", in the Journal of Abnormal and Social Psychology, Vol. 51, No. 1, July 1955, p. 94-106.

3 Ibid., p. 94-106.

4 Ibid., p. 94-106.

5 -----, Dimensions of Personality, London, Kegan Paul, 1947, xi-308 p.

categorizing the individual either to the introverted or extraverted portion of the dimension.

Eysenck⁶ stresses that this phenomenon differs according to the individual:

All responses leave behind in the physical structures involved in the evocation, a state or substance which acts directly to inhibit the evocation of the activity in question. The hypothetical inhibitory condition or substance is observable only through its effect upon positive reaction potentials. This negative reaction is called Reactive Inhibition. An increment of reactive inhibition (ΔI_R) is assumed to be generated by every repetition of the response (R), whether reinforced or not, and those increments are assumed to accumulate except as they spontaneously disintegrate with the passage of time.

Individuals in whom reactive inhibition is generated quickly, in whom strong reactive inhibitions are generated, and in whom reactive inhibition is dissipated slowly are thereby predisposed to develop hysterical disorders in cases of neurotic breakdown; conversely, individuals in whom reactive inhibition is generated slowly, in whom weak reactive inhibitions are generated, and in whom reactive inhibition is dissipated quickly, are thereby predisposed to develop introverted patterns of behaviour and to develop dysthymic disorders in cases of neurotic breakdown.⁷

In the application of this theory, Eysenck⁸ noted that these individual differences in autonomic reactivity and conditionability give rise to the personality dimensions of neuroticism and introversion-extraversion. If neuroticism

6 Eysenck, Dimensions of Personality, Op. Cit., p. 96.

7 Ibid., p. 96.

8 -----, (ed.), Behaviour Therapy and the Neurosis, Pergamon Press, New York, 1960, xi-479 p.

and introversion are combined, the result was the dysthymic individual who in pathological terms is more prone to suffer from anxieties, phobias, obsessions, and compulsions as well as reactive depressions. The person who shows a deficiency in conditionability and who is unable to form useful conditioned responses tends to develop a weaker pattern of socialization. In addition, this person exhibits high neuroticism, psychopathic and hysteric symptomatology.

Briefly then, Eysenck's theory links the concepts of inhibition and excitation with introversion-extroversion. Starting with a theory about the existence of two important personality dimensions, neuroticism and introversion-extraversion, an attempt was made to seek out causal factors to account for a given individual's position on these dimensions. Neuroticism was identified, with some misgivings, as a consequence of an over-labile autonomic system; extraversion being conceived as related to the notions of inhibition and excitation. It seemed that in order to mediate predictions from the conceptual and experimental levels to the behaviour level, it was necessary to postulate such mechanisms as defective conditionability in extraverts and enhanced conditionability in introverts.

Welch and Kubis,⁹ using PGR conditioning on eighty-two control subjects and fifty-one patients, found that the patients, most of whom were of the dysthymic type, conditioned much more quickly than did the controls. This study has lent some support to Eysenck's hypothesis.

Franks,¹⁰ using the eye wink reflex to a puff of air as the response, and a tone as the conditioned stimulus, tested a matched group of hysterics as well as normal and dysthymic groups. The author showed that dysthymics condition more quickly than normals, and normals more quickly than hysterics.

Eysenck¹¹ cited this work as supportive of his theory. It seems there is basis to question this interpretation if you consider that Eysenck has followed the Hullian¹² definition which postulates that I_R (Reactive

9 Livingston Welch and Joseph Kubis, "The Effect of Anxiety on the Conditioning Rate and Stability of the PGR", in the Journal of Psychology, Vol. 23, First Half, January 1947, p. 83-91.

10 C. Franks, "An Experimental Study of Conditioning as Related to Mental Abnormality", unpublished doctoral dissertation, University of London, 1954, quoted by H.J. Eysenck, "Cortical Inhibition, Figural After-Effect, and Theory of Personality", Op. Cit., p. 97.

11 Eysenck, "Cortical Inhibition, Figural After-Effect, and Theory of Personality", Op. Cit., p. 94-106.

12 C.L. Hull, Principles of Behaviour, New York, Appleton-Century, 1943, x-422 p.

Inhibition) is produced by response evocation and that the magnitude of this I_R is dependent on the amount of work involved. Furthermore, I_R cumulates under conditions of massed practice and becomes manifest in performance decrement. In the Franks'¹³ study noted, no indication was made of the intertrial interval used in the conditioning procedure, nor of the amount of work involved in each response. His results showed that the acquisition curves obtained differ on the initial conditioning trials and do not show any real tendency to diverge on the following trials. This seems to be somewhat of a contradiction to the reactive inhibition theory which Eysenck follows.

There have been a number of works written in the area of inhibition, and some of these studies have given support to Eysenck's hypothesis. Hamilton¹⁴ discusses the Pavlovian concept of cortical inhibition, and states that any inhibition that takes place involves the whole cortex, and in turn, learning itself is inhibited or enhanced by a generalized cortical functioning.

13 Franks, Op. Cit., p. 97.

14 Max Hamilton, "On the Nature of Inhibition in the Cerebral Cortex", in Psychological Review, Vol. 59, No. 1, January 1952, p. 49-53.

Wertheimer and Wertheimer¹⁵ felt that visual and kinesthetic figural after-effects would be positively correlated and that the amount of after-effect would show a correlation with metabolic efficiency. If this were so it could be implied that there is a holistic cortical mechanism controlling satiation. The reported findings of this research supported these hypotheses.

Wertheimer,¹⁶ in studying visual and kinesthetic after-effects and changes of visual and kinesthetic after-effects after changes in metabolic rate, found a significant positive relationship. This finding also seems to be corroborative support for the hypothesis that the figural after-effects, found in different sense modalities, are produced by the same physiological process.

15 Michael Wertheimer and Nancy Wertheimer, "Metabolic Interpretation of Individual Differences in Figural After-Effects", in Psychological Review, Vol. 61, No. 4, July 1954, p. 279-280.

16 Michael Wertheimer, "Figural After-Effects as a Measure of Metabolic Efficiency", in Journal of Personality, Vol. 24, September 1955, p. 56-73.

2. Satiation and Inhibition Theories.

Kohler and Wallach,¹⁷ (upon whose theory of satiation and after-effect Eysenck¹⁸ has based much of his reactive cortical inhibition hypothesis), believe that the basic distortion or after-effect was produced by a displacement of the test figure from the cortical area which was initially stimulated by the inspection figure. Satiation then, is interpreted as a phenomenon involving boundary current. The stronger the figural current, the stronger the counter forces engendered, and the stronger the figural after-effect. This satiation could be considered as lowered cortical conductivity in a localized cortical area, and the behavioural measure of this localized and temporary lowered conductivity is regarded as the figural after-effect.

One is tempted to say that the prolonged presence of an I-object lowers the conductivity of the cortical areas and adjacent regions. Actually, the change appears to be mainly an increase in polarizability of the tissue in question. (...) If the conductivity of the area is lowered, the intensity of a current which passes through this area is at once decreased.¹⁹

¹⁷ Wolfgang Kohler and Hans Wallach, "Figural After-Effects", in Proceedings of the American Philosophical Society, 88, 1944, p. 289-357, quoted by Carl Duncan, "On the Similarity Between Reactive Inhibition and Neural Satiation", in American Journal of Psychology, Vol. 59, No. 2, June 1956, p. 227-236.

¹⁸ Eysenck, "Cortical Inhibition, Figural After-Effect, and Theory of Personality", Op. Cit., p. 94-106.

¹⁹ Kohler and Wallach, Op. Cit., p. 684.

Thus, the authors use the term satiation to describe the electrotonic effect of figure currents on the cortical medium and figural after-effects to denote the alterations which a test object may undergo when their figure currents enter into a satiated area. From this it is assumed that the cortical medium affects and is effected by the figure process distribution, and that there is a dynamic interaction between the two. It can also be assumed that the condition of the cortical medium may be a determinant of one's perceptions.

Klein and Krech²⁰ maintained that resistance within an area stimulated, is heightened by any neural activity, and that the amount of stimulation distortion in a new pattern is not necessarily dependent upon strong figure-ground differentials.

²⁰ George S. Klein and David Krech, "Cortical Conductivity in the Brain-Injured", in Journal of Personality, Vol. 21, No. 1, September 1952, p. 118-148.

The current flow initiated by stimulation of a defined cortical area results in a heightened resistance, within that area, to further electrical activity. Should further stimulation occur, the resulting pattern of electrical activity would as a consequence of this increased resistance, be 'dampened', distorted or rerouted. In this event we can then speak of reactive or a temporary condition of decreased cortical conductivity; (...) For this temporary and localized condition we would assume that the degree of decrease in cortical conductivity is a function of the amount of original stimulation, such that the more stimulation the greater the drop in cortical conductivity (within certain limits). However, we would postulate another factor which contributes to the extent of drop in cortical conductivity: we would assume that the over-all state of the cortex helps to determine the initial or basal value of cortical conductivity prior to any stimulation, i.e., the basal or characteristic level of cortical conductivity.²¹

The authors regard kinesthetic after-effects as an indirect measure of cortical conductivity, and they infer that patients with brain injuries have a lowered conductivity and will show after-effects more readily, in greater degree and with greater persistence than normals. Their data supposedly supports the theory that an effect of cortical lesions is a marked change in general cortical conductivity.

Jaffe,²² testing brain-injured subjects with and without memory impairment, for kinesthetic figural after-effect produced contradictory results as compared to those

²¹ Klein and Kreeh, Op. Cit., p. 120-121.

²² Robert Jaffe, "Kinesthetic After-Effects Following Cerebral Lesions", in American Journal of Psychology, Vol. 67, No. 4, December 1954, p. 668-676.

of Klein and Krech previously mentioned. He found no significant differences in figural after-effect between his group of controls and brain injured.

Kovatch²³ compared after-image threshold measures of a group of fifteen males having intracranial pathology with the scores of a group of seventy-two RCMP. The results showed the mean and standard deviation of these two groups to be significantly different at the .01 level, thus supporting the theory that "the after-image is cortically influenced and that pathology of one area of the cortex can affect the functioning of the visual cortex".²⁴

Findings, contrary to predictions made on the basis of the Kohler and Wallach theory of satiation previously mentioned, have been found. Jaffe²⁵ tested twenty normal subjects for kinesthetic figural after-effect, but with the interpolated stimulus being the same as the standard one. He found that blindfolded controls showed no after-effects. An experimental group were exposed to additional visual stimuli, equal to the standard stimulus during test periods

23 J. Kovatch, Intracranial Pathology and the Negative-Image Threshold, unpublished Master's thesis presented to the School of Psychology and Education of the University of Ottawa, Ontario, 1961, vii-43 p.

24 Ibid., p. 39.

25 Robert Jaffe, "The Influence of Visual Stimulation on Kinesthetic Figural After-Effect", in the American Journal of Psychology, Vol. 59, No. 1, March 1956, p. 70-75.

and narrower or wider during satiation. The subjects in the experimental group showed a significant distortion in kinesthetic perception after viewing the wider stimuli. Under conditions where subjects were exposed to visual stimuli only during the satiation period no after-effects were demonstrated. As it is assumed that after-effects should be specific to one modality, according to Kohler and Wallach's theory, the results of this study appear contradictory inasmuch as they indicate that concurrent visual stimulation can induce a significant kinesthetic figural after-effect, but it appears only when contrasting size relationships are in existence between the visual stimuli.

Osgood and Heyer²⁶ objected to Kohler and Wallach's theory of satiation on the basis of the nebulousness of its character. In the fact that the theory is based upon field changes unknown to contemporary neurology. An attempt was made to explain the phenomenon of satiation through mechanisms already known to be functioning in the cortex.

Krauskopf²⁷ showed in his experimental findings that, beyond a certain period of time or exposure to a stimulus,

26 C.E. Osgood and A.W. Heyer, "A New Interpretation of Figural After-Effects", in Psychological Review, Vol. 59, No. 2, March 1952, p. 98-118.

27 John Krauskopf, "The Magnitude of Figural After-Effects as a Function of Duration of Test Period", in the American Journal of Psychology, Vol. 67, No. 4, December 1954, p. 684-690.

no appreciable change was made in the adaptation phenomenon.

In objecting to the Kohler theory, he stated:

If an increase in polarizability is the dominant result of prolonged fixation, it should be expected that when exposures of T-objects are short, their displacements should be smaller than with longer exposures.²⁸

The discovery that figural after-effects decrease in magnitude as a function of the length of time for the testing period, throws some doubt on the Kohler theory.

What has been previously discussed is a collection of studies attempting either to support or refute the Reactive Inhibition Theory as utilized by Eysenck, and to explain the neurological basis of sensory inhibition. It can be seen that the majority of this research only raises more questions. Unfortunately, these studies came to no definite agreement either for or against this theory. It becomes more apparent that a great deal of research has yet to be done in order to clarify many of the unanswered questions and disputes arising over the Reactive Inhibition Theory. As Barry²⁹ notes, and quite rightly so, Eysenck has found it necessary to propose further problems for research

²⁸ Krauskopf, Op. Cit., p. 684.

²⁹ William F. Barry, An Investigation of Relationships Between Introversiön-Extraversiön and the Negative After-Image Threshold, unpublished doctoral dissertation, University of Ottawa, School of Psychology and Education, 1961, ix-80 p.

to investigate the relationship between reactive cortical inhibition and the development of introverted or extraverted personality traits. The following section of this chapter will attempt to present some of the studies done which will possibly clarify the confusion that seemingly exists in this area.

3. Studies Concerning Introversiion-Extraversiion and Reactive Cortical Inhibition.

Eysenck³⁰ used pursuit-rotor learning as a measure of reminiscence and the MPI as a measure of introversiion-extraversiion and neuroticism in attempting to integrate personality theory and learning. The study concerned itself with the hypothesis derived from learning theory, demonstrating that extraverts should show greater reminiscence on the pursuit-rotor following massed practice than introverts. As a second part of this study, an attempt was made to investigate the relationship between neuroticism and reminiscence. The reminiscence phenomenon (or the recovery of motor precision) could be considered as the product of inhibition originating in the massing of practice. Eysenck hypothesized then, that extraverts should show a higher degree of

30 H.J. Eysenck, "Reminiscence, Drive and Personality Theory", in the Journal of Abnormal and Social Psychology, Vol. 53, No. 3, November 1956, p. 328-333.

reminiscence than introverts. The Maudsley Personality Inventory was used as a criterion for introversion-extraversion and neuroticism. The results were seen by Eysenck as positive proof of the relationship between the variables being investigated. He found a significant correlation of .29 between the extraversion scale and the first reminiscence score, but on the second testing, the results were not significant. Conditioned Inhibition combined with reactive inhibition might have been the factor that caused insignificant results on the second testing. The findings that extraversion and reminiscence were associated, following the stated hypothesis, and reminiscence being significantly greater for individuals with high neuroticism scores than those with low N scores, prompted Eysenck to be optimistic in linking the study of personality with drive and its neurological antagonists.

Smith and Raygor³¹ using distance in word associations as the criterion of satiation and the Sixteen Personality Factor Questionnaire as the criterion for introversion-extraversion, showed that extraverts differed significantly from introverts in the number of statistically uncommon responses.

³¹ Donald Smith and Alton Raygor, "Verbal Satiation and Personality", in the Journal of Abnormal and Social Psychology, Vol. 52, No. 3, May 1956, p. 325-326.

Lynn³² tested Kysenok's theory that extraversion, after-effect and reminiscence is related. He used the Archimedes Spiral After-Effect as a measure of satiation and an Inverted Alphabet Printing task as a measure of reminiscence. The Maudsley Personality Inventory was used as the criterion for introversion-extraversion. He made six predictions on the theory that extraverts accumulated reactive inhibition quickly and that it dissipates in them slowly. The hypotheses were: a negative correlation will be found between extraversion and duration of after-effect; extraverts would see progressively less of the after-effect with repeated massed trials; extraverts would see progressively less of the after-effect after a period of rest; there will be a negative correlation between duration of after-effect and a measure of reminiscence; there will be a positive correlation between extraversion and reminiscence; and finally, the extraverts will show a tendency for more work decrement with massed practice on the inverted alphabet printing task. Using forty male university students as subjects, he found that four of the six predictions were confirmed with significant correlations ranging from .41 to .43. Correlations were not significant between extraversion and

32 R. Lynn, "Extraversion, Reminiscence, and Satiation Effects", in the British Journal of Psychology, Vol. 51, No. 4, November 1960, p. 319-324.

reminiscence, and extraverts did not see progressively less of the after-effect after a period of rest.

Meier³³ tested five hypotheses in relation to the study of personality variables as measured by the Minnesota Multiphasic Personality Inventory of which probably only three are relevant here. The first one being, individual variation in the magnitude of kinesthetic figural after-effect varies negatively with the amount of reminiscence in inverted alphabet printing and secondly, individual variation in the persistence of kinesthetic figural after-effect varies positively with age and negatively with size of vocabulary, and lastly, reminiscence varies negatively with age and positively with size of vocabulary. The results of the study largely supported these hypotheses. The relationships observed between reminiscence in Inverted Alphabet Printing, kinesthetic figural after-effect, age, and vocabulary may derive from some neural process involving the generation and dissipation of reactive inhibition.

³³ Manfred Meier, "Interrelationships Among Personality Variables, Kinesthetic Figural After-Effect and Reminiscence in Motor Learning", in Journal of Abnormal and Social Psychology, Vol. 63, No. 1, July 1961, p. 87-94.

Meier's³⁴ results showed a significant negative correlation between the amount of reminiscence found in the task of inverted Alphabet Printing and the amount of figural after-effect in the kinesthetic sensation.

Ray³⁵ in his study looked for possible relationships between the personality variable of introversion-extraversion as determined by the Maudsley Personality Inventory and measures of motor reminiscence. Rather than just dividing his groups by the criterion of introversion and extraversion and neuroticism, he went a step further and established four new categories: normal introverts, neurotic introverts, normal extraverts, and neurotic extraverts. The results of the study indicated the extraverts demonstrated more reactive cortical inhibition than introverts, but no significant correlations between the measures of reminiscence and any of the four personality complexes.

Rechtschaffen,³⁶ in his study, attempted to investigate the hypotheses that extraverts developed greater visual

34 Meier, Op. Cit., unpublished doctoral dissertation, University of Wisconsin, Madison, 1956, p. 78, as quoted by W.C. Becker, "Cortical Inhibition and Extraversion-Introversion", in the Journal of Abnormal and Social Psychology, Vol. 61, No. 1, July 1960, p. 64.

35 Oakley S. Ray, "Personality Factors in Motor Learning and Reminiscence", in the Journal of Abnormal and Social Psychology, Vol. 59, No. 2, September 1959, p. 199-203.

36 Allan Rechtschaffen, "Neural Satiation, Reactive Inhibition and Introversion-Extraversion", in the Journal of Abnormal and Social Psychology, Vol. 57, No. 3, November 1958, p. 283-291.

after-effects than introverts; extraverts develop more I_R on a motor learning task than introverts; and that amounts of after-effect and I_R exhibited by individuals are positively correlated. The R Scale from Guilford's Inventory of Factors 3TDCR was used as the criterion for extraversion. Visual after-effects were measured with a specifically constructed apparatus, and two measures of I_R were obtained from an Inverted Alphabet Printing task. Results of the experiment do not support the hypotheses tested. While the obtained results were in the expected direction in each case, the degree of relationship demonstrated was uniformly small.

The results showed that the introversion-extraversion (Rhathymia) scores were not significantly correlated with either amount of visual after-effect or I_R measures. Further, amount of visual after-effect was not significantly correlated with I_R measures. An additional analysis was made comparing the thirty-five subjects with the highest Rhathymia scores (extraverts) with the thirty-five subjects with the lowest Rhathymia scores (introverts). The two groups also did not differ significantly on the after-effect I_R measures.³⁷

Spitz and Lipman,³⁸ in their experiment failed to find any significant intercorrelation of individual

37 Rechtschaffen, Op. Cit., p. 290.

38 Herman Spitz and R. Kipman, "Reliability and Intercorrelation of Individual Differences on Visual and Kinesthetic Figural After-Effects", in Perceptual Motor Skills, Vol. 10, 1960, p. 159-166.

differences in kinesthetic figural after-effect and visual after-effect scores, and were thus prompted to say that in the use of satiation measures, different results might be obtained when employing different modalities.

Rechtschaffen,³⁹ as if sensing criticism of this type, replicated his own previous experiment using a kinesthetic figural after-effect measure and, as before, reports negative results.

Confirming Rechtschaffen's studies previously mentioned, were the results of Norcross, Lipman and Spitz.⁴⁰ They measured the rate of development of visual satiation effects; total amount of visual satiation; total amount of kinesthetic satiation; rate of dissipation of kinesthetic satiation; and rate of dissipation of visual satiation. The Maudsley Personality Questionnaire was used as the measure for introversion-extraversion. Of twenty correlations made, only one was significant, (.29) at the .05 level between E scores of females and their total amount of visual satiation. The other nineteen correlations supported Rechtschaffen's

39 Allan Rechtschaffen and Lawrence Bookbinder, "Introversion, Extraversion and Kinesthetic After-Effects", in Journal of Abnormal and Social Psychology, Vol. 61, No. 3, November 1960, p. 495-496.

40 Kathryn Norcross, Ronald Lipman and Herman Spitz, "The Relationship of Extraversion-Introversion to Visual and Kinesthetic After-Effects", in Journal of Abnormal and Social Psychology, Vol. 63, No. 1, July 1961, p. 210-211.

previously mentioned results, finding that extraverts did not develop satiation effects more quickly, nor reach higher levels, nor dissipate more slowly than introverts.

Becker⁴¹ has probably written one of the most comprehensive and, at the same time, critical articles concerning the Eysenckian theory that cortical inhibition is one of the bases for individual differences in introversion-extraversion. Eysenck is judiciously criticized for using the terms satiation, cortical inhibition, and reactive inhibition synonymously. Becker attempts to clarify the misunderstanding fostered by the misuse of these terms, by reviewing their semantic and functional definitions, and also shows the differences between them. The author proposed three hypotheses for testing in his research:

a) that individual differences in satiation effect and reactive inhibition effects are correlated, thus, justifying the more general concept of reactive cortical inhibition; b) that individual differences in basal cortical inhibition are correlated with individual differences in reactive cortical inhibition, as assumed by Klein and Krech (1952); and c) that individual differences in satiation, reactive inhibition, or basal cortical inhibition are related to individual differences in extraversion-introversion.⁴²

⁴¹ Wesley C. Becker, "Cortical Inhibition and Extraversion-Introversion", in the Journal of Abnormal and Social Psychology, Vol. 61, No. 1, July 1960, p. 52-66.

⁴² Ibid., p. 53.

Becker used thirty-two male and thirty female students selected at random. Extraversion-introversion was determined from the results of Guilford's Rhathymia Scale, the Maudsley Personality Inventory, and Cattell's Personality Inventory. To assess cortical inhibition, the pursuit rotor reminiscence response alteration results were used as a measure of the reactive inhibition effect. The kinesthetic figural after-effect test, Archimedes Spiral and the Necker Cube Difference score were used to test out the satiation theory. GSR conditioning, critical fusion frequency and the uniseikonic lenses were used as the three approximated basal cortical inhibition measures.

The statistical findings enabled Becker to state that:

(...) No empirical evidence was found to support Eysenck's assumption that satiation and reactive inhibition form a unitary trait. Satiation and reactive inhibition measures were found to have some common variance with the basal inhibition measures, but they did not covary with each other. There was no evidence to support Eysenck's hypotheses that satiation measures covary with extraversion measures. There is very minimal evidence that some reactive inhibition measures covary with extraversion. However, there is equally compelling evidence to the contrary. If a relationship between reactive inhibition and extraversion exists, it is probably of such a small magnitude as to be practically and theoretically trivial.⁴³

From the results and discussions of his experiment, it appears that Becker had some difficulty in obtaining

⁴³ Becker, Op. Cit., p. 65.

reliable measures of individual differences for reactive inhibition and satiation. Much of this leaves the reader unable to decide whether it can be definitely said that there are no consistent individual differences between the two phenomena under study or whether the problem lies in the means of obtaining more reliable measures for reactive inhibition and satiation.

Much of the research evolving from Eysenck's attempt to establish a relationship between the introversion-extraversion continuum and reactive cortical inhibition, seems quite confusing and inconclusive. It should be noted for every article questioning the theory, one has been written with the intention of substantiating and supporting it. Taking into account all of these studies, a number of findings for serious consideration become evident. Significant correlations have been found between visual after-effect (a form of inhibition) and the personality variables of introversion-extraversion. It was also found that individual differences were seen in the inhibition of motor or perceptual behaviour. Finally, measurements obtained from the visual modality have shown to be sensitive to this reactive inhibition.

To cloud the picture even further, Petrie⁴⁴ in her experiment, and this author in a pilot study, found a group of people who do not react to satiation in the same manner as expected from reviewing research articles done on reactive inhibition and after-effect.

Let us call the persons who tend to reduce the size of the block subjectively after stimulation, the Reducers, as distinguished from the Augmenters, who tend to enlarge the block. It has been assumed that satiation is one process that expresses itself in a change in size, and that the direction of the change is determined by the size of the stimulus object in relation to the test object. Reducers will tend to reduce even if he is stimulated for equal amounts of time with a block that is larger than the object (...) that is to say, the total effect is for him to reduce. The contrary relation holds for the Augmenters who, when stimulated by objects in precisely the same way as the Reducer, will regularly tend to enlarge his estimate of size. Therefore, there are two contrasting processes manifesting themselves in different personality types - one, a tendency to enlarge; the other, a tendency to reduce.⁴⁵

Surprisingly, Petrie, in this article, makes no attempt to bring these findings into the basic discussions of Eysenck's theory of reactive cortical inhibition and introversion-extraversion. It seems from the results that the phenomenon of augmentation is a variable that should be taken into consideration when evaluation is made of the Eysenckian theory.

44 Asenath Petrie, "Some Psychological Aspects of Pain and the Relief of Suffering", Annals of the New York Academy of Sciences, Vol. 86, Art. 1, March 1960, p. 13-28.

45 Ibid., p. 16.

It is important to remember that Petrie found augmenters by using the same test for kinesthetic figural after-effect as was employed by Eysenck and many other authors. Inasmuch as no mention has been made of the phenomenon of augmentation in these studies, it was felt that research might prove fruitful in attempting to examine the reliability and significance of sensory augmentation, and its possible ramifications and implications in a critique or extension of the Eysenckian theory.

Thus, it might be said in summary: Eysenck in interpreting his dimensions of introversion-extraversion via the theory of reactive cortical inhibition has concerned himself only with the problem of stimulus reduction and deficiency of conditionability. He has not attempted to explain the phenomenon of reactive augmentation; that is the response tendency to augment or amplify sensory dimensions over and above their objective stimulus qualities. The following proposed research is aimed at integrating or differentiating the phenomenon of the response tendency of reactive augmentation from the Eysenckian scheme.

Translated into research questions, this proposed investigation will attempt to answer the following:

- 1) Does response augmentation occur in estimations of sensory stimuli, in a real and statistically significant manner?

- ii) Is there a relationship between the three modalities of kinesthesia, vision and audition in terms of sensory estimation?
- iii) Are augmentation and reduction tendencies related to Eysenck's operationally defined dimensions of introversion-extraversion?

Stated in the null form the hypothesis is: Having demonstrated that overestimation occurs with greater than chance frequency, those individuals displaying stimulus estimation do not differ significantly from introverts without overestimation on a questionnaire type test of introversion-extraversion.

Measurements of sensory estimation will be obtained for the three separate modalities of kinesthesia, vision, and audition. The apparatus used to obtain these measures, as well as the MPI which is the tool used in this research for obtaining introversion-extraversion scores will be described in the following chapter reporting on the experimental design.

CHAPTER II

EXPERIMENTAL DESIGN

This chapter will attempt to present a description of the experimental design used in this study. Section one deals with the sample population. Section two gives a description of the instruments used in measuring sensory estimation of kinaesthetic, auditory and visual stimuli. Section three discusses the psychological questionnaire used as the criterion for the personality variables of introversion-extraversion. Section four presents a description of the experimental procedures, which includes administration techniques. Section five will describe scoring and the major techniques used in handling the data.

1. The Sample Population.

The sample consisted of 127 "normal" male subjects whose ages ranged from twenty-two to 51 years with a mean age of 33.1 years. These subjects were obtained from the Department of Mines and Technical Survey of the Canadian Government, the Ottawa Police Department, the Knights of Pythias Lodge of Ottawa, and students of the School of Psychology and Education of the University of Ottawa. The participants from the Police Department and Civil Service were randomly selected by their immediate supervisors with only the criterion of sex

and age employed. The thirteen students, as well as the members of the Knights of Pythias, were obtained by requesting volunteers.

The purpose of this manner of sampling was to obtain a heterogeneous group of subjects with varied educational background, socio-economic status, and hopefully, diversified personality types.

2. The Psychophysiological Apparatus.

a) Tool Used in Measuring Kinesthetic Figural After-Effect.- An instrument similar to the one devised by Kohler, and later employed by Klein and Krech,¹ was used for measuring figural after-effect in the kinesthetic modality. In this article the authors give a detailed description of this apparatus, which reads as follows:

¹ George Klein and David Krech, "Cortical Conductivity in the Brain-Injured", in Journal of Personality, Vol. 21, No. 1, September 1952, p. 118-149.

The testing apparatus consisted of a Standard Test Object, a Stimulus Object, a Comparison Scale, and stands and tables upon which these various objects were mounted. The Standard Test Object was a block of unpainted, smoothed hardwood, 6 inches in length, $1\frac{1}{2}$ inches wide, 1 inch deep. The Stimulus Object was made of the same wood but with corresponding dimensions of 6 inches in length, $2\frac{1}{2}$ inches wide, 1 inch deep.

The Comparison Scale was a wooden block (similar to the other objects) which tapered in width from $\frac{1}{2}$ inch at the narrow end to 4 inches at the wide end. (...) To aid accuracy in measurement all three objects were equipped with a sliding "rider" which fixed the position of thumb and fore-finger as the subject held the sides of the object.²

Using this apparatus, as many authors have done, gives the opportunity to replicate, as much as possible, previous research using kinesthetic figural after-effect.

The actual procedure of how this instrument is used and what the subject does will be discussed later in this chapter.

For investigating the auditory and visual modalities, suitable instruments to fit the design of this experiment could not be found in the literature. With this in mind, two instruments were devised and built to serve this purpose.

b) Instrument for Measuring Auditory After-Effect.-

The instrument (see Figure 1) consists of a clock, audio generator, stimulus timer and a subject control button.

The clock (Industrial Timer Corporation) registers in two scales, seconds and $1/100$ of a second. It is used to

² Klein and Krech, Op. Cit., p. 123.

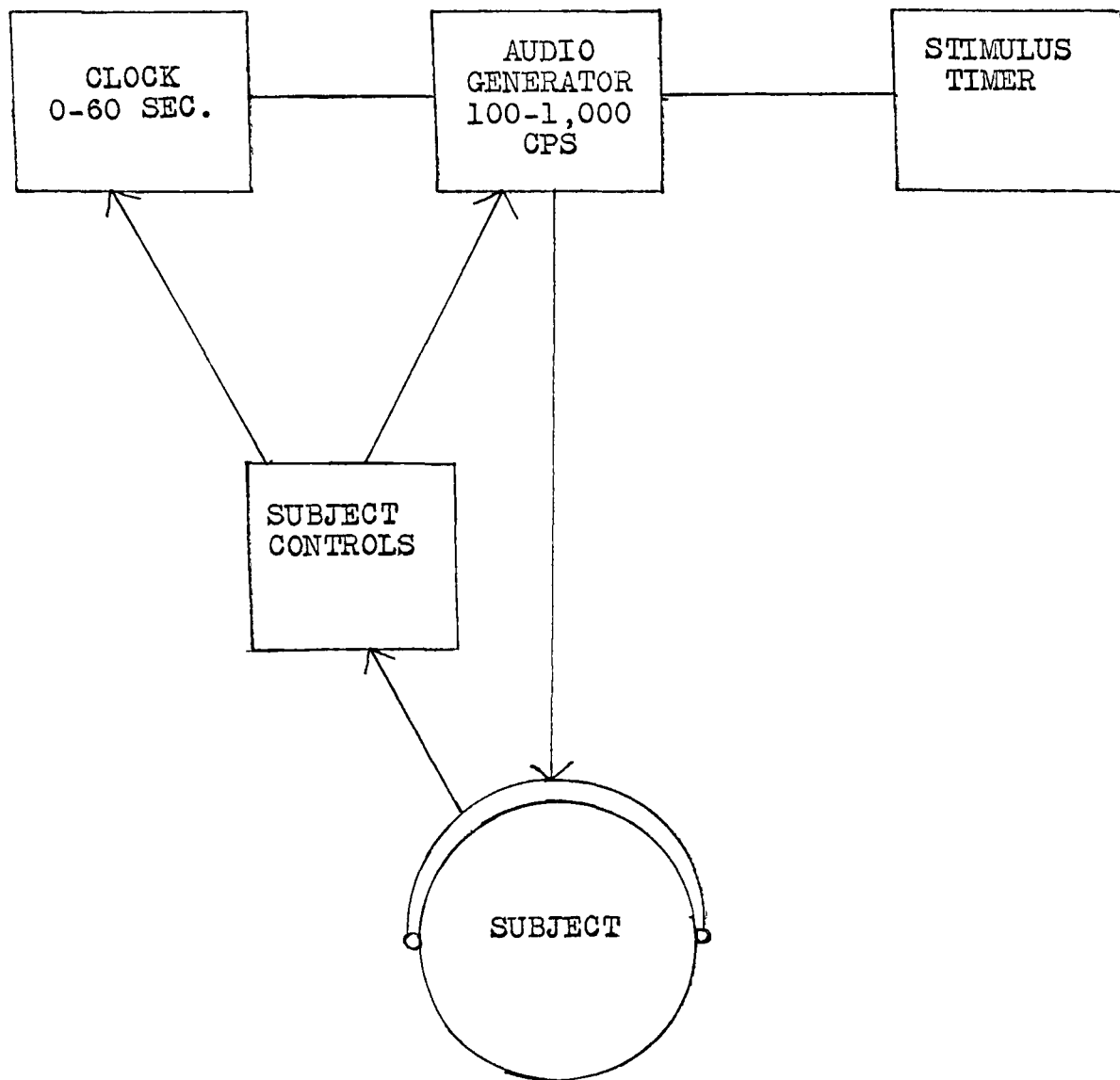


Figure 1.- Schematic Diagram of Apparatus Measuring Auditory After-Effect.

time the response duration. Fast reset (1/10 of a second) prevents delays between readings. The clock registers the subject's response time only, while the stimulus timer regulates the stimulus duration.

The audio generator produces tones of fixed frequencies from 100-1000 CPS in steps of 100 CPS. Sound volume is monitored by a D.B. meter, reading from -10 to + 6db. Stimulation may be administered to the left ear, right ear or both.

The stimulus timer controls the length of time the tone is on. Its range is from 0 to 30 seconds, and is controlled by the experimenter.

The subject's control is a push button switch which starts the audio generator and clock simultaneously. It is the means by which the subject reproduces the stimulus tone and the experimenter measures the duration of the response on the clock.

Reliability of the instrument: the stimulus tone is reproduceable within plus or minus 5/100 of a second and is limited by the accuracy of the stimulus timer. The subject's response is measurable with an accuracy of $\pm 1/100$ of a second, i.e. the accuracy of the clock.

The frequency stability of the stimulus tone is ± 1 per cent.

c) Instrument for Measuring Visual After-Effect.-

This apparatus (see Figure 2) is comprised of an experimenter control panel, a power supply box, a subject's dial, and the light element.

The experimenter control is used to adjust the power supplied to a 100 watt light bulb for a rheostat, and these power levels are read on a microammeter.

The A.C. power supply is controlled by a rheostat and read on a microammeter with a multi-range switch.

The subject's control consists of a rheostat which also controls the power supply to the lamp and is read on the meter on the experimenter's panel.

The light itself is a 100 watt bulb enclosed in a metal cabinet with a 3-inch diameter viewing screen. This opening is covered by two panes of froster glass which is used to obtain an evenly diffused light.

3. The Psychological Tool.

The Maudsley Personality Inventory,³ hereafter referred to as the MPI, was used as the criterion for obtaining a psychological measure of introversion-extraversion. Several

³ H.J. Eysenck, The Maudsley Personality Inventory Manual, prepared by Robert R. Knapp, Educational and Industrial Testing Service, 1962, San Diego, California, p. 21.

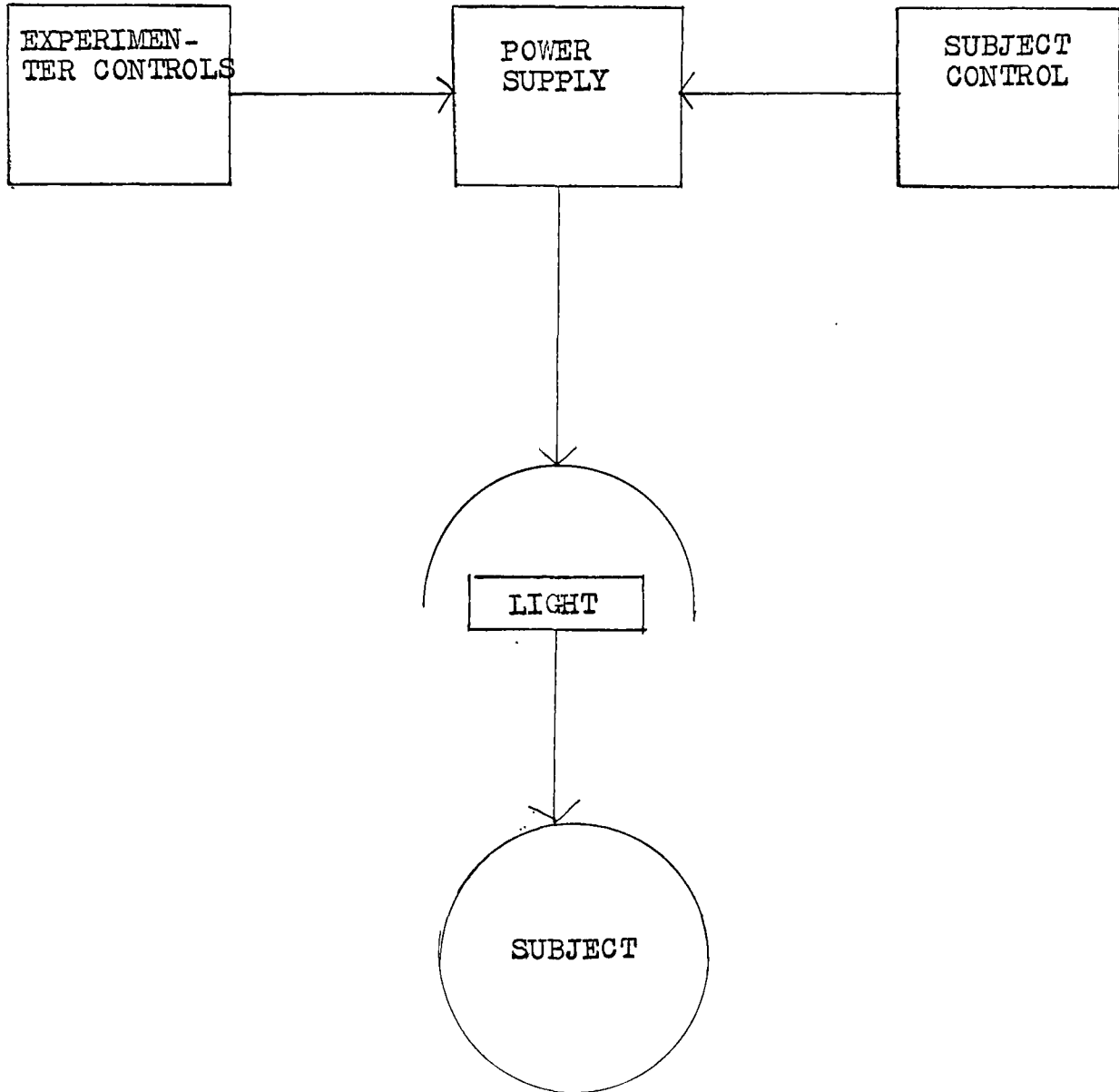


Figure 2.- Schematic Diagram of Apparatus Measuring Visual After-Effect.

authors, including Eysenck,⁴ Petrie,⁵ and Norcross,⁶ have used this questionnaire as a means of obtaining scores of individuals which can in turn be used as a measure of behaviour, in terms of the dimension of introversion-extraversion and neuroticism. This study is only concerned with the first dimension, i.e. introversion-extraversion. As the two scales are relatively independent, scores on one dimension have little effect on the scores of the other.

The MPI consists of forty-eight questions, 24 of which produce scores for introversion-extraversion and 24 which give scores for neuroticism. These questions have been selected on the basis of item and factor analyses. This questionnaire requires about ten to fifteen minutes to administer, yet has adequate reliability for individual use.

The most widely used definition to describe the behavioural traits of the introverts and extraverts, as measured by the MPI, is as follows:

4 H.J. Eysenck, "Reminiscence, Drive and Personality Theory", in the Journal of Abnormal and Social Psychology, Vol. 53, No. 3, November 1956, p. 328-333.

5 A. Petrie, "Some Psychological Aspects of Pain and the Relief of Suffering", in the Annals of the New York Academy of Science, Vol. 86, No. 1, March 1960, p. 13-28.

6 Kathryn Norcross, Ronald Lipman, and Herman Spitz, "The Relationship of Extraversion-Introversion to Visual and Kinesthetic After-Effects", in the Journal of Abnormal and Social Psychology, Vol. 63, No. 1, July 1961, p. 210-211.

The typical extravert is sociable, likes parties, has many friends, needs to have people to talk to, and does not like reading or studying by himself. He craves excitement, takes chances, often sticks his neck out, acts on the spur of the moment, and is generally an impulsive individual. He is fond of practical jokes, always has a ready answer, and generally likes change. He is carefree, easygoing, optimistic, and likes to 'laugh and be merry'. He prefers to keep moving and doing things, tends to be aggressive and may lose his temper quickly. His feelings are not kept under tight control, and he is not always a reliable person.

The typical introvert is a quiet, retiring sort of person, introspective, fond of books rather than people; he is reserved and distant except to intimate friends. He tends to plan ahead, 'looks before he leaps', and distrusts the impulse of the moment. He does not like excitement, takes matters of everyday life with proper seriousness, and likes a well ordered mode of life. He keeps his feelings under close control, seldom behaves in an aggressive manner, and does not lose his temper easily. He is reliable, somewhat pessimistic, and places great value on ethical standards.⁷

Regarding the reliability of this instrument, the manual reports scores of .75 to .85 with the majority above .80 for the introversion-extraversion scale. Split-half and Kuder-Richardson reliability coefficients were the methods used for obtaining these reliability scores. Knowles⁸ and Bartholomew⁹ both report test-retest reliabilities above .70 for the introversion-extraversion scale of the MPI.

⁷ Eysenck, The MPI Manual, Op. Cit., p. 4.

⁸ J. Knowles, "The Temporal Stability of the MPI Scores in Normal and Psychiatric Population", in the Journal of Consulting Psychology, Vol. 24, No. 3, June 1960, p. 278.

⁹ A.A. Bartholomew and E. Marley, "The Temporal Reliability of the Maudsley Personality Inventory", in the Journal of Mental Science, Vol. 105, 1959, p. 120-129.

Factorial analytic confirmation of the validity of the dimensions measured by the MPI are numerous, and all seem to show that the factor in question is definitely being measured by the scales of the MPI.

There also have been studies done to measure the effect of age, sex, and class difference on the MPI and these have shown that the factors mentioned have only the slightest effect on the scores.

The scales of the MPI have been found to be quite independent of measures of intelligence. There have not been any correlations found between I. . . and the introversion-extraversion scale of the MPI.

4. The Experimental Procedures.

This section of the chapter will include the procedures used in measuring for kinesthetic, auditory and visual estimations as well as the personality variable of introversion-extraversion. The methods of handling these results will be discussed in the next section.

All of the sample followed exactly the same procedures during the experiment. The order of testing was constant, with the MPI administered first, followed by the tests for kinesthetic, visual and auditory after-effects, in that order.

The subject was asked to be seated at a long wooden table which was clear of all apparatus, except for the MPI questionnaire. This is an important factor inasmuch as it is inadvisable for the subject to view the apparatus used in measuring kinesthetic figural after-effect. The individual is then requested to fill out the information consisting of name, date, age, sex, and occupation, which is found on the first page of the MPI. He then read the instructions, which were also printed on the first page, and then proceeded to take the test. The instructions read as follows:

Here are some questions regarding the way you behave, feel and act. After each question there is a "Yes", a "?", and a "No". Try and decide whether "Yes" or "No" represents your usual way of acting or feeling; then put a circle around the "Yes" or "No". If you find it absolutely impossible to decide, put a circle around the "?", but do not use this answer except very occasionally. Work quickly, and don't spend too much time over any question; we want your first reaction, not a long drawn-out thought process! The whole questionnaire shouldn't take more than a few minutes. Be sure not to omit any questions. Now go ahead, work quickly, and remember to answer every question. There are no right or wrong answers, and this isn't a test of intelligence or ability, but simply a measure of the way you behave.

Following completion of the MPI, the subject was then asked to blindfold himself with a pair of ski goggles, which had been treated for complete opaqueness. The apparatus for measuring kinesthetic figural after-effect was then placed on the table in front of him. The subject was then asked to grasp the sides of the Test Object with the thumb and

forefinger of his dominant hand. With these two fingers, he was required to estimate the width of the piece of wood that he held. He was given exactly five seconds in which to do this. When the time limit was up, the subject was required to place the same two fingers on the sides of a long tapered bar on the Comparison Scale. The subject was then told to run his fingers along this piece of wood until he had found the place which seemed to him to be as wide as the Test Object which he had recently examined. Movement back and forth on the Comparison Scale was permitted. The measurement of the width, the point where the subject estimated equality with the previous test object, was subsequently recorded by the experimenter. The subject repeated this procedure five times. The only alteration was that in making his estimate, his first two attempts started at the wider end of the scale, and his third and fourth attempts at the narrow end, with the fifth attempt started at the mid-point. Thus five measurements of estimation were obtained, the average of which was used as the base reading or Point of Subjective Equality against which were compared the average of his second and third set of five trials. These procedures of obtaining after-effect scores will be discussed in the next section of this chapter.

Following the completion of these first five estimates, the subject was required to place these same two

fingers on the Stimulus Object, a wider piece of wood. He was told to rub the sides of the block at a constant rate which lasted for thirty seconds. The purpose of this rubbing of a wider block was to induce satiation. After thirty seconds of rubbing, the subject went through the same procedures as required before the satiation period.

After making five more estimates, the individual rubbed the Stimulus Object for a period of sixty seconds and then proceeded to estimate the width of the Test Object in the same manner described previously. This concluded the administration of kinesthetic tasks. Thus were obtained five measures of estimation prior to any satiation which was used as the subject's base, and five measurements following thirty seconds of rubbing and five estimates following sixty seconds of rubbing.

The next step was to record measurements for auditory estimations of tone duration. This was done by using the apparatus described in this chapter.

The subject was given a set of earphones and a push button switch. He was instructed as follows:

You are asked to listen to a sound that I will play for you. Immediately after this sound stops, I want you, by pressing the button down, to play a sound for the same amount of time that you feel my sound was on. You release the button when you want your sound to stop. Do not count, tap your feet, or use any other cues that may help you estimate the length of the tone. You will hear both your sound and mine through your earphones, which you may now put on.

A ten second tone was then played and when it stopped, the subject made his estimate by the method described above. This procedure was followed five times. Completing these five trials, the subject was then asked to listen to the next sound. The length of time for this tone was set at fifteen seconds. The subject was also told to do nothing when this tone stopped. This longer sound was used to induce satiation.

Following this period of satiation, the subject again tried to estimate the length of a ten second sound. He did this five times in the same way as previously described.

When these five measures had been recorded, the subject then listened to a twenty second sound and was then required to make five estimates of the standard tone of ten seconds duration.

Thus was obtained five estimates prior to any satiation, five measures following a fifteen second period to induce satiation, and five more estimates following a twenty second interval to induce satiation.

The frequency and volume of the standard tone, the satiation inducing tone, and response tones were held constant for all subjects.

The final measurements obtained were those for visual estimations of light intensity. The procedures followed in this modality were basically the same as those for the kinesthetic and auditory measurements. The subject was

seated at the end of a long table, forty-two inches away from the box containing the light. The room was then completely darkened, and the instructions were given to the subject as follows:

You are going to be shown a light. You will fix your sight on this area of the box (area is pointed to by the examiner), and after a short time, the light will be turned off and I want you, by turning this dial, (placed in front of the subject) to attempt to adjust this light to the same intensity as the one I just showed you.

The subject was shown the Test Light five times and after each showing, he attempted to replicate it. The standard light was thirty-four microamperes in intensity.

Following these five trials, the subject was asked to look at a brighter light, but not to replicate it. After this five second period, attempting to induce satiation, the individual followed through the same procedures previous to the satiation period. This stimulus (satiation) light intensity was forty-two microamperes in intensity.

Immediately after the subject had completed the second set of five trials, he was shown a brighter light of fifty microamperes, the satiation stimulus, which he did not attempt to reproduce. He was then asked again to make five estimations of the thirty-four microamperes light (Standard Stimulus).

With the completion of these trials, the testing period was terminated and the subject excused from the room.

It is important to note that for each modality, the basic method for obtaining estimate scores was the same. The subject was asked to match, estimate or replicate a Standard Stimulus. He did this five times. A satiation period followed, in which the subject was presented with a larger, longer or brighter stimulus. Five more estimates were made, followed by a second period of satiation, after which the subject attempted estimating or matching the Standard Stimulus through another set of five trials.

It should be noted that for each sensation a different dimension is being investigated. In the kinesthetic modality the attribute of extent of size is used. This is considered to be the "spread-outness" of a sensation, or in this case the width of a piece of wood. In the auditory sensation, the dimension tapped was duration. This is the time dimension and refers to how long a sensation lasts. Finally, in the visual modality, the attribute of intensity was used. This refers to "the moreness or lessness" of a particular quality, such as brightness of a light, as was used here.

The following section of this chapter will present the method used in obtaining estimation scores, i.e. reduction or augmentation for each subject, and the statistical means by which these categories are determined. The statistical methods used in these attempts to find relationships

between introversion-extraversion scores and the estimation scores and means of analyzing these data will be covered also.

5. Methods for Analyzing the Data.

To determine the directionality of the individual's estimates, i.e. increase or decrease, it was necessary to obtain a baseline or, as it is sometimes termed, his point of subjective equality, hereafter referred to as PSE. The baseline for each subject was necessary in order to account for individual differences in the estimations of the kinesthetic, auditory and visual stimuli. The PSE is calculated by summing the subject's scores of his initial five estimates and obtaining the mean. The estimate scores for the succeeding two sets of five trials were then totalled and the mean on these ten scores was obtained. To find the trend of the individual's estimation scores, the base mean was subtracted from the mean of the final ten trials. This operation can be shown in the simple formula:

$$M_2 - M_1 = x$$

where M_1 = the average score of the initial five trials
or subject's PSE

M_2 = the average score of the final ten trials

x = the amount of deviation between these two means.

The score obtained could be either positive or negative depending on the magnitude of the individual's latter ten estimates, in respect to his original baseline. It must be pointed out that this initial procedure does not necessarily classify the subject either as an augmentser or reducer. The technique by which this is done will appear later in this section.

By using means of sets of trials random errors that are present can be minimized. It can also be assumed that even though it might be shown that single estimates are not randomly distributed, the means would tend to form a random distribution. In turn, it can be said that the difference between the two means is a normal distribution.

The stability of the phenomena being studied, i.e., reduction and augmentation, was determined by retesting thirty randomly selected subjects on the kinesthetic, auditory, and visual tasks. Utilizing these scores from the retest, the author was able to determine the coefficients of reliability by the Pearson r method.

This Pearson r statistic was again employed to determine the relationship between the three sense modalities studied; the relationships between each of these three modalities and the E scale of the MPI.

The Pearson r formula is stated thusly:

$$r_{xy} = \left[\frac{\frac{XY}{N} - M_x M_y}{S_x S_y} \right]$$

In order to test the significance of the r's obtained, these scores were converted into Fisher Z function¹⁰ and the standard error of Z was computed. This function Z has two advantages over r: i) its sampling distribution is approximately normal and ii) its standard error depends only upon the size of the sample N, and is independent of the size of r. To transform r to Z, Table H (appendix B), in Guilford¹¹ is consulted or the following formula can be used:

$$Z = \frac{1}{2} \log e \left(\frac{1+r_{xy}}{1-r_{xy}} \right)$$

where log e stands for a logarithm to the base e.

The standard error of Fisher's Z function is then computed by the following formula:

$$\sigma_z = \frac{1}{\sqrt{N-3}}$$

This standard error for Z, unlike that for r, is uniform for all values (with N constant). Using the value derived from computing σ_z , the confidence limits for Z are obtained and the r's corresponding to those of Z limits are determined.

¹⁰ R.A. Fisher, Statistical Methods for Research Workers, Oliver and Boyd, London, England, 1941, p. 190-203.

¹¹ J.P. Guilford, Fundamental Statistics in Psychology and Education, McGraw Hill Book Co., New York, 1956, p. 545.

The means, standard deviation, and standard error of the means and standard deviations were computed for estimation scores on the kinesthetic, auditory, and visual tasks as well as for the E scale of the MPI. The following formulae were used for obtaining these values:

Formula for the mean:

$$M_x = \frac{\sum X}{N}$$

Standard deviation:

$$\sigma_x = \sqrt{\frac{N}{N-1} \left(\frac{\sum X^2}{N} - \left(\frac{\sum X}{N} \right)^2 \right)}$$

Standard error of the mean:

$$\sigma_M = \frac{\sigma}{\sqrt{N}}$$

Standard error of the standard deviation:

$$\sigma = \frac{\sigma}{\sqrt{2N}}$$

To test the hypothesis that augmentation is a reliable phenomenon in the population, it was necessary to select randomly thirty subjects from the original sample of 127 and retest them in precisely the same manner followed in the original procedures. These thirty individuals were also used to obtain a test-retest correlation for the phenomenon of over-estimation, i.e. augmentation and underestimation, i.e. reduction as has already been discussed earlier in this section.

To classify individuals into categories of augmenters and reducers, cut off points had to be obtained. This meant finding test scores which gave a ninety-five per cent or ninety-nine per cent probability that retest scores would be consistently above or below a zero point.

The statistical method employed was that of a regression analysis and establishment of confidence limits around this regression line. The procedures to be outlined were obtained from Ezekial and Cox.¹²

To determine the slope of the line, it was necessary to find the constants for the equation of the line. This straight line can be expressed by the relation:

$$y = a + bx$$

where x = test scores

y = retest scores.

When the value of x is zero, b times x is zero and y is equal to a . This constant, a , therefore, gives the height of the line (in terms of y or vertical units) at the point where x is equal to zero. For the same equation, every time x increases one unit, y increases b times one unit, since y is computed as a plus b times x .

¹² Mordecai Ezekial and Karl A. Cox, Methods of Correlation and Regression Analysis, John Wiley and Sons, Inc., 1939, xv-548 p.

The next step was fitting the line by "least squares". This method takes all the observations into account, giving each of them an equal weight in determining the result - a line such that the sum of the squares of the departures from the line will be as small as possible. To compute the extensions each X item was squared and each X item was multiplied by the accompanying Y item, and the sums were obtained for these different values. This gave $\sum X$, $\sum Y$, $\sum(X^2)$ and $\sum XY$. The means of X and Y are also obtained.

In order to obtain the slope of the line the value for b was determined next by the following equation:

$$b = \frac{\sum(XY) - nM_xM_y}{\sum(X^2) - n(M_x)^2}$$

The equation for obtaining a value which will become the Y intercept of this line was calculated thusly:

$$a = M_y - bM_x$$

This line is called the "line of best fit", since it is the line which gives, for all the observed values of X, values of Y which come as near as possible to agreeing with all the different Y values observed, using the least squares criterion.

Once the line had been plotted, it was then necessary to calculate the estimated confidence bands around the regression line. Standard errors, firstly, had to be computed for the line itself, the group mean estimate and finally the slope. These formulae are as follows:

Standard error of the line:

$$S^2_{xy} = \left[\frac{N-1}{N-2} (sy^2 - b^2sy^2) \right]$$

Standard error of the group mean estimate:

$$S^2_{\bar{y}} = \frac{S^2_{xy}}{N}$$

Standard error of the slope:

$$S^2_b = \frac{S^2_{xy}}{Sx^2N}$$

where $S^2_x = \left[\frac{\sum X^2}{N} - \frac{M_x^2}{N-1} \right]$

These three variances were needed in the final formulae in order to estimate the confidence bands which are placed around the regression line. For individual retest scores the following formula is used:

$$Y'_1 = (a + bxi) \pm t \sqrt{S^2_{xy} + S^2_{\bar{y}} + S_b^2 (xi - Mx)^2}$$

For group retest scores the following formula was employed:

$$Y'_1 = (a + bxi) \pm t_{\gamma} \sqrt{S^2_{\bar{y}} + S_b^2 (Xi - Mx)^2}$$

where t_{γ} is the Student's t = the ratio of a deviation from the mean or other parameter, in a distribution of sample statistics, to the standard error of that distribution.

The significant t values used here were as follows:
at the .05 level with $df = 28 (N-2)$; $t = 2.048$
at the .01 level with $df = 28 (N-2)$; $t = 2.763$

where the group retest score is equal to the estimated mean score of all individuals in the group whose test score is exactly X_1 .

Having drawn the estimated confidence bands around the regression line, the "true" cut off points for determining augmenters and reducers were then established. This was done simply by moving along the retest axis and finding its zero point. From this zero point a horizontal line was drawn and the scores located at this line's points of intersection with the confidence bands considered as the cut off points. These cut off points were used to discriminate between augmenters, reducers, and a middle group composed of individuals showing neither of these two phenomena.

The following chapter will be devoted to the discussion of the results obtained by using the statistical methods just described. These results are investigated in light of the hypothesis stated earlier and for investigation areas for further research.

CHAPTER III

PRESENTATION AND INTERPRETATION OF RESULTS

In this chapter are presented the results of this experiment and a discussion of findings. It is divided into the following sections: Section one deals with the reliability of the estimation scores of the sensory phenomena under study. The second section studies the obtained data used to determine the criterion of augmentation, i.e., overestimation, and reduction, i.e., underestimation and its application to the sample used in this experiment. In section three are presented the results determining the relationship of the different variables under investigation. Finally, the relevancy of these results are discussed in relation to the Eysenckian theory of introversion-extraversion. These four sections are followed by proposed hypotheses for further research.

1. Test-retest Reliability.

One of the major factors that must be considered before any interpretation or discussion of results can be presented is that of the reliability of the scores of the sensory phenomena being measured.

To obtain an index of consistency for the directionality of estimation and the degrees of over and underestimation, a second testing was performed for thirty

subjects randomly selected from the total population of 127 subjects. These estimation scores were obtained for the three modalities under study, i.e., kinesthetic, auditory, and visual. The degrees of overestimation or underestimation were computed (as described fully in chapter two) by means of the formula $M_2 - M_1 = x$.

Treating each of these senses separately, a scatter-gram was plotted for the test-retest scores around a line of best fit. These figures can be seen in Appendix 1. As can be observed, the points plotted for the two sets of scores in the kinesthetic and auditory modalities fit closely around the regression line. It should also be noted that there are no points falling in either the upper left or lower right quadrants. This factor can be interpreted in reference to consistency in directionality from the first to second testing. For audition, however, it is seen that the points plotted are somewhat scattered and not as close to the line as for the other two modalities. There were also three individuals whose direction of scores was not the same in trial 2 as in trial 1 for the auditory measure. A possible explanation for this might be in the lack of sensitivity of the instrument for measuring visual after-effects. This cannot be stated with absolute certainty, but the range of variability in estimates for this apparatus might not have been wide enough to give effective stimuli for a wide range

of estimation scores to occur. Nevertheless, as will be seen shortly, the correlation coefficient for the auditory scores is still significantly high.

The Pearson Product Moment Method of Correlation was then employed to obtain reliability coefficients for the test-retest scores in the three modalities being studied. It was possible to apply this statistic to the data since the major assumptions, of randomness of sample and rectilinearity, underlying its use appear to be fulfilled. Random sampling has already been mentioned and a straight line relationship does exist between the scores of the first and second testing.

The obtained reliability coefficients for these scores were as follows: for kinesthesia, audition and vision, r 's of 0.908, 0.825 and 0.783 respectively were computed.

The significance of the obtained r 's can be interpreted in two ways. Firstly, the high consistency in test-retest scores for these subjects could lead one to state that over and underestimation are consistent physiological qualities of a person, and that the direction of estimation scores is consistent. Secondly, and more specific to this experiment, it can be proposed that any augments or reducer defined on the basis of consistency in algebraic score is exhibiting a valid phenomenon. It will be seen later

in this chapter, that identifying augmenters and reducers by means of a statistical cut-off point will be of major significance in an attempt to show that augmentation is a reliable phenomenon. The ability to find "true" augmenters in this population will be supported even more by having found r 's of .908, .825, and .783. This will be discussed further in section two.

The following section will present a discussion of the cut-off scores used to determine augmenters and reducers as well as the number of subjects classified into these two categories according to the determined criteria.

2. Statistically Determining the Augmenter and Reducer.

Probably one of the major facets of this research was the attempt to find individuals in the population who overestimate a stimulus over a certain number of trials. The procedure for determining the quantitative amount of overestimation or underestimation for each subject was described in section five of chapter two. However, by just obtaining a certain score, either positive or negative, it was impossible to determine whether this score could be used to categorize either an augmenter, i.e. overestimator or reducer, i.e. underestimator. In the light of this problem, statistically significant cut-off points or scores

had to be established. By using these points, it could then be said that an individual with a score equal to or larger than the criterion score could be considered as a valid augmenter. On the other hand, a subject with a score falling on or greater than the lower cut-off point could be categorized as being a "true" reducer.

To accomplish this task, the test-retest scores of the reliability group were computed to obtain a regression coefficient. The results of trial 1 were plotted against the scores on trial 2, and the two sets of scores were found to differ in a linear fashion.

From this regression line a standard error of estimate was computed, so that given any score on test 1, it was possible to estimate what the score on test 2 would be \pm a certain error. By multiplying a t value times this obtained standard error, confidence bands were then able to be adjusted around the regression line so that either 95 per cent or 99 per cent of the estimated scores would fall within this range. Or, it could be said, the line gives, for a hypothetical test score, a predicted hypothetical retest score. The upper and lower bounds give the regions above and below predicted hypothetical scores for each individual or group considered on the basis of their test score.

The formulae for this computation and method of deriving cut-off scores were fully outlined in section five of chapter two.

Table I shows the cut-off points computed from the individual scores as well as the group mean for the three modalities at both the .95 and .99 levels of probability.

By using this method an attempt was made to define augmenters and reducers in such a way that the probability of misclassifying an individual or a group of individuals is as small as possible.

The more stringent of the statistical criteria was that obtained by using the individual estimates. This method produced severely high cut-off scores and immediately reduced the number of subjects who could be reliably classified as either augmenters or reducers. A third group was formed by subjects who did not obtain scores equal to or greater than the obtained limits and were classified as non-augmenters and non-reducers. However, it is important to note, that even with this strict criterion, augmenters were still found in all three modalities.

The interpretation that can be given for the results based on the individual estimates can be stated as follows: any individual who scores equal to or above the cut-off score can reliably be classified as an augmentor or reducer at either the 95 per cent or 99 per cent level of confidence.

Table I.-

Cut-Off Scores Derived from Individual Estimates and Group Mean Scores Used to Determine Augmenters and Reducers at the 95% and 99% Levels of Probability in the Kinesthetic, Auditory and Visual Modalities.

| | Augmentation | | | | Reduction | | | |
|-------------|--------------|------|-------|------|------------|------|-------|------|
| | Individual | | Group | | Individual | | Group | |
| | 95 | 99 | 95 | 99 | 95 | 99 | 95 | 99 |
| Kinesthesia | +1.3 | +1.3 | +0.2 | +0.3 | -1.3 | -1.3 | -0.3 | -0.4 |
| Audition | +1.4 | +1.4 | +0.2 | +0.3 | -1.6 | -2.1 | -0.4 | -0.5 |
| Vision | +3.0 | +3.0 | +0.5 | +0.7 | -3.1 | -3.2 | -0.6 | -0.9 |

Given an individual with a hypothetical test score, it can be safely stated that his retest score will be within the limits stated.

The second and less severe cut-off scores were obtained by using the group mean estimates. This method greatly increased the number of augmenters and reducers in all three modalities. Because of this, the middle group, i.e., non-augmenters and non-reducers was decidedly diminished. The findings obtained through this method can be interpreted in the following manner. Any group of people, each of whom score equal to or above the cut-off score could be classified as an augmenting or reducing group at either the 95 per cent or 99 per cent level of confidence. Considering all the individuals with hypothetical test scores of a certain quantity, these individuals will give a mean retest score between the limits stated.

The frequency of augmenters and reducers in the three modalities under study, computed at both the 95 per cent and 99 per cent levels of probability for individual and group mean estimates can be seen in Table II.

The following section will present the correlation coefficients computed for the different variables under investigation in this research.

Table II.-

Frequency of Augmenters and Reducers in the Kinesthetic, Auditory and Visual Modalities, Based on Cut-Off Scores Derived from Individual and Group Mean Estimates at Both the 95% and 99% Levels of Probability.

| | <u>No. of Augmenters</u> | | | | <u>No. of Reducers</u> | | | |
|-------------|--------------------------|----|--------------|----|------------------------|----|--------------|----|
| | <u>Individual</u> | | <u>Group</u> | | <u>Individual</u> | | <u>Group</u> | |
| | 95 | 99 | 95 | 99 | 95 | 99 | 95 | 99 |
| Kinesthesia | 29 | 29 | 61 | 60 | 19 | 12 | 58 | 54 |
| Audition | 16 | 16 | 70 | 64 | 1 | 0 | 29 | 27 |
| Vision | 4 | 4 | 54 | 49 | 5 | 5 | 51 | 40 |

3. Correlations of Variables Being Studied.

The results of a number of experiments have led Eysenck¹ to postulate that cortical inhibition, as measured by one of the methods used in this experiment, is one of the bases for individual differences in introversion-extraversion. The extravert is assumed to generate more cortical inhibition than the introvert. Applying the theory stated to this research, an attempt was made to find if there was any relationship between introversion-extraversion as measured by the MPI E scale and after-effect scores as operationally defined in terms of scores of estimation in three modalities. If Eysenck's hypothesis is correct, extreme introverts should show significantly lower reduction in comparison to extraverts. It was also hypothesized by this writer that the phenomenon of overestimation would occur and the individuals reacting in this manner would fall into the extreme introvert range.

Neither Eysenck's theory nor the writer's hypothesis was substantiated on the basis of results obtained in this experiment. Utilizing the Pearson r technique for obtaining correlation coefficients, the after-effect scores were

1 H.J. Eysenck, "Cortical Inhibition, Figural After-Effect and Theory of Personality", Journal of Abnormal and Social Psychology, July 1955, Vol. 51, No. 1, p. 94-106.

compared with scores obtained on the E scale of the MPI. These correlations, as well as Fisher z scores can be seen in Table III.

For the kinesthetic scores and the E scale of the MPI an $r = .03772$ was obtained. The correlation found was not significant at either the .05 or .01 level. The same procedure was followed for the auditory and visual senses in relation to the E scale, and the r's computed were those of .09576 and $-.10500$ respectively. These r's were also found to be not significant at the .05 or .01 level. Inasmuch as these correlations were so low, the Fisher z scores computed were the same as the Pearson r's to the fourth decimal place, for the r and z are identical when correlation coefficients are below .25.

In light of these results, the hypothesis postulating a relationship between the scores of estimation and the E scale must be seriously questioned. This could also be projected to Eysenck's stated theory, inasmuch as the mean and standard deviation of the MPI scale² for his subjects ($M = 25.26$ and 24.62 ; $\sigma = 8.85$ and 10.04) were quite similar to the mean (25.89) and standard deviation (9.05) for the population being studied here.

² H.J. Eysenck, "The Differentiation Between Normal and Various Neurotic Groups on the Maudsley Personality Inventory", British Journal of Psychology, Vol. 50, Pt. 2, May 1959, p. 176-177.

Table III.-

Computed r and z Values for Estimation Scores in the Three Modalities of Kinesthesia, Audition and Vision as Well as the MPI E Scale : N 127.

| | Kinesthesia | | Audition | | Vision | | E Scale | |
|-----|-------------|-------|----------|-------|--------|-------|---------|-------|
| | r | z | r | z | r | z | r | z |
| Kin | | | -.045 | -.045 | -.049 | -.049 | .037 | .037 |
| Aud | -.045 | -.045 | | | -.174 | -.175 | .095 | .096 |
| Vis | -.049 | -.049 | -.174 | -.175 | | | -.105 | -.105 |

On the basis of the findings in this experiment, it must be asked whether the MPI measurements of introversion-extraversion could be discussed in relation to physiological behavior induced by reactive cortical inhibition. There seems to be reason for doubt as to whether introversion-extraversion as determined by scores on the E scale is of the same nature as the introversion-extraversion (facilitation, inhibition) criteria found in the physiological realm. The MPI questionnaire is undoubtedly tapping the social behavior of the individual and this leaves room for speculation as to whether it can be equated with the physiological criterion based on the inhibition theory. Further discussion in this area will be presented in section four of this chapter.

Possibility of a relationship in estimation scores for the three modalities under study was also hypothesized. Pearson r 's were calculated between kinesthesia and audition, kinesthesia and vision, as well as audition and vision. These r 's can be noted in Table III. As can be observed, the correlation coefficients obtained are most significant. A possible interpretation of these specific results is that an individual's estimation in one modality is not necessarily dependent upon his estimation scores in a second modality. On the basis of these data, it would not be feasible at this time to say that the overestimation or underestimation of a

stimulus by an individual in one modality specifically means his performance will be in the same direction in other modalities. If an individual, for example, showed estimation scores of a certain direction and amount in the kinesthetic sense, it cannot be assumed that his estimation scores in the auditory modality will be in the same direction and of the same quantity. In other words, it would appear from an analysis of the data that satiability is not a general trait extending across modalities. The implications of these findings will be discussed later in regard to the possibility for further research.

The following section discusses these results as related to the Eysenckian theory of introversion-extraversion. It also presents questions and hypotheses for further research.

4. Discussion of Results.

One of the major aims of this research was to determine whether overestimation could be considered a real phenomenon in the population over and above chance, and to investigate the possible relationship of the phenomenon to the Eysenckian schema.

The results obtained by this author are in partial agreement with Eysenck in that some subjects can be statistically classified as reducers. However, a second

group of subjects were found to display a completely opposite phenomenon. These individuals showed a tendency to overestimate or augment in attempting to replicate standard stimuli. Their estimation scores were in the opposite direction than those of the reducers. This latter group of subjects, i.e. augmenters were not taken into account by Eysenck in establishing psychoneurological correlates to his personality dimension of introversion-extraversion.

At this point it is necessary to emphasize that the reduction and augmentation that occurred was not observed as a cross modal habitual response or trait. On the basis of the results found, augmentation and reduction do not appear to be generalized physiological traits and their reliability as criteria for classifying introverts and extraverts must be seriously questioned.

Previous investigations of the after-effect phenomenon have categorized subjects who, according to Eysenck, showed a consistent tendency to decrease their estimates of a standard stimulus. Extreme extraverts were reported to have displayed larger amounts of reduction than introverts in different modalities. But, reduction or underestimation was the accepted behaviour irrespective of the subject's ranking on the introversion-extraversion continuum. It became only a matter of degree of the underestimation occurring as to determine where on this personality scale the subject

should be placed. The two limits of this continuum ranged from the extreme extravert at one end to the extreme introvert at the other with amount of reduction in estimations ranging from the extreme in the extravert to the minimal amount at the introvert end of the spectrum.

As mentioned above, individuals who showed a tendency toward overestimation, i.e. augmentation, have not been taken into account as a possible physiological event in the study of reactive cortical inhibition as related to the variable of extraversion. This raises some doubt as to the legitimacy of a portion of Eysenck's reporting. However, one should not misconstrue this as an attempt to invalidate Eysenck's work in this area. It is only an attempt to extend the personality continuum of introversion-extraversion as defined in psychoneurological terms.

It is also interesting to note that Eysenck³ computed t tests between introverts and extraverts for after-effect scores, i.e. amount of reduction, and found that only one critical ratio was significant, and that was at the .05 level using a one tailed test. Other t's were also computed in this study and proved to be significant only at the .10 level.

3 H.J. Eysenck, "Cortical Inhibition, Figural After-Effect and Theory of Personality", Op. Cit., p. 94-106.

Granted the results in this study might be suggestive, but are definitely far from striking or conclusive.

His statistical analysis of the data could possibly substantiate the point being made here, that he tended to overlook an important response tendency in the segment of the population being studied. Overestimation, as noted here, might have been statistically observed in Eysenck's work had it not been for the utilization of one tailed tests and the necessity for him to accept results at extremely low levels of probability.

It was also hypothesized that augmenters if found would tend to cluster in the extreme introvert end of the continuum. This hypothesis would hold true if Eysenck's basic assumptions are accepted. However, as can be noted, there were no significant correlations found between the estimation scores and the scores for introversion-extraversion. Needless to say, the individuals who augmented did not tend to group in this expected area of the continuum. Neither could the subjects showing minimal amounts of reduction be classified as extreme introverts according to the MPI scores. In fact, the estimation scores tended to be normally distributed in the population under study. These findings do not appear to substantiate Eysenck's reported results. If a relationship between reactive cortical inhibition, as determined by the phenomenon of satiation, and extraversion

exists, it is probably of such a small magnitude as to be practically and theoretically trivial.

Having shown augmentation to be a statistically significant phenomenon in the population studied, only tends to leave many questions unanswered. It undoubtedly is not in the expected direction when one discusses satiation and figural after-effects. It also cannot be explained by the theory of reactive cortical inhibition as utilized by Kysenk. A possible explanation for such a phenomenon could follow a psychoneurological theory and that overestimation, i.e. augmentation, appears to be occurring at a cortical level. A tendency to reduce would be comparable to the interpretation of reactive inhibition and a tendency to augment may be the extreme variety of a lack of inhibition, i.e. the individual could possibly be deficient in building up of inhibition. It might also be true that in the after-effect responses in the expected direction, sensory traces in the cortex would decay at a normal rate. However, in augmenters the action potentials seem to persist and contaminate other neural networks causing an exaggeration in forthcoming judgments.

If this could be one of the possible explanations for augmentation, it might be feasible to study individuals showing this phenomenon on tests of reminiscence as measured by the pursuit rotor task. Following the theory of reactive

cortical inhibition, augmenters should exhibit low reminiscence scores.

Electroencephelographic measures via evoked cortical potentials may also prove to be a fruitful area for further research. For, it is probable that individuals with high cortical inhibition will show wider banded evoked cortical waves or higher intracortical delays than those with less inhibition. Other EEG variables that may be investigated are conditioning of brain waves with the postulate being that low inhibitors would be more difficult to condition at the cortical level.

Another possibility for further study would be an investigation of these augmenters and reducers in relation to habitual response and trait levels in actual living experiences rather than in synthetic laboratory tasks or by ego-distorted self-reporting inventories of the MPI variety.

SUMMARY AND CONCLUSIONS

This dissertation reported on an investigation of the figural after-effect phenomenon as observed in events of sensory reduction and augmentation. Underestimation, i.e. reduction was considered as an effect of reactive cortical inhibition and was employed in an investigation of the possible relationship to Eysenck's introversion-extraversion theory. An attempt was made here to demonstrate that overestimation, i.e. augmentation is a reliable and significant phenomenon in the population. These physiological phenomena were tested in three separate modalities by using apparatus to measure physiological effects of satiation on estimation scores. The Maudsley Personality Inventory was employed as the objective criterion for the personality variables under study.

The literature surveyed which was relevant to the study of the introversion-extraversion problem failed to take into account the possibility⁴ of augmentation as an existing psychoneurological event and, in turn, no attempt was made to incorporate it into the study of personality. Only one author recognized the possibility of such a physiological event occurring, but was mainly interested in its relation to pain tolerance and sensory deprivation.

Using a regression analysis on the estimation scores, statistically significant and reliable augmentation was found to have occurred in the population under study. To test the null hypothesis: having demonstrated that overestimation occurs with greater than chance frequency, those individuals displaying stimulus overestimation do not differ significantly from introverts without overestimation on a questionnaire-type test of introversion-extraversion, a Pearson r was calculated to determine correlations between these variables. The second part of the null hypothesis was not rejected. The correlation coefficients computed showed no significant correlations between the variables under study. In turn, there were no significant relationships found between estimation scores and the personality trait of introversion-extraversion.

The results as obtained in this experiment were discussed in relation to the Eysenckian theory of introversion-extraversion and its psychoneurological correlates. In this area, many questions were raised regarding Eysenck's studies and the justifiability of some of his assumptions.

Suggestions for further study of these neurological phenomena, especially augmentation, were proposed. Specifically, it was suggested that other physiological investigations be undertaken to study cortical behaviour of individuals showing augmentation in figural after-effect tasks.

BIBLIOGRAPHY

Becker, Wesley C., "Cortical Inhibition and Extraversion-Introversion", in the Journal of Abnormal and Social Psychology, Vol. 61, No. 1, July 1960, p. 52-66.

This study attempts to examine Eysenck's hypothesis that cortical inhibition is one of the bases for individual differences in extraversion-introversion. It presents a thorough assessment of the phenomenon of cortical inhibition and the findings appear to be critical of Eysenck's work.

Eysenck, H.J. Dimensions of Personality, London, Keegan, Paul, 1947, xi-308 p.

Eysenck's initial work is presented in this book. It is an attempt to distinguish between introversion-extraversion using objective criteria. Unfortunately, no theoretical framework is given for the basis of this research. Various older theories of these two personality types are discussed in this text.

Eysenck, H.J., "Cortical Inhibition, Figural After-Effect, and Theory of Personality", in the Journal of Abnormal and Social Psychology, Vol. 51, No. 1, July 1955, p. 94-106.

In this study an attempt was made to account for experimental findings in the area of personality and relate them to the concept of extraversion-introversion. It presents the concept of reactive cortical inhibition and attempts to explain the influence on the development of the personality types. The basic controversy for this writer is found in this article and it is from here that the present research was developed.

Klein, George S., and David Krech, "Cortical Conductivity in the Brain-Injured", in the Journal of Personality, Vol. 21, No. 1, September 1952, p. 118-148.

Investigation was made in this study to determine whether a group of brain-injured subjects would produce more incidents of kinesthetic figural after-effect inhibition than a normal group. The authors found this to be so, thus indirectly supporting Eysenck's hypothesis. Unfortunately, the sample used was small and the levels of significance used were low.

Kohler, Wolfgang, and Hans Wallach, "Figural After-Effects. An Investigation of Visual Processes", in the Proceedings of the American Philosophical Society, 88, 1944, p. 269-357, quoted by G.S. Klein and D. Krech, "Cortical

Conductivity in the Brain-Injured", in the Journal of Personality, Vol. 21, No. 1, September 1952, p. 118-148.

These authors discuss and attempt to explain the phenomenon of figural after-effects as accounted for by cortical functioning. Many of their proposed explanations are based on unknown neurological mechanisms, and other authors have criticized them for this.

Nerocross, Kathryn J., Ronald Lipman, and Harman Spitz, "The Relationship of Extraversion-Introversion of Visual and Kinesthetic After-Effects", in the Journal of Abnormal and Social Psychology, Vol. 63, No. 1, July 1961, p. 210-211.

The results presented by the authors confirm those previously reported by Rechtschaffen and fail to confirm Eysenck's hypothesis. It was reported in this study that satiation effects in extraverts do not develop more quickly nor reach higher levels, or even dissipate more slowly than in introverts. This appears to be in complete contradiction to Eysenck's theory.

Petrie, Asenath, "Some Psychological Aspects of Pain and the Relief of Suffering", in the Annals of the New York Academy of Sciences, Vol. 86, Art. 1, March 1950, p. 13-28.

The first author to theorize the possibility that individuals might not react to satiation in the same way as Eysenck stated. There is, however, no attempt at connecting this phenomenon of overestimation, or as it is called in this article augmentation, to Eysenck's introversion-extraversion theory. It was from this point that the writer proceeded to test for this phenomenon and relate it to the personality variables mentioned.

Rechtschaffen, Allen J., "Neural Satiation, Reactive Inhibition, and Introversion-Extraversion", in the Journal of Abnormal and Social Psychology, Vol. 57, No. 3, November 1958, p. 285-291.

This study was designed to investigate the hypothesis put forth by Eysenck in respect to the variables of reactive inhibition, after-effect, and the personality dimension of introversion-extraversion. Results of this research do not support the theories stating that the amount of after-effect, or the accumulation of reactive inhibition is related to introversion-extraversion. This article belongs as part of the long list of research criticizing the Eysenckian findings.

APPENDIX 1

SCATTERGRAM OF TEST-RETEST ESTIMATION SCORES

APPENDIX 1

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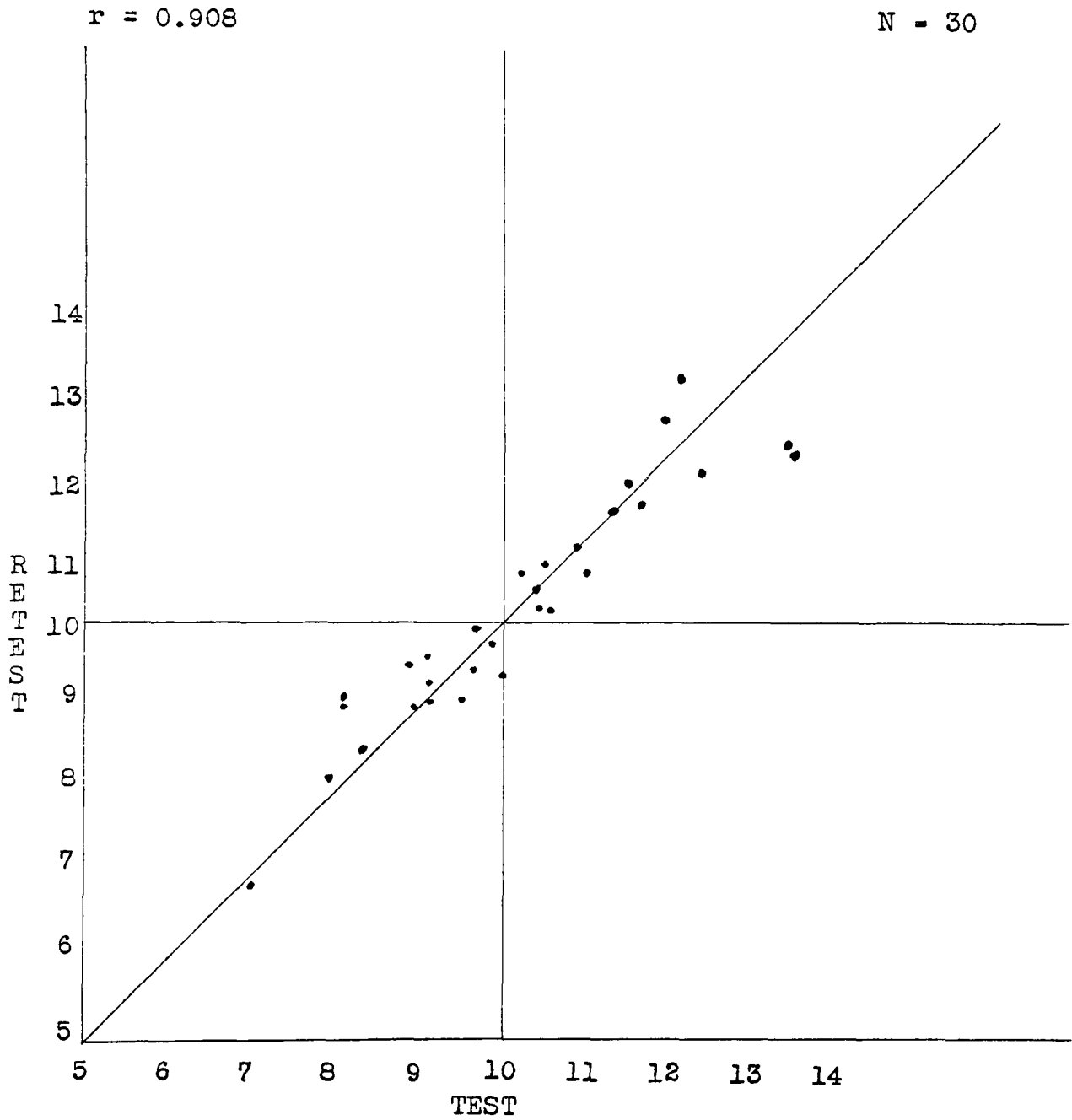


Figure 3.- Scattergram of Test-Retest Estimation Scores for Kinesthesia.

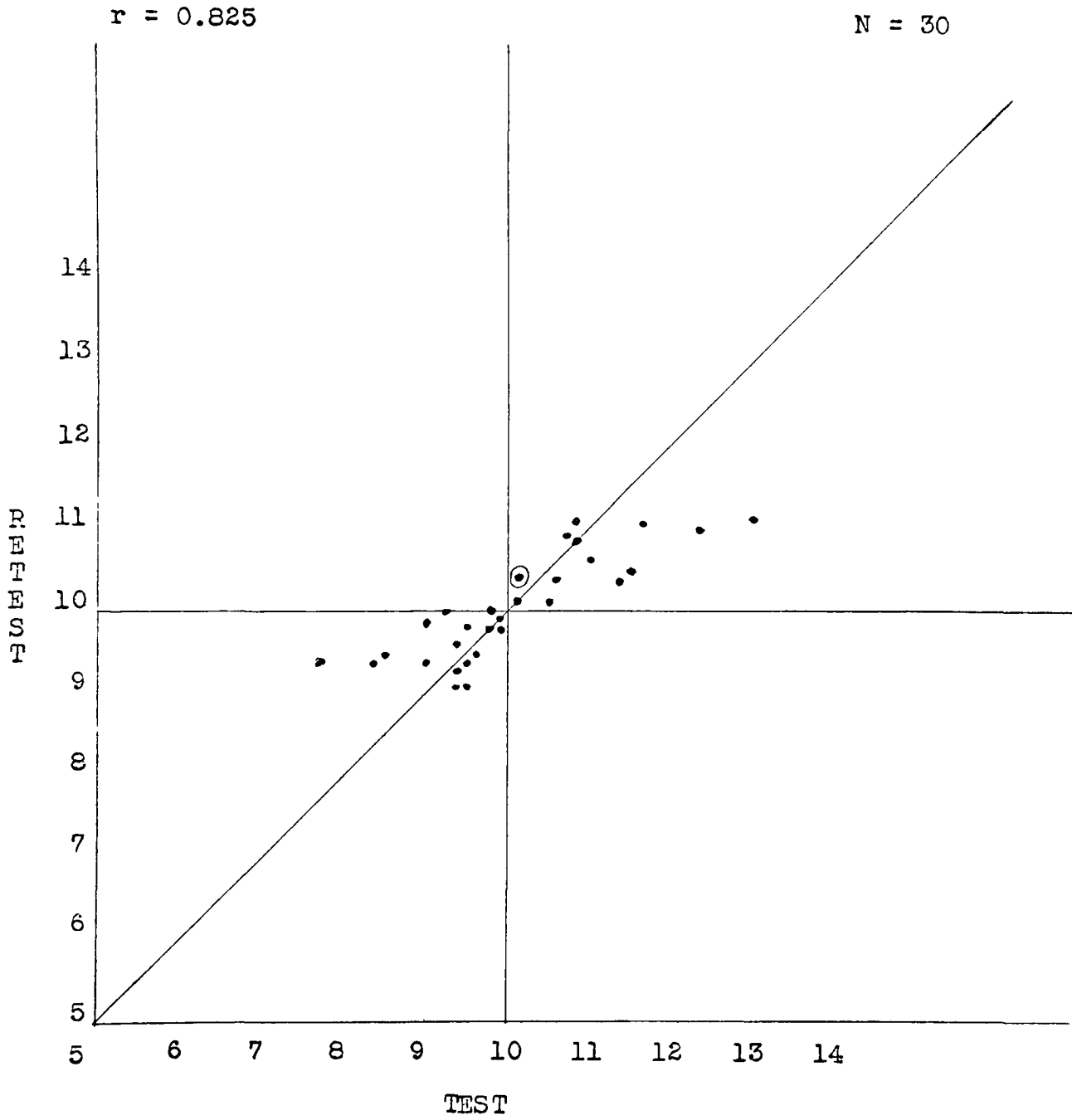


Figure 4.- Scattergram of Test-Retest Estimation Scores for Audition.

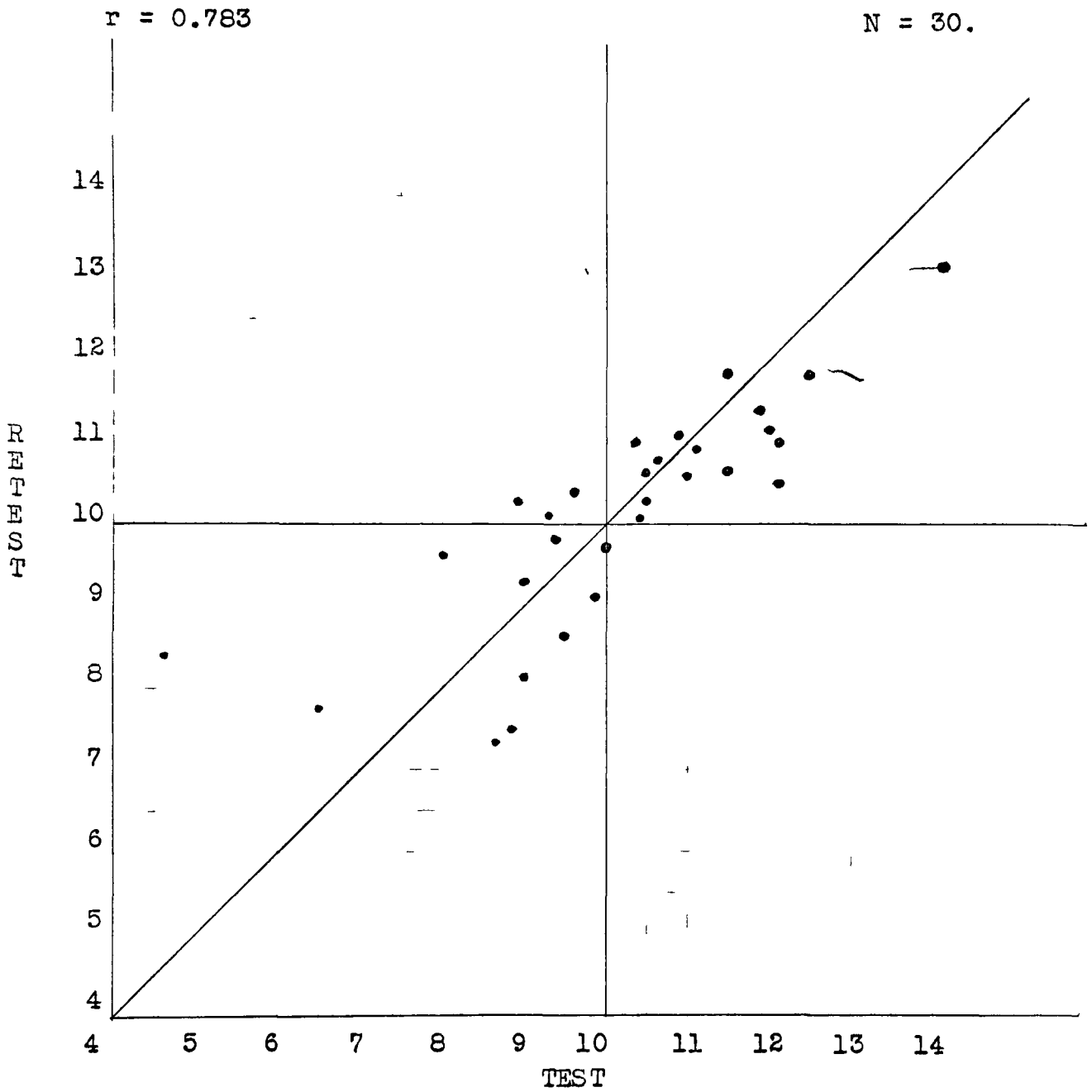


Figure 5.- Scattergram of Test-Retest Estimation Scores for Vision.

APPENDIX 2

**MEASURES OF CENTRAL TENDENCY AND VARIABILITY
FOR ESTIMATION SCORES AND MPI E SCALE**

APPENDIX 2

MEASURES OF CENTRAL TENDENCY AND VARIABILITY
FOR ESTIMATION SCORES AND MPI E SCALE

Table IV.-

Measures of Central Tendency and Variability for Estimation
Scores and MPI E Scale for the Sample Made
up of 127 Male Subjects.

| | Mean | σ | σ_M | $\sigma_{\bar{X}}$ |
|--------------------|----------|----------|------------|--------------------|
| Kinesthesia | .16377 | 1.48316 | .13160 | .093061 |
| Audition | .28188 | .96513 | .08564 | .060552 |
| Vision | -.07086 | 1.68004 | .14908 | .105413 |
| <u>MPI E</u> Scale | 25.89763 | 9.05261 | .80328 | .568015 |

APPENDIX 3

ABSTRACT OF

Sensory Augmenters: A Possible Extension of the Eysenckian
Theory of Introversiön-Extroversiön

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Sensory Augmenters: A Possible Extension of the Eysenckian Theory of Introversiion-Extraversiion.¹

Previous work done in this area has reported a variety of results in linking the effects of reactive cortical inhibition to the personality dimension of introversiion-extraversiion. Many of the studies done have been in complete agreement with Eysenck, while a good number of investigations have failed to substantiate this theory.

Until recently, the effects of inhibition have been fully accepted as expecting a reduction in estimation scores. However, a study was done which identified individuals failing to react in the expected manner, but an attempt was not made to investigate these results in the light of Eysenckian findings.

In this study, sensory augmentation, i.e., over-estimation, was tested in three separate modalities. It was hypothesized that this phenomenon would be found statistically significant in the population under study and that those

¹ Bertram T. Rotman, doctoral dissertation presented to the School of Psychology and Education of the University of Ottawa, Ontario, 1964, ix-79 p.

individuals in whom augmentation was observed could be classified as extreme introverts on the basis of the Maudsley Personality Inventory.

The results of this study only partially support Eysenck's findings inasmuch as some subjects did produce estimation scores in the expected direction. The data, however, did reveal the hypothesized phenomena occurring in the sample randomly selected for this research. But neither the reduction scores nor the augmentation scores correlated with the MPI results which were used as the criterion for objectively defining introverts and extraverts. These findings seemed to be in complete disagreement with Eysenck's stated theory.

Another relevant factor was observed in the data gathered in this experiment. The estimation scores observed, either in the expected or in the opposite direction, did not show itself to be a generalized physiological trait over a set of three modalities. This finding opens up new avenues for further research in respect to the theory of figural after-effects and satiation.

Possibilities for further research with this phenomenon of augmentation were proposed and it was suggested to study augmenters on a pursuit rotor task in order to determine their reminiscence scores. It was also suggested that evoked cortical potentials and conditionability of brain waves of augmenters be investigated using the EEG apparatus.