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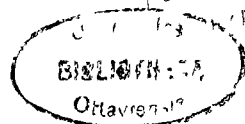
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**AN INVESTIGATION OF RELATIONSHIPS BETWEEN
INTROVERSION-EXTRAVERSION AND THE
NEGATIVE AFTER-IMAGE THRESHOLD**

by William F. Barry

**Thesis presented to the School
of Psychology and Education of
the University of Ottawa as
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Doctor of Philosophy**

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CURRICULUM STUDIORUM

William F. Barry was born May 21, 1928, in Montreal, Quebec, Canada. He received his Bachelor of Arts degree from Loyola College, Montreal, in 1951. He received his Masters of Psychology degree in Clinical Psychology from the University of Ottawa, Ottawa, Ontario, in 1958. The title of his scientific paper was The Design and Use of a New Apparatus for Measuring the Negative After-Image Phenomenon as a Function of Reactive Cortical Inhibition.

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INTRODUCTION

The stature and scope of modern Psychology has justified a certain amiable distantiation from the earlier patronage of the biological sciences; nevertheless a profound and essential interest remains in the biological determinants of human behavior and personality. Such an interest is shared by educators and therapists alike. The nature and knowledge of the human developmental process has long prompted investigations of the individual differences in learning. The word learning itself seems a pitifully inadequate symbol for such a multidimensional and problematic process of change and becoming. As great as the need for identification of individual differences in learning ability is the need for adequate didactic formulae, in both the pedagogic and therapeutic instances. Without an understanding of the biological boundaries of the human learning mechanisms, which set not only the limits of changeability but dictate the methodologies for successful learning stimuli, a useful intervention in learning anomalies is difficult to visualize.

Investigations into the psychobiology of learning and personality have taken a dominant position in modern psychological research. One example of this research interest may be seen in the investigations of reactive cortical

inhibition as a factor in the development of introverted or extraverted personality traits, by H.J. Eysenck¹. He has postulated that the qualitative differences in learning, especially early social learning, are partly due the degree of constitutional cortical resistance to stimulation. Thus the type of learning, linked to the type of central neurological make-up, would dispose the individual to either the introverted or extraverted pole of this personality dimension.

Both Eysenck and his contemporaries have tested these postulates, employing for the most part, measures of reactive inhibition in peripheral muscle functions. The contradictory and confusing findings may stem from the nature of the measurements, in that peripheral functions are generally victimized by obtuse and uncontrollable variables, distinct from the cortical contribution. In addition, many of these studies have failed to report the reliabilities of their testing techniques.

This dissertation reports on a further study which attempts to evaluate the Eysenck theory of introversion-extraversion, through measurements of the after-image phenomenon. An instrument is designed and applied which produces a sustained negative after-image, and measures

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

the intensity of ground illumination required to maintain the phenomenon, thus presuming to assess the degree of cortical accessibility or cortical reluctance present. In measuring this visual phenomenon, it has the advantage of tapping a psychoneurological function presumably more intimate with the cortical economy than muscle complex activity. It has the additional advantage of requiring little training for the Subject, hence could be administered to children, mental deficient, or psychotics; moreover it is considered free from past learning and voluntary control.

Measurements of introversion-extraversion, in a sample of normal individuals, using an inventory acceptable to Eysenck as identifying his concept of the personality types was tested for correlations with measurements from the negative after-image threshold apparatus.

The thesis is divided into three chapters. Chapter one presents the Eysenck theory together with a review of the literature on this theory and on after-image research with personality variables. Chapter two is devoted to the experimental design, including descriptions of the apparatus, the sample population, the psychological tool, the experimental procedures and techniques for data evaluation. Chapter three presents the results of the investigation, a discussion of these results, and some suggestions for future research.

CHAPTER I

CORTICAL INHIBITION AND THE NEGATIVE AFTER-IMAGE THRESHOLD

This chapter reports Eysenck's psychoneurological theory of the introversion-extraversion personality dimension, and pertinent research on reactive inhibition, and on the after-image phenomenon. Section 1 deals specifically with this theory and related contemporary research. Section 2 presents more recent investigations on the same problem, and Section 3 reports on the few studies investigating the possible personality correlates of the after-image phenomenon.

1. The Eysenck Theory and Related Studies.

Eysenck¹ has interpreted his introversion-extraversion continuum² as resulting from a hereditary cortical predisposition which inhibits the response process to successive stimulation. Early learning and conditioning are understood as effective in inverse proportion to the degree of such cortical inhibition, disposing the individual either to the introverted or extraverted half of the

1 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.

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

dimension by limiting conditionability, hence socialization and related learning.

Whenever any stimulus response connection is made in an organism (excitation) there also occurs simultaneously a reaction in the nervous structures mediating this connection which opposes its recurrence.

Human beings differ with respect to the speed with which reactive inhibition is produced, the strength of reactive inhibition, and the speed with which reactive inhibition is dissipated. Individuals in whom reactive inhibition is generated quickly, in whom strong reactive inhibition is generated, and in whom reactive inhibition is dissipated slowly are thereby predisposed to develop extraverted patterns of behavior, and to develop hysterical disorders in cases of neurotic breakdown; conversely, individuals in whom reactive inhibition is generated slowly, in whom weak reactive inhibition is generated, and in whom reactive inhibition is dissipated quickly, are thereby predisposed to develop introverted patterns of behavior, and to develop dysthymic disorders in cases of neurotic breakdown³.

Within the confines of the same theory, Eysenck⁴ understands the hysteric and the psychopath as being at the extreme in the extravert range, with the dysthymic (the anxiety neurotic, depressive neurotic and obsessive-compulsive neurotic) at the extreme of the opposite pole. The classical category, then, is presumed a resultant of neurotic increment superimposed upon the constitutional continuum.

3 Eysenck, Ibid., p. 96.

4 Eysenck, Ibid., p. 95.

Franks⁵ has experimented with matched hysterics, normals, and introverted neurotics, measuring their conditionability for eye-blink to puff of air, and has obtained strong evidence that the introverted neurotics conditioned more quickly than the normals, and that the normals conditioned more quickly than the hysterics.

Welch and Kubis⁶ have lent some support to the theory in finding, in like manner, that the dysthymics conditioned more rapidly than the control group.

Other researchers, though not specifically concerned with the theory mentioned, have contributed information related to inhibition which appears to support the Eysenck stand. Hamilton⁷, in discussing the Pavlovian concept of cortical inhibition, states that inhibition involves the whole cortex rather than specific inhibitor areas, and that learning itself is facilitated

5 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", in Journal of Abnormal and Social Psychology, Vol. 51, No. 1, July 1955, p. 97.

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

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

or inhibited by a generalized cortical function.

Wertheimer and Wertheimer⁸ hypothesized that variations in figural after-effects, both visual and kinesthetic, would show a positive correlation; that variation would remain parallel; that the size of the after-effects should correlate with metabolic efficiency, thus implying a holistic cortical mechanism controlling satiation. They claim that such hypotheses have been empirically substantiated, however, the reporting is obscure, and the experimental group had been contaminated with the inclusion of a schizophrenic sample.

Klein and Krech⁹, in studying cortical conductivity in the brain injured, have contributed incidentally but substantially to the inhibition theory:

And neural activity induces heightened resistance within the area stimulated. The current flow initiated by stimulation of a defined cortical area results in 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.

. . . the more stimulation the greater the drop in cortical conductivity (within certain limits).

⁸ Michael Wertheimer, and Nancy Wertheimer, "A Metabolic Interpretation of Individual Differences in Figural After-Effects", in Psychological Review, Vol. 61, No. 4, July 1954, p. 279-280.

⁹ 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.

However, we would postulate another factor which contributes to the extent of the 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 and the degree of drop possible¹⁰.

In actuality, the population studied in the above experiment were brain injured subjects, and the inhibition was observed through a measure of kinesthetic figural after-effects. The frequency and intensity of satiation effects were significantly greater in the brain injured than in the control group. In addition, the brain injured subjects reached maximal satiation more quickly, and remained in the satiated state longer. Though the relationship between the performance of the brain injured and the performance of hysterico-psychopaths is painfully indirect and smacks of "begging the question", nevertheless the results may imply a broad common denominator underlying the acute inhibited brain state and the chronic constitutional inhibition effecting the "devil may care" attitudes of the extravert.

Klein¹¹ also used the negative after-image to assess the degree of inhibition in the brain injured,

10 Klein and Krech, Op. cit., p. 120-122.

11 George S. Klein, "Studies of Duration of Negative After-Image; Effect of Brain Injury", quoted by Klein and Krech, "Cortical Conductivity in the Brain Injured", in Journal of Personality, Vol. 21, No. 1, September 1952, p. 122.

where persistence of the image as a function of stimulus time marked the satiation taking place. The after-images of the brain injured fell off significantly as compared with the non-brain injured. He also found that the rate of decrease in after-image duration upon repeated exposures was more rapid in the brain injured.

Jaffe¹² conducted a similar experiment, using kinesthetic figural after-effects, with brain injured subjects, with and without memory impairment, and his findings contradicted the work of Klein and Krech previously mentioned. No significant differences in figural after-effect satiation were found between the control group and the brain injured group, not even in that group suffering from penetrating cerebral lesions. The contradictory findings may have resulted from uncontrolled typing. Future studies along these lines should anticipate the possible influence of constitutional inhibition. Brain injured introverts may not perform differently from normal extraverts on tests of satiation, hence matching on this dimension may clarify the results of similar research.

¹² Robert Jaffe, "Kinesthetic After-Effects Following Cerebral Lesions", in American Journal of Psychology, Vol. 67, No. 4, December 1954, p. 668-676.

The actual physiological mechanisms underlying reactive cortical inhibition are, as yet, unknown. Eysenck¹³ implicitly has incorporated some of the features of the Köhler-Wallach satiation theory¹⁴, but has also upheld that the true physiological factors operative remain only of secondary interest to the psychologist.

In attempting to explain the phenomenon of figural after-effects, Köhler and Wallach¹⁵ conceived the form displacement occurring as due to an increase in polarizability in the specific projection area of the occipital brain:

One is tempted to say that the prolonged presence of an I-object lowers the conductivity of the cortical area 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 decreased¹⁶.

13 H.J. Eysenck, "Cortical Inhibition, etc.", in Journal of Abnormal and Social Psychology, Vol. 51, No. 1, p. 94-106.

14 Wolfgang Köhler and Hans Wallach, "Figural After-Effects", in Proceedings of the American Philosophical Society, 88, 1944, p. 269-357, quoted by John Krauskopf, "The Magnitude of Figural After-Effects as a Function of Duration of Test Period", in American Journal of Psychology, Vol. 67, No. 4, December 1954, p. 684-690.

15 Idem, Op. cit., p. 684.

16 Idem, Op. cit., p. 684.

Serious objections have been raised against this theory. Osgood and Heyer¹⁷ objected to the nebulous character of it, which depends on field changes unknown contemporary neurology, and have contributed themselves by explaining the phenomenon of such satiation through established mechanisms.

Krauskopf also objected to the Köhler theory, remarking, "If an increase in polarizability is the dominant result of prolonged fixation, it should be expected then that when exposures of T-objects are short, their displacements should be smaller than with longer exposures"¹⁸.

His experimentation discovered that the figural after-effects decreased in magnitude as a function of the length of the testing period, thus seemingly disproving Köhler. Here again, the contradictory findings may have resulted from a sampling bias, that is, a contamination of the experimental group with an over-balance of introverts.

17 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.

18 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.

Both the direct and indirect research that can be related to the Reactive Inhibition Theory is both inconclusive and overly inferential. Though the term theory is warranted, many hypotheses yet to be tested are derived from a qualitative analysis of the whole. Eysenck¹⁹ himself has extended problems as stated hypotheses, predominantly in the field of perceptual and motor response measurements, to test the general assumption that reactive cortical inhibition contributes significantly to the development of introverted or extraverted personality traits. Suggestions for phenomena likely to demonstrate such cortical inhibition are exemplified by the following: the Müller-Lyer illusion disappearance rate in time; the rate of reversals of perspective as a function of massed practice; the degree of motor reminiscence as a function of rest after massed practice; the duration of the negative after-image as a function of stimulus time; all of these measurements should demonstrate a peripheralization of cortical inhibition if it is sufficiently universalized in the cortex, and not restricted to specific corticopetal or corticofugal projective functions.

¹⁹ Eysenck, Op. cit., p. 103.

2. Recent Research in Reactive Cortical Inhibition

Smith and Raygor²⁰ investigated the relationship between verbal satiation and introversion-extraversion, employing distance in word-associations as the criterion of satiation. The results showed that extraverted subjects differed significantly in the number of statistically uncommon responses from the introverted sample. The test criterion of introversion-extraversion was the second order factor of the Sixteen Personality Factor Questionnaire.

Eysenck²¹ studied the amount of reminiscence in a rotor pursuit task as the measurement of reactive cortical inhibition, hypothesizing that extraverts, building up more inhibition during a motor performance, would show more reminiscence (or recovery of motor precision) than would introverts after a period of rest. The dichotomization of the sample into the type extremes, at the psychological level, was done by means of the Maudsley Personality Inventory. His findings indicated a significant correlation of .29 between the extraversion scale and the first

20 Donald Smith and Alton Raygor, "Verbal Satiation and Personality", in the Journal of Abnormal and Social Psychology, Vol. 52, No. 3, May 1956, p. 323-326.

21 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 score, but an insignificant correlation of .10 with a second testing. The lack of significance on the second score was thought due to the addition of conditioned inhibition along with reactive inhibition. Conditioned inhibition, understood as a habit of not responding, reinforced by increments of reactive inhibition, does not dissipate as quickly as the reactive variety, hence interferes with the reliability of measurements. In a personal communication to Becker²², Eysenck mentions that one exact replication and one replication using a different task had given similar significant results.

Lynn²³ utilized both the Archimedes Spiral After-Effect, and an Inverted Alphabet Printing task as measurements showing the effect of satiation and reminiscence respectively. Selecting introverts and extraverts on the basis of the Maudsley Personality Inventory, he hypothesized that there should be a negative correlation between extraversion and the duration of the spiral after-effect; a tendency for extraverts to see progressively less of the after-effect with massed practice; that there

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

23 R. Lynn, "Extraversion, Reminiscence, and Satiation Effects," in the British Journal of Psychology, Vol. 51, Part 4, November 1960, p. 319-324.

should be a tendency for extraverts to recover in their perception of the after-effect after a period of rest; a negative correlation between duration of after-effect and a measure of reminiscence in the inverted alphabet printing task; a positive correlation between extraversion and reminiscence; and finally a tendency for extraverts to show more work decrement with massed practice on the inverted alphabet printing task. All but two hypotheses investigated were confirmed with significant correlations from .41 to .43. No significant correlation was obtained between extraversion and recovery of after-effect, nor between extraversion and reminiscence on the inverted alphabet printing task. The author suggests that his method of scoring reminiscence for both tasks may have disguised the effects.

Ray²⁴ also investigated the possible relationships between introversion-extraversion via the Maudsley Personality Inventory and measures of motor reminiscence. He further clarified the psychological criteria by introducing four categories: normal introverts, neurotic introverts, normal extraverts, and neurotic extraverts. While performance slope differences were statistically

²⁴ 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.

significant between introverts and extraverts, indicating that extraverts showed more reactive cortical inhibition, no significant correlations were found between reminiscence scores and any of the four scale categories.

Rechtschaffen²⁵ studied reactive inhibition and perceptual satiation via the inverted alphabet printing task and classical figural after-effects, and introversion-extraversion. His criterion of extraversion was the R scale from Guilford's Inventory of Factors STDCR.

The results showed that the introversion-extraversion (Rhathymia) scores were not significantly correlated with either amount of visual after-effect or Ir (Reactive Inhibition) measures. Further, the amount of visual after-effect was not significantly correlated with the Ir measures. An additional analysis was made comparing the 35 S's with the highest Rhathymia scores (extraverts) with the 35 S's with the lowest Rhathymia scores (introverts). The two groups did not differ significantly on the after-effect and Ir measures²⁶.

These results are partially supported by the findings of Lynn²⁷ previously mentioned, though Lynn criticizes the use of the Guilford R scale for its low correlation with the Extraversion scale of the Maudsley Personal-

²⁵ 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.

²⁶ Rechtschaffen, Op. cit., p. 290.

²⁷ R. Lynn, "Extraversion, etc.," in the British Journal of Psychology, Vol. 51, Part 4, 1960, p. 319-324.

ity Inventory. Bendig and Vaughan²⁸, also using the inverted alphabet printing task to obtain measurements of motor reminiscence, failed to find any significant relationships with introversion-extraversion and neuroticism. They employed the Maudsley Personality Inventory, and evaluated the data by analysis of variance.

To date, the most ambitious and energetic research on the problem of introversion-extraversion, and on the clarification and identification of phenomena sensitive to the effects of inhibition has been carried out by Wesley C. Becker²⁹ of the University of Illinois. Firstly, Becker rightly objected to Eysenck's synonymical interpretation of the terms inhibition, cortical inhibition, reactive inhibition, satiation, and cortical conductivity. Becker proceeded to define these terms and their differences, both semantic-historical and functional, and to categorize the multitude of psychological and psychophysiological measurements pertaining to the specific types of inhibition via factor analytic methods.

²⁸ A.W. Bendig and Charles J. Vaughan, "Extraversion Neuroticism and Motor Learning", in the Journal of Abnormal and Social Psychology, Vol. 59, No. 3, November 1959, p. 399-403.

²⁹ 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.

Becker's ultimate aim was to investigate the relationships between the various kinds of inhibition, and finally, to determine whether or not the various measurements of inhibition were correlated to individual differences in introversion-extraversion.

The main hypotheses to be examined are:
 a) that individual differences in satiation effects 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-introversion³⁰.

The design and findings are as follows:

Sixty-two college students of both sexes randomly selected from an elementary psychology pool of 1000 students were used as S's. Consistent with Eysenck's earlier work, criterion measures of extraversion-introversion were derived from the Guilford and Cattell personality inventories.

. . . While it was not always possible experimentally to separate basal and reactive effects, two of the eight experimental tests used clearly measured reactive inhibition effects (pursuit rotor reminiscence and response alteration), three fitted the definition of a satiation effect (kinesthetic after-effect, Archimedes spiral, and Necker cube difference score), while three approximated basal type measures (GSR conditioning, aniseikonic lenses, and CFF).

. . . The findings indicated that the concept of basal cortical inhibition as used by Franks appeared as a unitary factor, but was not found to be related to extraversion-introversion.

30 Becker, Ibid., p. 53.

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 trivial³¹.

This investigation has, without doubt, contributed in no small way to a better understanding of the specificities of inhibition in human sensory and motor behavior. However, in view of the size of the sample and the likely sophistication of psychology students, the validity of the inventory criteria must be questioned.

Despite the confusion and fluctuation of evidence and opinion from the studies mentioned, three facts become obvious: 1) inhibition of motor or perceptual behavior can be measured for individual differences; 2) visual measurements seem particularly sensitive to this inhibition, classically labeled satiation in this modality; 3) some studies, using visual after-effect satiation, have obtained significant correlations between this form of inhibition and introversion-extraversion, and thus support

³¹ Becker, Ibid., p. 65.

Eysenck.

The distal aim of this present research is to further the understanding of reactive cortical inhibition, in relation to introversion-extraversion, and proximally to investigate the possible demonstration of the inhibition phenomenon through a measurement of retino-cortical saturation in the negative after-image.

3. The Negative After-Image and Personality.

Though universally considered as an adaptive function and generally as a retino-cortical phenomenon, the sporadic and diverse interest in the negative after-image has been unified by the psychophysiological nature of the investigations and by the exclusion of studies aimed at uncovering personality correlates.

Jaensch³² discovered and utilized the relationship between long after-image duration and eidetic ability in children, selecting the probable strong eidetic group on the basis of their ability to sustain the negative after-image. This may be viewed as an empirical correlate in keeping with the interpretation that learning and conditioning (and the required imagery) may be facilitated or inhibited by constitutional factors. It is an interesting

³² E.R. Jaensch, Eidetic Imagery, London, Kegan Paul, Trench and Trubner, 1930, p. 5.

side point to note that Eysenck³³ studied the incidence of introversion-extraversion in identical and fraternal twins, discovering that the trait resemblances in identical twins were significantly greater.

Cooper³⁴ found considerable individual differences in after-image duration, and also consistent diminishing in after-image lengths. He discovered that total image time was very stable to the point of being individually identifying.

Levinson³⁵ in pilot studies for his major work, noted strong individual differences in the curves of after-image duration. In addition, he observed that alcoholics had much shorter after-images than normals, and that very sick lobotomy patients had very short after-images as compared with normals.

33 H.J. Eysenck, "The Inheritance of Extraversion-Introversion", in Acta Psychologica, Vol. XII, No. 2, 1956, p. 95-110.

34 Joseph B. Cooper, "Some Characteristics of Negative After-Images", in Journal of General Psychology, Vol. 39, 2nd Half, October 1948, p. 217-228.

35 Harry Levinson, The Relationship of After-Image Duration to Certain Aspects of Personality, unpublished doctoral dissertation, University of Kansas, 1952, from University Microfilms, Ann Arbor, Michigan, No. 4502, p. 1-75.

Smith³⁶ found, in studying identical twins, that there were greater similarities in the after-image phenomenon among identical twins than in fraternal twins and explained the similarities on the basis of "similarities of the inner world" rather than upon the objective environment.

Young³⁷ likewise, observed the marked individual differences, and concluded that these differences were not due to variations in fixation during the stimulation.

By far, the most important research in after-images and personality measurements was conducted by Levinson³⁸, in his study of the relationship between after-image duration and the personality characteristics measured by the Minnesota Multiphasic Personality Inventory. Besides incorporating the classical measurement of after-image duration by the projection (and subjective) technique, Levinson used a measure of the After-Image Disappearance Threshold by means of a device described by

36 Gudmund Smith, Psychological Studies in Twin Differences, Copenhagen, Ejnor Munksgaard, 1949, quoted by Harry Levinson, Op. Cit., p. 7.

37 Francis A. Young, "Studies of the Projected After-Image: I. Methodology and the Influence of Varying Stimulus Times", in Journal of General Psychology, Vol. 46, First Half, January 1952, p. 73-86.

38 Levinson, Op. cit., p. 1-75.

Lehmann³⁹, for obtaining a more objective assessment by measuring the illumination required to sustain the phenomenon. He had hypothesized that the duration of the after-image, and related measurements, would also tap the experimental involvement of the subject, and hence the more permanent life attitudes, and that the level of involvement would also be related to personality measurements on the Minnesota Multiphasic Personality Inventory. Though not employing the cortical inhibition theory, some of Levinson's findings are supportive of it.

Though his use of the Lehmann device added nothing to the research findings, except the fact that such disappearance threshold obtained were not significantly related to any of the personality characteristics tapped by the employed inventory, Levinson's measurements of the after-image, by the conventional projection method, demonstrated significant relationships between the mean of such durations and the D, Hy, Pt, and Sc scores of the inventory⁴⁰.

Those subjects with a longer mean after-image duration had a significantly higher D score (.05 level),

³⁹ H. Lehmann, "Preliminary Report on a Device for the Objective Measurement of the Negative After-Image", in Science, Vol. 112, No. 2903, August 1950, p. 199-201.

⁴⁰ Levinson, Op. cit., p. 42.

a higher Pt score (.02 level), and a higher Sc score (.05); these relationships may be interpreted in terms of the cortical inhibition theory, as demonstrating depressive, obsessive-compulsive-phobic, and schizoid tendencies, all characteristic of the introverted pole of the Eysenck continuum. The one discrepant finding in Levinson's experiment was that those with longer after-image duration means were very significantly higher in their Hy scores, a measure of hysterical tendency (.01 level). It must be remembered that this research did not utilize the cortical inhibition concept, nor was the basal range of the subjects taken into consideration. When such a measurement was applied by this writer from the descriptive accountings of the findings, those with high Hy scores and long after-image means built up considerable inhibition to respond after the initial measurement of after-image duration, and it was this first duration which counted them among the high scores on the projection measurements.

Levinson has attributed much to the attitude pattern of the subject, conceding the eventual measurements to the degree of involvement, expectancy and the desire to comply with the experimental procedure. It might appear to some that the psychophysiological contribution is avoided or underplayed. Though attitudes and other propensities of the subject must naturally enter into any

perceptual measurement, it may be through these attitudes and habits of involvement that the constitutional elements are most easily expressed, rather than in a pure neurological reluctance, devoid of behavioral patterning.

That Levinson found no correlation between the negative after-image disappearance threshold and the personality characteristics tapped by the Minnesota Multiphasic Personality Inventory, is not surprising to this writer. The device used in the experiment was extremely primitive from the point of view of instrumental precision, as was the administration, which introduced the onus of a difficult judgement task, and thereby introduced a wide and variable "decision area", which may have masked the true threshold zone.

Eysenck, Holland and Trouton⁴¹ have investigated the differential effects of stimulant and depressant drugs on visual after-effects, justifying the interpretation of central brain influence over the phenomenon of the Archimedes Spiral After-Image.

⁴¹ J. H. Eysenck, H. Holland, and D.S. Trouton, "Drugs and Personality: III. The Effects of Stimulant and Depressant Drugs on Visual After-Effects", in Journal of Mental Science, Vol. 103, 1957, p. 650-655.

Of particular interest is the study by Eysenck and Aiba⁴² on the effects of stimulant and depressant drugs utilizing a modified Lehmann after-image device. They interpret the complementary image phenomenon as resulting from pre-excitatory inhibition of the primary stimulus at the retinal level. In their view, the after-image is inhibiting the primary image. Though Eysenck has been adamant in his opinion that after-effects and after-images are predominantly under the influence of the Central Nervous System, he avoids or evades such an interpretation in this case.

Using the Lehmann device, and varying alternately the intensity of the primary stimulus (the red light) and the amount of inhibitory white field of the chopping disc, by control of rotation speed, they hypothesized that depressant drugs would raise the threshold for the primary stimulus and stimulant drugs would lower it. They observed that dexamphetamine effected the lowest thresholds, but that amytol, though causing a raised threshold, was effecting a lower level than that achieved under a placebo. In addition the diurnal fluctuations tended to raise thresholds

⁴² H.J. Eysenck and S. Aiba, "Drugs and Personality, IV. The effects of Stimulant and Depressant Drugs on the Suppression of the Primary Visual Stimulus", in Journal of Mental Science, Vol. 103, 1957, p. 661-665.

like the administration of amytol, and with a constant white field stimulation time of twenty milliseconds all the thresholds were raised regardless of the drug type administered. No explanations were offered for the various discrepancies.

Aiba⁴³ has recently repeated the experiment, using amylobarbitone as the depressant and dexampetamine as the stimulant. The findings appear more stable; amylobarbitone effected raised thresholds, whereas the amphetamine lowered the threshold for the primary stimulus.

Some important insights into the nature of the differential drug action on the after-image threshold have been offered by Kaplan⁴⁴ from his investigations of autonomic visual regulation. The work of Kravkov⁴⁵ had indicated that autonomic arousal effected a decreased visual sensitivity to hues of short wave length, such as blues and greens. Modifying the Lehmann After-Image Threshold

⁴³ Satoru Aiba, "The Effects of Stimulant and Depressant Drugs on the Bidwell Phenomenon", in the British Journal of Psychology, Vol. 51, Part 4, November 1960, p. 311-318.

⁴⁴ Solomon D. Kaplan, "Autonomic Visual Regulation; (Part I. The After-Image Spectral Photometer)", in Explorations in Physiology and Emotions, Psychiatric Research Reports of the American Psychiatric Association, No. 12, January 1960, p. 104-114.

⁴⁵ S.V. Kravkov, in Journal Opt. Soc. Amer., Vol. 31, p. 335, quoted by Kaplan, Op. cit., p. 105.

Device to permit homogeneity of hue despite the reduction in chopper illumination, Kaplan investigated the possible use of the instrument to measure differential spectral sensitization to autonomic arousal by drugs, as well as effects of clinical depression on such autonomic differentiation. His findings indicated that Sympathomimetic drugs reduce the subject's ability to perceive hues of short wave length, causing loss of the after-images of short wave length at brighter ranges of chopper illumination. Parasympathomimetic drugs have an inverse effect, in general. These findings confirm those reported by Eysenck and Aiba⁴⁶. Kaplan investigated the differential spectral sensitization to autonomic drugs in depressive psychotic subjects, hypothesizing that depression would be related to stereotopy in autonomic responses, regardless of the drug type. The results supported this hypothesis, demonstrating a rutting of spectral differentiation, as if the depression had destroyed the autonomic differentiation of central excitation⁴⁷.

⁴⁶ H.J. Eysenck and S. Aiba, "Drugs and Personality: IV. The Effects of Stimulant and Depressant Drugs on the Suppression of the Primary Visual Stimulus", in Journal of Mental Science, Vol. 103, 1957, p. 661-665.

⁴⁷ Solomon D. Kaplan, "Autonomic Visual Regulation; Part II. Differential Spectral Sensitization to Autonomic Drugs in Depression", in Explorations in Physiology and Emotions, Psychiatric Research Report of the American Psychiatric Association, No. 12, January 1960, p. 115-118.

As yet, this writer cannot report on the problem of autonomic spectral sensitization as a factor influencing the measurements made by the apparatus employed in this study. What psychiatric testing has been done with the instrument tends to confirm Kaplan's findings, that psychotic depressives show little variability in their after-image thresholds, and a strong tendency toward long after-image duration⁴⁸. Perhaps the nature of visual inhibition entails a diencephalic regulation of autonomic and central antagonism. Whatever the physiological bases are, this writer conceives cortical inhibition in perception as an inverse expression of the brain's kinetic intake energy. Halstead⁴⁹, in his famous factor analytic study of brain functioning, identified a measurement cluster which he called the Power Factor, reflecting the undistorted, Id free capacity of the brain to function in a moment of time.

The particular aim of this study is an investigation of the possible relationships between the personality dimension of introversion-extraversion, as understood by Eysenck, and after-image sensitivity. This sensitivity or

⁴⁸ A separate study is in progress at the School of Psychology and Education, University of Ottawa, to compare the after-images of normals and psychiatric patients.

⁴⁹ Ward C. Halstead, Brain and Intelligence, University of Chicago Press, Chicago, 1947, xiii- p. 147.

lack of it, interpreted as an effect of reactive cortical inhibition, will be measured by the negative after-image threshold.

A new instrument will be employed and described which provides a reliable measurement of figure-ground light intensity required to produce and sustain the negative after-image phenomenon. The term "negative after-image threshold" will be used throughout the following chapters to denote the point or zone where loss of the image occurs as a function of the particular type of field illumination intensity.

The criterion for the dimension of introversion-extraversion used will be scale scores on the Guilford Inventory of the Factors STD CR⁵⁰. The problem is stated in the form of the null hypothesis: there will be no significant correlations between STD CR scores and Negative After-Image Threshold scores for sixty-nine male subjects.

The following chapter will be devoted to the reporting of the experimental design.

⁵⁰ J.P. Guilford, An Inventory of Factors STD CR, Beverly Hills, California, Sheridan Supply Company, 1942.

CHAPTER II

EXPERIMENTAL DESIGN

The introductory pages of this chapter contain a brief outline of Lehmann's original instrument, from which the instrument used in this study was partially devised, along with certain criticisms of the original design and the consequent ameliorations.

Section 1, which follows the above description and critique, includes a detailed description of the new instrument designed to measure the negative after-image threshold. This section also contains illustrations of the instrument showing the whole unit, and a cross-sectional exposition of the stimulus cabinet. Section 2 describes the sample population and the criteria for the inclusion of subjects. Section 3 presents the psychological test criteria for the personality dimension of introversion-extraversion. Section 4 is devoted to a description of the experimental procedures, which include the standardized administrative techniques and score conversion method. Finally section 5 reports on the technique for data evaluation, including the statistical formulae employed.

To experiment with a more objective method of measuring the after-image phenomenon, Lehmann¹ devised an instrument, capable of sustaining a negative after-image, in the complementary color of the original stimulus color, without allowing the subject to perceive the original stimulus.

In essence, it comprised a double red circle stimulus on a white card, intermittently obscured from the direct vision of the subject, by means of a ten inch rotating disc, painted half white and half black, with a thirty degree segment cut out of it. The rotating disc was driven by a motor, controlled by a friction brake, and kept constant at 240 revolutions per minute. This RPM constancy was determined by reference to a stroboscopic pattern pasted on the distal face of the disc. Both the stimulus and the rotating disc were illumined by the same sixty watt bulb, placed overhead to shine equally on these components.

The one variable reported was the illumination required to sustain the complementary image, that is, without

¹ H. Lehmann, "Preliminary Report on a Device for the Objective Measurement of the Negative After-Image", in Science, Vol. 112, No. 2903, August 1950, p. 199-201.

allowing the real color of the stimulus rings to break through into awareness. By decreasing the illumination, a measure could be taken of what was named "the after-image disappearance threshold", or that point or zone at which or in which the negative after-image faded and the true stimulus color broke through. The required decreasing of the illumination was done by means of glass polaroid lenses inserted into the viewing aperture. The proximal lens was rotated counter-clockwise, thus inhibiting the reflected light to the subject's eyes, and, in effect, resulted in an apparent decrease in light intensity. The amount of angular rotation required to inhibit the after-image phenomenon was thus measured on a pointer attached to the rotated glass lens.

Since the quality of the device could not be properly judged from a review of the literature, in as much as it had only been used by the original designer, and only once in a published work by another researcher², this present author was fortunate in being permitted to examine the original instrument, in being tested with it by its designer, and in discussing with him its advantages and

² Harry Levinson, The Relationship of After-Image Duration to Certain Aspects of Personality, unpublished doctoral dissertation, University of Kansas, 1952, from University Microfilms, Ann Arbor, Michigan, No. 4502, p. 1-75.

disadvantages. From this inspection, certain shortcomings appeared paramount:

a) A friction braked motor had been employed, and the constancy in revolutions, though inspected by means of the stroboscopic pattern, was doubtful.

b) No precautions had been taken to guard against irregularities in the electrical current for motor or light.

c) The apparent dimming of the illumination of stimulus and disc was achieved by the rotation of the polaroid lens, and the resulting spatial measurement of the angular rotation lacked reliability and linearity.

d) The shared illumination of stimulus and disc introduced a second variable, the dimming of the stimulus itself, which had not been considered by the designer.

e) No check was made on the constancy of the illumination, which does change with the aging of the bulb.

The modifications reported in this chapter have been aimed at improving on the features noted above, for the purpose of instrumental reliability and communication of a standardized electro-mechanical structure and methodology.

1. The Psychophysiological Tool

The instrument consists of two cabinets, a control cabinet which houses the measuring instruments and regulating apparatus, and a second cabinet containing the stimulus system. The stimulus employed is a red light, intermittently obscured from the Subject's direct line of vision by a ten inch rotating metal disc with two 15 degree pie cuts at opposite ends of the diameter, that is, with the apex of each pie cut meeting at the center of the disc. The disc is assembled from three aluminum leaves, two painted flat white and the other painted flat black. This leaf arrangement permits variation of the white-black ratio independent of the pie cut arc chosen. The disc is driven by a synchronous motor geared down to revolve at one hundred and twenty revolutions per minute. The proximal face of the disc is illumined by two 40 watt bulbs. Both the stimulus light and the disc lights are read by photoelectric cells connected to microampere meters in the control cabinet. The intensity of the stimulus light and the disc lights is controlled by means of separate variacs in the control cabinet, the stimulus light being kept constant during the measurements, while the disc illumination is decreased through the whole range of its reading meter, by a motor driven variac. The initial intensity of the

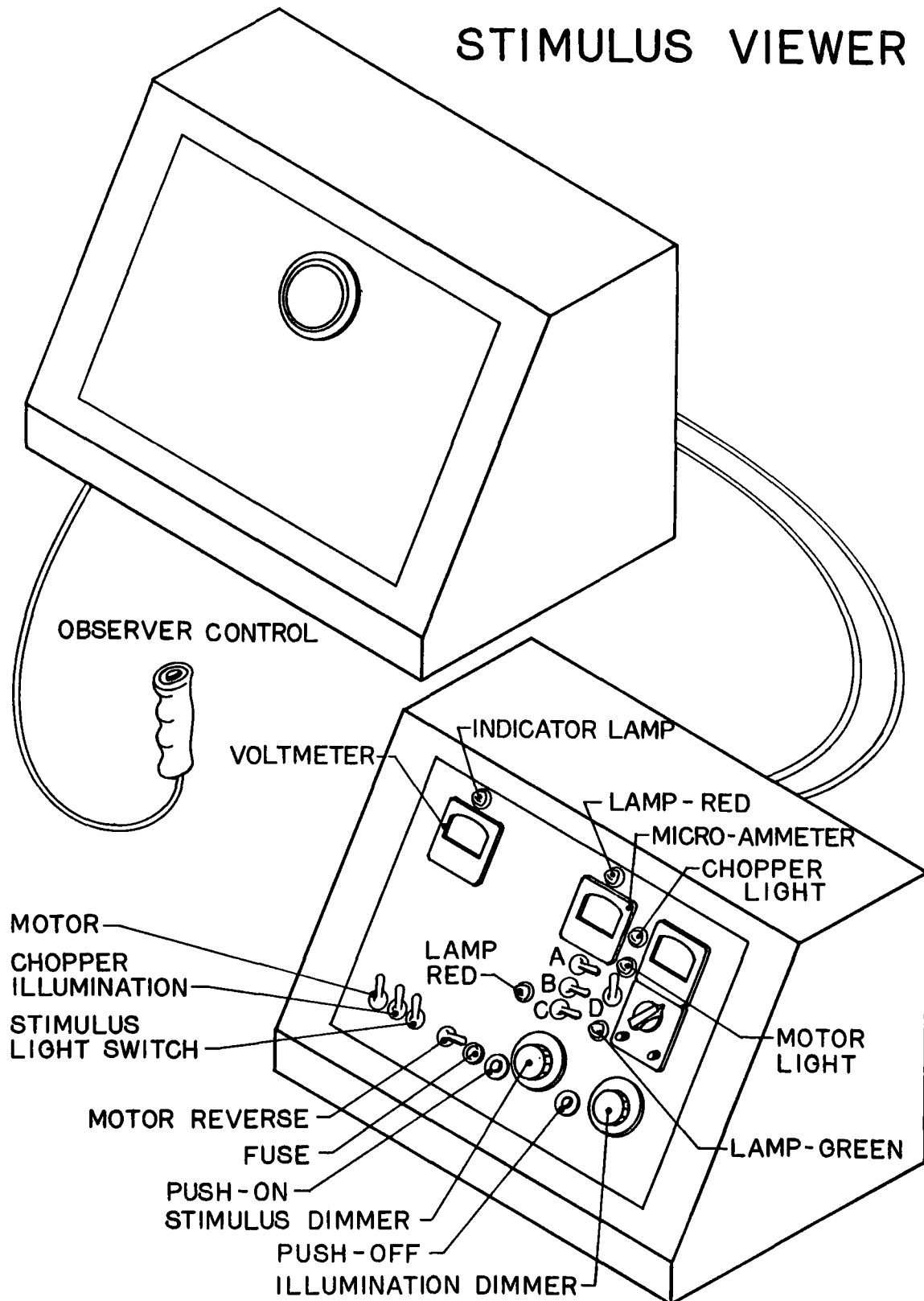
stimulus light and the disc lights is kept below the maximum meter range so that compensation for aging of the bulbs is obtained. The electrical current for motors and lights is protected against fluctuations in house flow by means of a constant voltage transformer.

Figure 1 on page 33a shows the two components of the Negative After-Image Apparatus, the stimulus cabinet (labeled Stimulus Viewer) and the control cabinet (labeled Control Unit). Figure 2 on page 33b presents a sectional view of the stimulus cabinet, demonstrating the angular location of the disc drive system, the components in the stimulus housing, the disc and its light shield, and the arrangement of lights and photocells on the back of the stimulus cabinet face. An included line drawing of the back of the stimulus cabinet (labeled Back of Stimulus Viewer Panel) demonstrates the disposition of lights and photocells in relation to the viewing aperture. In both Figures 1 and 2, the term chopper is synonymous with the word disc used in this report.

Appendix 2, page 77, presents the wiring diagram. In this illustration the control cabinet (labeled Control Turret) is shown connected to the stimulus cabinet (labeled Display Turret).

The components of the NAIT apparatus may now be described in detail:

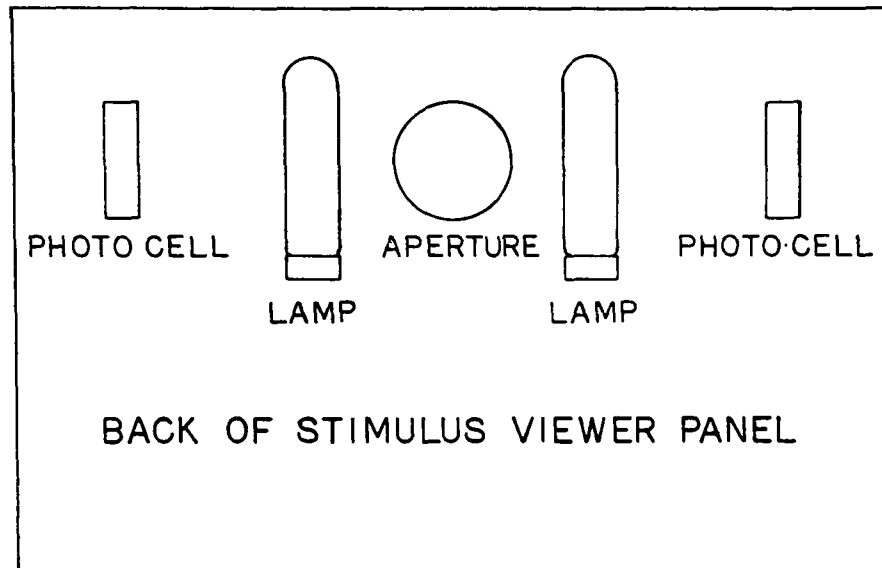
STIMULUS VIEWER ^{33a}



CONTROL UNIT

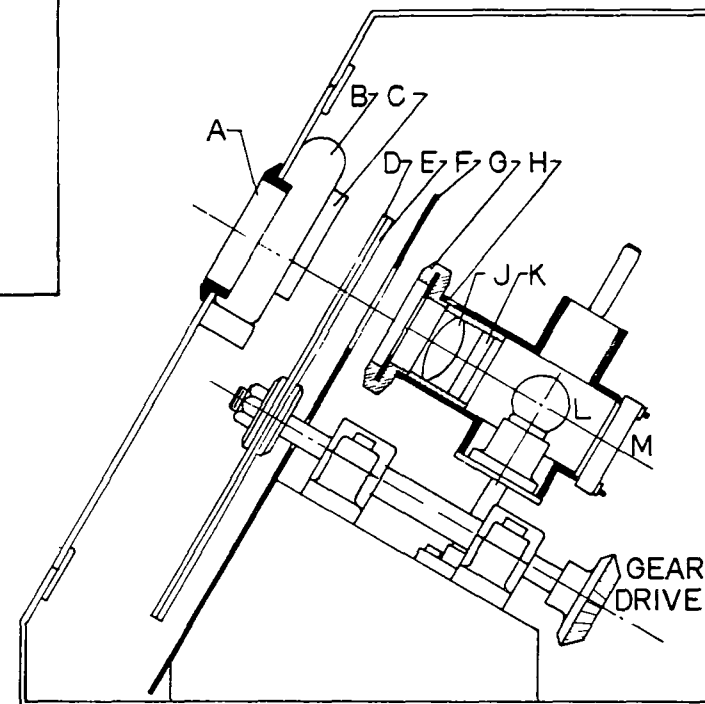
Figure 1.- The Nait Apparatus.

Figure 2.- Details of Stimulus Cabinet.



DETAILS OF THE STIMULUS VIEWER

- | | |
|------------------------------|-------------------|
| A- APERTURE | F- SHIELD |
| B- SECTOR LAMP | G- IRIS |
| C- PHOTOCELL | H- LAMP HOUSE |
| D- CHOPPER SECTOR
(WHITE) | J- CONDENSER LENS |
| E- CHOPPER SECTOR
(BLACK) | K- RED FILTER |
| | L- LAMP |
| | M- PHOTO CELL |



SECTIONAL VIEW

The Disc Motor: The synchronous motor employed is a Bodine motor, split phase, category B-2246E-10, type NSY-12R, of 1/150 H.P., with a speed reducer to 180 RPM. Further speed reduction and coupling to the disc assembly was accomplished by using bevel gears (Boston Gear L-146Y, 16DP) effecting a reduction of 3:2

A standard bushing (Boston Gear) was used to match the disc axle to the motor output shaft. When these gears had been carefully located, the gear noise was not excessive.

The Stimulus System: The stimulus system is housed in the stimulus cabinet. The stimulus light is a white 7.5 watt General Electric bulb enclosed in a black plastic pipe housing (Refer Figure 2). The illumination projects through an Ednalite photographic filter, type Dark Red, 1.5 inches in diameter. This red light is then passed through a condensing lens with a frosted front surface. The condensing lens effects an homogeneity in the red stimulus field, and the frosting excludes projected visual inclusions. An Evans Electroselenium Photo Cell, (category EE1, 25mm., circular mounted), is inserted in the rear of the stimulus housing tube to read the bulb intensity. A Wollensak iris and shutter, Betax No. 3, is attached to the front end of the stimulus housing tube, with an aperture of 3.5. Though no experimentation was done with alternate stimulus sizes, this iris provides this flexibility. The stimulus housing is supported by a retort stand and clamp, with the front end 4 inches from the viewing port of the cabinet. The viewing port is a circular cutout, 3 inches in diameter, in the center of the cabinet face, framed by a black rubber collar to prevent incidental reflection on the cut metal.

The Disc Illumination System: Two 40 watt General Electric Bed Lamp bulbs, chosen for their elongated shape which facilitated an even distribution of light were mounted vertically on the inner face of the stimulus cabinet. The initial mounting was done by attaching magnets to the sockets of the lights. When the optimum placement had been determined, the lights were permanently cemented to the metal cabinet, 3 inches from the center of the viewing port, one on each side. Two matched General Electric photocells, type 8PV1AAB, were cemented, one for each bulb, 3 inches from the axis of the bulb. A thin metal screen, painted a flat black, was mounted immediately behind the rotating disc to prevent light seepage and possible effect on the stimulus light photocell. A 4 inch port in this screen admitted the stimulus.

The Control System: The control system is housed in the control cabinet. It includes two variacs controlling stimulus light intensity and disc light intensity respectively, and related ON-OFF power switches.

The power supply to the stimulus light is controlled by a General Radio W2 variac. The constant stimulus setting is obtained, however, by reference to the light meter reading and not by the scale setting on the face of the variac dial. The power supply control over the disc illumination is had through a General Radio W2-BB variac which is driven by a Bodine Model K synchronous motor with spur gear reduction to 1 RPM. This servo-motor can provide a 110 inch-ounce torque whereas the variac requires less than a 10 inch-ounce torque. To provide for manual resetting a PIC-R3-3-50 adjustable slip clutch was added to the gear design. Further speed reduction to 1/2 RPM was obtained by using spur gears. Boston gear G-258 was machined for use with the PIC clutch and Boston gear H-2448 was used as the driven gear, and fits the variac shaft without alteration. No braking is used on this servo system. The coasting is less than 1°/sec. at the variac shaft and the angular velocity of the variac is about 3°/sec. A push-button OFF switch mounted in a handle with a 3 foot wire is connected to the circuit of the variac servo motor through the stimulus cabinet connectors. The servo motor's ON switch is located on the control cabinet panel. An OFF switch for the servo motor is also included on the panel as an alternate method of stopping the variac.

The Measuring System: The measuring meters are housed in the control cabinet, with their photoelectric cells tapping the stimulus light and disc light intensity in the stimulus cabinet. The meter reading the stimulus light is a Simpson microammeter, model 27, with a range of 0-500 microamperes. During the testing the stimulus intensity is kept constant at 250 microamperes. The meter reading the intensity of the disc lights is a Simpson microammeter, model 374, with a range from 0-1000 microamperes. A Simpson alternating current voltmeter, model 57, range 0-150, was introduced into the circuit for an observation of current changes, though all current is generally stabilized through a Sola constant voltage transformer, C.V.T. (30806), 20-13-112.

Other Components: The OFF-ON switches for the disc motor, stimulus light and disc lights are mounted on the lower left face of the control cabinet. The disc motor OFF-ON switch is a double pole-double throw type, permitting

reversal of motor direction for experimental flexibility. The servo motor for the disc light variac is also reversible by the same method. Switches are also provided to alternate the variacs and microammeters, i.e., the disc light ammeter could be used to read the stimulus light, and the stimulus light ammeter could read the disc light intensity, with the concomitant shift of their respective variacs, under manual control. Switches were included to halve the disc illumination and disc illumination photocells, if desirable in subsequent research. Pilot lights are installed on the face of the control cabinet to monitor the operation of the stimulus light, disc lights, disc motor, variac servo motor, OFF-ON switches, direction of servo motor rotation, and current flow from the constant voltage transformer. Such pilot lights are needed if the control cabinet and stimulus cabinet are separated any distance, for example, in separate rooms. The two cabinets are connected by a Cannon connector system.

2. The Sample Population

The sample consisted of eighty-two men, both officers and constables, of the Royal Canadian Mounted Police Headquarters, Ottawa, Ontario. This selection was made by the personnel officer from the office population of the headquarters, strictly on the basis of volunteering.

The men's ages ranged from 24 to 47 years with a mean age of 33.6 years, and an educational range of grade 12 to B.A. and an educational mean of grade 12. Of the eighty-two volunteers, 72 have been included in this study. Ten men were deleted for the following reasons: one had recently recovered from cerebral meningitis; eight reported varying degrees of color blindness; one Subject was taking a tranquillizing drug. The seventy-two remaining volunteers

reported no serious illnesses nor head injuries, and abstention from drugs or other medication. Color blindness was ruled out on the basis of being able to report the proper color of the negative after-image. The insistence on freedom from head injury and drug effect was dictated from the studies previously discussed.

A prime factor in choosing this sample was the assumption that the homogeneity of training and medical requirements and supervision partially controlled the variable of systemic health. Further, in view of future research with the apparatus, this sample would provide normative data against which a variety of clinical samples might be compared.

3. The Psychological Tool

To measure the introversion-extraversion components in the sample population from the "psychological test criterion" point of view, the Guilford Inventory of Factors STDCR was selected, hereafter referred to as the STDCR. Eysenck has used this test extensively as a verbal self-

3 Guilford J.P., An Inventory of Factors STDCR, Beverly Hills, California, Sheridan Supply Company, 1942.

4 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.

reporting measure of behavior correlated to his interpretation of the personality traits included in the dimension of introversion-extraversion. In particular, Eysenck has used the E scale as an acceptable measure of extraversion. This study has included all five scales in the inventory.

The following quotation outlines Guilford's description of the behavioral traits tapped by each scale:

- S- Social Introversion-Extraversion.- Shyness, seclusiveness, tendency to withdraw from social contacts, versus sociability, tendency to seek social contacts and to enjoy the company of others.
- T- Thinking Introversion-Extraversion.- An inclination to meditative or reflective thinking, philosophizing, analysis of one's self or others, versus an extravertive orientation of thinking.
- D- Depression.- Habitually gloomy, pessimistic mood, with feelings of guilt and unworthiness, versus cheerfulness and optimism.
- C- Cycloid Disposition.- Strong emotional fluctuations, tendencies toward flightiness and emotional instability, versus uniformity and stability of mood, evenness of disposition.
- R- Rhathymia.- A happy-go-lucky, carefree disposition, liveliness, impulsiveness, versus an inhibited, over-controlled, conscientious, serious-minded disposition ⁵.

⁵ Guilford, Op. cit.

Guilford⁶ reports the reliability of the scales, using a split-half method and the Spearman-Brown formula. His sample consisted of one hundred men and one hundred women, randomly selected from the criterion group. The estimated reliabilities are .92, .89, .91, .91 and .89 for factors S, T, D, C, and R respectively. Corresponding reliabilities, in the same sample by the Kuder-Richardson method were .92, .85, .90, .87, and .91 for the factors S, T, D, C, and R respectively.

In subsection 5 of this chapter a description of the split-half technique for internal consistency will be described, as used in this study, from the sample of RCMP volunteers. The results will be demonstrated in Chapter III.

4. The Experimental Procedures

The experimental procedures to be described were determined as the optimum techniques after four pilot studies, with other samples.

Two matched Negative After-Image Threshold devices, hereafter referred to as the NAIT apparatus, were installed on benches 30 inches high, in a darkened room. Two Nait apparatus were employed for the joint purposes of obtaining

⁶ Guilford, Op. cit.

a test-retest on each Subject; and in alternating the instrument, an empirical measure of reliability on the Nait apparatus, although they had been carefully matched for electro-mechanical equivalence.

The Subject was then seated in front of the stimulus cabinet and adjustment of viewing distance was made by the tester. The distance of the viewing port from the eyes of the Subject was 12 inches, measured by a tape attached to the stimulus cabinet. A period of three minutes for dark adaptation was given each Subject, and during this period the general information on name, age, education, health, eyesight, and use of drugs or medication was obtained. Eyesight was considered adequate if normal or corrected by glasses to function as normal.

Subjects were then instructed in the following manner: "This is a special test for color vision. During the test try hard not to move your head or body. What is more important, try hard not to blink your eyes. When you look into this hole you will see a colored circle. What color is it? The Subject cannot see the color of the primary stimulus due to the particular stimulation of the rotating disc. The disc allows stimulation from the primary stimulus to impinge, but the Subject is only "aware" of it in its complementary color, as a negative after-image continually sustained, and reports this color as green,

blue or turquoise. "Very good. Now you are to gaze at the center dot in the green (or blue etc.) circle. That green color may fade or reappear, or it may get darker until it completely disappears. Before we begin the test, we will show you how it happens". A trial test is begun. The variac controlling the disc illumination is set at 800 microamperes on the 1000 scale, and the disc light turn down is initiated by pressing the ON switch for the variac's servo motor. The disc light meter is always left in the SHORT range switch position to avoid pegging the needle on the initial bright level of stimulation. During this trial run the meter is left in SHORT, since no readings are taken. During this trial the operator may question the subject or answer questions to clarify the nature of the phenomenon. When the operator decides that the Subject understands the procedure, he continues, "Now we can begin the test. You are to gaze at the center dot in the green circle. You are to press this button (at this point the Subject is handed the push button OFF switch) as soon as you are no longer able to see any of the green color. The green color may fade or reappear, or it may get darker, as you have seen, but, you are to press the button as soon as you feel that the green is all gone".

After these instructions, with the included trial test, the operator resets the disc light variac, presses the

ON switch, and after ten seconds, turns the disc light microammeter from SHORT to the first measuring range, the 1000 microamperes range. As the Subject persists in his perception of the green after-image, the operator continues to lower the microammeter's range. The point of after-image disappearance is always read from the meter in the lowest appropriate meter range. As soon as the Subject presses the OFF switch, the operator takes the visual reading, sets the microammeter range switch to SHORT, turns the disc light intensity to its initial level of brightness, and repeats the testing. The mean time interval between the end of one trial and the beginning of another was two seconds.

Each Subject was given six trials, composing one testing period, followed by a three minutes rest to allow for the dissipation of visual satiation, and then another six trials. The instructions for the re-test include only the last few words of the previous instruction. "Now we can begin again. You are to gaze at the center dot in the green circle. You are to press this button as soon as you are no longer able to see any of the green color. The green color may fade or reappear, or it may get darker as you have seen, but you are to press the button as soon as you feel the green color is all gone".

In a previous pilot study, with a less refined apparatus, this writer⁷ enumerated the disadvantages of the instrument employed, one of which was a manual turn-down of the disc light variac by the Subject, to the point of after-image disappearance. It was assumed that liminal or subliminal cueing to the manual turn-down could determine the disappearance point. This new apparatus used in this study was specially designed to avoid motor cueing, since the disc light turn-down is both silent and automatic. In like manner, the stimulus system in this new instrument is designed to minimize the cueing from the light intensity level of the figure-ground contrast between the stimulus and the rotating disc. In the older instrument mentioned, a cueing from the level of ground brightness was a greater problem.

The readings obtained from the sample, in test and re-test, were then converted from microamperes to foot-candles to minimize random fluctuations in the meter measurements, and to obtain maximum linearity from the extended meter range. The technique of obtaining precise conversion data is reported in Appendix 1 and the conversion table for changing microampere readings into foot-candle units is

⁷ William Barry, The Design and Use of a New Apparatus for Measuring the Negative After-Image Phenomenon as a Function of Reactive Cortical Inhibition, unpublished paper to upgrade a Masters degree obtained without thesis, 1958, University of Ottawa, p. 28.

shown on the following page, in Figure 3.

5. Techniques for Data Evaluation.

The raw data, having been obtained in the described manner, from a six trial test-retest on 72 adult males, using the NAIT apparatus, the following features were investigated: the test-retest reliability of the raw trial scores in foot-candles; the test-retest reliability of the total inhibition score (algebraic score); the statistical significance of the increment between trial one and trial six, interpreted as reactive inhibition; statistical analysis of the significance of the differences of means and standard deviations for each trial on test-retest; an investigation of the possible relationships between introversion-extraversion inhibition scores as measured by the STDCR and a split-half reliability test on the STDCR.

Since this study was especially interested in the investigation of reactive inhibition as interpreted and demonstrated through a rise in after-image threshold on the NAIT apparatus, a score was devised which, presumably, would reflect the increments of inhibition on each trial. An algebraic sum of the six trials, under massed practice, was chosen. This sum was identical to the figure obtained by subtracting the Subject's score on trial one from his final score on trial six. Thus, the effects of trial one

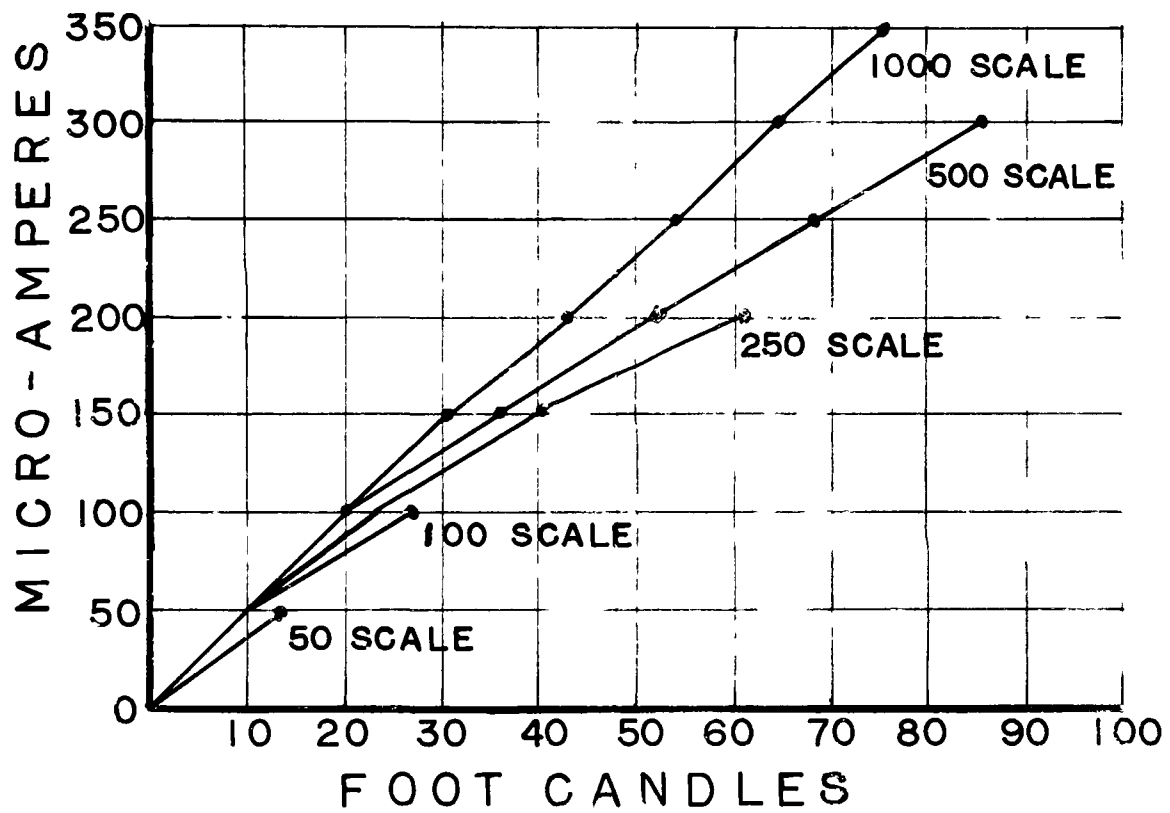


Figure 3

Graph for Converting Microampere Scores
to Foot-Candle Scores.

are subtracted from trial two, which are subtracted from trial three, and in the same way, through trial six, isolating the increments of a rise in the after-image disappearance threshold, which is interpreted as retino-cortical inhibition.

A measure of reliability was obtained by correlating the raw score of each trial in foot-candles for the initial testing session with the raw scores of each trial in foot-candles for the final session. Reliability was also estimated for the algebraic score obtained from both testing sessions.

The formula used was the Pearson product moment correlation coefficient:

$$r = \frac{N\sum XY - \sum X \sum Y}{\sqrt{N\sum X^2 - (\sum X)^2} \sqrt{N\sum Y^2 - (\sum Y)^2}}$$

The results are reported and tabulated in Chapter III, pages 50 and 51.

To test the statistical significance of the mean increment between trials one and six, for the sample of 72 subjects, for both initial and final test sessions, was imperative. If such a rise between first and last scores could be ascribed to chance fluctuations, the application of the inhibition theory would be inadvisable. Therefore,

the differences between the correlated variances were evaluated by the following formula:⁸

$$\underline{t} = \frac{\sigma_1^2 - \sigma_2^2 \sqrt{N-2}}{\sqrt{4\sigma_1^2 \sigma_2^2 (1 - r_{12}^2)}}$$

where $\sigma^2 = \frac{\sum (X-M)^2}{N-1}$

This test was followed by "critical ratio" tests for correlated groups, on the mean and standard deviations of both testing sessions, employing the formula:

$$\underline{CR} = \frac{D}{\sigma_D}$$

$$\text{where } \sigma_{D_{M_1-M_2}} = \sqrt{\sigma_{M_1}^2 - \sigma_{M_2}^2 - 2r_{12} \sigma_1 \sigma_2}$$

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

$$\text{where } \sigma_{D_{\sigma_1-\sigma_2}} = \sqrt{\sigma_{\sigma_1}^2 - \sigma_{\sigma_2}^2 - 2r_{12} \sigma_{\sigma_1} \sigma_{\sigma_2}}$$

$$\text{and } \sigma_\sigma = \frac{\sigma}{\sqrt{2N}}$$

In order to investigate the possibility of combining the data of both testing sessions, and to represent the separate score curves as one average curve, an

⁸ Quinn McNemar, Psychological Statistics, New-York, John Wiley and Sons, 1955, p. 244.

analysis of the mean scores of the six trials, test-retest, was undertaken, using the t and CR formulae previously shown.

The algebraic scores for each testing period (or the average algebraic score, if the sessions can be combined) will be correlated to the scale scores for each factor of the STDCR. The formula will be the Pearson product moment coefficient of correlation.

Finally, the reliability of the separate scales of the STDCR will be determined. Since a test-retest was not possible with the sample, anonymity being a condition for experiment cooperation, a type of split-half reliability was devised. The items comprising each scale were extracted, and a new key was devised. Then, for each scale a random sample was obtained, dividing the items into equal halves. Beginning from the middle items, items were assigned to each half by the following succession:

1	2
4	3
5	6
8	7 etc.

Scores on each half, for each factor were tested for reliability by the Pearson product moment coefficient of correlation, corrected by the Spearman-Brown formula: $r_{12} = \frac{2r_{\frac{1}{2}\frac{1}{2}}}{1 + r_{\frac{1}{2}\frac{1}{2}}}$

The following chapter will be devoted to the reporting of the experimental results, and to a discussion of these results, and their possible implications.

CHAPTER III

RESULTS AND DISCUSSION

There will be five parts to this chapter. Section 1 presents the coefficients of reliability for the NAIT test raw scores and algebraic scores, and the tables of data on the required t tests and CR tests utilized. Section 2 presents the estimations of statistical significance of the algebraic scores. Section 3 presents the coefficients of reliability estimated from the split-half reliability calculations on the separate scales of the STDCR. Section 4 presents the Pearson product moment coefficients of correlation between the STDCR scale scores and the NAIT test scores, with a short discussion of an item analysis employed as an additional check on possible intertest relationships. Section 5 contains the discussion of the results on the reliability and validity of the NAIT test and its relationship to introversion-extraversion.

1. The Reliability of the NAIT Test.

Test-retest coefficients of reliability on raw scores were calculated, for the sample of seventy-two males, on each of the six trials on the initial and final testing sessions, and for the algebraic score of the six trials in both testing sessions. The coefficients obtained were .781,

.769, .727, .793, .618 and .866 for the six trials respectively, and .730 for the algebraic score, all significant at the .01 level.

A t test was then calculated on the correlated variances, to determine whether or not an average performance curve could be derived and utilized instead of the double test data. The formula employed was that described in the preceding chapter.

Significant t ratios were obtained for trials one, five, and six at the .01 level, and at the .05 level for trials three and four. Table I on the following page presents these data.

The test for correlated variances was followed by critical ratio tests to isolate the factors effecting the differential variability of the two test sessions.

The raw score means for trials one, two, and six were found to be significantly different at the .05 level, and the standard deviations of trials one, five and six were found to be significantly different at the .01 level, and of trials three and four at the .05 level.

The algebraic scores, obtained by subtracting the score of trial one from trial six, for each Subject, were found to have no significant differences of means or standard deviations at the .01 or .05 levels. Since this study was primarily interested in this algebraic score, as

Table I.-

Test for Correlated Variances on NAIT Raw Scores and Algebraic Scores. N = 72.

Trial	Session	$\Sigma(X-M)^2$	σ^2	r_{12}	t	Sign.
1	Initial	3029.87	42.67	.781	3.282	.01
	Final	4922.98	69.34			
2	Initial	5234.50	73.72	.768	1.746	-
	Final	6826.00	96.14			
3	Initial	6826.00	96.14	.727	2.408	.05
	Final	10099.22	142.24			
4	Initial	7865.99	110.79	.793	2.603	.05
	Final	11506.99	162.07			
5	Initial	8029.28	113.09	.618	3.245	.01
	Final	14627.78	206.03			
6	Initial	9429.65	132.81	.866	3.245	.01
	Final	13810.61	194.52			
Alg.	Initial	4285.94	60.37	.730	.208	-
	Final	4434.32	62.46			

the measure interpreted to be demonstrating the build up of reactive cortical inhibition, the absence of significant differences of the means and standard deviations permitted the utilization of an average algebraic score from both ⁺resting sessions, to be employed in correlations with psychological criteria later to be described and discussed in this chapter.

Table II, on the following page, presents the data of the critical ratio tests on the means and standard deviations of raw scores for the six trials in both test sessions, including the coefficients of reliability for each trial. Table III presents the critical ratio tests on the means and standard deviations of algebraic scores.

Table II.-

Critical Ratio Tests on the Means and Standard Deviations of NAIT Raw Scores on Two Test Sessions for Six Trials.
N = 72.

Trial	Stats.	Initial Test	Final Test	Diff.	σ_D	CR	Sign.
1	M	9.46	11.01	1.55	.605	2.562	.05
	σ	6.487	8.269	1.782	.559	3.188	.01
	σ_M	.765	.969				
	σ_σ	.540	.689				
	$r_{12} =$	.781					.01
2	M	11.99	13.67	1.68	.747	2.249	.05
	σ	8.527	9.737	1.210	.643	1.746	
	σ_M	1.005	1.148				
	σ_σ	.711	.811				
	$r_{12} =$	.768					.01
3	M	14.50	15.44	1.44	.965	1.492	
	σ	9.737	11.803	2.066	.883	2.340	.05
	σ_M	1.148	1.391				
	σ_σ	.811	.984				
	$r_{12} =$	.727					
4	M	14.26	15.24	.98	.909	1.078	
	σ	10.451	12.642	2.191	.849	2.581	.05
	σ_M	1.232	1.490				
	σ_σ	.878	1.054				
	$r_{12} =$	.793					.01
5	M	15.69	17.06	1.37	1.359	1.008	
	σ	10.560	14.529	3.969	1.183	3.356	.01
	σ_M	1.245	1.712				
	σ_σ	.880	1.211				
	$r_{12} =$	.618					.01
6	M	16.43	18.36	1.93	.819	2.357	.05
	σ	11.444	13.849	2.405	.768	3.132	.01
	σ_M	1.349	1.632				
	σ_σ	.954	1.154				
	$r_{12} =$	.866					.01

Critical Ratio Tests on the Means and Standard Deviations of NAIT Algebraic Scores on Two Test Sessions. N = 72.

[illegible]

The reliability of the NAIT test was calculated on raw scores in foot-candles. No attempt was made to ascribe weighted scores for the hierarchy of zones or ranges. In a previous study¹ the use of zone scores, the weighted score for any raw score falling within a specified range, had given higher coefficients of reliability.

The significant differences found in the means and standard deviations reported may have resulted from too short a rest period between testing sessions, thus not allowing sufficient time for the dissipation of reactive or conditioned inhibition built up in the initial testing period. Only five Subjects appear to effect the differential variance, all others remaining very consistent in test-retest.

2. Significance of the Algebraic Score.

Following the calculations of reliability, the algebraic score was investigated for significance. If the rise in foot-candle scores from trial one through six could be interpreted as a chance fluctuation, the interpretation of the increment as reactive inhibition would not be applicable.

¹ William Barry, The Design and Use of a New Apparatus for Measuring the Negative After-Image Phenomenon as a Function of Reactive Cortical Inhibition, unpublished paper to upgrade a Masters degree obtained without thesis, 1958, University of Ottawa, p. 33.

The t test for correlated variances was applied, followed by critical ratio tests on the differences of means and standard deviations of the raw score differences between trials one and six, for both testing sessions. Significant t ratios were found at the .01 level, on both testing sessions. The critical ratio tests indicated significant differences in the mean subtractions and standard deviations between trials one and six, for both testing sessions, at the .01 level. Thus, the score rises observed were not accredited to chance fluctuations. Table IV on the following page contains the data of the t tests for correlated variances, and Tables V and VI, on pages 58 and 59 present the data of the critical ratio tests.

Table IV.-

Test for Correlated Variances on Raw Score Differences Between Trial One and Trial Six for Two Test Sessions. N = 72.

Trial	Session	$\Sigma(X-M)^2$	σ^2	r_{12}	t	Sign.
1	Initial	3029.87	42.67	.714	7.106	.01
6	Initial	9429.65	132.81			
1	Final	4922.98	69.34	.867	9.109	.01
6	Final	13810.61	194.52			

Critical Ratio Tests on the Mean and Standard Deviation of NAIT Raw Score Differences Between Trial One and Trial Six on the Initial Test Session. N = 72.

[illegible]

**Critical Ratio Tests on the Mean and Standard Deviation of
NAIT Raw Score Differences Between Trial One and Trial Six
on the Final Test Session. N = 72.**

[illegible]

3. Reliability of the STDCR.

Test-retest reliability calculations on the STDCR could not be made in this study for two reasons: 1) the inventory was administered anonymously, and 2) the RCMP officials were reluctant to engage in further testing. Therefore, a split-half reliability test was employed as the alternate technique. Since the separate scales of the STDCR contain differentially weighted items, a random sample splitting was done by the method described in Chapter II. Coefficients of correlation, corrected by the Spearman-Brown formula, were obtained for each scale. The coefficients were .887, .768, .759, .843, and .797 for S, T, D, C, and R respectively, at the .01 level of significance. The sample had been reduced to 69 in these calculations due to the holiday absence of three Subjects.

4. Correlations between NAIT Scores and STDCR Scores.

Coefficients of correlation were estimated between each scale score of the STDCR and the NAIT algebraic scores of sixty-nine male Subjects. The coefficients obtained were -.226, -.104, -.109, -.088, and -.142 for S, T, D, C, and R respectively, with no coefficient significant at either the .01 or .05 level.

An item analysis was done on each of the 175 items of the STDCR for Yes, ?, and No responses between high,

intermediate, and low NAIT scoring subjects, as well as for high and low extreme scoring subjects. Visual inspection identified no observable differences for any item, or response direction. Chi square tests were calculated on items hinting marginal differences, only to corroborate the visual inspection.

5. Discussion

The discussion of results to follow has been divided into 2 subsections. Subsection A deals with the reliability and validity of the NAIT test as a measure of reactive cortical inhibition, and Subsection B includes a discussion of the NAIT test and the personality dimension of introversion-extraversion.

A.- The Reliability and Validity of the NAIT test.

The individual trial reliability coefficients reported in this chapter demonstrate the consistency of Subjects in the reporting of after-image disappearance, via a motor response. An average coefficient of reliability of .76 was estimated by converting the coefficients to Fisher² z scores for averaging, and reconvertng to a coefficient

² Quinn McNemar, Psychological Statistics, New York, John Wiley and Sons, 1955, p. 355.

of correlation. Considering the variations anticipated in visual-motor judgment responses to the dynamic psycho-physiological phenomenon of an after-image, the obtained reliability recommends the NAIT apparatus and procedures employed.

The validity of the instrument as a measure of retino-cortical reactive inhibition is supported by the finding that the mean score increment of the sample, on both test sessions, was significantly higher than an increment expected from chance fluctuations alone. If the obtained increment is not credited to chance errors, it must be explainable on the basis of learning, improved reaction speed, errors of set, or expectancy, or other unknown factors.

It would seem that NAIT score curves, when learning has been observed, do not resemble classical learning curves, on the NAIT apparatus, seen in the performances of some naive subjects. When learning is evident, it is usually demonstrated by a declining curve as insight and task perseverance develop, thus effecting an increase in after-image awareness. Consideration has been given to the possibility that the learning may involve a reduction in judgment difficulty, expressed as a rising score. If such learning is taking place, it does not explain the return to the same basal level of functioning, in the second set

of six trials, after a three minute rest, followed by a near identical increment growth.

That the intratrial increment is not due to an improvement in digital reaction time is obvious from the nature of the instrumental task. Classic reaction time variability remains within time ranges far below the latency required to effect a significant difference on the NAIT apparatus.

Neither set nor expectancy errors appear operative in effecting the rising scores, since the error transfer would be expected in the first trial of the second test session. Unfortunately, it was not possible to alter the method, speed, or timing of the stimulus presentation due to the automation of the instrument.

Despite these observations in favour of a reactive cortical inhibition interpretation of the NAIT phenomenon, the observed score increment may have been due to other unknown factors. For the time being, this writer is content to employ the "interpretation" until future research into the electroretinographic and electroencephalographic characteristics of the phenomenon are clarified.

B.- The NAIT Test and Introversion-extraversion.

The null hypothesis; there will be no significant coefficients of correlation between STDCR scores and negative after-image threshold scores for sixty-nine male subjects, was not rejected.

In so far as the NAIT measurements may be measures of retino-cortical reactive inhibition, the results of this investigation do not support Eysenck's explanations of the psychoneurological bases of the personality dimension of introversion-extraversion. Conversely, the results are in agreement with the findings of Rechtschaffen³, and Becker⁴. A further point of agreement with Becker's findings is that basal and reactive inhibition, though cooperative, appear to be distinct. This specificity was observed from the analysis of the correlated variances of the two test sessions. Although the means of the intratrial increments were not significantly different in the two sessions, the basal level of functioning was significantly elevated in the second test session, probably due to the inadequate

³ 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.

⁴ 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.

rest period between trials. This basal level difference itself was not related to the personality dimension, observed in the inspection of the item analysis previously mentioned.

The absence of obtained correlations between the STDCR scores and NAIT scores is best considered from four points of view: 1) The NAIT test may not measure reactive cortical inhibition; 2) Reactive cortical inhibition measurement through visual after-image threshold may not be related to introversion-extraversion; 3) The STDCR may not measure introversion-extraversion; 4) The relationship between reactive cortical inhibition and introversion-extraversion may not to be expected in samples of the normal population.

1) The NAIT test may not measure reactive cortical inhibition: Discussion has already been presented on the problem of NAIT test validity. The intratrial score rise, observed in this study, and four previous pilot studies, as well as in current studies⁵ with clinical samples, provides, in the estimation of this writer, sufficient evidence that retino-cortical inhibition gives the best interpretation of the increment phenomenon.

⁵ Current studies with NAIT thresholds in Intracranial pathology, and other Psychiatric categories is presently being conducted by the School of Psychology and Education, of the University of Ottawa.

Eysenck and Aiba⁶, as previously reported, using a similar instrument, interpret the duration of the after-image as inhibition, and the perception of the primary stimulus as facilitation, at a peripheral level of functioning. Since the after-image phenomenon is generally considered as an inverse measure of pre-stimulation, this interpretation is inconsistent, and smacks of motivational distortion on the part of the investigators. Cortical inhibition is a central phenomenon. It may be the cause or the effect of many sums, products, and neurological quotients at the peripheral sensory level.

2) Reactive cortical inhibition measurement through visual after-image threshold may not be related to introversion-extraversion: If Eysenck's theory of inhibition and personality is consistent with neurological knowledge, then reactive cortical inhibition should be best tapped, apart from direct neurological measurements of the cortex itself, from visual phenomena. This position obtains its validity from the fact that the optic retinae, and optic tracts are more closely related to the brain embryologically, anatomically, and functionally, than other spinal nerve tracts.

⁶ H.J. Eysenck and S. Aiba, "Drugs and Personality, IV. The Effects of Stimulant and Depressant Drugs on the Suppression of the Primary Visual Stimulus", in the Journal of Mental Science, Vol. 103, 1957, p. 661-665.

Much of the experimentation on the cortical inhibition theory of introversion-extraversion, as postulated by Eysenck, has been done on measures of reactive inhibition in the voluntary muscular system, through performance precision and conditioning. If such modalities are suspect, as indirect registrars of central brain economy, then retino-occipital phenomena should occupy an elite position, if the neurological state is in any way related to a type and trait psychology.

3) The STDCR may not measure introversion-extraversion: This aspect of the problem seems the most tenuous and elusive. Does the inventory measure the traits subsumed under the personality types? Are subjects able to report their behavior at a habitual response level and trait level in a valid and reliable way? Since Eysenck himself had accepted the STDCR, and particularly the R scale, as an inventory measuring the personality characteristics included in his concept of introversion-extraversion, his postulates must be investigated within the same limits and framework.

4) Relationship between reactive cortical inhibition and introversion-extraversion may not be expected in samples of the normal population: Eysenck's original investigations⁷ with the personality dimension of introversion-extraversion

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

obtained the most significant differences, utilizing a battery of objective tests, with samples of clinical populations, predominantly neurotic. Nevertheless, he conceived the differential quality of non-psychotic character disorders as stemming from a factor of psychological stress, named Neurosis, superimposed on the pre-existing degree of normal introversion or extraversion. This position of the Subject, along the personality continuum, was not understood as effected by psychological malaise, but represented a basic, constitutional predisposition.

Such a basic and "normal" predisposition, along a continuum, would seem to be accessible to psychological measurement in a sample of normal individuals, and the obtained distributions of both NAIT scores and STDOR scores in this study approximate the Gaussian curve.

SUMMARY AND CONCLUSIONS

This dissertation has reported on an investigation of possible relationships between introversion-extraversion, as measured by the STDCR and negative after-image thresholds. The negative after-image threshold measurements, via a new apparatus, were employed and interpreted as measurements of reactive cortical inhibition in the visual modality, to test Eysenck's postulate that reactive cortical inhibition is related to the personality dimension of introversion-extraversion.

Following a pertinent review of the literature related to the Eysenck theory, the instrument was described in detail, and its test-retest reliability was expressed. The validity of the instrument as a measuring instrument for retino-cortical reactive inhibition was defended.

Utilizing Pearson product moment coefficients of correlation, the relationships between the STDCR scale scores and the NAIT test scores were investigated, testing the null hypothesis: there will be no significant correlations between STDCR scale scores and NAIT test scores for a sample of sixty-nine male subjects. The findings did not justify a rejection of the hypothesis and, therefore, do not support Eysenck's psychoneurological explanation of the personality dimension of introversion-extraversion.

The findings do support recent investigations which have likewise rejected Eysenck's position.

Future research possibilities with the NAIT apparatus should include a needed investigation of the electroretinographic and electroencephalographic nature of the after-image threshold, to determine the validity of the algebraic score as indicating true neurological inhibition.

Investigations should also attempt to estimate the possible correlations between NAIT performances and introversion-extraversion in extreme groups, such as in samples of extraverted criminals, and in conversion hysteria.

If introversion-extraversion is related to constitutional brain architecture, various forms of intracranial pathology might be investigated for the presence of abnormal inhibitory levels. Such an instrument may also provide a reliable tool for the investigation of central drug effects, and finally, the NAIT test might offer a new technique for the measurement of both tonic and phasic autonomic balance, through its particular sensitivity to changes in hue inhibition.

BIBLIOGRAPHY

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An important study for its contribution, through factorial analysis, of the types of inhibition and the tests which measure them.

Cooper, Joseph B., "Some Characteristics of Negative After-Images", Journal of General Psychology, Vol. 39, Second Half, October 1948, p. 217-228.

This experiment gives information on the individual differences in after-image duration. It also showed that "eye dominance" was not a contributing factor, and that eye blinking tended to restore the image.

Csank, J.Z., and H.E. Lehmann, "Developmental Norms on Four Psychophysiological Measures for Use in the Evaluation of Psychotic Disorders", in the Canadian Journal of Psychology, Vol. 12, No. 2, June 1958, p. 127-133.

An important study with the original apparatus, giving developmental norms, and age and sex differences. From this experimentation, it was possible to disregard age and sex variability within the confines of the sample.

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

This book reported on the initial research, using objective measurements, to distinguish between introversion-extraversion, but without incorporating a theoretical basis for the experimentation. The factor analytic methods used for the differentiation of the pathological groups is demonstrated.

-----, "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.

From the theory postulated in this study, and from the psychoneurological information provided, the writer initiated the present research. The study outlines the concept of reactive cortical inhibition and its possible influence on the development of personality types.

Eysenck, H.J., and S. Aiba, "Drugs and Personality: IV. The Effects of Stimulant and Depressant Drugs on the Suppression of the Primary Visual Stimulus", in the Journal of Mental Science, Vol. 103, 1957, p. 661-665.

This study was made, employing an apparatus similar to Lehmann's, on the inhibition effects of drug action. The interpretation of inhibition in the after-image phenomenon implies a cortical contribution, acting through sensory inhibition. Such an interpretation is disputed by this writer.

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

This is not a report but rather a review of Pavlov's experimentation with cortical inhibition. It is useful in that it clarifies the nature of inhibition as a generalized cortical function, and not stemming from the activity, or dearth of activity in a specific area.

Hochberg, Julian R., and William Triebel, "Figural After-Effects with Colored Stimuli", American Journal of Psychology, Vol. 68, No. 1, March 1955, p. 133-135.

An investigation which determined that colored stimuli, of themselves, effected no special change in the inhibition phenomenon, and hence could be used as a proper stimulus for adaptation studies.

Kaplan, Solomon D., "Autonomic Visual Regulation; (Part I. The After-Image Spectral Photometer)", in Explorations in Physiology and Emotions, Psychiatric Research Report of the American Psychiatric Association, No. 12, January 1960, p. 104-114.

An important contribution to the understanding of nervous control over the after-image hue sensitivity. The findings advised control over drug use and stimulants with the experimental subjects.

Klein, George S., "Studies of Duration of Negative After-Image; Effect of Brain Injury", quoted by George S. Klein and David Krech, "Cortical Conductivity in the Brain Injured", Journal of Personality, Vol. 21, No. 1, September 1952, p. 118-118.

This report indicates that the negative after-image duration was significantly shorter in those subjects with brain damage than in the normal group.

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

A very important study, indirectly supporting the Eysenck theory, by finding more kinesthetic figural after-effect inhibition in the brain injured group than in the normal group. The main weakness of the study was in the small sample used.

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

A report of research which demonstrated that beyond certain lengths of exposure no appreciable change was made in the adaptation phenomenon.

Lehmann, H., "Preliminary Report on a Device for the Objective Measurement of the Negative After-Image", Science, Vol. 112, No. 2903, August 1950, p. 199-201.

A description of a psychophysiological apparatus that served as the basis for the development of a new device.

Levinson, Harry, "The Relationship of After-Image Duration to Certain Aspects of Personality", unpublished doctoral dissertation, University of Kansas, 1952, from University Microfilms, Ann Arbor, Michigan, No. 4502, p. 1-75.

An important study in that it incorporated a similar device for the measurement of the negative after-image threshold, and a reinterpretation of the findings indicated that such a visual measurement was sensitive to reactive inhibition.

Young, Francis A., "Studies of the Projected After-Image: I. Methodology and the Influence of Varying Stimulus Times", Journal of General Psychology, Vol. 46, First Half, January 1952, p. 73-86.

Experimentation indicating that the individual differences noted in the size of the image were not due to fixation time fluctuation, level of luminance of stimulus, or distances of the subjects. Important information for the control of variables influential in the measurements.

APPENDIX 1

Light Measuring Technique for Obtaining
Foot-Candle Conversion Data

Light Measuring Technique for Obtaining
Foot-Candle Conversion Data.

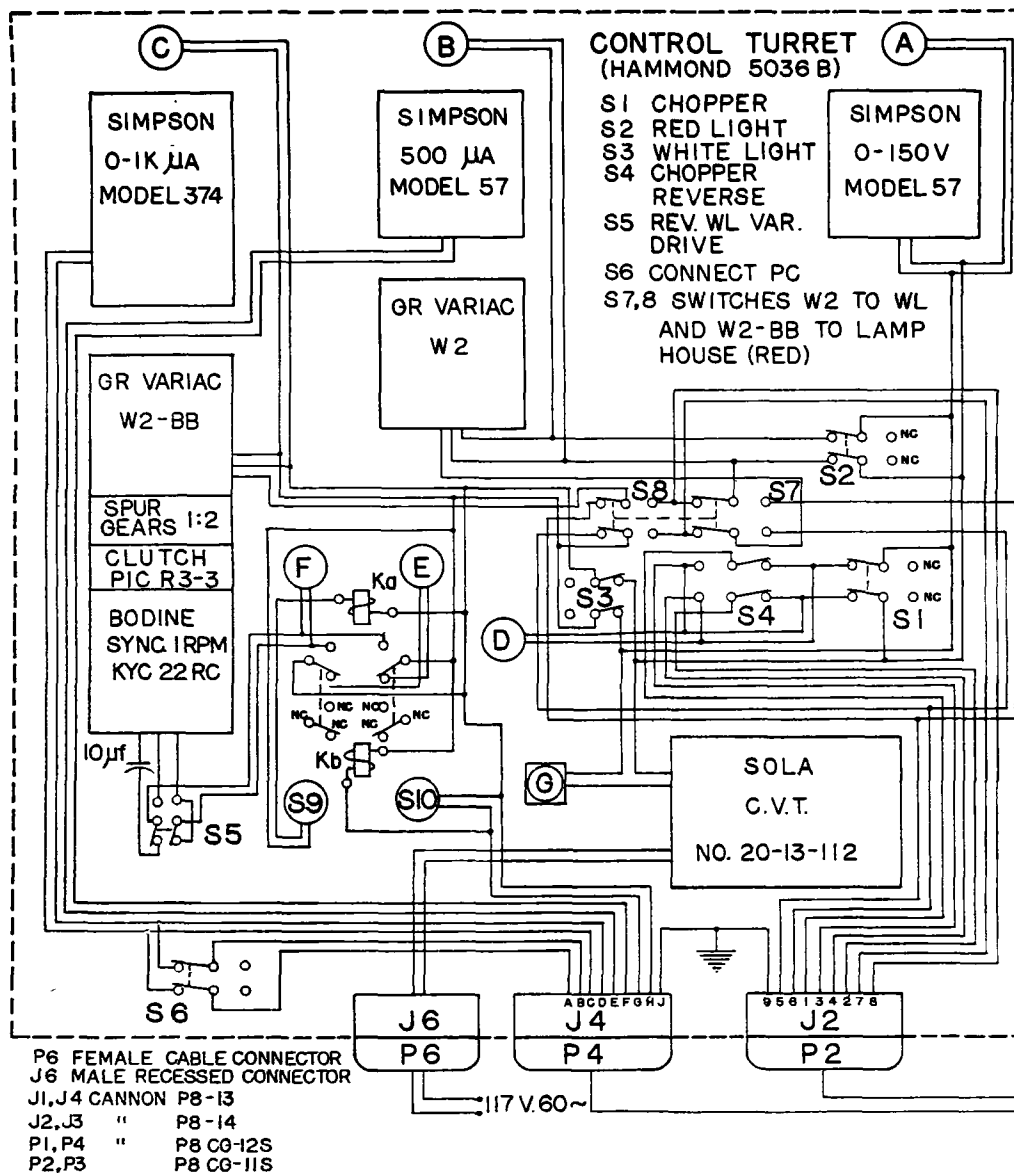
The conversion scale from microamperes to foot-candles, included as Figure 3, page 45, was calculated from light measurements of the revolving disc, adjusted so as to show only a white surface. The readings were taken with room darkness approximating that of normal testing conditions. The stimulus light was on and set at the normal intensity level.

A Macbeth Illuminometer, No. 496979, recently callibrated by the National Research Council, was employed. The illuminometer telescope measured 24.5 inches. It was set and masked in the viewing aperture of the stimulus cabinet. No correction was made for the color variation of the samples since this constant error would not affect the measurements.

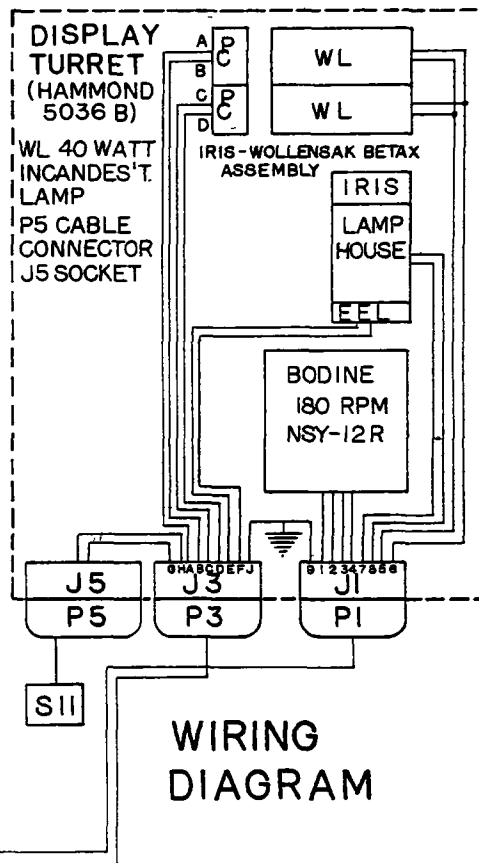
Readings were obtained for each scale increment on all ranges for the disc illumination microammeter. The values obtained were the means, at each scale point, for a set of three observations.

APPENDIX 2

Wiring Diagram of NAIT Apparatus



S1-S8 DPDT. CESCO NO. 8363K7
S9, 10 PUSH BUTTON N.O. GREYHILL CESCO NO. 7196 K1
A-F PILOT LIGHT ASSY. (LAMP NE 51)
S11 PUSH BUTTON N.O. GREYHILL CESCO NO. 4001
G FUSE ASSY. PANEL MTG. (1.25 AMP)
P PHOTOCELL MATCHED GE. MODEL 8 PVI
EEL PHOTOCELL EVANS ELECTROSELENIUM CIRC 25^{MM}
K LATCHING RELAY P & B
P1, 4 CANNON P8, 13; J2, 3 CANNON P8, 14



Wiring Diagram of NAIT Apparatus.

APPENDIX 3

ABSTRACT OF

An Investigation of Relationships Between
Introversion-Extraversion and the Negative
After-Image Threshold

ABSTRACT OF

An Investigation of Relationships Between
Introversion-Extraversion and the Negative
After-Image Threshold¹

Eysenck has postulated that the personality dimension of introversion-extraversion is the consequence of individual differences in learning, due to an inherited brain disposition. This cortical characteristic is expressed in the degree of reactive inhibition generated by the cortex to successive sensory stimulation. Such a cortical exonomy would dispose the individual to either introverted or extraverted personality traits by its effect on early social learning, and the patterning of subsequent behavior.

This study investigated the Eysenck theory by measuring reactive cortical inhibition to retino-occipital stimulation, presuming that it is a more sensitive and direct modality for such measurements. Subsequently these psychophysiological measurements were tested for correlations with introversion-extraversion scores on the Guilford STDCR inventory.

William F. Barry, doctoral thesis presented to the School of Psychology and Education of the University of Ottawa, Ontario, April, 1961, ix-80 p.

The measurements of retino-cortical reactive inhibition were obtained through the employment of a new instrument which produced a sustained negative after-image of a subliminal primary stimulus. The intensity of the ground illumination required to maintain the after-image, measured photoelectrically, provided the measurements interpreted as cortical inhibition.

The apparatus test and the STDCR inventory were administered to sixty-nine RCMP officers and constables. The reliability of the after-image test was found to be acceptable, and the validity of the test as a measure of cortical inhibition was argued from the identification of rising scores through six trials, not explainable on the basis of random fluctuations or learning.

Calculations of Pearson r^2 between STDCR scores and the negative after-image threshold scores obtained no significant relationships. The null hypothesis that "there will be no significant correlations between STDCR scores and negative after-image threshold scores for sixty-nine males", was not rejected.

The results of this study do not support Eysenck's theory of introversion-extraversion, but do support recent and similar studies which have found no justification for accepting a relationship between this personality dimension and reactive inhibition.

