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EXTRAVERSION-INTROVERSION AND RECOGNITION SENSITIVITY TO RED AND BLUE HUES

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CURRICULUM STUDIORUM

Paul F. Smith was born July 29, 1941, in Waterloo, Ontario. He received the Bachelor of Arts degree in Philosophy from the University of Western Ontario, London, Ontario, in 1964. He received the Bachelor of Arts degree in Theology from the University of Western Ontario, London, Ontario, in 1968. He graduated from the Althouse College of Education, London, Ontario, in 1970.

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INTRODUCTION

Artists are well aware of the aesthetic value of color in creating various mood tones in their works. It has long been known, for example, that colors in the orange-red end of the spectrum create an experience of warmth and arousal in the observer; while the blue-green end, which is low in the color spectrum, gives rise to an experience of coolness and calmness. The dynamics of the relationship between color and personal factors such as affect and mood tone is not well understood. The present study endeavours to explore this question in terms of individual differences in extraversion and their concomitant physiological differences.

The first studies to attempt a delineation of the relationship between color and personality linked color preference to various personality traits. Thus, blue hues were preferred by individuals who were described as calm; while red hues were chosen by individuals who were described as outgoing. This research showed that color and personality were related, but left unanswered the question of the dynamics of this relationship.

Some authors have suggested that the link between color and personality is indirect and might be understood in terms of physiological responsivity. There is modest experimental evidence to support the notion that color causes a differential autonomic responsiveness as measured by Galvanic Skin Response, with red being considered more physiologically arousing than green.

Clinical research has been consistent in finding a relationship between color responses and personality. Recent literature in projective techniques has suggested a theoretical rationale to explain these results which relies upon individual differences in autonomic responsivity.

Studies conducted at the Faculty of Psychology of the University of Ottawa, using a signal detection method of analysis as a measure of sensory capacity to chromatic stimuli in a size judgement task, have found trends indicating differences in sensitivity to color along the extraversion-introversion dimension of Eysenck's physiological model of personality. The introverted group in this study showed a greater mean sensitivity to blue than the extraverted group; while the reverse trend was noted for the red hue stimuli.

There tends to be a congruence between this study and experimental findings which have observed individual

differences in chromatic sensitivity due to sympathetico-parasympathetico-mimetic activity of certain drugs. Pilocarpin, a parasympathetico-mimetic drug was found to increase the sensitivity of the eye to red; while adrenalin, a sympathetico-mimetic drug increased sensitivity to blue. The similarity of these findings suggests that individual differences in chromatic sensitivity along the extraversion dimension of Eysenck's physiological model of personality might be understood in terms of sympathetic and parasympathetic like activity of the autonomic nervous system.

The present study proposes to determine absolute sensitivity to red and blue chromatic stimuli among groups varying in degrees of extraversion. The signal detection method of analysis which purports to provide a measure of sensitivity independent of the response criteria adopted by the observer was employed in this experiment.

Chapter one contains a review of the theoretical background and relevant research findings which led to the formulation of the hypotheses to be investigated by the present study. Chapter two describes the sample, the instruments, and the methods of analysis of the statistical procedures employed in the testing of these hypotheses. The

results are presented in chapter three. Chapter four discusses the results in relation to the theoretical problems posed in chapter one.

CHAPTER I

REVIEW OF THE LITERATURE

This chapter presents a discussion of the research findings and various theoretical models which led to the hypotheses to be tested in the present study. Section 1 examines the attempts of color preference studies, experimental findings, and clinical research in explicating the link between color and personality. Section 2 relates this literature to Eysenck's theory of personality. Section 3 discusses the experimental studies on chromatic sensitivity and differential autonomic functioning in the light of Eysenck's personality theory. Section 4 examines the theoretical rationale of signal detection theory and its contributions to the present study. The chapter ends with a brief summary of the theoretical background which led to the statement of the hypotheses.

1. Chromatic Stimuli and Personality.

The relationship between color stimuli and individual differences in personality is a prestigious, yet enigmatic one in the literature. Early research in psychology attempted to define the relationship between these two variables through color preference studies, which linked color

descriptions to personality traits. Thus Pressey[1] and Lewinski[2] have noted that red is considered as exciting and arousing; while blue is considered as relaxing and pleasant. In the same vein, red and yellow are regarded by Goldstein and Rosenthal[3] as having an expansive effect on the organism, increasing the effect of the external world; while green and blue have the reverse effect, causing concentration and contraction. Schaie[4], in reviewing the literature pertaining to color preference studies, summarizes the personality traits that have been associated with various hues. For purposes of the present study, it is noted that red stimuli are associated with more outgoing and expressive personality traits; while blue hues are related to individuals who are described as quiet and

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1. S.L. Pressey, "The Influence of Color Upon Mental and Motor Efficiency", American Journal of Psychology, Vol. 32, 1921, p. 351.

2. R.J. Lewinski, "An Investigation of Individual Responses to Chromatic Illumination", The Journal of Psychology Vol. 6, 1938, p. 155-160.

3. K. Goldstein, and O. Rosenthal, "Zum Problem der Wirkung der Farben auf den Organismus", Schweiz. Arch. Neurol. Psychiat., Vol. 26, 1930, p. 13-26, quoted by R.D. Norman, and W.A. Scott, "Color and Affect: A Review and Semantic Evaluation", The Journal of General Psychology, Vol. 46, 1952, p. 217.

4. K. Warner Schaie, "On the Relation of Color and Personality", Journal of Projective Techniques and Perscnality Assessment, Vol. 30, 1966, p. 512-524.

rational. Unfortunately, these studies have been debased because of attempts to relate color preferences to universally valid and meaningless descriptions of personality. The result of this research is, nonetheless, valuable in that it does point out the existence of a relationship between color and personality, and poses the question of the dynamics of this relationship. The present study addresses itself to this problem. Specifically, it asks the question: Are there individual differences in absolute chromatic sensitivity to red and blue hue stimuli among groups differing in degrees of extraversion, and their concomitant physiological differences?

As early as 1934, Guilford[5] suggested that the link between color and personality was indirect and tenuous and might better be approached through physiological measurement. In a more recent article, Smets[6] has argued that colors are not only experienced as having various qualities, but that chromatic stimuli bring to bear a greater or lesser physiological and behavioural activity on the organism, with

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5. J.P. Guilford, "The Affective Value of Color as a Function of Hue, Tint, and Chroma", Journal of Experimental Psychology, vol. 17, 1934, p. 342-370.

6. G. Smets, "Time Expression of Red and Blue", Perceptual and Motor Skills, Vol. 29, 1969, p. 511.

the so-called warm colors of the orange-red end of the spectrum having the greater effect; while colors lower in the spectrum, blue-green, have a lesser physiological effect. This indirect evidence is given support by Wilson[7] who has found that red is a more physiologically arousing stimulus than green in terms of Galvanic Skin Response (GSR).

Clinical studies, which have consistently found a relationship between individual differences in response to chromatic stimuli and individual differences in personality, have recently attempted to provide a theoretical rationale for this relationship in terms of individual differences in autonomic responsivity to color stimuli. Schaie[8] hypothesized that color responses on personality tests were related to influences involving emotional behaviour, and that color stimuli produce, therefore, physiological arousal. In the same vein, Shapiro[9] speculates that the link between color responses on the Rorschach Inkblots[10], and individual

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7. G.D. Wilson, "Arousal Properties of Red Versus Green", Perceptual and Motor Skills, Vol. 23, 1966, p. 947-949.

8. K. Warner Schaie, op. cit., p. 512-525.

9. David Shapiro, "Color Responses and Perceptual Passivity", Journal of Projective Techniques, Vol. 20, 1956, p. 52-59.

10. H. Rorschach, The Rorschach Inkblot Test, Berne Switzerland, Hans Huber, Publisher, 1942.

differences in personality on the extraversive-introversive dimension of that test, are due to a differential autonomic response to chromatic stimuli. He predicts that individuals whose perceptual style is passive and immediate, in Rorschach terms, extratensive, may have a lower absolute threshold for chromatic stimuli than introversive individuals.

Studies conducted at the Faculty of Psychology of the University of Ottawa, by Bourgeois[11], have shown that chromatic sensitivity may be related to individual differences in personality along the extraversion-introversion dimension as theorized by Eysenck[12], in his physiological model of personality. Using a signal detection method of analysis in a size judgement task involving chromatic stimuli, he found that the introverts showed a greater mean sensitivity to the blue hue stimuli (2.80) than the extraverted group (2.14). This tendency was reversed for the red stimuli, with the extraverts tending to obtain greater mean sensitivity

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11. Robert-Paul Bourgeois, Introversion-Extraversion and the Role of the Orienting Reaction Habituation Rate in Sensitivity to the Apparent Size of Hue, Unpublished doctral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1972, p. 91.

12. H.J. Eysenck, "A Physiological Explanation of Extraversion-Introversion", in H.J. Eysenck (ed.), The Biological Basis of Personality, Springfield, Ill., Charles C. Thomas Publishers, 1970, p. 242 ff.

values (2.29) than the introverted group (2.09). The ambivert group showed the widest change overall. They followed the pattern of the introverts under the blue stimuli, but tended to obtain slightly higher sensitivity scores (2.83) to the blue. For the red hue, this group showed less sensitivity (1.72) than the introverted group. These results are quite in keeping with the predictions of color preference studies, that outgoing and expressive individuals prefer red; while quiet and rational subjects prefer blue. However, the findings seem to be at odds with Shapiro[13] who hypothesized that extraversive individuals have a lower absolute threshold for all chromatic stimuli. The results also question the generalizability of Eysenck's[14] prediction that introverts tend to have a lower absolute threshold for all sensory stimuli. Nonetheless, Bourgeois' results are promising in relating chromatic sensitivity to the theoretical physiological model of personality formulated by Eysenck. It is this model which describes personality along the extraversion-introversion dimension that will serve as a framework for understanding individual differences in personality in the present study.

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13. David Shapiro, op. cit., p. 52-69

14. H.J. Eysenck, "Conditioning, Introversion-Extraversion and the Strength of the Nervous System", in H.J. Eysenck (ed.), Readings in Extraversion-Introversion, Vol. III, Bearings on Basic Psychological Processes, London, Staples, 1971, p. 500.

2. Eysenck's Model of Personality and Perceptual Sensitivity.

Eysenck[15] has proposed that individual differences in the cortico-reticular loop which modulates cortical arousal and inhibition can be applied to individual differences in personality along the extraversion-introversion dimension. Introverts, who are characterized as being in a state of cortical arousal, are expected to display enhanced sensitivity and efficiency in sensory information processing and in conditionability, because of a lower threshold of reticular arousal. Extraverts, on the other hand, who are characterized as more cortically inhibited, are expected to show reduced sensitivity and efficiency in sensory information processing and conditionability, presumably because of a more easily stimulated thalmocortical inhibitory system.

Eysenck's observations on the differences in performance on sensory tasks between introverts and extraverts, as measured by the Eysenck Personality Inventory, (EPI)[16], are cited as evidence linking cortical arousal

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15. H.J. Eysenck, The Biological Basis of Personality, Springfield, Ill., Charles C. Thomas Publishers, 1970, p. 242 ff.

16. H.J. Eysenck, and S.B.G. Eysenck, The Eysenck Personality Inventory, San Diego, Educational Testing Service, 1968.

and extraversion-introversion. Eysenck's predictions, which rely on the expectation that introverts display a lower sensory threshold, is given modest support by Smith[17], who has shown that introverts have a lower absolute sensory threshold for simple tone. Similarily, Haslam[18] has found that introverts have a lower absolute sensory threshold for painful stimuli. Finally, Siddle, Moorish, White, and Mangan[19] have noted a lower threshold for luminous intensity for groups of introverted subjects. Based on these findings, Eysenck would predict that introverts, who are characterized as being in a state of cortical arousal, would have a lower absolute sensory threshold for chromatic stimuli than extraverts, who are described as cortically inhibited.

3. The Autonomic Nervous System and Chromatic Sensitivity.

The excitation-inhibition model of the autonomic nervous system was used in an obscure study conducted by

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17. S.L. Smith, "Extraversion and Sensory Threshold", Psychophysiology, Vol. 5, 1968, p. 296-297.

18. D. Haslam, "Individual Differences in Pain Threshold and Level of Arousal", British Journal of Psychology, Vol. 58, 1967, p. 139-142.

19. D. Siddle, R.B. Moorish, K.D. White, and G.L. Mangan, "Relation of Visual Sensitivity to Extraversion", Journal of Experimental Research in Personality, Vol. 3, 1969, p. 264-267.

Kravkov[20] to explain individual differences in chromatic sensitivity. He found that sensitivity to color changes when the pupil is instilled with adrenalin and pilocarpin which are sympathetico and parasympathetico-mimetic agents, respectively. Sensitivity to blue increases when adrenalin is instilled on the pupil; while sensitivity to red-orange hues decreases. The reverse effect is noted with the instillation of pilocarpin on the pupil. Sensitivity to orange-red hues increases; while sensitivity to the blue hues decreases. These results are supported by Kaplin[21] who noted that ephedrine, a parasympathetico-mimetic agent produced the greatest negative after-image for a red stimulus; while prostigmine, a sympathetico-mimetic drug, produced the greatest negative after-image to blue. Similarily, Costello[22] found that meprobamate, a depressant drug which induces a state of inhibition, decreased the duration of an after-image to a red stimulus.

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20. S.V. Kravkov, "Color Vision and the Autonomic Nervous System", Journal of the Optical Society of America, Vol. 31, 1941, p. 335-337.

21. S.D. Kaplin, "A Visual Analog of the Funkenstein Test", Archives of General Psychiatry, Vol. 3, 1960, p. 383-388.

22. C.G. Costello, "The Effects of Meprobamate on the Visual After-Image", in H.J. Eysenck (ed.), Experiments with Drugs, London, Pergamon, 1963.

There tends to be a congruence between these findings and the results of Bourgeois'[23] study. The performance of Bourgeois' extraverted group is similar to the increased sensitivity to the orange-red end of the color spectrum noted by Kravkov when he instilled pilocarpin, a parasympathetico-mimetic agent, on the pupils of his subjects; while the tendency for the introverted group in Bourgeois' sample to be more sensitive to blue hue stimuli, bears a resemblance to Kravkov's observations following the instillation of adrenalin, a sympathetico-mimetic agent, on the pupils of his sample group. The relationship between these two studies raises the following question, which guides the present research: Can individual differences in chromatic sensitivity be understood in terms of individual differences along the Eysenckian extraversion dimension of personality and sympathetico-parasympathetico like activity? The present research proposes to approach this question by addressing itself to the more fundamental issue of the link between individual differences in absolute sensitivity to red and blue hue stimuli and extraversion-introversion.

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23. Robert-Paul Bourgeois, op. cit., p. 91.

4. The Signal Detection Method of Analysis.

Eysenck has pointed out that one of the difficulties in measuring sensitivity by the traditional psychophysical methods is that of response sets [24,25].

> ...it would be difficult to test the hypotheses about sensitivity by traditional methods of threshold measurement since a failure to find differences might pertain more to the decision making habits and risk taking propensities of the subject groups than to their actual thresholds. In other words, extraverts might be predicted to guess more frequently and therefore appear to have thresholds as low as or lower than those of the careful scrupulous introverts.[26]

Hake and Rodwan[27] point out that response style may take either of two forms. The individual may be unwilling to respond to a particular stimulus until the evidence for its presence is great. This is called the error

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24. E.G. Boring, "The Control of Attitude in Psychophysical Experiments", Psychological Review, Vol. 27, 1920, p. 450-452.

25. J.P. Guilford, "Fluctuation of Attention with Weak Visual Stimuli", American Journal of Psychology, Vol. 38, 1927, p. 534-583.

26. H.J. Eysenck, The Biological Basis of Personality, Springfield, Ill., Charles C. Thomas Publishers, 1967, p. 100.

27. H.W. Hake, and A.S. Rodwan, "Perception and Recognition", in J.B. Sidowski (ed.), Experimental Methods and Instrumentation in Psychology, New York, McGraw-Hill, 1966, p. 332-281.

of habituation. On the other hand, the individual may show a willingness to respond on the basis of minimal evidence for the presence of a particular stimulus making thereby, the error of anticipation. In order to minimize these difficulties, the method of analysis used to investigate the hypothesized differences in chromatic sensitivity among groups varying in extraversion relies upon the theory of signal detection proposed by Green and Swets[28], and Swets, Tanner, and Birdsall[29]. The use of this procedure in studies of perception and personality has been documented by Price[30]. The principal advantage of the signal detection method is that it compresses non-sensory factors, such as motive, attitude or set, as well as the experiential background of the subject, into a response criterion. The response criterion is estimated by false alarm responses in which the subject reports the difference of a stimulus in the physical continuum when in fact it is not different. Unlike the classical psychophysical measures, the response criterion is determined not simply on the basis

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28. D. Green, and J.A. Swets, Signal Detection Theory and Psychophysics, New York, Wiley, 1966, p. 252-257.

29. J.A. Swets, W.P. Tanner Jr., and T.G. Birdsall, "Decision Processes in Perception", Psychological Review, Vol. 68, 1961, p. 301-340.

30. R.H. Price, "Signal Detection Methods in Personality and Perception", Psychological Bulletin, Vol. 66, 1966, p. 55-62.

of correct identification, but also on the basis of false alarms, thereby avoiding the errors of habituation and anticipation inherent in classical psychophysical experiments.

The paradigm of the signal detection model is a forced choice between two classes of stimuli varying on one dimension with fixed a priori probabilities of occurrence. In the context of the present study, the two classes of stimuli are the presence or absence of a hue. The subject is asked to make a forced choice response stating which stimulus event occurred. If he correctly identifies the stimulus event, it is recorded as a hit. If he incorrectly identifies the stimulus event, his response is counted as a miss. The response criterion for the task is defined as the ratio of the probability of the occurrence of a hit to the probability of the occurrence of a miss.

Besides taking into account the errors of anticipation and habituation, the signal detection method also controls for guessing. Price[31] has noted that the classical threshold is only a global indicator of the hit rate of the observer, and does not take into account the criterion matrix adopted by the observer in making his judgement.

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31. R.H. Price, op. cit., p. 55-62.

Egan, Schulman, and Greenberg[32] have proposed a rating procedure for the signal detection model, in which the subject is not only required to give a forced choice response in his detection of the presence or absence of the stimulus, but is also asked to give a confidence rating of positive, fairly sure, or guess, in his observations on each trial. The final rating matrix that results after completion of all the trials is used in the computation of the response criterion of the subject by means of the EPC ROC computer program for ROC parameters which has been developed by Ogilivie and Creelman[33].

5. Summary and Statement of the Hypotheses.

The primary purpose of the present study is to investigate chromatic sensitivity to red and blue hue stimuli among groups varying in degrees of extraversion according to Eysenck's physiological model of personality. Early studies in the literature on color preference have

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32. J.A. Egan, A.I. Schulman, and G.Z. Greenberg, "Operating Characteristics Determined by Binary Decision and Ratings", Journal of the Acoustical Society of America, Vol. 31, 1959, p. 768-773.

33. J.C. Ogilivie, and C.D. Creelman, "Maximum Likelihood Estimation of Receiver Operating Characteristic Curve Parameter", The Journal of Mathematical Psychology, Vol. 5, 1968, p. 387.

predicted that outgoing and expressive individuals show a preference for red hues; while quiet and rational subjects have a tendency to prefer blue hues. The literature in clinical research is quite consistent in showing a positive link between individual differences in response to color stimuli and individual differences in personality. More recent literature in projective techniques has speculated that the relationship between color and personality is due to individual differences in physiological responsivity. It has been hypothesized on the basis of Rorschach studies that extraversive individuals may have a lower absolute sensory threshold for chromatic stimuli. Preliminary research at the Faculty of Psychology of the University of Ottawa, using the Eysenckian physiological model of personality has shown that in a size judgement task involving chromatic stimuli, introverts tend to have a greater sensitivity for blue hues as compared to extraverts; while the reverse is true for red chromatic stimuli. Experimental studies in color sensitivity have speculated that chromatic sensitivity may be due to individual differences in autonomic responsivity along the sympathetic-parasympathetic dimension. It may be that individual differences in color sensitivity can be understood in terms of individual differences in

levels of extraversion and sympathetic-parasympathetic activity.

As a first step in answering this question, the present research examines the effect of red and blue hues, which represent extreme ends in the color spectrum, on groups varying in degrees of extraversion. The method of analysis used in the evaluation of absolute sensory capacity employs signal detection procedures which minimize the problem errors of habituation, anticipation, and response set which are inherent in traditional psychophysical experiments.

The independent variables in the present study are two hues, red and blue, equated for luminous reflectance and saturation. The concomitant independent variable is groups of high, middle and low extraversion. The dependent variable is a measure of sensitivity computed by the EPC ROC program of d* parameters which provides an index that is independent of non-sensory and personal factors.

The present research, in investigating the link between differential chromatic sensitivity among subjects varying in degrees of extraversion with their possible concomitant physiological autonomic differences, addresses itself to the following questions:

1. Do extraverted subjects have a lower recognition sensitivity to the red hue than introverted subjects?

2. Do introverted subjects have a lower recognition sensitivity to the blue hue than extraverted subjects?

From these considerations the following null hypotheses are derived:

1. There is no significant difference between groups of introverted, middle, and extraverted subjects in their sensitivity to the red hue stimulus.

2. There is no significant difference between groups of introverted, middle, and extraverted subjects in their sensitivity to the blue hue stimulus.

During the data analysis, a high correlation between neuroticism and sensitivity to blue was observed. This prompted a subsequent post hoc inquiry into individual differences in neuroticism and sensitivity to the blue hue stimulus.

The methods used to test the preceding hypotheses are presented in the following chapter.

CHAPTER II

EXPERIMENTAL DESIGN

This chapter presents the methodology of the experiment. It describes the subjects involved in the hue discrimination task, as well as the procedure used in the classification of the subjects into groups of high, middle, and low extraversion. The psychological instrument, and the apparatus used to present the hue stimuli, as well as the procedures followed in the experiment are set forth. The chapter concludes with a note on the methods of analysis employed in the hue discrimination task and an explanation of the general experimental design and statistical procedures involved in the testing of the hypotheses outlined in chapter I.

1. The Subjects.

Sixty female elementary school teachers between the ages of twenty-one and forty-three (mean age 28.5; standard deviation 6.9) were personally approached and given a copy of the Eysenck Personality Inventory, (EPI), Form B[1], to fill in at their own convenience. The subjects

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1. H.J. Eysenck, and S.B.G. Eysenck, Manual for the Eysenck Personality Inventory, San Diego, Educational Testing Service, 1968, p. 5-24.

were then asked to mail their completed Inventory.

The Eysenck Personality Inventory, (EPI), purports to measure two distinct and orthogonal personality dimensions, namely, extraversion-introversion, and neuroticism-stability. Farley[2] and Eysenck and Eysenck[3] present evidence for the independence of these two dimensions. Form B is made up of fifty-seven items to which the subject must answer true or false. The EPI, Form B, appears as Appendix 1.

From the initial sample of sixty volunteers, thirty subjects were selected on the basis of the scores obtained on the EPI, Form B. These were the ten highest, ten intermediate, and ten lowest scores on the extraversion dimension of the test, and were designated as the extraverted group, the middle group, and the introverted group, respectively. The three groups were equated on their neuroticism score.

To explore certain hypotheses subsequent to the initial analysis regarding the correlation between

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2. F.H. Farley, "On the Independence of Extraversion and Neuroticism", in H.J. Eysenck (ed.), Readings in Extraversion-Introversion, Vol. 1, Theoretical and Methodological Considerations, London, Staples, 1970, p. 248-251.

3. S.B.G. Eysenck, and H.J. Eysenck, "On the Dual Nature of Extraversion", British Journal of Social and Clinical Psychology, Vol. 23, 1963, p. 46.

neuroticism and sensitivity to the blue hue stimulus, three more subjects who were low on the extraversion score and low on the neuroticism score were chosen. This permitted an equal number of subjects high and low on neuroticism and extraversion to be compared with respect to four possible combinations; high neuroticism, high extraversion; high neuroticism, low extraversion; low neuroticism, high extraversion; low neuroticism, low extraversion.

After the testing sample was chosen, using the EPI, Form B, each subject attended a two hour testing session in order to determine her sensitivity on the hue discrimination task, for which she was not paid. Prior to being measured for her chromatic recognition sensitivity, each subject was screened for color blindness with the Dvorine Color Perception Training Charts[4]. None of the subjects was found to be color blind.

2. Hue Stimuli.

The stimuli were constructed from Munsell papers[5] and represented two hues, red (6R), blue (6B) and a neutral

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4. Israel Dvorine, Dvorine Color Perception Training Charts, Vol. 2, Baltimore, Maryland, Waverly Press, 1944.

5. Munsell Book of Color, Baltimore, Maryland, Munsell Color Co., 1943.

grey. The red, blue, and grey were equated for value, Munsell value of 6. Each of the two hues, and the neutral grey had the same level of saturation, Munsell chroma of 10. All three stimuli were essentially equivalent for luminous reflectance (brightness) and saturation.

Each of the three stimuli, measuring one-half inch square, was centered on black cardboard cards. Each card was then placed in a four by five inch stainless steel card holder. A fourth card holder, containing only the black cardboard, was placed in the blank channel of the tachistoscope used for light adaptation.

3. The Apparatus.

A Scientific Prototype 2-channel tachistoscope, Model 800-F was used to present the stimulus hues. The optical system is a 2-channel Dodge Type with a single mirror to mix the images in the two separate channels. The mirror has a special front surface laminated with a magnesium fluoride anti-reflection back coating. The two channels each contain two lamps which illuminate the stimulus material. The level of illumination in the blank channel (background) was used to maintain light adaptation. The stimulus channel of the tachistoscope had a level of illumination of 1.1

footcandles as measured by the Spectra Pritchard Photometer, Model 1970-PR. Each of the two hue stimuli, and the neutral grey were presented in this channel. The viewing distance from the subject to the stimulus was 88 centimeters. The visual angle subsumed was 1 degree.

4. The Experiment.

The general procedure considers a two alternative forced choice task with rating, as outlined by Egan, Schulman, and Greenby[6]. The task was to detect whether a hue stimulus (e.g. red) was present during a specific interval, or whether a grey stimulus was present. The duration of exposure during the red condition was 2.35 milliseconds, which was the recognition threshold for red determined by the method of limits, in a pilot study. The blue hue recognition threshold was determined to be 3.65 milliseconds. The neutral grey, which served as a blank trial in the experiment, was presented at 3.65 milliseconds and 2.35 milliseconds for the blue and red hue conditions, respectively. The recognition thresholds,

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6. J.P. Egan, A.I. Schulman, and G.Z. Greenby, "Operating Characteristics Determined by Binary Decision and by Ratings", Journal of the Acoustical Society of America, Vol. 31, 1959, p. 768-773.

defined in terms of duration of exposure[7] gave a baseline which hypothetically allowed a fifty percent chance of successfully distinguishing a particular hue from the neutral grey blank.

The subjects who took part in the hue discrimination experiment were acquainted with the general purpose of the study. The procedure was as follows: Each subject was taken into a dimly lighted room and seated comfortably in front of the tachistoscope, and given the following instructions:

> As you look into the tachistoscope you will notice an illuminated background. Against this background and in the middle of it, I am going to flash two series of colors; a blue-grey series and a red-grey series. Your first task is to tell me the color that you see. Each series will be presented in a random order, so don't expect any fixed pattern. The task is more difficult than it sounds, because the colors will be presented very quickly, so just do your best. After you have told me what color was flashed, I want you to tell me how confident you are of your judgement. Tell me whether you were positive, fairly sure, or whether it was a guess. For example, if you are fairly sure you saw a blue, you would say, blue, fairly sure. Try to use all three ratings: positive, fairly sure, and guess.

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7. P.K. Kaiser, "Color Names of Very Small Fields Varying in Duration", Journal of the Optical Society of America, Vol. 58, 1968, p. 690-696.

In effect on a series of 200 trials the subject was required to determine whether she saw a red or a grey stimulus, both of which appeared an equal number of times in a random order. The same decision was required for a blue-grey series. She was also required to tell how confident she was of her choice.

The instructions thus required the selection of one of the two permissable response alternatives to each series, as well as a confidence rating of positive, fairly sure, and guess. The rating scale, therefore, took the following form for the blue-grey, and red-grey series:

1) blue positive, 2) blue fairly sure, 3) blue guess,
4) grey positive, 5) grey fairly sure, 6) grey guess.

1) red positive, 2) red fairly sure, 3) red guess,
4) grey positive, 5) grey fairly sure, 6) grey guess.

After the instructions were read, a series of ten practice trials was administered to the subject in a predetermined random order, which was identical for all subjects. This verified whether or not the subject had understood the task required of her.

Following the practice trials, the two hue stimuli conditions (red-grey, and blue-grey) were presented in blocks of 200 random experimental trials. A written predetermined random order of presentation was employed for

each subject and for each of the two hue conditions. Each subject thus made a total of 400 judgements[8].

In the experiment, a trial began when the experimenter said "Now". The signal was then flashed by the experimenter. The inter-stimulus interval was approximately 7 seconds during which time the subject responded with her decision. The subject was not informed whether her decision was correct or incorrect. The presentation of the two series of hues was varied among the thirty subjects, so that half of the subjects were presented with the blue-grey series first, followed by the red-grey series. The remaining fifteen subjects received the counter-balanced design with the red-grey series first, and then the blue-grey series.

5. Method of Analysis of the Hue Sensitivity Data.

Following the procedure of signal detection, two stimulus situations were defined corresponding to the noise, and signal plus noise conditions. In the present study the stimuli situations were: (1) presentation of the CFF

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8. D.M. Green, and J.H. Swets, Signal Detection Theory and Psychophysics, New York, Wiley, 1966, p. 203.

stimulus of blank trial (grey stimulus), defined as noise; and (2) presentation of the ON stimulus or the two hue conditions (red and blue stimuli), defined as signal plus noise.

Following each presentation, the subject responded either "Blue" or "Grey" (for the blue-grey series) or "Red" or "Grey" (for the red-grey series). The two types of stimulus conditions, ON and OFF, and the response categories "Blue" (Red) and "Grey", resulted in four stimulus response alternatives[9] for each of the two conditions, which are illustrated in the stimulus response matrix in Figure 1.

The hit rate P(Jon/SON), judged On, Stimulus ON, is the probability that the subject would judge the stimulus (e.g. red) as being On, when in fact it was ON. The false alarm rate, P(Jon/SOFF), judged On, Stimulus OFF, is the probability that the subject would judge the stimulus as being On (e.g. red), when in fact it was OFF (e.g. grey). These two stimulus response alternatives are sufficient to describe the stimulus and response alternatives matrix. When the hit rate is known, the miss rate P(Joff/SON), judged off, stimulus ON, is equal to 1.0 - hit rate. Similarly, the correct rejection rate, P(Joff/SOFF), judged

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9. J.A. Swets, W.P. Tanner Jr., and T.G. Birdsall, "Decision Processes in Perception", Psychological Review, Vol. 68, 1961, p. 306.

RESPONSE ALTERNATIVES	Stimulus Alternative: ON	Stimulus Alternative: OFF
On	P(Jon/SON) Judged On/Stimulus ON Hit	P(Jon/SOFF) Judged On/Stimulus OFF False Alarm
Off	P(Joff/SON) Judged Off/Stimulus ON Miss	P(Joff/SOFF) Judged Off/Stimulus OFF Correct Rejection

Figure 1-Stimulus and Response Matrix for Signal Detection Analysis.

off, stimulus OFF, is equal to 1.0 - false alarm rate.

Following the rating procedure described by Egan et al.[10] each decision, i.e. Blue (Red) or Grey, was taken according to a response criteria (positive, fairly sure, guess) adopted by the subject. In actual fact, the subject divided her observations into six response categories, representing a continuum of various judgement criteria, attitude or motivation adopted by her during the psychophysical experiment.

The frequency of response to the six response categories to the ON condition was computed. The six response categories for the OFF condition were also tabulated. An example of this procedure is given in Appendix 2. This was done for the two hue conditions, red (signal ON) - grey (signal OFF) condition; and the blue (signal ON) - grey (signal OFF) condition.

The twelve response values for each of the two hue conditions were punched on IBM data cards for subsequent analysis. Computation of the signal detection data was carried out by an IBM Fortran IV computer program, for the rating procedures (EPC ROC), developed by Ogilivie

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10. J.P. Egan, A.I. Schulman, and G.Z. Greenby, op. cit., p. 768-773.

and Creelman[11] which presents maximum likelihood estimates of ROC parameters. The program was run on an IBM 360/120 computer.

The ratio of the hits proportion to the proportion of false alarms provided an index of sensitivity to the hue discrimination task. The greater the hit proportion, and the smaller the false alarm proportion, the greater was the sensitivity to the stimuli, and the greater the d*.

6. Statistical Design.

The statistical design follows the one factor analysis of variance, fixed effects model[12]. Since the duration of exposure to the two hue conditions was different, it was not considered appropriate to make comparisons between red and blue d* sensitivity measures. Consequently, a one way analysis of variance was applied to both the red and blue hue conditions, and differences in d* between the groups was observed.

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11. J.C. Ogilivie, and C.D. Creelman, "Maximum Likelihood Estimation of Receiver Operating Characteristic Curve Parameters", The Journal of Mathematical Psychology, Vol. 5, 1968, p. 387.

12. V. Keith, Design and Analysis in Experimentation, Ottawa, University of Ottawa Press, 1972, p. 147-148.

The groups consisted of three levels of extraversion, an introverted group, a middle group, and an extraverted group. All subjects in a group were tested under the two hue conditions, red-grey, and blue-grey. The dependent measure was the d* which represented the sensory capacity of the criteria adopted by the subject in making her judgements. This measure was taken under the two conditions.

CHAPTER III

PRESENTATION OF RESULTS

This chapter presents the results of the statistical analysis of the data. It begins with an examination of the selection data of the sample. The signal detection measure of sensory capacity under the red and blue hue conditions for groups of low, middle, and high extraversion is presented in Section 2. Section 3 gives the signal detection d* data under the blue hue condition for groups of subjects high and low in neuroticism and extraversion.

1. Selection Data for Groups of Introverted, Middle, and Extraverted Subjects.

Three groups of ten introverted, ten middle, and ten extraverted subjects were selected from an initial sample of sixty elementary school teachers, on the basis of their scores obtained on the Eysenck Personality Inventory, (EPI), Form B[1]. The means of the extraversion and neuroticism dimensions for the total population of sixty subjects were 13.4 and 10.6, respectively. The means of the extraversion and neuroticism dimension for the total

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1. H.J. Eysenck, and S.B.G. Eysenck, The Eysenck Personality Inventory, San Diego, Educational and Industrial Testing Service, 1968.

sample group of thirty subjects were 13.6 and 10.5, respectively. It is noted that these results are quite similar to the norms for teachers provided by Eysenck and Eysenck in their EPI Manual[2], where the mean for extraversion is 13.4 and the mean for neuroticism is 10.1.

The means for the extraversion dimension of the ten introverted, ten middle, and ten extraverted subjects were 9.1, 13.9, and 17.9, respectively. The means of the neuroticism dimension for the ten introverted, ten middle, and ten extraverted subjects were 11.2, 10.3, and 10.2, respectively. The mean and standard deviation scores for the extraversion and neuroticism dimension of the EPI for the population sample, total test sample, and the three sample groups are shown in Table I. It is noted that the three sample groups differed significantly from one another on the extraversion dimension of the EPI, ($F = 122.75$, df 2/27, $p < 0.001$), but not on the neuroticism dimension of the EPI, ($F = .146$, df 2/27, $p > 0.05$), when an analysis of variance was applied to the data. The Levene test showed that the homogeneity of variance assumption was met.

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2. H.J. Eysenck, and S.B.G. Eysenck, Manual for the Eysenck Personality Inventory, San Diego, Educational and Industrial Testing Service, 1968, 5-24p.

Table I

EPI Form B, Score Distributions on Extraversion (E) and Neuroticism (N) for the Total Sample Group, Test Sample, Introverted, Middle, and Extraverted Groups.

Group	Size	E		N	
		Mean	S.D.	Mean	S.D.
Total Sample Group	60	13.4	3.1	10.6	4.8
Test Sample Group	30	13.6	3.8	10.5	4.4
Introverted Group	10	9.1	1.5	11.2	4.7
Middle Group	10	13.9	.94	10.3	4.4
Extraverted Group	10	17.9	.94	10.2	3.7

Note: The raw Extraversion (E) and Neuroticism (N) scores for the Introverted, Middle and Extraverted subjects are given in Appendix 3.

2. Extraversion and d* Sensitivity to the Red and Blue Hues.

A measure of perceptual sensitivity was determined for each subject under the red and blue hue conditions. The larger the value of d*, the sensitivity measure, the greater was the discrimination of the hue stimulus.

In the preceding chapter, it was noted that the recognition threshold for the blue and red hue stimuli was 3.65 and 2.35 milliseconds, respectively. Since the hue stimuli differed in their duration of exposure, it would be misleading to compare recognition sensitivity between the hues. The primary interest in the experiment is the relative sensitivity between the introverts, ambiverts, and extraverts, first under the red condition, then under the blue condition. The raw d* scores for the three groups under the two conditions are given in Appendix 4.

For the red hue condition, a one way analysis of variance indicated a significance between the groups on the d* sensitivity measure, ($F = 2.33$, df 2/27, $p<0.12$), with the extraverted group achieving the highest mean d* score of 4.78. The middle group was the next highest with a mean of 3.47, followed by the introverted group with a mean of 2.93. The grand mean was 3.73. These

results are presented in Table II. The analysis of main effects, using the Tukey test[3] as a post hoc procedure yielded a significant difference of 0.18 for between groups, the difference being 2.89 between the extraverted and introverted group. The homogeneity of variance assumption was met when the Levene test was applied to the data. The result of the analysis of variance data is given in Table III.

For the blue hue condition, a one way analysis of variance indicated that there were no significant differences between the groups on their d* sensitivity scores ($F = 1.08$, df 2/27, $p > 0.05$). A reverse trend in mean d* sensitivity was noted under this condition as compared to the red condition, with the introverted group scoring highest with a mean d* of 5.59, followed by the extraverted group with a mean of 4.75. The middle group scored lowest with a mean of 4.19. The grand mean was 4.84. These results are presented in Table II. A geometric representation of the mean d* scores under both the red and blue hue stimuli conditions is given in Figure 2. The Levene test was used as a post hoc procedure and

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3. V. Keith, Design and Analysis in Experimentation, Ottawa, Ontario, University of Ottawa Press, 1972, p. 145-188.

Table II

Mean d* scores for the Red and Blue Hue Conditions for Introverted, Middle and Extraverted Groups.

Group	N	Red		Blue	
		Mean	S.D.	Mean	S.D.
Introverted	10	2.93	1.26	5.59	2.45
Middle	10	3.47	1.99	4.19	1.59
Extraverted	10	4.78	2.33	4.75	1.91
Average	30/3	3.73	1.85	4.84	1.98

Table III

Analysis of Variance d* Scores for the Red Hue Condition for Introverted, Middle and Extraverted Groups.

Source of Variation	SS	df	MS	F ratio
Between Subjects	18.14	2	9.07	
Within Subjects	109.76	27	4.06	
Total Variance	127.90	29		2.33*

$F_{.88}(2,27) = 2.30$

*$p < 0.12$

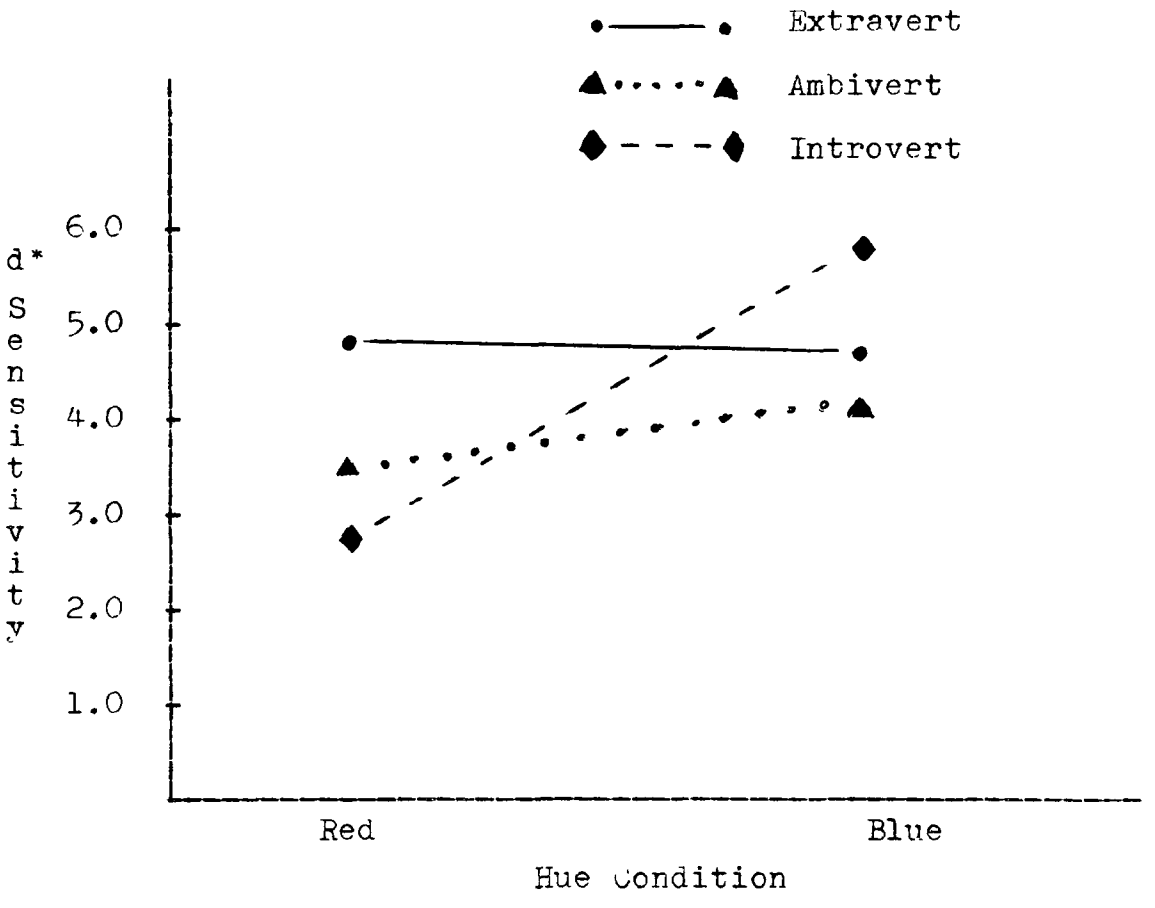

Figure 2- Mean d* Sensitivity Scores for Red and Blue Hue Conditions, for Introverted, Middle, and Extraverted Groups.

indicated that the homogeneity of variance assumption was met. The results of the analysis of variance are given in Table IV.

Under the blue hue condition it was noted that the extraverted group had a higher mean d* than the ambiverts. The eta statistic[4] revealed a curvilinear relationship which was a significant departure from linearity ($F = 1.19$, df 2/27, $p<0.05$). It may also be noted that the high extraversion group displayed a higher mean d* when the blue condition was presented after the red stimulus. This is an order effect. A two way analysis of variance indicated that this order effect was significant ($F = 5.64$, df 2/24, $p<0.01$).

In using the EPC ROC program for the computation of the ROC parameters of the d* a difficulty occurred in scores of individuals who discriminated between noise and signal plus noise perfectly, or nearly so. This small change in the hit/false alarm ratio resulted in a large change in d*, since d* approaches infinity as the difference between the means of the signal and noise distributions increases. For this reason, it seemed appropriate

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4. J.P. Guilford, Fundamental Statistics in Psychology and Education, New York, McGraw-Hill, 1959, p. 341.

Table IV

Analysis of Variance d* scores for the Blue Hue Condition for Introverted, Middle and Extraverted Groups.

Source of Variation	SS	df	MS	F ratio
Between Subjects	9.89	2	4.95	
Within Subjects	122.87	27	4.55	
Total Variance	132.76	29		1.08

$F_{.95}(2,27) = 3.35$

$p > 0.05$

to apply the Kruskal-Wallis H test[5], a nonparametric test, analogous to a one way analysis of variance, to the d* data.

Under the red hue condition a significant difference at the 0.18 level of confidence was noted (H = 4.45, df 2, $p<0.18$) among the introverted, middle and extraverted groups, indicating a significant difference among the groups in their rank order.

Under the blue hue condition the H ratio indicated that the introverted, middle and extraverted groups did not differ significantly in their rank order (H = 2.35, df 2, $p>0.05$).

3. Extraversion, Neuroticism and d* Sensitivity to the Blue Hue.

The intercorrelation matrix for extraversion, neuroticism, and d* sensitivity to blue is shown in Table V. It is to be noted that the Pearson Product Moments for the d* blue may be attenuated because of the significant departure from linearity, noted earlier in this chapter. It was observed that the correlation between neuroticism

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5. B.J. Winer, Statistical Principles in Experimental Design, 2nd. ed., New York, McGraw-Hill, 1971, p. 848-849.

Table V

Correlation Matrix Indicating the Relationship of Extraversion Neuroticism, and Sensitivity to the Blue and Red Hue Conditions

	Extraversion	Neuroticism	d* Blue	d* Red
Extraversion		-.196	-.232	.333
Neuroticism			.348*	.146
d* Blue				.473**
d* Red				

N = 30

**p<0.06

*p<0.01

and d* blue of 0.348 was significant at the 0.06 level of confidence. In view of the fact that the extraversion scores of the low extraversion group in the original sample were relatively high, three more subjects who were low on the extraversion and neuroticism dimensions of the EPI were given the hue recognition test. These three subjects, when added to the original sample, permitted the effects of neuroticism on sensitivity to d* blue to be observed. The raw extraversion, neuroticism, and d* blue scores of the three additional subjects are given in Appendix 5.

All the subjects were classified into equal groups of high and low neuroticism, and high and low extraversion, according to a fourfold combination of high neuroticism, high extraversion; high neuroticism, low extraversion; low neuroticism, high extraversion; low neuroticism, low extraversion. These high and low groups, for both neuroticism and extraversion were defined by a median split. The mean and standard deviations of the groups on the neuroticism, and extraversion dimensions of the EPI are given in Table VI. A one way analysis of variance applied to these scores indicated that the high groups differed significantly from the low groups on both neuroticism ($F = 25.69$, df 3/28, $p < 0.001$) and extraversion ($F = 25.14$, df 3/28, $p < 0.001$).

Table VI

EPI (Form B) Score Distributions on Extraversion (E) and Neuroticism (N) for the Re-Classified Sample Groups High and Low on Extraversion and Neuroticism.

Group	N	Extraversion Mean	Extraversion S.D.	Neuroticism Mean	Neuroticism S.D.
High N, High E	8	16.25	1.98	14.13	1.17
High N, Low E	8	9.50	2.06	13.75	2.63
Low N, High E	8	16.38	1.65	6.00	2.63
Low N, Low E	8	10.87	1.83	7.25	2.63
Total Sample	32	13.25	1.88	10.28	2.14

Note: The raw Extraversion (E) and Neuroticism (N) scores for these groups, high and low on Neuroticism and Extraversion are given in Appendix 6.

The Levene test showed that the homogeneity of variance assumption was met in both cases.

It is to be noted that even though the analysis of variance assumption could not be met because extraversion and neuroticism are correlated, nonetheless, for the sake of interest, the effects of neuroticism and extraversion on sensitivity to blue were observed. The two way analysis of variance did not indicate any significant main effects or interaction for neuroticism or extraversion. It was observed that the high neuroticism, high and low extraversion groups had a larger mean d* blue score of 5.12, than the low neuroticism, high and low extraversion groups who had a mean of 4.64. It was also noted that the low extraversion groups had a higher mean d* of 5.52, than the high extraversion, high and low neuroticism groups with a mean of 4.24. These results are presented in Table VII.

Table VII

Mean d' Scores for the Blue Hue Condition for Groups High and Low in Extraversion (E) and Neuroticism (N).

		Neuroticism		
		High	Low	Average
Extraversion	High	N 8 Mean 4.64 S.D. 1.90	N 8 Mean 3.84 S.D. 1.58	N 16/2 Mean 4.24 S.D. 1.74
	Low	N 8 Mean 5.59 S.D. 2.10	N 8 Mean 5.45 S.D. 2.77	N 16/2 Mean 5.52 S.D. 2.17
	Average	N 16/2 Mean 5.12 S.D. 2.00	N 16/2 Mean 4.64 S.D. 1.91	N 32/4 Mean 4.88 S.D. 2.08

Note: Raw d' Scores for the Blue Hue Condition are given in Appendix 6.

CHAPTER IV

DISCUSSION OF RESULTS

This chapter begins with a summary of the results of the hue discrimination task, which is given in Section 1. Section 2 interprets these results in the light of the literature reported in chapter one. Section 3 provides some implications for further research. Section 4 concludes the chapter with some considerations for a replication study.

1. Summary of the Results.

The results reported in the previous chapter show that the measure of sensitivity computed by signal detection analysis revealed a significant difference at the 0.12 level of confidence among introverted, middle and extraverted groups in their sensitivity to the red hue condition. The Tukey test showed that the extraverted group differed significantly from the introverted group at the 0.18 level of confidence. When the Kruskal-Wallis was used as a non-parametric method of analysis, significant differences at the 0.18 level of confidence were noted between the groups under the red condition.

Under the blue hue condition a one way analysis of variance applied to the d* data did not reveal any significant differences between introverted, middle and extraverted groups in their sensitivity scores. The Kruskal-Wallis did not indicate significant differences between the groups.

An order effect was noted under the blue hue condition with the extraverted group showing a significant improvement in their performance when the blue condition was presented to them second in the experiment.

A correlation of 0.06 was observed between sensitivity to blue and neuroticism, when groups were classified into high and low neuroticism, and high and low extraversion.

2. Interpretation of Results.

The first hypothesis of this study was to determine if subjects high on the extraversion dimension of the EPI would have significantly higher d* scores under the red condition than subjects classified as low on the extraversion dimension of the EPI. The results of the analysis show that the extraverted group had a significantly greater d* sensitivity than the introverted group of

of subjects, at the 0.18 level of confidence. There tends to be a parallel between these results and the findings of color preference studies[1], in which outgoing and expressive individuals show a preference for red hues. The results give some support to Shapiro's[2] speculations, based on Rorschach studies, that extraversive individuals have a greater sensitivity for chromatic stimuli. The performance of the extraverted group under the red hue would seem to lend some weight to his hypothesis. The results of the present study appear to be congruent with the trend noted by Bourgeois[3] in which extraverts displayed a greater mean sensitivity than introverts to the apparent size of red stimuli. However, the performance of the extraverted group in the present study, under the red hue condition, questions the

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1. K. Warner Schaie, "On the Relation of Color and Personality", Journal of Projective Techniques and Personality Assessment, Vol. 30, 1966, p. 512-524.

2. David Shapiro, "Color Responses and Perceptual Passivity", Journal of Projective Techniques, Vol. 20, 1956, p. 52-69.

3. Robert-Paul Bourgeois, Introversion-Extraversion and the Role of the Orienting Reaction Habituation Rate in Sensitivity to the Apparent Size of Hue, Unpublished doctral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1972, p. 91.

generalizability of Eysenck's[4] prediction that introverts tend to have a lower absolute sensory threshold for all sensory stimuli. A theoretical explanation which renders these findings compatible with Eysenckian theory rests upon a twofold relationship between the level of performance and the level of arousal, on the one hand; and the level of arousal and the extraversion dimension of personality, on the other.

The relation between the level of performance and the level of arousal can be characterized as an inverted-U based on the findings of Yerkes[5], Schlosberg[6], Stennett[7], and Malmo[8]. This same relationship has been noted in a study conducted at the Faculty of Psychology of the

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4. H.J. Eysenck, The Biological Basis of Personality, Springfield, Ill., Charles C. Thomas Publishers, 1967, p. 100.

5. R.M. Yerkes, and J.D. Dodson, "The Relation of Strength of the Stimulus to Rapidity of Habit Formation", Journal of Comparative and Physiological Psychology, Vol. 18, 1908, p. 458-482.

6. H.S. Schlosberg, "Three Dimensions of Emotion", Psychological Review, Vol. 61, 1954, p. 81-85.

7. R.G. Stennett, "Performance Level and Level of Arousal", Journal of Experimental Psychology, Vol. 54, 1957, p. 54-61.

8. R.B. Malmo, "Activation: A Neuropsychological Dimension", Psychological Review, Vol. 66, 1959, p. 367-386.

University of Ottawa, by Campbell[9], in which extraverts showed a tendency to do better under a high frequency auditory task, than an introverted group of subjects. The inverted-U theory holds that there is a continuum extending from deep sleep at the one end, to a high state of arousal, at the other. From low arousal up to a point that is optimal for a given function, arousal increases performance, monotonically. However, beyond this optimal point, further increases in arousal level produce decreases in performance level, thereby causing a nonmonotonic relationship.

The relationship between level of arousal and Eysenck's[10] extraversion-introversion dimension of personality has already been noted in chapter I. Equal amounts of stimulation are not experienced by introverts, ambiverts, and extraverts as being equal. If the ambivert is used as a reference point, the introvert would experience a low level of arousal as optimal, the ambivert would experience

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9. Kenneth B. Campbell, Introversion-Extraversion and Auditory Sensitivity to High and Low Frequency Tones, Unpublished Master of Arts thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1973, p. 5[illegible].

10. H.J. Eysenck, op. cit., p. 100.

the same stimulus as moderate, and the insensitive extravert would experience it as too low.

From what has been said earlier of the inverted-U relationship between level of arousal and performance, it is theoretically possible that along the personality dimension of extraversion-introversion, that a highly arousing stimulus would be experienced by the introvert as too arousing and would cause a decrement in his performance level. This same stimulus would be experienced by the ambivert as moderate, and he would maintain his level of performance; while the extravert would experience the stimulus as optimal and he would maintain or increase his level of performance.

In the context of the present study, it would appear that the introvert, whose nervous system is already highly aroused, would find the additional arousal level of the red hue[11] as too much of a burden for his system to carry, and thus cortically command inhibition, which would be reflected in a lowered level of sensitivity to red. The insensitive extravert would experience the red hue

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11. G.D. Wilson, "Arousal Properties of Red Versus Green", Perceptual and Motor Skills, Vol. 23, 1966, p. 947-949.

as optimal, thus cortically commanding arousal, which would be reflected in a heightened sensitivity to red.

This modification in Eysenck's theory would appear to explain the trend noted in the greater sensitivity of the extraverts under the red hue condition. This modification further allows a speculative basis to be formulated in relating the performance of the extraverts on the red hue condition with the increase in sensitivity to red hue stimuli noted by Kravkov[12], when he instilled pilocarpin, a parasympathetico-mimetic agent on the pupil. Kravkov's observations are given support by Kaplin[13], who found that ephedrine produced the greatest negative afterimage to a red hue stimulus. The congruence between these findings, and the results of the present study, show promise in relating chromatic sensitivity to a red hue stimulus and parasympathetic like activity with a modified theory of extraversion, as proposed by Eysenck.

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12. S.V. Kravkov, "Color Vision and the Autonomic Nervous System", Journal of the Optical Society of America, Vol. 31, 1941, p. 335-337.

13. S.D. Kaplin, "A Visual Analog of the Funkenstein Test", Archives of General Psychiatry, Vol. 3, 1960, p. 383-388.

The second hypothesis of the study was whether subjects low on the extraversion dimension of the EPI would have significantly higher a* scores under the blue condition than subjects classified as high on the extraversion dimension of the EPI. The results of the analysis suggest a trend indicating that introverts have a higher mean sensitivity to the blue hue than extraverts or ambiverts. There tends to be a parallel between this result, and the hypothesis of color preference studies[14] which indicated that quiet and rational subjects show a preference for blue. The results also appear congruent with Bourgeois'[15] findings that introverts tend to have a greater sensitivity to the apparent size of blue hue stimuli. The performance of the introverts under the blue hue condition in the present study also tends to be in accord with Eysenck's[16] prediction that introverts have a lower sensory threshold. However, the performance of the introverts tends to call into

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14. K. Warner Schaie, op. cit., p. 512-524.

15. Robert-Paul Bourgeois, op. cit., p. 91.

16. H.J. Eysenck, op. cit., p. 100.

question the generalizability of Shapiro's[17] speculation that extraversive individuals have a lower absolute threshold for chromatic stimuli. A possible reason for this divergence is that Shapiro's hypothesis rests upon observations of the performance of individuals on the Rorschach Inkblots, which are largely made up of chromatic stimuli on the orange-red end of the color spectrum. It could be argued that because of the chromatic nature of the Rorschach cards, introversive individuals, who show a tendency to be more sensitive to colors at the blue-green end of the color spectrum, would therefore show limited color responses on the Rorschach test.

There tends to be a congruence between the performance of the introverted group under the blue hue condition and the increased sensitivity to blue chromatic stimuli, noted by Kravkov[18], when adrenalin, a sympathetico-mimetic agent, was instilled on the pupils of his subjects. Kravkov's observations are given support by Kaplin[19], who

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17. David Shapiro, op. cit., p. 69.

18. S.V. Kravkov, op. cit., p. 635-647.

19. S.D. Kaplin, op. cit., p. 383-408.

noted that prostigmine caused the greatest negative after-image for a green hue stimulus. The trend in the present study for the introverts to have a greater sensitivity to the blue hue, as compared to extraverts, and the congruence between the performance of the introverts and Kravkov's observations on increased sensitivity to blue stimuli when adrenalin is placed on the eye, shows promise in relating chromatic sensitivity to blue hues and sympathetic like activity, with Eysenck's theory of extraversion-introversion.

3. Implication of the Findings.

The main purpose of the study was to investigate individual differences in chromatic sensitivity to red and blue hues among groups varying in degrees of extraversion with their concomitant physiological differences.

The limited but promising findings of the study suggest several areas for further investigation. The highly speculative framework in making the performance of the extraverts under the red hue condition compatible with the Eysenckian theory of personality suggests that further experimental research into the link between levels of arousal, performance, and personality is needed to

clarify the logical but very theoretical relationship. An EEG study measuring the performance of groups varying in degrees of extraversion to stimuli in a high-low continuum may clarify this relationship.

The present study also suggests some interesting directions for Rorschach research. The present results which indicate a trend relating individual differences in personality to differences in chromatic sensitivity, suggest that color responses on the Rorschach may not simply be responses to color in general, but could well be responses to particular hues. In the case of the Rorschach Inkblots, the chromatic stimuli appear to be largely made up of colors in the orange-red end of the spectrum. Further research into individual differences to colors high in the spectrum among clinical populations may increase the effectiveness of the Rorschach as a diagnostic instrument.

A final area for further research is the effect of sympathetico and parasympathetico mimetic drugs on sensitivity to chromatic stimuli among groups varying in degrees of extraversion. This would serve as a direct basis for determining a biological base for personality along Eysenck's extraversion-introversion dimension of personality.

4. Suggestions for a Replication Study.

There were three difficulties encountered in this study. The first concerned itself with the selection of the low extraversion group in the test sample. The scores of this group on the extraversion dimension of the EPI were somewhat higher than was desired. One can speculate that if this group had had a lower mean extraversion score, that their performance on the hue recognition test may have shown them to be significantly more sensitive to the blue hue stimulus and less sensitive to the red hue stimulus. If a replication study is done, it is suggested that the mean extraversion score of the introverted group on the EPI be as low as possible.

A second problem with the study was the spuriously high d* sensitivity scores noted under both the blue and red hue conditions. This problem was caused by the adoption of too high a sensitivity threshold of 2.35 milliseconds for the red hue, and 3.65 milliseconds for the blue hue. These values made the recognition task too easy for the subjects, thereby increasing their hit/false alarm rate, and inflating their d* sensitivity scores. It is recommended that if a replication study is done, that a procedure other than the method of limits be used

in the determination of the thresholds. One suggestion is that only ascending trials be given for each hue, with each trial alternating between a red and blue hue, in a predetermined random order of presentation. This would minimize the errors of habituation and anticipation inherent in the method of limits.

The third difficulty that was encountered was the significant order effect in the presentation of the stimuli under the blue hue condition. This problem could have been avoided if an independent groups design had been used.

SUMMARY AND CONCLUSIONS

The first hypothesis stated that there is no significant difference between groups of high, middle and low extraversion under the red hue condition. A one way analysis of variance was significant at the 0.12 level of confidence. The Tukey test indicated that the extraverted group showed a significantly greater sensitivity to the red condition than the introverted group of subjects, at the 0.18 level of confidence. The Kruskal-Wallis, a nonparametric test, showed a significant difference at the 0.18 level of confidence among the three groups under the red condition.

The second hypothesis stated that there was no significant difference between groups high, middle and low in extraversion under the blue hue condition. A one way analysis of variance was not significant for the data. A Kruskal-Wallis indicated that there were no significant differences among the groups.

A significant order effect in the presentation of the hue stimuli was observed under the blue condition.

This was believed to have been caused by a faulty design in the experiment.

Neuroticism was significantly related to d* sensitivity to blue at the 0.06 level of confidence.

The results of the experiment are promising in relating individual differences in chromatic sensitivity to groups varying in degrees of extraversion, with their concomitant physiological differences. The findings of the present study on absolute chromatic sensitivity tend to parallel the predictions of color preference research[1] which predicts that outgoing and expressive individuals show a preference for red hues; while quiet and rational subjects show a preference for blue hues. The results also appear to be congruent with the trend noted by Bourgeois[2] in a size judgement task involving chromatic stimuli, in which the extraverted group of

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1. K. Warner Schaie, "On the Relation of Color and Personality", Journal of Projective Techniques and Personality Assessment, Vol. 30, 1966, p. 512-524.

2. Robert-Paul Bourgeois, Introversion-Extraversion and the Role of the Orienting Reaction Habituation Rate in Sensitivity to the Apparent Size of Hue, Unpublished doctral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1972, p. 91.

subjects showed a trend in greater mean sensitivity to the apparent size of red hue stimuli; while the introverted subjects showed a trend in greater mean sensitivity to the apparent size of blue hue stimuli. The results of this study question the generalizability of Eysenck's[3] prediction that introverts have a lower absolute sensory threshold. However, a rapprochement is possible through an appeal to the relationship between the level of arousal, performance and personality[4]. The results of this research also question the generalizability of Shapiro's[5] speculations that extraversive individuals have a lower absolute sensory threshold for chromatic stimuli. A possible reason for this divergence, is the difference between the color stimuli used in this experiment, and the chromatic nature of the Rorschach Inkblots[6].

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3. H.J. Eysenck, The Biological Basis of Personality, Springfield, Ill., Charles C. Thomas Publishers, 1967, p. 100.

4. R.B. Malmo, "Activation: A Neuropsychological Dimension", Psychological Review, Vol. 66, 1959, p. 367-386.

5. David Shapiro, "Color Responses and Perceptual Passivity", Journal of Projective Techniques, Vol. 20, 1956, p. 52-69.

6. H. Rorschach, The Rorschach Inkblot Test, Berne, Switzerland, Hans Huber, Publisher, 1942.

There tends to be a congruence between the results of the present study and Kravkov's[7] observations on the effect of pilocarpin and adrenalin, which are parasympathetico and sympathetico mimetic drugs, respectively, on sensitivity to red and blue stimuli. The performance of the extraverted group in the present study bears a resemblance to Kravkov's observations that the instillation of pilocarpin on the pupil increased sensitivity to red; while the performance of the introverted group of subjects appears to reflect Kravkov's observations that the instillation of adrenalin on the pupil increased sensitivity to blue hues. These findings would tend to suggest that extraverts tend to be more sensitive to a red hue, and may show a dominance of parasympathetic like activity; while introverts tend to show an increased sensitivity to blue chromatic stimuli and may show a dominance of sympathetic like activity. Further research is needed to verify these considerations before a suitable biological basis for the extraversion dimension of personality can be posited.

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7. S.V. Kravkov, "Color Vision and the Autonomic Nervous System", Journal of the Optical Society of America, Vol. 31, 1941, p. 335-337.

BIBLIOGRAPHY

Bourgeois, Robert-Paul, Introversion-Extraversion and the Role of the Orienting Reaction Habituation Rate On Sensitivity to the Apparent Size of Hue, Unpublished doctral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1972, ix-128p.

The result of this study helped in the formulation of the hypotheses and the use of signal detection methods as a measure of absolute chromatic sensitivity.

Egan, J.P., Schulman, A.I., and G.Z. Greenberg, "Operating Characteristics Determined by Binary Decisions and by Ratings", Journal of the Acoustical Society of America, Vol. 31, 1959, p. 768-773.

This article presents the rationale for the use of a rating criterion within the context of signal detection theory, which served as a basis for adopting a criterion matrix in the present study.

Eysenck, H.J., The Biological Basis of Personality, Springfield, Ill., Charles C. Thomas Publishers, 1967, p. 226-262

A comprehensive statement of the author's neurophysiological model of personality along the extraversion-introversion dimension is presented.

Green, O.M., and J.A. Swets, Signal Detection Theory and Psychophysics, New York, Wiley and Sons, 1966, xi-455p.

This book relates the signal detection theory to various experimental situations.

Hake, H.W., and R.S. Rodwan, "Perception and Recognition", in J.B. Sidowski (ed.), Experimental Methods and Instrumentation in Psychology, New York, McGraw-Hill, 1966, p. 332-381.

The authors show the inadequacy of psychophysical methods in the determination of sensory thresholds.

Kravkov, S.V., "Color Vision and the Autonomic Nervous System", Journal of the Optical Society of America, Vol. 31, 1941, p. 335-337.

The observations of this experiment show promise in relating chromatic sensitivity with the functioning of the autonomic nervous system.

BIBLIOGRAPHY

Lewinski, R.J., "An Investigation of Individual Responses to Chromatic Illumination", The Journal of Psychology, Vol. 6, 1938, p. 155-160.
This paper is one of the classic studies on color preference.

Malmo, R.B., "Activation: A Neuropsychological Dimension", Psychological Review, Vol. 66, 1959, p. 367-386.
Relates the level of arousal to the level of performance.

Price, R.H., "Signal Detection Methods in Personality and Perception", Psychological Bulletin, Vol. 66, 1966, p. 55-62
The article provides a rationale for the use of signal detection methods in studying personality.

Schaie, Warner K., "On the Relation of Color and Personality", Journal of Projective Techniques and Personality Assessment, Vol. 30, 1966, p. 512-524.
Besides reviewing the literature on color preference studies, the author provides a theoretical physiological basis for chromatic sensitivity.

Shapiro, David, "Color Responses and Perceptual Passivity", Journal of Projective Techniques, Vol. 20, 1956, p. 52-69.
The author provides a theoretical rationale for linking chromatic sensitivity with differential autonomic responsivity.

Wilson, G.D., "Arousal Properties of Red Versus Green", Perceptual and Motor Skills, Vol. 23, 1966, p. 947-949.
The results of this study relate chromatic perception and GSR arousal.

APPENDIX 1

THE EYSENCK PERSONALITY INVENTORY, (EPI), FORM B

EYSENCK PERSONALITY INVENTORY

FORM B

By H. J. Eysenck
and Sybil B. G. Eysenck

Name_____ Age_____ Sex_____

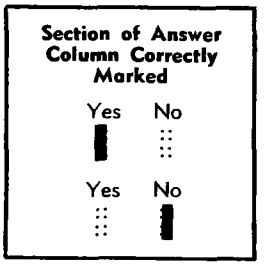
Grade or Occupation_____ Date_____

School or Firm_____ Marital Status_____

INSTRUCTIONS

Here are some questions regarding the way you behave, feel and act. After each question is a space for answering "Yes," or "No."

Try and decide whether "Yes," or "No" represents your usual way of acting or feeling. Then blacken in the space under the column headed "Yes" or "No."



Work quickly, and don't spend too much time over any question; we want your first reaction, not a long drawn-out thought process. The whole questionnaire shouldn't take more than a few minutes. Be sure not to omit any questions. Now turn the page over and go ahead. Work quickly, and remember to answer every question. There are no right or wrong answers, and this isn't a test of intelligence or ability, but simply a measure of the way you behave.

PUBLISHED BY EDUCATIONAL AND INDUSTRIAL TESTING SERVICE
BOX 7234, SAN DIEGO, CALIFORNIA 92107

E N L

1. Do you like plenty of excitement and bustle around you? Yes No
2. Have you often got a restless feeling that you want something but do not know what? Yes No
3. Do you nearly always have a "ready answer" when people talk to you? Yes No
4. Do you sometimes feel happy, sometimes sad, without any real reason? Yes No
5. Do you usually stay in the background at parties and "get-togethers"? Yes No
6. As a child did you always do as you were told immediately and without grumbling? Yes No
7. Do you sometimes sulk? Yes No
8. When you are drawn into a quarrel, do you prefer to "have it out" to being silent hoping things will blow over? Yes No
9. Are you moody? Yes No
10. Do you like mixing with people? Yes No
11. Have you often lost sleep over your worries? Yes No
12. Do you sometimes get cross? Yes No
13. Would you call yourself happy-go-lucky? Yes No
14. Do you often make up your mind too late? Yes No
15. Do you like working alone? Yes No
16. Have you often felt listless and tired for no good reason? Yes No
17. Are you rather lively? Yes No
18. Do you sometimes laugh at a dirty joke? Yes No
19. Do you often feel "fed-up"? Yes No
20. Do you feel uncomfortable in anything but everyday clothes? Yes No
21. Does your mind often wander when you are trying to attend closely to something? Yes No
22. Can you put your thoughts into words quickly? Yes No
23. Are you often "lost in thought"? Yes No
24. Are you completely free from prejudices of any kind? Yes No
25. Do you like practical jokes? Yes No
26. Do you often think of your past? Yes No
27. Do you very much like good food? Yes No
28. When you get annoyed do you need someone friendly to talk to about it? Yes No
29. Do you mind selling things or asking people for money for some good cause? Yes No
30. Do you sometimes boast a little? Yes No
31. Are you touchy about some things? Yes No
32. Would you rather be at home on your own than go to a boring party? Yes No
33. Do you sometimes get so restless that you cannot sit long in a chair? Yes No
34. Do you like planning things carefully, well ahead of time? Yes No
35. Do you have dizzy spells? Yes No
36. Do you always answer a personal letter as soon as you can after you have read it? Yes No
37. Can you usually do things better by figuring them out alone than by talking to others about it? Yes No
38. Do you ever get short of breath without having done heavy work? Yes No
39. Are you an easy-going person, not generally bothered about having everything "just-so"? Yes No
40. Do you suffer from "nerves"? Yes No
41. Would you rather plan things than do things? Yes No
42. Do you sometimes put off until tomorrow what you ought to do today? Yes No
43. Do you get nervous in places like elevators, trains or tunnels? Yes No
44. When you make new friends, is it usually you who makes the first move, or does the inviting? Yes No
45. Do you get very bad headaches? Yes No
46. Do you generally feel that things will sort themselves out and come right in the end somehow? Yes No
47. Do you find it hard to fall asleep at bedtime? Yes No
48. Have you sometimes told lies in your life? Yes No
49. Do you sometimes say the first thing that comes into your head? Yes No
50. Do you worry too long after an embarrassing experience? Yes No
51. Do you usually keep "yourself to yourself" except with very close friends? Yes No
52. Do you often get into a jam because you do things without thinking? Yes No
53. Do you like cracking jokes and telling funny stories to your friends? Yes No
54. Would you rather win, than lose a game? Yes No
55. Do you often feel self-conscious when you are with superiors? Yes No
56. When the odds are against you, do you still usually think it worth taking a chance? Yes No
57. Do you often get "butterflies in your stomach" before an important occasion? Yes No

APPENDIX 2

STIMULUS-RESPONSE HUE MATRIX

APPENDIX 2

Stimulus-Response Frequency Matrix for One Subject Under the Red Hue Condition

Response Category	Signal	Noise
Red Positive	36	11
Red Fairly Sure	24	13
Red Guess	10	6
Grey Positive	39	5
Grey Fairly Sure	23	14
Grey Guess	9	10

APPENDIX 3

RAW EPI SCORES FOR GROUPS OF INTROVERTED, MIDDLE, AND EXTRAVERTED SUBJECTS

APPENDIX 3

Eysenck Personality Inventory, (EPI), Form B, Scores for Extraversion (E), and Neuroticism (N) for Groups of Introverted, Middle, and Extraverted Subjects.

Subject	Extraver-ion	Neuroticism
Introverted		
1	7	16
2	11	4
3	11	5
4	10	14
5	8	11
6	10	14
7	8	11
8	9	9
9	7	13
10	9	11
Middle		
1	15	16
2	12	11
3	15	13
4	14	14
5	14	14
6	15	1
7	13	14
8	14	6
9	13	7
10	14	8
Extraverted		
1	18	6
2	20	14
3	17	13
4	18	7
5	18	16
6	17	14
7	18	5
8	19	12
9	17	8
10	17	7

APPENDIX 4

d* FOR GROUPS OF INTROVERTED, MIDDLE, AND EXTRAVERTED SUBJECTS

APPENDIX 4

d* for Groups of Introverted, Middle, and Extraverted Subjects.

Subject	Hue Condition	
	Blue	Red
Introverted		
1	6.391	4.184
2	2.130	1.805
3	6.289	3.180
4	6.599	3.986
5	8.746	2.388
6	9.768	5.407
7	2.207	1.638
8	3.455	2.497
9	6.370	3.166
10	3.924	1.029
Middle		
1	3.331	3.166
2	4.801	2.190
3	6.337	8.483
4	6.637	4.588
5	5.043	4.060
6	1.576	1.329
7	4.695	1.878
8	2.849	2.595
9	4.448	4.467
10	2.184	1.960
Extraverted		
1	3.445	8.515
2	1.139	1.517
3	6.490	9.287
4	3.432	3.073
5	2.976	3.540
6	4.802	3.700
7	5.728	3.310
8	8.050	5.557
9	5.513	4.004
10	5.955	5.306

APPENDIX 5

RAW SCORES FOR ADDITIONAL SUBJECTS ON EXTRAVERSION, NEUROTICISM, d* BLUE AND RED

APPENDIX 5

Raw Scores for Additional Subjects on Extraversion, Neuroticism, d* Blue and d* Red.

Subject	Extraversion	Neuroticism	d* Blue	d* Red
Introverted				
11	12	6	7.314	3.811
12	9	8	3.536	4.166
13	13	10	7.704	5.198

APPENDIX 6

RAW NEUROTICISM, EXTRAVERSION, AND d* BLUE SCORES FOR SUBJECTS RE-CLASSIFIED AS HIGH AND LOW ON NEUROTICISM AND EXTRAVERSION

APPENDIX 6

Raw Neuroticism, Extraversion, and d* Blue Scores for Subjects Re-classified as High and Low on Neuroticism and Extraversion.

Subject	Extraversion	Neuroticism	d* Blue
High N, High E			
1	15	16	3.331
2	14	14	6.637
3	20	14	1.139
4	17	13	6.590
5	18	16	2.967
6	17	14	4.802
7	15	13	6.637
8	14	13	5.043
High N, Low E			
1	8	11	2.207
2	12	11	4.801
3	13	14	4.695
4	7	16	6.391
5	10	14	6.599
6	10	14	9.768
7	7	19	6.370
8	9	11	3.924
Low N, High E			
1	15	1	1.576
2	14	6	2.849
3	14	8	2.184
4	18	6	3.445
5	18	7	3.432
6	18	5	5.728
7	17	8	5.513
8	17	7	5.955
Low N, Low E			
1	11	4	2.130
2	12	3	6.280
3	9	9	3.445
4	13	7	4.448
5	12	6	7.314
6	9	8	3.536
7	13	10	7.704
8	8	11	8.746

APPENDIX 7

ABSTRACT OF

Extraversion-Introversion and Chromatic Recognition Sensitivity to Red and Blue Hues

APPENDIX 7

ABSTRACT OF

Extraversion-Introversion and Recognition Sensitivity to Red and Blue Hues[1]

The present study attempted to investigate the differences between chromatic sensitivity to red and blue hues and the Eysenckian personality dimension of extraversion-introversion with their concomitant physiological differences. Three groups of ten female subjects selected on the basis of the Eysenck Personality Inventory, Form B, and designated as introverted, middle and extraverted subjects were tachistoscopically presented with red and blue Munsell color samples equated for luminous reflectance and saturation. The measure of sensitivity was computed by the signal detection method.

There were no significant results found when the data was analyzed, but the trends suggested that the extraverted group tended to have a higher mean d* sensitivity score to the red hue than the introverted, and middle group of subjects. A reverse trend was observed

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1. Paul F. Smith, master of arts thesis presented to the School of Graduate Studies of the University of Ottawa, Ontario, 1974, x-80p.

under the blue condition with the introverted group achieving a greater mean d* sensitivity score than the extraverted and middle groups of subjects.

These results tend to parallel the predictions of color preference studies which indicate that outgoing and expressive individuals show a preference for red hues; while quiet subjects prefer blue hues. The results also tend to be congruent with a trend noted in a size judgement task using chromatic stimuli conducted at the Faculty of Psychology of the University of Ottawa, in which extraverted subjects tended to be more sensitive to the apparent size of red hues; while introverted subjects tended to be more sensitive to the apparent size of blue hue stimuli. These findings appear to be in agreement with a modified interpretation of Eysenck's theory of extraversion-introversion, which would take into account the relationship between the level of arousal, performance, and personality.

There tends to be a congruence between the results of this study and the observations that pilocarpin and adrenalin, parasympathetico and sympathetico mimetic agents, respectively, increase sensitivity to chromatic stimuli. The performance of the extraverted group tends to reflect

the observations that pilocarpin increases sensitivity to red when it is instilled on the pupil; while the performance of the introverted group of subjects appears to resemble the results noted that adrenalin increases sensitivity to blue when it is instilled on the pupil.

These findings would tend to suggest that extraverted individuals are more sensitive to a red hue stimulus which may be associated with parasympathetic like activity; while introverted individuals have a tendency to be more sensitive to a blue hue stimulus which may be associated with sympathetic like activity.