EXTRAVERSION AND ELECTRODERMAL RESPONSE TO
RED AND BLUE STIMULI

by Charles Pickard

A thesis submitted to the School of Graduate Studies
of the University of Ottawa as partial fulfillment
of the requirements for the M.A. degree in Psychology

CURRICULUM STUDORIUM

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ACKNOWLEDGEMENTS

The author would like to express his gratitude to Robert Stelmack, Ph.D. of the Faculty of Psychology of the University of Ottawa for his supervision and attentive direction from the inception of this research to its conclusion.

The writer is indebted as well to Mr. Ed Achorn for his patient advice and for the technical direction concerning the instrumentation. Appreciation is also expressed to those associates of the author who so willingly and enthusiastically solicited the cooperation of the necessary subjects.

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INTRODUCTION

It is a long and commonly known "fact" that different colors have different potentials for arousal and that people who like red are Extraverts while people who like blue are Introverts. The advertising industry has been making use of these "facts" for decades now, using certain colors to attract attention to an advertisement, using other hues to create mood tones within their advertisements which are in keeping with an image which they wish to project or in making an advertisement appealing to a certain segment of the populace. Though the relationship between color, it's arousal value and personality is one which is rather broadly accepted, the dynamics underlying this relationship remain relatively obscure despite an abundant investigatory literature on the subject. The present study endeavours to explore this relationship in terms of individual differences in Extraversion and individual differences in autonomic nervous system functioning which are speculatively related to this dimension of personality.

Early research attempted to explore this "known' association through studies involving color preference, mood-tone and affect. Though there were always difficulties with confounding variables the cumulative evidence clearly suggests that Introverts do prefer colors of short wavelength and that Extraverts do prefer colors of long wavelength. The trend for different hues to be associated with certain mood tones and affect values was also, by and large, confirmed.

Concomitant with these approaches has been a concern with the effect of color on the organism behaviorally and physiologically. The implication underlying these approaches is that different hues have different potential for arousal. Modest support of this contention has been garnered by a number of studies which have assessed physiological arousal to different hues indirectly through behavioral observation or directly through physiological measures such as electroencephalography or electrodermal activity.

Relevant to the level of arousal are a number of studies involving drugs which are known to function as a central nervous system depressant or stimulant or as a sympathetico/mimetic or parasympathetico/mimetic agent. These studies, in general, indicate that sympathetic arousal increases the sensitivity to hues of short wavelength and decreases the sensitivity to hues of long wavelength while parasympathetic activation has an opposite effect. One, most pertinent study, has shown very directly that sympathetic arousal, not pharmacologically induced, has this same effect.

Recent findings at the University of Ottawa, while speculative, might indicate a possible linkage between individual differences in Introversion-Extraversion and the sympathetic-parasympathetic involvement in chromatic sensitivity which is indicated by this research. Using a signal detection method of analysis in a study designed to explore a trend revealed in earlier research, it was found that Extraverts were more sensitive to a red stimulus than to a blue stimulus while the converse was found to be in evidence for Introverts. The similarity between these findings and the results of studies which have shown that the state of the autonomic nervous system is a determining factor in chromatic sensitivity is taken to possibly indicate a complex involvement of the autonomic nervous system and individual differences in Extraversion. It is speculated, on the basis of these similarities, that Extraverts demonstrate parasympathetic dominance while Introverts demonstrate sympathetic dominance. Extraverts would therefore be expected to be more sensitive to red than blue while Introverts would be expected to be more sensitive to blue than red, as was found.

Evidence from a number of sources suggest that the electrodermal response (and, in particular, the Orienting Reaction) may serve as a useful vehicle for exploring these hypothetical autonomic differences which subsume individual differences in Extraversion and response to chromatic stimuli. First, there is evidence that Introverts show greater electrodermal response and greater sensitivity to stimuli in a number of modalities. Secondly, a number of autonomic indices of the Orienting Reaction have suggested that the presence of this response facilitates sensitivity and that the magnitude and persistence of the response is correlated with greater perceptual sensitivity.

The present study proposes to investigate the relationship between electrodermal response amplitude and electrodermal response habituation rate for red and blue hue stimuli and individual differences along the Extraversion dimension of personality. It is as well concerned with the electrodermal response amplitude and rate of habituation for a red hue stimulus as compared with a blue hue stimulus.

Chapter one contains a review of the relevant research findings on which the formulation of hypotheses to be investigated are founded. Chapter two describes the sample, the materials and equipment attendant to the experiment, the response and habituation criteria, the methods of quantifying the electrodermal response data and the design and statistical analyses which were employed. The results are presented in chapter three. Chapter four discusses the results in relation to the hypotheses posed in chapter one.

CHAPTER I

DEVELOPMENT OF THE PROBLEM

This chapter presents the research findings which led to the formulation of the hypotheses to be tested in the present study. The first section discusses the literature relating the physiological effects of color and the relationship between the experience of color and individual differences in personality. The following section relates the evidence implicating autonomic involvement in chromatic sensitivity. The third section deals with the properties and functions of the Orienting Reaction and its role in perceptual sensitivity and the Eysenckian dimension of Extraversion. The speculated links between chromatic sensitivity and the autonomic nervous system are then presented. Finally a brief summary of the rationale is given from which the hypotheses are then formulated.

1. Chromatic Stimuli, Arousal and Individual Differences

Interest in the physiological effects of color, the experience of color and the relationship between the experience of color and individual differences in personality has, since the turn of the century, provided the necessary impetus for the production of an abundant psychological literature.

Researchers, while always attempting to illuminate the complexities of these long assumed parallels, have been plagued by inseparable variables, issues clouded by semantic confusion and, in the early stages, by theories grounded in anecdotal conjecture occasionally verging on fantasy. Despite these problems evidence has emerged which is supportive of the view that individuals are affected differently by different hues and that the same hue affects different individuals differently.

One contention which is commonly encountered in the literature[1, 2, 3, 4, 5] is that individuals who demonstrate preferences for warm colors (i.e., red, orange, yellow) exhibit behaviors generally ascribed to Extraverted individuals while those showing preferences for cold colors (i.e., green,

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1 F. Birren, Color Psychology and Color Therapy, New York, University Books, Inc., 1961, p. 138.

2 J.W. von Goethe, Theory of Colors, The M.I.T. Press, Cambridge, Massachussetts and London, England, 1970 (reproduced from Goethe's Theory of Colors, translated from the German by Charles Lock Eastlake, published by John Murray, Albemarle Street, London, 1840), p. 327-328.

3 E. Jaensch, Eidetic Imagery and Typological Methods of Investigation, Harcourt, Brace and Company, New York, 1930.

4 M. Rickers-Ovsiankina, "Some Theoretical Considerations Regarding the Rorschach Method", Rorschach Research Exchange, 1943, Vol. 7, p. 41-53.

5 K.W. Schaie, "On the Relation of Color and Personality", Journal of Projective Techniques and Personality Assessment, 1966, Vol. 30, No. 6, p. 512-524.

blue-green, blue) display behaviors ascribed to Introverted individuals. Birren, deriving his assumptions primarily from the writings of Jaensch and Rickers-Ovsiankina sees these overt characteristics on a continuum of Introversive-Extraversive balance directly varying with exhibited preference for hues of short wavelength through hues of long wavelength. Choungourian[6] in a test of Birren's hypotheses found despite the socio-cultural learning influences which have been observed[7], that there is a trend for Introverts to prefer more "cool" colors and Extraverts to prefer more "warm" colors. The inference is that of being differentially affected by hues of short and long wavelengths.

Concomitant with attempts to link preference with personality characteristics and mood-tone has been a concern with the effects which color has upon the organism. Though most of these studies have explored this relationship from the experiential and behavioral approaches the implication, though not necessarily delineated, is that color of different wavelengths has different physiological arousal value for the organism. In attempting to experimentally explore

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6 A. Choungourian, "Introversion-Extraversion and Color Preferences", Journal of Projective Techniques, 1964, Vol. 31, No. 4, p. 92-94.

7 A. Choungourian, "Color Preferences and Cultural Variation", Perceptual and Motor Skills, 1968, Vol. 26, No. 3, Part 2, p. 1203-1206.

this concept psychologists have latched onto a popularly accepted idea whose recorded history finds its early exposition in the writings of Goethe[8] and in those of contemporary authors such as Smets[9], Schaie[10], and Birren. The latter states that,

> Emotionally the red end of the spectrum is exciting, the blue end subduing. Physically and physiologically the same sort of complimentation exists. Red colors tend to increase bodily tension, to stimulate the autonomic nervous system, while green and blue colors release tension and have a lesser physiological effect.[11]

Of the experientially oriented studies, Lewinski's[12] finding that colors of short wavelength are experienced as pleasant-depressing-cold while colors of long wavelength are experienced as unpleasant-stimulating-hot is a prime example. Though affect-mood studies such as this have value in bearing out broad trends the question of socio-cultural learning in such research has always been present as

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8 Goethe, Op. Cit., p. 326.

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

10 Schaie, Op. Cit., p. 517.

11 F. Birren, "Color Preference as a Clue to Personality", Art Psychotherapy, 1973, Vol. 1, p. 13.

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

an inseparable contaminant. Norman and Scott[13] have also pointed out the fact that such studies really differ very little from color preference studies, if in fact at, all beyond mere semantics.

Most pertinent to this research are those studies which have attempted to show the arousal value of different hues in terms of their gross disruptive-facilitative effects on intellectual and motoric tasks, their attention getting value and their effects on the more discrete behavioral indices provided by physiological measures.

Pressey[14] and Nakshian[15], in separate studies designed to assess Goldstein's[16] claim that red has an influence on the organism which is disruptive of performance while that of green is facilitative, failed to find significant differences for the effect of hue, independent of brightness, on the functions tested. However, Nakshian did find that the

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13 R.D. Norman and W.A. Scott, "Color and Affect: A Review and Semantic Evaluation", Journal of General Psychology, 1952, Vol. 46, p. 213.

14 S.L. Pressey, "The Influence of Color Upon Mental and Motor Efficiency", American Journal of Psychology, 1921, Vol. 32, p. 326-356.

15 J.S. Nakshian, "The Effects of Red and Green Surroundings on Behavior", Journal of General Psychology, 1964, Vol. 70, p. 143-161.

16 K. Goldstein, The Organism, The Beacon Press, Boston, 1963, p. 265-266.

efficiency of performance on a Motor Inhibition Task and on a Hand Tremor Task was greater in a green environment than in a red environment although the differences failed to reach statistical significance.

The attentional value of identical chromatic/achromatic drawings was investigated by Dodd and Lewis[17] who found among pre-school children a significantly greater fixation valence for chromatic drawings. In a somewhat allied study, Staples[18] found infants between six and twenty-four months to be unequally responsive to different colors. Red was the most effective stimulus, followed by yellow, blue and green.

Complimenting such behavioral studies are those studies utilizing more direct physiological measures. For example, finding a significant correlation between threshold level and post stimulus alpha abundance for words presented with a red stimulus as opposed to a green stimulus, Dixon[19] suggests that red has a greater effect than green.

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17 C. Dodd and M. Lewis, "The Magnitude of the Orienting Response in Children as a Function of Changes in Color and Contour", Journal of Experimental Child Psychology, 1969, Vol. 1, p. 296.

18 R. Staples, "The Response of Infants to Color", Journal of Experimental Psychology, 1932, Vol. 5, p. 119-141.

19 N.F. Dixon, "E.E.G. Correlates of Threshold Regulation as a Function of Stimulus Wavelength; A Comparison Between Normal Subjects and Psychiatric Patients", British Journal of Psychiatry, 1966, Vol. 57, No. 3 and 4, p. 238-253.

Gerard[20] found a difference between the effect of watching red and that of watching blue upon the subjects respiration rate, pulse, P.G.R., and percentage alpha rhythm in the electroencephalogram. This effect was, however, only significant for subjects possessing a medium or high score on the Taylor Manifest Anxiety Scale. For subjects with a low anxiety index the effect was not significant.

Another physiological index which has been quite fruitful has been the electrodermal response. Wilson[21] has shown that electrodermal conductance level and initial electrodermal amplitude are significantly ($p. < .002$) greater for a red stimulus than for a green stimulus. Using the same independent variables, Nourse and Welch[22] found a significantly greater ($p. < .05$) response to a violet stimulus as opposed to a green stimulus.

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20 R.U. Gerard, "Differential Effects of Colored Lights on Psychophysiological Functions", unpublished doctoral dissertation, University of California, Los Angelos, California, 1958, as reported by G. Smets in Aesthetic Judgement and Arousal: An Experimental Contribution to Psycho-Aesthetics, Leuven University Press, Leuven, Belgium, 1973, p. 74.

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

22 J.D. Nourse and R.B. Welch, "Emotional Attributes of Color: A Comparison of Violet and Green", Perceptual and Motor Skills, 1971, Vol. 32, p. 403-406.

The bearing of these latter two studies is particularly important to the present study where a partial replication of the relative arousal value of short versus long wavelength hues will be provided in the question "Is red more physiologically arousing than blue when measures of initial electrodermal response amplitude and electrodermal habituation rate serve as dependent variables?"

2. Autonomic Involvement in Chromatic Experience

Relative to how color effects the organism are a number of investigations whose results would imply that more than being just the passive tabula rosa on which color is "written", the organism acts as the mediator of its color experience through its characteristic physiological/autonomic organization. Certainly Bornstein[23] has put forth a very convincing theory of biologically mediated (retinal attenuation) color experience to account for the common and consistent color naming practices which he shows to be related to solar proximity. Accepting the viability of this theory, when the possibilities implied are viewed in light of sociocultural learning and the complexities in the studies to be presented and the permutations in terms of individual

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23 M.H. Bornstein, "Color Vision and Color Naming: A Psychophysiological Hypothesis of Cultural Difference", Psychological Bulletin, 1973, Vol. 80, p. 257-285.

differences are considered, it is perhaps not surprising that research which has tried to demonstrate a one to one relationship between hue and behavioral correlates has oftimes failed to find significant results.

Particularly relevant to the possible involvement of the autonomic nervous system in the experience of color are the data of Kravkov[24] showing that adrenalin, a sympatheticomimetic agent, when applied to the pupil increases the sensitivity to blue-green stimuli; while pilocarpin conversely effects sensitivity. Similarly, Aiba[25] found that the visual threshold for a red stimulus was raised by amylobarbitone, a CNS depressant, and lowered by dexamphetamine, a CNS stimulant.

Analogous to these findings are studies involving the duration of visual after-image. Subsequent to oral ingestion of prostigamine or ephedrine, Kaplan[26, 27] found that subjects taking prostigamine experienced the greatest

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

25 S. Aiba, "The Suppression of the Primary Visual Stimulus", in H.J. Eysenck, (ed.), Experiments with Drugs, London: Pergamon, 1963, p. 49-55.

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

27 S.D. Kaplan, "Autonomic Visual Regulation", Psychiatric Research Reports, 1960, Vol. 12, p. 104-118.

negative after-image for a green stimulus while subjects taking ephedrine experienced the greatest negative after-image for a red stimulus. And, Costello[28] found that meprobamate (a CNS depressant) decreases the duration of the visual after-image for a red stimulus.

The apparent implication of these studies is that sympathetic arousal decreases sensitivity to hues of long-wavelength, while parasympathetic arousal has an opposite effect. Partial support of this possibility has been provided by Dixon[29] who found that in terms of the color of subliminally presented emotionally arousing (sympathetically arousing) words, threshold changes differed for a red and a green group. Whereas the red group was generally less sensitive to red during the presentation of emotional words the green group was significantly more sensitive to green during the presentation of the emotional subliminal stimulus item. The most conclusive evidence for autonomic involvement in color perception is provided by Allen and Schwartz[30] who

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28 C.G. Costello, "The Effects of Meprobamate on the Visual After-Image", in H.J. Eysenck, (ed.), Experiments with Drugs, London; Pergamon, 1963, p. 197-227.

29 N.F. Dixon, "Apparent Changes in the Visual Threshold: Central or Peripheral?", Journal of Psychology, 1960, Vol. 51, p. 297-309.

30 F. Allen and M. Schwartz, "The Effect of Stimulation of the Senses of Vision, Hearing, Taste and Smell Upon the Sensibility of the Organs of Vision", Journal of General Physiology, 1940, Vol. 24, p. 105-121.

found that the stimulation of the retina, the influence of loud noise, strong odors and tastes, all modes of sympathetic arousal, depress sensitivity to red stimuli and increase the sensitivity to green stimuli.

3. The Orienting Reaction, Sensitivity and Extraversion.

The Orienting Reaction is a system of reactions which either directly or indirectly provides the most favorable conditions for stimulus reception.[31] The system involves components which can be somatic (bodily oriented relative to the source of stimulation); autonomic (changes in electrodermal potential, vascular changes, changes in respiration, heart rate deceleration); and sensory (lowered sensory thresholds).[32]

The Orienting Reaction characteristically is an unspecific reflex initiated by any increase, decrease or qualitative change of a stimulus, regardless of modality, and it is subject to extinction or habituation on repeated presentation.[33] Currently the most widely accepted explanation

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31 Y. Sokolov, Perception and the Conditioned Reflex, New York, Pergamon Press, 1963, p. 132.

32 Y. Sokolov, "Neuronal Models and the Orienting Reflex," in M.A. Brazier (ed.), The Central Nervous System and Behavior, New York, J. Moon, 1960, p. 214-218.

33 Ibid., p. 189.

for the elicitation and habituation of the Orienting Reaction is provided by Sokolov's two-stage neuronal model[34] which assumes that the Orienting Reaction is a cortically aroused phenomenon. Eysenck, noting the similarities between the Sokolovian neuronal model for the Orienting Reaction and his own rationale for the neurological basis of Introversion/Extraversion, has suggested that the former may be usefully applied in the explication of his theory of Extraversion. According to Eysenck[35] Extraverts are centrally inhibited and suppressive of sensory input because of more easily triggered cortical activity of the thalamo-cortical inhibitory system. Introverts, by contrast, are more tonically aroused presumably because of a lower threshold of reticular arousal which enhances the efficiency of the sensory receptors.

The Orientation Reaction and it's stimulus reception facilitatory function was a major research interest of Sokolov.[36, 37] Demonstrating this relationship he reports[38]

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34 Ibid., p. 214-217.

35 H.J. Eysenck, The Biological Basis of Personality, Springfield, Ill., Charles C. Thomas, Publishers, 1970, p. 231.

36 Sokolov, "Neuronal Models....", Op. Cit., p. 187-276.

37 Sokolov, "Perception and the....", Op. Cit., p. I-390.

38 Ibid., p. I-309.

a number of studies of the type in which the arousal of an Orienting Reaction to a tone resulted in an increase in sensitivity to visual stimuli. Others[39, 40, 41, 42] exploring this relationship have, as well, demonstrated that the magnitude of the Orienting Reaction is related to attention, arousal, perceptual intake and discriminatory efficiency.

Within this context the linkage of Introversion/Extraversion with arousal and perceptual sensitivity has garnered some support. Smith[43] and Siddle et. al.[44] both found lower absolute sensory thresholds for Introverts than for

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39 J. Germana, "Response Characteristics and the Orienting Reflex", Journal of Experimental Psychology, 1968, Vol. 78, p. 610-616.

40 D.C. Raskin, "Semantic Conditioning and Generalization of Autonomic Responses", Journal of Experimental Psychology, 1969, Vol. 79, p. 69-76.

41 P.E. Baer and M.J. Fuhere, "Cognitive Processes in the Differential Trace Conditioning of Electrodermal and Vasomotor Activity", Journal of Experimental Psychology, 1970, Vol. 84, p. 178.

42 I. Maltzman and D.C. Raskin, "Effects of Individual Differences in the Orienting Reflex on Conditioning and Complex Processes", Journal of Experimental Research in Personality, 1965, Vol. 1, p. 1-16.

43 S.L. Smith, "Extraversion and Sensory Threshold", Psychophysiology, 1968, Vol. 5, p. 293-299.

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

Extraverts. Introverts have also been noted[45] to display greater behavioral arousal than Extraverts in their persistance at a vigilance task. This relationship has also been demonstrated by Ross et. al.[46] who found electrodermal conductance level to be positively related to high vigilance performance and by Coles and Gale[47] who found a positive relationship between GSR habituation rate and detection efficiency in a discrimination task.

Finally, the relationship between physiological arousal and Extraversion has been shown by Mangan and O'Gorman[48] who found Introverts to have longer Orienting Reaction habituation rates to auditory stimuli than Extraverts. Similarly, Sadler et. al.[49] noted a greater mean

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45 P. Bakan, "Extraversion-Introversion and Improvement in an Auditory Vigilance Task", British Journal of Psychology, 1959, Vol. 50, p. 325-332.

46 S. Ross, J. Dardano, R.C. Hackman, "Conductance Levels During Vigilance Task Performance", Journal of Applied Psychology, 1959, Vol. 43, p. 69.

47 M.G.H. Coles and A. Gale, "Physiological Reactivity as a Predictor of Performance in a Vigilance Task", Psychophysiology, 1971, Vol. 8, p. 598.

48 G.L. Mangan and J.G. O'Gorman, "Initial Amplitude and Rate of Habituation of OR in Relation to Extraversion and Neuroticism", Journal of Experimental Research in Personality, 1969, Vol. 3, p. 275-282.

49 T.G. Sadler, R.B. Mefferd and R.L. Houck, "The Interaction of Extraversion and Neuroticism in Orienting Response Habituation", Psychophysiology, 1971, Vol. 8, Nos. 1 and 3, p. 314.

number of GSR responses to Auditory stimuli for Introverts than for Extraverts.

4. Speculated Links Between Chromatic Sensitivity and the Autonomic Nervous System

While admittedly speculative, recent findings at the University of Ottawa offer some support for the hypothesized linkage between individual differences in Introversion/Extraversion and the sympathetic/parasympathetic involvement in sensitivity revealed in the research of Kravkov,[50] Kaplan,[51, 52] and Allan and Schwartz.[53]

Smith[54] exploring a trend revealed in the work of Bourgeois,[55] found that Introverts as measured by the Eysenck Personality Inventory (EPI) were more sensitive to blue stimuli than to red and that Extraverts were more

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50 Kravkov, Op. Cit., p. 335-337.

51 Kaplan, "A Visual Analog....", p. 383-388.

52 Kaplan, "Autonomic....", p. 104-118.

53 Allan and Schwartz, Op. Cit., p. 105-121.

54 P.F. Smith, "Extraversion-Introversion and Chromatic Recognition Sensitivity to Red and Blue Hues", unpublished Masters thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1974, p. I-83.

55 R.P. Bourgeois, "Introversion-Extraversion and the Role of the Orienting Reaction Habituation Rate in Sensitivity to the Apparent Size of Hue", unpublished Doctoral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1972, p. I-131.

sensitive to red stimuli than to blue when both hues were equated for luminance and saturation. The similarity of these findings with those of Kravkov, Kaplan, and Allan and Schwartz seem to point toward a complex involvement of the autonomic nervous system and individual differences in Extraversion. From the correlates of these results, i.e., Extraversion/parasympathetico-mimetic agents and Introversion/sympathetico-mimetic agents and intermodal sensory stimulation, it would be speculated that Extraverts demonstrate parasympathetic dominance while Introverts demonstrate sympathetic dominance. That is, Extraverts would be expected to be more sensitive to red than blue while Introverts would be expected to be more sensitive to blue than to red.

From the relationship which has been observed between sensitivity of intake and Orienting Reaction arousal it might also be anticipated that Extraverts would experience greater Orienting Reactivity to a red stimulus than to a blue stimulus, while the opposite would obtain for Introverts.

5. Summary and Statement of Hypotheses

As has been noted, amplitude of electrodermal response is related to sensitivity of stimulus intake and has also provided an index of arousal value for hues of high and low wavelength. Similarly, electrodermal habituation rate has been noted to be related to stimulus intake and superior discriminatory ability. Using these measures, the present study is designed to investigate the initial amplitude and habituation rate of electrodermal response to red and blue hue stimuli among groups varying in degrees of Extraversion as defined by the Eysenck Personality Inventory (EPI).

One common theme in the literature on the relationship between individual differences and color is that Extraverts tend toward a preference for hues of long wavelength while Introverts tend to prefer hues of short wavelength. Studies exploring the subjective experience of color have repeatedly shown that descriptors applied to colors of long wavelength are dynamic while those for hues of short wavelength are of a passive nature. Exploration of the effects which different hues have on the organism have consistently shown that red and colors of long wavelengths are more physiologically arousing than blue and colors of short wavelengths. Research at the Faculty of Psychology of the University of Ottawa, using the Eysenckian model of personality, has shown that Introverts have a greater sensitivity for blue than for red; while the reverse is true for Extraverts. Experimental studies have indicated that a relationship between color sensitivity and autonomic arousal exists such that sympathetic arousal decreases sensitivity to red (colors of long wavelength) and increases sensitivity to green (hues of short wavelength). Other studies have implied that parasympathetic arousal (or sympathetic quiescence) has a reverse effect. It has been speculated that individual differences in color sensitivity which have been shown to exist between Introverts and Extraverts may be understood in terms of individual differences in levels of Extraversion and sympathetic/parasympathetic activity. These differences should be amenable to exploration using the electrodermal response parameter of the Orienting Reaction which has been shown to be positively correlated with sensitivity of stimulus intake.

The general problem area which this study, then, embraces, involves the search to define a rationale for the relationship between Extraversion and response to chromatic stimuli on the basis of the autonomic indices provided by initial electrodermal response amplitude and electrodermal response habituation rate. The specific route which the present research takes attempts to determine whether Introverts exhibit greater electrodermal response (amplitude and habituation rate) to a blue stimulus than to a red stimulus and whether or not the converse of this relationship is applicable for Extraverts. Of secondary interest is the relationship which exists between electrodermal response (amplitude and habituation rate) and red and blue hue stimuli; i.e., "Is electrodermal response greater for a red hue stimulus than for a blue hue stimulus?".

Specifically, the following hypotheses, stated in the null, encompass the thrust of the present research:

1. There is no significant Hue-Extraversion interaction for the initial electrodermal amplitude data.

2. There is no significant difference between the initial electrodermal amplitude for red and blue hue stimuli.

3. There is no significant Hue-Extraversion interaction for the electrodermal habituation rate data.

4. There is no significant difference between the electrodermal habituation rate data for red and blue hue stimuli.

CHAPTER II

EXPERIMENTAL DESIGN

This chapter presents the methodology of the experiment. It describes the subjects from whom the electrodermal measures were gathered and presents the classification instrument and the classification data for the Introverted, Ambiverted and Extraverted groups. The hue stimuli and the apparatus used to present the stimuli are then discussed. This is followed by a presentation of the equipment and materials attendant to the recording of the electrodermal measures. Methods and criteria for quantification of the physiological data are subsequently given. The chapter concludes with an explanation of the experimental design and the statistical procedures involved in the testing of the hypotheses outlined in Chapter I.

1. Classification of Subjects

The subjects were sixty women varying in age from eighteen to thirty-two. They were from such diverse areas of activity as teaching, secretarial work, student, journalism, cartography, housewife, nursing, medical technology and psychology. Participation in the experiment was voluntary and gratis. The subjects were solicited in person or by telephone following receipt of the Eysenck Personality

Inventory (EPI)[1] by the author either directly from subjects he had approached or from associates of the author who were recruiting subjects on his behalf.

As a psychological instrument the EPI was designed as a dimensional system of personality classification to replace categorical psychiatric classifications. It purports measuring two distinct and orthoganal personality dimensions, namely, Extraversion/Introversion and Neuroticism/Stability. Farley[2] and Eysenck and Eysenck[3] have presented evidence for the independence of these two dimensions. Form B, as used in this study, is composed of fifty-seven items to which the subject provides responses of true or false. Form B of the EPI is presented as Appendix 1.

For purposes of comparison all subjects were differentiated into one of three groups according to their scores on the EPI: Introverted, Ambiverted or Extraverted. The means of the Extraversion and Neuroticism factors for the total sample were 13.78 and 11.42 with standard deviations

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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.

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, 1963, Vol. 23, p. 46.

of 4.65 and 4.48, respectively. These values are noted to be quite similar to norms provided by Eysenck[4] on a normal population. The means of the Extraversion factor for the Introverted, Ambiverted and Extraverted groups were 8.45, 13.80 and 19.10 with corresponding standard deviations of 1.61, 1.36 and 1.71. The means of the Neuroticism factor for the Introverted, Ambiverted and Extraverted groups were 12.94, 11.00 and 10.30 with standard deviations of 4.99, 4.44 and 3.70, respectively. The means and standard deviations for the Extraversion and Neuroticism dimensions of the EPI for the test sample and the three sample groups are shown in Table I.

Analysis of variance on the sample data revealed that the three groups of subjects differed significantly from each other on the Extraversion factor ($F_{2,57}=230.53$; $p < .001$), but did not differ significantly on the Neuroticism factor ($F_{2,57}=1.94$; $p > .05$). The F_{max} test showed that the homogeneity of variance assumption was met for both analyses.

The mean ages for the Introverted, Ambiverted and Extraverted groups were 23.74, 24.42, and 22.79 years with corresponding standard deviations of 2.68, 3.45 and 2.24 years, respectively. The mean ages and standard deviations

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4 Eysenck, "Manual for the....", Op. Cit., p. 10.

Table I

EPI Form B Score Distributions on Extraversion (E) and Neuroticism (N) and Age Distributions for the Total Sample, Introverted (I), Ambiverted (A) and Extraverted (E) Groups.

Group	Size	Extraversion		Neuroticism		Age	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Total	60	13.77	4.65	11.42	4.48	23.65	2.87
(I)	20	8.45	1.61	12.95	4.99	23.74	2.68
(A)	20	13.80	1.36	11.00	4.44	24.42	3.45
(E)	20	19.10	1.71	10.30	3.70	22.79	2.25

Note: The raw Extraversion (E) and Neuroticism (N) scores and the Ages for the Introverted, Ambiverted and Extraverted subjects are given in Appendix 2.

for the total sample and for subjects within the Introverted, Ambiverted and Extraverted groups are shown in Table I.

Analysis of variance of the age data indicated that the three groups of subjects did not differ significantly from each other with respect to age ($F_{2,57}=1.58; p > .05$). The homogeneity of variance assumption was met as indicated by an F_{max} test.

In order to insure the appropriateness of the subjects for an experiment utilizing hue stimuli they were each screened for color blindness with the Dvorine Color Perception Training Charts.[5] None of the subjects was found to be color blind.

2. Hue Stimuli

The stimuli, representing two hues, red (6R) and blue (6B) and a neutral stimulus of gray, were constructed of Munsell papers.[6] The red, blue and gray were equated for value, Munsell value 6. Each of the two hues had the same level of saturation, Munsell chroma 8. All three stimuli were essentially equivalent for luminous reflectance and value.

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5 I. Dvorine, Dvorine Color Perception Training Charts, Baltimore, Maryland, Waverly Press, 1944, Vol. 2.

6 Munsell Book of Color, Baltimore, Maryland, Munsell Color Company, 1943.

Each of the three stimuli, measuring five by seven inches was placed in a five by seven inch stainless steel card holder for ready placement of the stimulus in the appropriate channel of the tachistoscope in which presentation of the stimuli was made.

3. Apparatus for Presentation of the Stimuli

Two channels (blank and field #2) of a Scientific Prototype 3-Channel Tachistoscope, Model GB[7] were used to present the stimuli. The optical system is a 3-channel Dodge Type with three mirrors to bring the three fields into a common plane and give similar visual brightness for identical illumination. The mirrors have a special front surface laminated with a magnesium flouride anti-reflection back coating. Each channel contains two lamps which illuminate the stimulus material. The channel (field #2) in which the hue stimuli were presented and the channel (blank) in which the interstimulus neutral gray was presented both had an illumination level of 3.6 footcandles as measured by the Spectra Pritchard Photometer, Model 1970-PR. The viewing distance from the subject to the stimulus was 119.4 centimeters. The visual angles subsumed were 2°24' on the

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7 Instruction and Maintenance Manual: Three Channel Tachistoscope, Model GB, Scientific Prototype Manufacturing Corporation, New York, N. Y., 10027.

vertical plane and 3°24' on the horizontal plane.

To insure that subject responses were to the hue stimuli and not to extraneous auditory stimuli each subject was fitted with earphones connected to a Philips Sonalgenic Model CP-9100[8] white noise generator operating at 81 decibels.

4. Equipment and Material Attendant to Electrodermal Recording

An electrolytic medium, suggested by Lykken[9], was utilized. It's composition was one pound of Unibase (Parke-Davis) whipped into one half part by volume of physiological saline. Providing contact with the electrolytic medium were silver electrodes (.9 centimeters in diameter) made by Grass Instruments Company.[10] These were maintained as silver-silver-chloride electrodes according to a method recommended by Lykken.[11]

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8 Instruction Booklet, Sonalgenic Model CP-9100, Philips Electronic Industries Limited, Toronto, Ontario, p. 1-6.

9 D.R. Lykken and P.H. Venables, "Direct Measurement of Skin Conductance: A Proposal for Standardization", Psychophysiology, 1971, Vol. 8, No. 5, p. 665.

10 Grass Instruments Company, Quincy, Massachussetts

11 D.R. Lykken, "Properties of Electrodes Used in Electrodermal Measurement", Journal of Comparative and Physiological Psychology, 1959, Vol. 52, No. 5, p. 631.

Following methyl alcohol cleansing of the skin, electrode placement was made to the second phalanx of the distal and third fingers of the right hand. An area of one square centimeter was masked off with a water proof tape and the electrolytic medium applied to that area. The electrode was then centered to this area and taped and sealed securely. The subject was asked to relax her arm and hand on the arm of the chair and to not bend her fingers in order to avoid disturbing the electrode contact.

The electrodes were attached to an electrodermal transducer box incorporating a constant current electrodermal method using an operational amplifier technique to give 10 microamps constant current. This provided the basal skin resistance plus the response. To get only the response an amplifier and a high pass filter with a time constant of two seconds was used.

The transducer box fed into a Watanabe Multi-Corder Model MC611-S61.[12] The multicorder is a three channel servo-type potentiometric recorder designed for research calling for synchronous recording of simultaneous input variables. This transistorized recorder affords highly precise and stable data in three channels of ten inch overlap recording with a one-fifth time unit delay between each pen.

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12 Maintenance Manual for Multicorder, Model MC611-S61, Watanabe Instruments Corporation, Tokyo, Japan.

One channel provided D.C. recordings of absolute electrodermal resistance and the second channel provided amplified A.C. recordings of the response resistance change. A third channel was an event marker activated by a relay from the tachistoscope. The recorder was set at five volts full scale for the D.C. channel and five volts full scale for the A.C. channel. The chart speed was set at 300 milimeters per hour for the ten minutes prior to the first stimulus presentation just before which it was reset to 300 milimeters per minute where it remained for the duration of the recording session.

5. Quantification of Electrodermal Response

Electrodermal responses were recorded as change in resistance utilizing both A.C. and D.C. recordings. The D.C. channel provided an absolute measure of the basal level of resistance. Sensitivity settings for this channel varied such that one complete excursion of the pen over the graph paper represented either 500 kilohms or 1000 kilohms, depending on individual differences in basal resistance level. The A.C. channel provided an amplification of response changes in resistance and was maintained at a constant sensitivity setting such that one complete excursion of the pen over the graph paper represented a 20 kilohm change.

The advantage of this system is one of optimal accuracy wherein the response change in resistance is provided by the amplified A.C. recordings while the D.C. channel provides an ongoing measure of the absolute level of resistance. This latter measure was essential for conversion of resistance changes into changes in conductance.

Although most all responses were within a range readily recorded by the A.C. channel, when the magnitude of a response was so great as to be off-scale the response was scored from the D.C. channel by taking a reading of basal resistance at the onset of a response and subtracting from it the basal resistance at the point of greatest decrease in resistance before a subsequent increase. Though some loss of accuracy occured in these instances, when responses were of such magnitude the loss was insignificant.

Only the first observable decrease in resistance of 400 ohms or greater occuring between the onset of the stimulus and six seconds thereafter were scored as stimulus-bound responses. These criteria are in accord with those established in the current literature.[13, 14, 15]

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13 J. Germana, "Response Characteristics and the Orienting Reflex", Journal of Experimental Psychology, 1968, Vol. 78, p. 612.

14 J.G. O'Gorman, G.L. Mangan and J.A. Gowen, "Selective Habituation of Galvanic Skin Response Component of the Orienting Reaction to an Auditory Stimulus", Psychophysiology, 1970, Vol. 6, p. 716-721.

15 T.G. Sadler, R.B. Mefferd and R.L. Houck, "The Interaction of Extraversion and Neuroticism in Orienting Response Habituation", Psychophysiology, 1971, Vol. 8, p. 313.

Since analysis of variance has been shown to provide different results for different methods of quantifying electrodermal data[16] and since an "appropriate" mode of quantification from the plethora of different methods of quantifying electrodermal data remains a point of debate within the literature,[17, 18] it was planned at the outset to quantify the data by those methods most popularly reported in the literature: Change in Resistance, Change in Conductance and Change in Log of Conductance. While a number of the different methods of quantification were designed to deal with the Law of Initial Value (LIV),[19] the appropriateness of making such adjustment when groups of different composition serve as an independent variable has been strongly questioned by Montagu and Coles[20] and recognized as a questionable

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16 E.A. Haggard, "On the Application of Analysis of Variance to GSR Data: II. Some Effects of the Use of Inappropriate Measures", Journal of Experimental Psychology, 1949, Vol. 39, p. 861-867.

17 H.A. Heath, and D. Oken, "The Quantification of 'Response' to Experimental Stimuli", Psychosomatic Medicine, 1965, Vol. 27, p. 457-471.

18 D.R. Lykken and P.H. Venables, "Direct Measurement of Skin Conductance: A Proposal for Standardization", Psychophysiology, 1971, Vol. 8, No. 5, p. 656-671.

19 J. Wilder, "Basimetric Approach (Law of Initial Value) to Biological Rhythms", Annals of the New York Academy of Sciences, 1962, Vol. 98, p. 1211-1228.

20 J.D. Montague and E.M. Coles, "Mechanism and Measurement of the Galvanic Skin Response", Psychological Bulletin, 1966, Vol. 65, No. 5, p. 261-279.

procedure by Lykken.[21] In as much as the present study incorporates as an independent variable groups which reportedly differ on a physiological basis the present author accepts the position of these authors in not adopting a procedure specifically designed to remove the effects of LIV.

Although, as previously noted, Change in Resistance measures were made directly, conversions were made to obtain the Change in Conductance and the Change in Log of Conductance scores by using the following formulae where: R_1 = the basal level of resistance at the onset of the response and R_2 = the basal level of resistance at the point of greatest decrease preceding an increase:

$$1000\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \text{Change in Conductance}$$

$$100\left(\log_{10}\frac{1}{R_1} - \log_{10}\frac{1}{R_2}\right) = \text{Change in Log of Conductance}$$

The electrodermal habituation rate is defined as the number of stimulus repetitions preceding three consecutive non-responses (responses of less than 400 ohm Change in Resistance) to the stimulus presentation. This criterion, established by Sokolov,[22] was selected on the basis of current

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21 Lykken and Venables, Op. Cit., p. 670-671.

22 E.N. Sokolov, Perception and the Conditioned Reflex, Oxford: Pergamon Press, 1963.

practices in Orienting Reaction research.[23, 24, 25, 26]

6. The Experimental Procedure

As the subjects presented themselves at the laboratory they were randomly assigned to one of two groups of ten subjects each, within the particular level of Extraversion for which the subject qualified, according to the demands of the experimental design.

Subsequently, the chair in which the subject was to be seated was adjusted to allow an adequate fit to the viewing hood of the tachistoscope. Each subject was then briefed as follows:

> As you seat yourself before the tachistoscope I would like you to assume a position in which you will be maximally comfortable for approximately thirty minutes. It is important that you make as few bodily movements as possible as these will distort the skin response measurements being recorded. If movements are necessary please confine these to those periods immediately following a period of a few seconds after the offset of the colored stimulus to be presented and during the time in which a neutral gray interstimulus is

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23 Sadler _et. al._, _Op. Cit._, p. 313.

24 F.L. Royer, "Cutaneous Vasomotor Components of the Orienting Reflex", _Behavior Research and Therapy_, 1965, Vol. 3, p. 161.

25 O'Gorman _et. al._, _Op. Cit._, p. 718.

26 E.S. Katkin and R.J. McCubbin, "Habituation of the Orienting Response as a Function of Individual Differences in Anxiety and Autonomic Lability", _Journal of Abnormal Psychology_, 1969, Vol. 74, p. 54-60.

> present. In order to allow you to relax and become accustomed to the apparatus you will be viewing this gray neutral stimulus for approximately ten minutes before presentation of the first colored stimulus. Your task is to remain as relaxed as possible while attending to the lighted rectangular field within the tachistoscope. A set of earphones through which you will hear a sound comparable to a nearby waterfall will be placed over your ears. The purpose of this is to eliminate any extraneous auditory stimuli which might occur. The experiment is completely harmless and no noxious stimuli will be applied. The electrodes which will be attached to your right hand are merely to record the electrical activity of your skin over the course of the experiment. Following the experiment an explanation of the hypotheses being investigated will be provided. Have you any questions.

If there were no questions the electrodes were then applied, the earphones fitted, the subject placed in position before the viewing hood of the tachistoscope and the room darkened. The equipment attendant to the experiment was then activated.

Following ten minutes during which the subject viewed the neutral gray interstimulus, the first hue stimulus (red or blue according to the subjects random group assignment) was presented. The first hue stimulus and each one thereafter was presented for a period of four seconds alternating with the neutral gray interstimulus. The period of the neutral gray interstimulus varied randomly between twenty-five and thirty-five seconds in an effort to attenuate anticipatory responses. Randomization of the interstimulus period was accomplished by manual manipulation of the tachistoscope timer. Following twenty presentations of the appropriate first hue stimulus and during the period in which the neutral gray interstimulus was present in the blank channel, the first hue stimulus was removed from channel #2 and replaced by the second hue stimulus. The second hue stimulus then continued the series unbroken for twenty further presentations following the procedure just discussed. Following the twentieth presentation of the second hue stimulus all equipment was inactivated, the electrodes and earphones removed, and the subject informed of the purpose of the experiment and asked not to discuss the experiment with anyone whom she may know who was yet to participate as a subject in the study.

7. Experimental Design and Statistical Procedures

Three levels of the Extraversion factor (Introverted, Ambiverted and Extraverted groups)and two levels of the hue factor (red and blue) comprised the principle independent variables for this study. The third variable, a product of the experimental design, was one of Order (First and Second). As has sometimes been observed when two stimulus series are presented in succession there is a progressively diminishing response to the total experiment which affects response to the specific stimulus of interest, i.e., the response to the second stimulus series is generally less than to the first stimulus series. Ordinarily this effect is confounded with the response of interest or treated by employing designs which do not involve repeated measures. Although this effect has no direct bearing on the present study, it was economical and of interest to present both stimuli to all subjects in order to maximize the available information. To accomplish this and avoid the noted difficulties a modified Latin Squares design was adopted which entailed the additional independent variable of Order of Presentation.

The design[27] considers all factors to be fixed and considers the group factor and the subjects within groups to be random. All interactions with the group and subject effects are considered negligible. This modified Latin Squares design utilizes the same square for all three levels of the Extraversion factor. Within each of the squares are confounded the same components of the Hue and Order interactions; while the same components of the Extraversion, Hue and Order interaction are confounded in the differences between squares. Thus full information is provided on all main effects as well as on some components of both the Hue-Order and Extraversinn-Hue-Order interactions.

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27 B.J. Winer, Statistical Principles In Experimental Design, 2nd Ed., New York, McGraw-Hill, 1971, p. 727-736.

Statistical analysis involved a three way analysis of variance as outlined by Winer.[23] The Tukey[24] test for significance of difference between means served as the appropriate post hoc procedure. The relationship between those variables of interest was established with the Pearson Product Moment Coefficient of Correlation.[25]

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23 Winer, Op. Cit., p. 729-735.

24 V. Keith, Design and Analysis in Experimentation, Faculty of Education, University of Ottawa, Ottawa, Ontario, p. 202-204.

25 Ibid., p. 61-70.

CHAPTER III

PRESENTATION OF RESULTS

This chapter presents the results of the statistical analyses of the data. It begins with an examination of the analyses for the initial amplitude data. This is followed by the presentation of the habituation data. The chapter concludes with the presentation of a matrix of correlations which were found to be of interest.

1. Initial Amplitude Data

The amplitude of electrodermal response to the first stimulus for red and blue hue stimuli in the first and second order presentation positions for groups differing on the Extraversion dimension was observed for each of the methods of quantification and the analyses made. Interscorer rating reliability for the electrodermal amplitude data was .96.

For the initial Change in Resistance amplitude scores analysis of variance revealed no significant difference for: the Extraversion factor ($F_{2,54}=1.56; p > .05$); the Hue factor ($F_{2,54}=.78; p > .05$); the Order-Extraversion interaction ($F_{2,54}=.79; p > .05$); the Hue-Extraversion interaction ($F_{2,54}=.09; p > .05$). A significant difference was observed for the Order factor ($F_{1,54}=20.72; p < .001$). The means for the first and second Order positions for the initial Change in

Resistance amplitude scores were 28.04 and 9.69, respectively. A summary of the means, standard deviations and their averages for Order positions one and two for the experimental groups are provided in Appendix 3. Results of the analysis of variance of the initial Change in Resistance amplitude scores is presented in Table II.

Analysis of variance of the initial Change in Conductance amplitude scores showed no significant differences for: the Extraversion factor ($F_{2,54}$=2.18;$p > .05$); the Hue factor ($F_{1,54}$=1.00;$p > .05$); the Order-Extraversion interaction ($F_{2,54}$=.79;$p > .05$); the Hue-Extraversion interaction ($F_{2,54}$=.09;$p > .05$). A significant difference was observed for the Order factor ($F_{1,54}$=28.00;$p < .05$). The means for the first and second Order positions for the initial Change in Conductance amplitude scores were .362 and .146, respectively. A summary of the means, standard deviations and their averages for Order positions one and two are presented in Appendix 3. The analysis of variance table is presented in Table III.

Similar to the analyses of the initial Change in Resistance and Change in Conductance amplitude scores, the analysis of variance of the initial Change in Log of Conductance amplitude scores showed no significant differences for: the Extraversion factor ($F_{2,54}$=2.45;$p > .05$); the Hue factor ($F_{1,54}$=.09;$p > .05$); the Order-Extraversion interaction

Table II

Analysis of Variance of the Initial Change in Resistance Amplitude Scores for the First Presentation of the Red and Blue Hue Stimuli in Order Positions One and Two for Extraversion Groups.

Source of Variation	SS	df	MS	F Ratio
Between Subjects	55719.05	59		
C(Extraversion)	3030.90	2	1515.45	1.56
Rows	25.12	1	25.12	.03
C X Row	41.83	2	20.92	.02
Subjects within groups	52621.20	54	974.47	
Within Subjects	37635.46	60		
A(Order)	10092.51	1	10092.51	20.72[a]
B(Hue)	378.43	1	378.43	.78
AC	775.88	2	387.94	.79
BC	84.68	2	42.34	.09
(AB)'	.00	0	.00	.00
(ABC)'	.90	0	.00	.00
Error within	26303.06	54	487.09	

a $p < .001; F_{.95}(1,54) = 12.16$

Note: The initial Change in Resistance amplitude scores for Introverted, Ambiverted, Extraverted subjects are given in Appendix 4.

Table III

Analysis of Variance of the Initial Change in Conductance Amplitude Scores for the First Presentation of the Red and Blue Hue Stimuli in Order Positions One and Two for Extraversion Groups.

Source of Variation	SS	df	MS	F Ratio
Between Subjects	10.49	59		
C(Extraversion)	.73	2	.37	2.18
Rows	.51	1	.51	3.00
C X Row	.17	2	.09	.53
Subjects within groups	9.08	54	.17	
Within Subjects	4.29	60		
A(Order)	1.40	1	1.40	28.00[a]
B(Hue)	.05	1	.05	1.00
AC	.10	2	.05	1.00
BC	.01	2	.01	.20
(AB)'	.00	0	.00	.00
(ABC)'	.00	0	.00	.00
Error within	2.73	54	.05	

a $p < .001; F_{.95}(1,54) = 12.16$

Note: The initial Change in Conductance amplitude scores for Introverted, Ambiverted and Extraverted subjects are given in Appendix 4.

($F_{2,54}$=1.26;$p > .05$); the Hue-Extraversion interaction ($F_{2,54}$=.05;$p > .05$). Again a significant difference for the Order factor was observed ($F_{1,54}$=32.26;$p < .001$). The means for the first and second Order positions for the initial Change in the Log of Conductance amplitude scores were 3.95 and 1.47, respectively. A summary of the means, standard deviations and their averages for Order positions one and two for the experimental groups is presented in Appendix 3. The analysis of variance table is presented in Table IV.

As is commonly noted with physiological data, electrodermal response in particular, F_{max} testing showed that the homogeneity of variance assumption was not met for any one of the methods of quantification (see Table V). In order to overcome this problem electrodermal studies[1, 2, 3] commonly incorporate a square root transformation[4] of the raw data prior to analysis. By making such a transformation the

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1 J. Germana, "Response Characteristics and the Orienting Reflex, Journal of Experimental Psychology, 1968, Vol. 78, No. 4, p. 612.

2 R.A. Lockhart, "Interrelations Between Amplitude, Latency, Rise Time, and the Edelberg Recovery Measure of the Galvanic Skin Response", Psychophysiology, 1972, Vol. 9, No. 4, p. 437-442.

3 T. Uno, "The Effects of Awareness and Successive Inhibition on Interoceptive and Exteroceptive Conditioning of the Galvanic Skin Response", Psychophysiology, 1970, Vol. 7, No. 1, p. 27-43.

4 W.W. Grings and D.E. O'Donnell, "Magnitude of Response to Compounds of Discriminated Stimuli", Journal of Experimental Psychology, 1956, Vol. 52, p. 354-359.

Table IV

Analysis of Variance of the Initial Change in the Log of Conductance Amplitude Scores for the First Presentation of the Red and Blue Hue Stimuli in Order Positions One and Two for Extraversion Groups.

Source of Variation	SS	df	MS	F Ratio
Between Subjects	921.44	59		
C(Extraversion)	74.90	2	37.45	2.45
Rows	20.94	1	20.94	1.37
C X Row	1.40	2	.70	.05
Subjects within groups	824.21	54	15.26	
Within Subjects	506.87	60		
A(Order)	183.89	1	183.89	32.26[a]
B(Hue)	.03	1	.03	.01
AC	14.37	2	7.19	1.26
BC	.61	2	.31	.05
(AB)'	.00	0	.00	.00
(ABC)'	.01	0	.00	.00
Error within	307.96	54	5.70	

a $p < .001; F_{.95}(1,54) = 12.16$

Note: The initial Change in the Log of Conductance amplitude scores for Introverted, Ambiverted and Extraverted subjects are given in Appendix 4.

Table V

F_{max} Values for the Amplitude Scores and for the Transformed Amplitude Scores Quantified as Change in Resistance, Change in Conductance and Change in the Log of Conductance.

Method of Quantification	Raw Scores	Transformed Scores ($\sqrt{X+.5}$)
Change in Resistance	99.98[a]	13.24[a]
Change in Conductance	34.40[a]	17.75[a]
Change in the Log of Conductance	91.44[a]	16.50[a]

a $_{.95}F_{max}(12,9) = 10.07$

magnitude of extreme responses are effectively reduced while responses of lesser magnitude are left relatively unchanged thus rendering the variances more homogeneous and appropriate for analysis of variance without changing the relative scalar positions of responses.

Following analysis of variance of the raw data in the present study a square root transformation of the data was thus performed such that each score (S) became ($\sqrt{X+.5}$). Although the F_{max} values, presented in Table V, indicated that the homogeneity of variance assumption still remained unmet for all methods of quantification, in light of Glass, Peckham and Sanders,[5] and Scheffe',[6] the ratios indicate violations of the assumption which are of an acceptable magnitude. The presentation of the analyses of these transformed scores follows.

Analysis of variance of the transformed initial Change in Resistance amplitude scores revealed no significant differences for: the Extraversion factor ($F_{2,54}=1.03; p > .05$); the Hue factor ($F_{1,54}=.04; p > .05$); the Order-Extraversion interaction ($F_{2,54}=.18; p > .05$); the Hue-Extraversion

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5 G.V. Glass, P.D. Peckham and J.R. Sanders, "Consequences of Failure to Meet Assumptions Underlying the Fixed Effects Analyses of Variance and Covariance", Review of Educational Research, 1972, Vol. 42, No. 3, p. 237-288.

6 H. Scheffe', The Analysis of Variance, John Wiley and Sons, Inc., New York, 1967, p. 345.

interaction ($F_{2,54}$=.16;$p>.05$). A significant difference was observed for the Order factor ($F_{1,54}$=28.02;$p<.001$). The means for the first and second Order positions for the transformed initial Change in Resistance amplitude scores were 4.602 and 2.483, respectively. A summary of the means, standard deviations and their averages for Order positions one and two for the experimental groups are presented in Appendix 3. The analysis of variance is shown in Table VI.

For the transformed initial Change in Conductance amplitude scores, analysis of variance showed no significant differences for: the Extraversion factor ($F_{2,54}$=2.16;$p>.05$); the Hue factor ($F_{1,54}$=.83;$p>.05$); the Order-Extraversion interaction ($F_{1,54}$=.83;$p>.05$); the Hue-Extraversion interaction ($F_{1,54}$=.00;$p>.05$). Significance of difference was observed for the Order factor ($F_{1,54}$=31.65;$p<.001$). The means for the first and second Order positions for the transformed initial Change in Conductance amplitude scores were .906 and .793, respectively. A summary of the means, standard deviations and their averages for Order positions one and two for the experimental groups are presented in Appendix 3. The analysis of variance for the transformed Change in Conductance scores is presented in Table VII.

For the transformed initial Change in the Log of Conductance amplitude scores no significant differences were observed for: the Hue factor ($F_{1,54}$=.03;$p>.05$); the Order-

Table VI

Analysis of Variance of the Transformed ($\sqrt{X+.5}$) Initial Change in Resistance Amplitude Scores for the First Presentation of the Red and Blue Hue Stimuli in Order Positions One and Two for Extraversion Groups.

Source of Variation	SS	df	MS	F Ratio
Between Subjects	637.80	59		
C(Extraversion)	22.43	2	11.22	1.03
Rows	13.64	1	13.64	1.25
C X Row	11.12	2	5.56	.51
Subjects within groups	590.61	54	10.94	
Within Subjects	398.15	60		
A(Order)	134.76	1	134.76	28.02[a]
B(Hue)	.19	1	.19	.04
AC	1.70	2	.85	.18
BC	1.52	2	.76	.16
(AB)'	.01	0	.00	.00
(ABC)'	.01	0	.00	.00
Error within	259.98	54	4.81	

a $p < .001; F_{.95}(1,54) = 12.16$

Note: The transformed initial Change in Resistance amplitude scores for Introverted, Ambiverted and Extraverted subjects are given in Appendix 4.

Table VII

Analysis of Variance of the Transformed ($\sqrt{X+.5}$) Initial Change in Conductance Amplitude Scores for the First Presentation of the Red and Blue Hue Stimuli in Order Positions One and Two for Extraversion Groups.

Source of Variation	SS	df	MS	F Ratio
Between Subjects	2.76	59		
C(Extraversion)	.19	2	.095	2.16
Rows	.13	1	.130	2.95
C X Rows	.04	2	.020	.45
Subjects within groups	2.40	54	.044	
Within Subjects	1.06	60		
A(Order)	.38	1	.380	31.67[a]
B(Hue)	.01	1	.010	.83
AC	.02	2	.010	.83
BC	.00	2	.000	.00
(AB)'	.00	0	.000	.00
(ABC)'	.00	0	.000	.00
Error within	.65	54	.012	

a $p < .001; F_{.95}(1,54) = 12.16$

Note: The transformed initial Change in Conductance amplitude scores for Introverted, Ambiverted and Extraverted subjects are given in Appendix 4.

Extraversion interaction ($F_{1,54}$=.27;$p>.05$); the Hue-Extraversion interaction ($F_{1,54}$=.00;$p>.05$). This analysis, aside from the commonly noted significant difference for the Order factor ($F_{1,54}$=16.22;$p<.001$), also showed a significant difference for the Extraversion factor ($F_{2,54}$=3.37;$p<.05$). The means for the first and second Order positions for the transformed initial Change in the Log of Conductance amplitude scores were 1.873 and 1.241, respectively. The mean amplitudes for the Introverted, Ambiverted and Extraverted groups were 1.809, 1.516 and 1.345, respectively. The means for the first and second Order positions and the means for the experimental groups are provided in Appendix 3. While the largest difference between the experimental groups is noted to be that between the Introverted and Extraverted groups, it failed to emerge as significant when subjected to the very conservative Tukey test for the significance of difference between means. Results of this test are provided in Table VIII. A geometric representation of the mean amplitude scores for the Hue stimuli in Order positions one and two for Introverts, Ambiverts and Extraverts is presented in Figure 1. The analysis of variance for the transformed initial Change in the Log of Conductance amplitude scores is presented in Table IX.

Table VIII

Tukeys Test for Significance of Difference Between Pairs of Group Means for the Transformed ($\sqrt{X+.5}$) Initial Change in the Log of Conductance Amplitude Scores for Introverted (I), Ambiverted (A) and Extraverted (E) Groups.

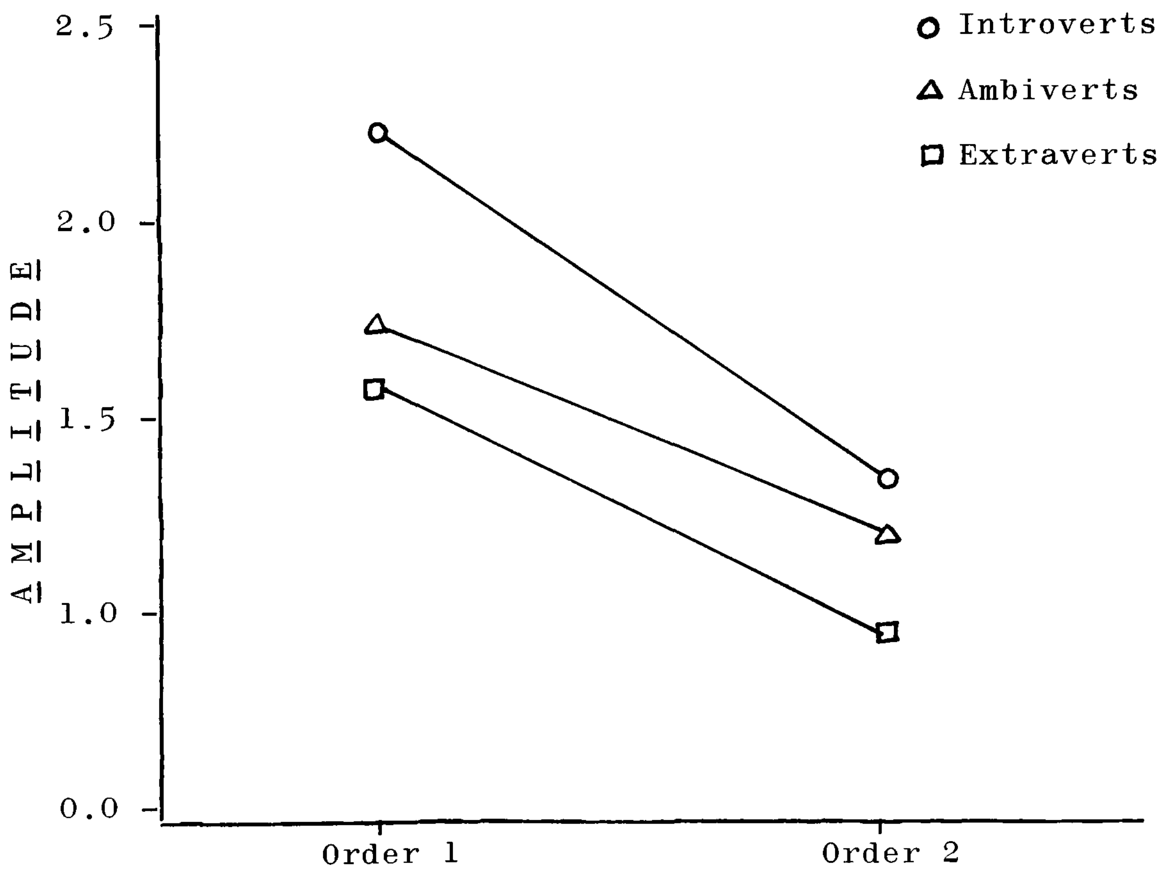
Comparison of Means	Absolute Contrast[a]	q statistic[b]	p[c]
I-A	.293	1.626	n.s.
I-E	.464	2.575	n.s.
A-E	.171	.949	n.s.

a Means for Introverted, Ambiverted and Extraverted subjects were 1.809, 1.516 and 1.345, respectively.

b q statistic = HSD or Contrast/.180

c $_{.95}q_{(3,57)} = 3.405$

Figure 1



Mean of the Transformed $(\sqrt{X+.5})$ Initial Change in the Log of Conductance Amplitude Scores for the First Presentation of the Hue Stimuli in Order Positions One and Two for Extraversion Groups.

Table IX

Analysis of Variance of the Transformed ($\sqrt{X+.5}$) Initial Change in the Log of Conductance Amplitude Scores for the First Presentation of the Red and Blue Hue Stimuli in Order Positions One and Two for Extraversion Groups.

Source of Variation	SS	df	MS	F Ratio
Between Subjects	41.84	59		
C(Extraversion)	4.38	2	2.19	3.37[a]
Rows	1.82	1	1.82	2.80
C X Row	.42	2	.21	.32
Subjects within groups	35.22	54	.65	
Within Subjects	52.53	60		
A(Order)	12.00	1	12.00	16.22[b]
B(Hue)	.02	1	.02	.03
AC	.40	2	.20	.27
BC	.00	2	.00	.00
(AB)'	.00	0	.00	.00
(ABC)'	.01	0	.00	.00
Error within	40.10	54	.74	

a $p < .05; F_{.95}(2,54) = 3.17$

b $p < .001; F_{.95}(1,54) = 12.16$

Note: The transformed initial Change in the Log of Conductance Amplitude scores for Introverted, Ambiverted and Extraverted subjects are given in Appendix 4.

2. Habituation Rate Data

The Orienting Reaction habituation rate for red and blue hue stimulus series in the first and second Order presentation positions for Introverted, Ambiverted and Extraverted groups was observed and the analyses made. Interscorer rating reliability for the Orienting Reaction habituation rate data was .98.

Analysis of variance of the Orienting Reaction habituation rate data revealed no significant differences for: the Hue factor ($F_{1,54}$=.00;p $>$.05); the Order-Extraversion interaction ($F_{2,54}$=2.85;p $>$.05); the Hue-Extraversion interaction ($F_{2,54}$=.36;p $>$.05). Similar to the amplitude data for the transformed ($\sqrt{X+.5}$) initial Change in the Log of Conductance amplitude scores, the main effect due to Order was significant ($F_{1,54}$=4.16;p $<$.05) as was the main effect due to Extraversion ($F_{2,54}$=3.80;p $<$.05). The means for the first and second Order positions for the habituation rate data were 9.816 and 7.866. The mean Orienting Reaction habituation rates for the Introverted, Ambiverted and Extraverted groups were 11.43, 9.60 and 5.50, respectively. A summary of the means for the first and second Order positions and for groups differing on the Extraversion dimension are presented in Table X. The F_{max} ratio (4.279) indicated that the homogeneity of variance assumption for the Orienting Reaction habituation rate data was met ($_{.95}F_{max}$12,9=10.07). The results of the analysis of variance

Table X

Means and Standard Deviations of the Orienting Reaction Habituation Rate Data for the Hue Stimuli Series in Order Positions One and Two for Extraversion Groups.

Group	N	Order 1		Order 2		Average	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Introverted	20	11.30	7.14	11.55	8.56	11.43	7.85
Ambiverted	20	12.15	8.00	7.05	8.18	9.60	8.09
Extraverted	20	6.00	7.36	5.00	7.08	5.50	7.22
Average	60	9.82	7.50	7.87	7.94	8.84	7.72

Note: The Orienting Reaction habituation rate scores for Introverted, Ambiverted and Extraverted subjects are given in Appendix 5.

is presented in Table XI.

Testing the significance of Difference between pairs of means for the Extraversion factor, as with the amplitude data, the Tukey failed to yield significance of difference for the Introversion-Extraversion comparison. As the difference between these means was the greatest, the q statistic for the Introversion-Extraversion comparison (2.96) did, however, approach significance ($_{.95}q_{(3,57)}=3.40$). The results of the Tukey comparisons are presented in Table XII.

In light of this finding and the near significance for the Order-Extraversion interaction (see Table XI) it was decided to perform two separate one-way analyses of variance on the Orienting Reaction habituation rate data for the Extraversion factor at each of the two levels of Order.

The analyses of variance of the habituation rate data along the Extraversion dimension at Order positions one and two both indicated significant differences ($F_{2,57}=3.74; p < .05$) and ($F_{2,57}=3.36; p < .05$), respectively. A summary of these analyses of variance are presented in Tables XIII and XIV, respectively. The means, presented in Table X, for Order position one for Introverts, Ambiverts and Extraverts were 11.30, 12.15 and 6.00 and the corresponding means for Order position two were 11.55, 7.05 and 5.00. A geometric representation of the Orienting Reaction habituation rate data for Order positions one and two for groups differing on the

Table XI

Analysis of Variance of the Orienting Reaction Habituation Rate Data for the Red and Blue Hue Stimuli Series Presented in Order Positions One and Two for Extraversion Groups.

Source of Variation	SS	df	MS	F Ratio
Between Subjects	6419.49	59		
C(Extraversion)	736.62	2	368.31	3.80[a]
Rows	267.01	1	267.01	2.75
C X Row	175.11	2	87.56	.90
Subjects within groups	5240.75	54	97.05	
Within Subjects	1772.50	60		
A(Order)	114.07	1	114.07	4.16[b]
B(Hue)	.07	1	.07	.00
AC	156.65	2	78.33	2.85
BC	19.95	2	9.98	.36
(AB)'	.01	0	.00	.00
(ABC)'	.00	0	.00	.00
Error within	1481.75	54	27.44	

a $p < .05; F_{.95}(2,54) = 3.17$

b $p < .05; F_{.95}(1,54) = 4.02$

Note: The Orienting Reaction habituation rate scores for Introverted, Ambiverted and Extraverted subjects are given in Appendix 5.

Table XII

Tukeys Test for Significance of Difference Between Pairs of Group Means for the Combined (Orders One and Two, Hues Red and Blue) Habituation Rate Data for Introverted (I), Ambiverted (A), and Extraverted (E) Groups.

Comparison of Means	Absolute Contrast[a]	q statistic[b]	p[c]
I-A	1.83	.83	n.s.
I-E	5.93	2.96	n.s.
A-E	4.10	1.86	n.s.

a Means for Introverted, Ambiverted and Extraverted groups were 11.43, 9.60 and 5.50, respectively.

b q statistic = HSD or Contrast/2.20

c $.95q(3,57) = 3.405$.

Table XIII

Analysis of Variance of the Orienting Reaction Habituation Rate Scores for the Combined Hue Stimulus Series Presented in Order Position One to Introverted, Ambiverted and Extraverted Groups.

Source of Variation	SS	df	MS	F Ratio
Between Subjects	444.23	2	222.12	3.74[a]
Within Subjects	3380.75	57	59.21	
Total	3824.98			

a $p < .05; F_{.95}(2,57) = 3.16$

Note: The Orienting Reaction habituation rate scores for Order position one for Introverted, Ambiverted and Extraverted subjects are given in Appendix 5.

Table XIV

Analysis of Variance of the Orienting Reaction Habituation Rate Scores for the Combined Hue Stimulus Series Presented in Order Position Two to Introverted, Ambiverted and Extraverted Groups.

Source of Variation	SS	df	MS	F Ratio
Between Subjects	449.03	2	224.52	3.36[a]
Within Subjects	3803.90	57	66.74	
Total	4252.93	59		

a $p < .05; F_{.95}(2,57) = 3.16$

Note: The Orienting Reaction habituation rate scores for Order position two for Introverted, Ambiverted and Extraverted subjects are given in Appendix 5.

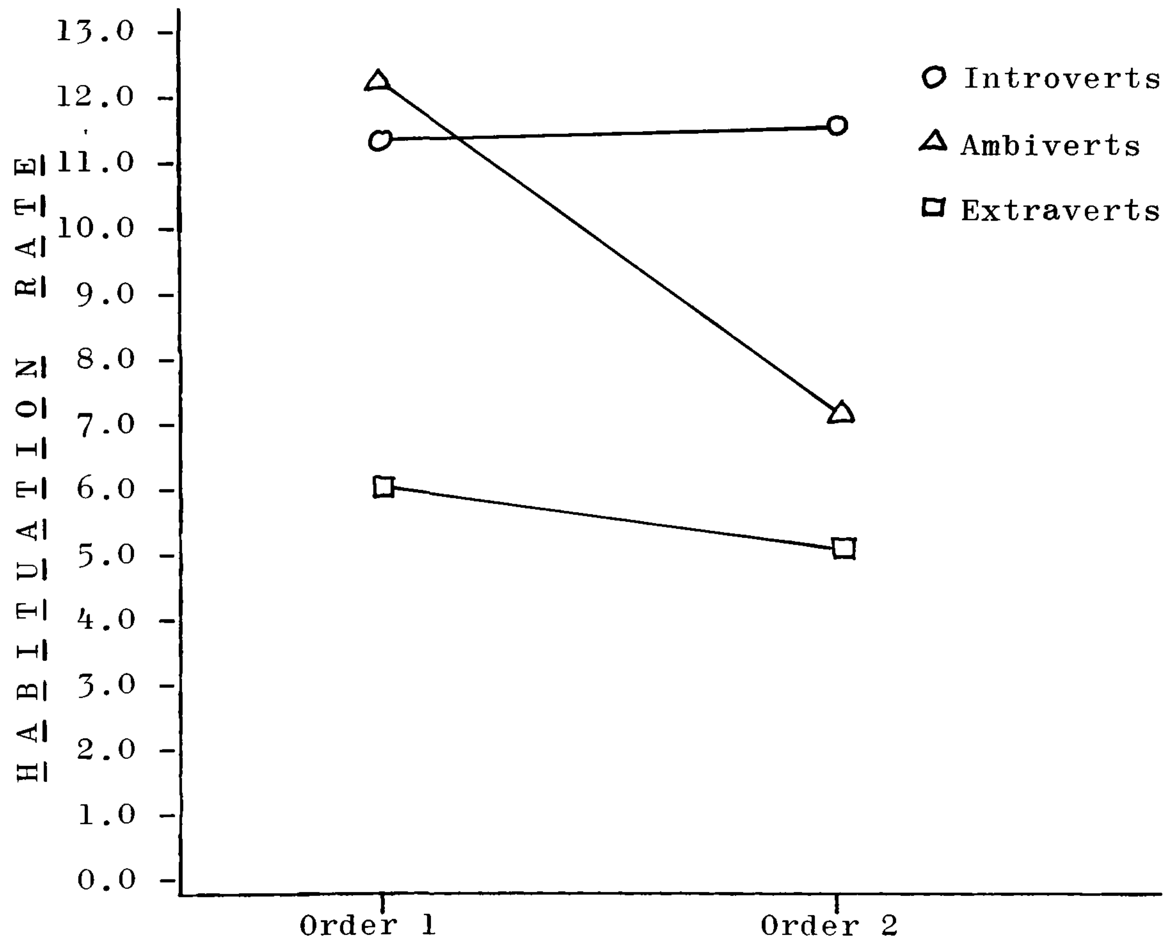
Extraversion dimension are presented in Figure 2. From the Tukey contrasts at Order position one the q statistic (3.58) reveals a significant difference ($_{.95}q_{(3,57)}$=3.405) for the Ambivert-Extravert comparison. Although not significant the q statistic (3.08) for the Introvert-Extravert comparison does approach significance ($.95^{q}(3,57)$=3.405). At Order position two for Extraversion groups the q statistic (3.58) reveals a significant difference ($_{.95}q_{(3,57}$=3.405) for the Introvert-Extravert comparison. A summary of the Tukey comparisons of the Orienting Reaction habituation rate data at Order positions one and two is given in Tables XV and XVI, respectively.

3. Extraversion, Neuroticism, Amplitude of Response, Habituation Rate and Basal Resistance

The relationship between a number of major parameters of the present study which were deemed of importance in providing additional insight into the outcome was assessed by means of the Pearson Product-Moment correlation and the correlations observed. These correlations are reported in the following paragraphs.

Extraversion was noted to correlate significantly with rate of habituation ($r=-.293; df=58; p < .05$) and with amplitude quantified as Change in the Log of Conductance ($r=-.255; df=58; p < .05$). By contrast it was interesting to

Figure 2



Mean Orienting Reaction Habituation Rate Scores for Order Positions One and Two for Extraversion Groups.

Table XV

Tukeys Test for Significance of Difference Between Pairs of Group Means for the Habituation Rate Scores to the Hue Stimulus Series in Order Position One for Introverted (I), Ambiverted (A) and Extraverted (E) Groups.

Comparison of Means	Absolute Contrast[a]	q statistic[b]	p[c]
I-A	.85	.49	n.s.
I-E	5.30	3.08	n.s.
A-E	6.15	3.58	.05

a Means for Introverted, Ambiverted and Extraverted groups were 11.30, 12.15 and 6.00, respectively.

b q statistic = HSD or Contrast/1.72

c $_{.95}q_{(3,57)} = 3.405$

Table XVI

Tukeys Test for Significance of Difference Between Pairs of Group Means for the Habituation Rate Scores to the Hue Stimulus Series in Order Position Two for Introverted (I), Ambiverted (A) and Extraverted (E) Groups.

Comparison of Means	Absolute Contrast[a]	q statistic[b]	p[c]
I-A	3.50	1.91	n.s.
I-E	6.55	3.58	.05
A-E	2.05	1.12	n.s.

a Means for Introverted, Ambiverted and Extraverted groups were 11.55, 7.05 and 5.00, respectively.

b q statistic = HSD or Contrast/1.83

c $_{.95}q_{(3,57)} = 3.405$

note that Neuroticism failed to correlate significantly with rate of habituation or with amplitude regardless of the method of quantification. These findings are particularly interesting in light of the finding that a non-significant correlation ($r=.182; df=58; p > .10$) was observed between Extraversion and initial basal resistance level while a significant relationship ($r=-.304; df=58; p < .05$) was found between Neuroticism and initial basal resistance level. Under such a circumstance and in consideration of the Law of Initial Value[5] it might be expected that amplitude of response would correlate more highly with Neuroticism than with Extraversion, the converse of which was true. These findings seem to lend credence to Eysencks[6] claim that autonomic response is a function of Extraversion rather than of Neuroticism.

Also of interest among the correlational data was the fact that initial amplitude quantified as Change in the Log of Conductance showed a closer relationship with both the initial Change in Resistance amplitude scores ($r=.880; df=58; p < .001$) and the initial Change in Conductance amplitude scores ($r=.850; df=58; p < .001$) than do either of these

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5 J. Wilder, "Basimetric Approach (Law of Initial Value) to Biological Rhythms", Annals of the New York Academy of Sciences, 1962, Vol. 98, p. 1211-1228.

6 H.J. Eysenck, The Biological Basis of Personality, Springfield, Ill., Charles C. Thomas, Publishers, 1967, p. 170.

measures with the other ($r=.513; df=58; p < .001$). Amplitude scores, regardless of the method of quantification, all showed positive and significant correlation with the rate of habituation, i.e., initial Change in Resistance with habituation ($r=.353; df=58; p < .01$), initial Change in Conductance with habituation ($r=.618; df=58; p < .001$), initial change in the Log of Conductance with habituation ($r=.525; df=58; p < .001$).

Initial amplitude of response quantified as Change in Conductance and Change in the Log of Conductance also showed a significant negative correlation with initial basal resistance, i.e., ($r=-.521; df=58; p < .001$) and ($r=-.276; df=58; p < .05$), respectively. These correlations were expected inasmuch as Change in Conductance and Change in the Log of Conductance conversions of Change in Resistance scores are both a function of the basal level of resistance which showed a positive but insignificant correlation with Change in Resistance scores ($r=.215; df=58; p > .05$).

Although this is an area (Law of Initial Value) in which, as mentioned before, a great deal of debate is still being waged, it is generally expected that an individuals ability to respond is a function of his basal level of arousal. Basically, if he is very highly aroused, i.e., very low basal resistance level, he has a very small potential for further arousal when compared to the individual who is experiencing a very low level of arousal, i.e., high basal level of resistance. Within the current data the expectation that low levels of arousal will result in greater response than will high levels of arousal seems not to have occurred. Even though, as noted, there was not a significant correlation between Extraversion and initial basal resistance level, the mean initial basal resistance (446.5) for Extraverts was significantly greater ($t=1.27; df=38; p < .02$) than for Introverts (363.8) when the data was evaluated with a one-tailed t-test for the difference between means. In conclusion, the rate of habituation was observed to be significantly correlated with initial basal resistance ($r=-.426; df=58; p < .001$). A matrix of the discussed correlational data is provided in Table XVII.

Table XVII

Correlation Matrix for Extraversion (E), Neuroticism (N), Amplitude of Response for First Stimulus Presentation at Order Position One Quantified as Change in Resistance (CIR), Change in Conductance (CIC) and Change in the Log of Conductance (CILD), Habituation Rate for the Hue Stimulus Series of Order Position One (HROPO) and Basal Resistance at the Onset of the First Response for Order Position One (BROFS).

	(E)	(N)	AMPLITUDE (CIR)	AMPLITUDE (CIC)	AMPLITUDE (CILC)	(HROPO)	(BROFS)
(E)		-.238[a]	-.167	-.055	-.255[b]	-.293[b]	.182
(N)			.005	.139	.079	-.105	-.304[b]
AMPLITUDE (CIR)				.513[e]	.880[e]	.353[d]	.215[a]
AMPLITUDE (CIC)					.850[e]	.618[e]	-.521[e]
AMPLITUDE (CILC)						.525[e]	-.276[b]
(HROPO)							-.426[e]
(BROFS)							

N = 60

a $p < .10$, $r = .215$
b $p < .05$, $r = .255$
c $p < .02$, $r = .310$
d $p < .01$, $r = .331$
e $p < .001$, $r = .415$

CHAPTER IV

DISCUSSION OF RESULTS

This chapter begins with a summary of the results of the analyses of the electrodermal amplitude and habituation rate data. This is followed by an evaluation of the hypotheses which were posed in light of the results. A discussion of possible alternative explanations for the relationship observed between Extraversion and chromatic sensitivity ensues. The third section reviews the implications of the present study for Eysenck's theory of Extraversion and relates these to the relevant research. The chapter concludes with a summary of the intent of the research, its outcome and suggestions related to future research in the area.

1. Summary of Results

Analyses of variance of the initial electrodermal amplitude scores quantified as Change in Resistance, Change in Conductance, their transformations $(\sqrt{X+.5})$, and of the Change in the Log of Conductance, all showed a significant F Ratio for the main effect of Order but not for the main effect of Extraversion, Hue, the Hue-Extraversion interaction or the Order-Extraversion interaction. However, analysis of variance of the transformed $(\sqrt{X+.5})$ initial Change in the Log of Conductance amplitude scores, in addition to the significant

Order effect observed for all methods of quantification, showed that the mean amplitude for groups of Introverts, Ambiverts and Extraverts varied significantly. Although post hoc procedures failed to yield a significant comparison, the greatest range of difference was observed for the Introvert-Extravert comparison. In consideration of these findings null hypotheses one and two, presented in Chapter One, are accepted:

> 1. There is no significant Hue-Extraversion interaction for the initial electrodermal amplitude data.
>
> 2. There is no significant difference between the initial electrodermal amplitude for red and blue hue stimuli.

Analysis of variance of the electrodermal habituation rate data, as with the data for the transformed ($\sqrt{X+.5}$) initial Change in the Log of Conductance amplitude scores, showed significant differences for the main effects of Order and Extraversion. Again, post hoc testing failed to yield a significant comparison although the Introvert-Extravert difference was the greatest. Within this data, however, the near significance of the Order-Extraversion interaction in dicated that one-way analysis of the Extraversion factor at each level of Order might be justified and fruitful as was subsequently shown. Analyses of variance of the habituation rate data for Extraverted groups at Order positions one and two both revealed significant differences. Subsequent testing for differences between means revealed a significant Ambivert-Extravert difference for Order position one and a significant comparison for the Introvert-Extravert difference at Order position two. The higher mean habituation rate for the Ambiverts accounted for the near significant Order-Extraversion interaction. As noted before, the Introvert-Extravert comparison at Order position one did tend to approach significance. Significance was not observed for the main effect of Hue, the Hue-Extraversion interaction or the Order-Extraversion interaction. Accordingly, hypotheses three and four of Chapter One are also accepted.

> 3. There is no significant Hue-Extraversion interaction for the electrodermal habituation rate data.

> 4. There is no significant difference between the electrodermal habituation rate data for red and blue hue stimuli.

2. Evaluation of the Hypotheses

The failure to find significance for the main effect of Hue in either the amplitude data or the habituation rate data, both of which were anticipated on the basis of the work of Wilson[1], Nourse and Welch[2], and Gerard[3], could be accounted for by the oversight in each of these studies to institute the stimulus control which was exercised in this study. Although comparisons are difficult to make owing to the different methods of stimulus presentation used in each of these studies, i.e., slide projected hues and colored lights, the one factor which each of these studies have in common as opposed to the present study is a failure to control for the variables of saturation, value or brightness of the stimuli. The greater electrodermal amplitude to hues of long wavelength compared to hues of short wavelength which was found in these studies may well fail to obtain, as was borne out in this study, where electrodermal response to different hues, independent of these variables, are compared. On evidence of the present study the contention of Smets[4],

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

2 J.D. Nourse and R.B. Welch, "Emotional Attributes of Color; A Comparison of Violet and Green", Perceptual and Motor Skills, 1971, Vol. 23, p. 403-406.

3 R.U. Gerard, "Differential Effects of Colored Lights on Psychophysiological Functions", unpublished doctoral dissertation, University of California, Los Angeles, California, 1958, as reported by G. Smets, in Aesthetic Judgement and Arousal; An Experimental Contribution to Psycho/Aesthetics, Leuven University Press, Leuven, Belgium, 1973, p. 74.

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

Schaie[5] and Birren[6] that colors of long wavelength are more physiologically arousing than colors of short wavelength fails to be substantiated.

The fact that significance was not found for the Hue-Extraversion interaction for either amplitude or habituation rate fails to support speculations derived from similarities noted in the work of Kravkov[7], Kaplan[8, 9], Allen and Schwartz[10], and Smith[11], i.e., the expectation that Introverts, speculated to demonstrate sympathetic dominance, would exhibit greater electrodermal amplitude and longer

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5 K.W. Schaie, "On the Relation of Color and Personality", Journal of Projective Techniques and Personality Assessment, Vol. 30, No. 6, 1966, p. 512-524.

6 F. Birren, "Color Preference as a Clue to Personality", Art Psychotherapy, 1973, Vol. 1, p. 13.

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

8 S.C. Kaplan, "A Visual Analog of the Funkenstein Test", Archives of General Psychiatry, 1960, Vol. 3, p. 383-388.

9 S.D. Kaplan, "Autonomic Visual Regulation", Psychiatric Research Reports, 1960, Vol. 12, p. 104-118.

10 F. Allen and M. Schwartz, "The Effect of Stimulation of the Senses of Vision, Hearing, Taste and Smell Upon the Sensibility of the Organs of Vision", Journal of General Physiology, 1940, Vol. 24, p. 105-121.

11 P.F. Smith, "Extraversion-Introversion and Chromatic Recognition Sensitivity to Red and Blue Hues", unpublished Masters thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1974, p. I-83.

electrodermal habituation rates for a blue hue stimulus than for a red hue stimulus, whereas the converse would obtain for Extraverts who were speculated to be subject to parasympathetic dominance. Despite the outcome, this possibility is seen to be no less valid than it was at the inception of this research. While the present study indicates that the phenomenon of differences in sensitivity to red and blue hue stimuli for Introverts and Extraverts[12] is not reflected in electrodermal reactivity, it does not exclude the possibility that it may be the result of physiological differences, involving the autonomic nervous system or not, the mechanics of which may be operative at some discrete level of the visual apparatus such as the retina. The work of Kravkov[13] and Kaplan[14, 15] seem to establish the precedent for this possibility. It could well be that the autonomic nervous system, speculated to function differently for Introverts and Extraverts, exercises its influence within the dual innervation of the intrinsic eye muscles, i.e., the lens controlling ciliary ring. Conceivably the state of the lens could itself be the

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12 Ibid., p. I-83.

13 Kravkov, Op. Cit., p. 335-337.

14 Kaplan, "A Visual Analog....", Op. Cit., p. 383-388.

15 Kaplan, "Autonomic Visual....", Op. Cit., p. 104-118.

source of the threshold differences observed between Introverts and Extraverts. For example, different wavelengths, known to be refracted at different angles, could make more or less optimal impact on the retina depending on the state of the autonomically regulated lens.

3. Implications for Extraversion and Individual Differences in Arousal

Although among the various amplitude quantifications significance for the main effect of Extraversion was observed only for the transformed ($\sqrt{X+.5}$) initial Change in the Log of Conductance scores, the direction of the differences, were always the same regardless of the method of quantification. That is, the Introverted group consistently gave greater mean amplitude than the Ambiverts and the Ambiverts consistently gave greater mean amplitude than the Extraverts. This finding is similar to those of others[15, 16, 17, 18]

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15 A. Bronzaft, R. Hayes, L. Welch and M. Koltur, "Relationship Between P.G.R. and Measures of Extraversion; Ascendence and Neuroticism", Journal of Psychology, 1960, Vol. 50, p. 171.

16 Sadler et al., Op. Cit., p. 314.

17 S.G.B. Eysenck and H.J. Eysenck, "Salivary Response to Lemon Juice as a Measure of Introversion", Perceptual and Motor Skills, 1967, Vol. 24, p. 1047-1053.

18 N. Mandelzys, "An Investigation of Differential Pupillary and G.S.R. Reactivity Between Groups Differing in Degree of Extraversion", unpublished Masters thesis presented to the Faculty of Psychology, University of Ottawa, Ontario, 1973.

who have used the magnitude or quantity of autonomic measures as an index of individual differences in physiological arousal along the Extraversion dimension.

The direction of the differences for the habituation rate data, with the Introverted group giving longer mean habituation rates than the Ambiverted group and the Ambiverted group giving longer mean habituation rates than the Extraverted group, was consistent with the findings of other authors[19, 20, 21] whose studies were, in part, designed to test this very phenomenon.

The successful replication of Orienting Reaction studies has consistently been a decided weakness in the literature. The value of successful replications, such as is provided by the present research, is underscored by O'Gorman.[22] In consideration of issues raised by Koriat,

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19 M.G.H. Coles, A. Gale, and P. Kline, "Personality and Habituation of the Orienting Reaction: Tonic and Response Measures of Electrodermal Activity", Psychophysiology, 1971 Vol. 8, No. 1, p. 54-63.

20 G.L. Mangan and J.G. O'Gorman, "Initial Amplitude and Rate of Habituation of OR in Relation to Extraversion and Neuroticism", Journal of Experimental Research in Personality, 1969, Vol. 3, p. 275-282.

21 T.G. Sadler, R.B. Mefferd, and R.L. Houck, "The Interaction of Extraversion and Neuroticism in Orienting Response Habituation", Psychophysiology, 1971, Vol. 8, p. 314.

22 J.G. O'Gorman, "A Comment on Koriat, Averill and Malmstrom's 'Individual Differences in Habituation'", Journal of Research in Personality, 1974, Vol. 8, p. 198-202.

Averill, and Malmstrom[23], he proposes that the ambiguity in the literature on the personality correlates of habituation is due to a failure to give consideration to the difference in stimulus conditions rather than to problems involving the consistency and reliability of habituation measures per se. Studies, such as the present research, which undertake systematic manipulation of stimulus conditions along various parameters, may, cumulatively, serve to reconcile discrepant findings on the relationship between habituation and personality dimensions such as Extraversion.

Within the present study, the consistency of the observed differences between Introverts and Extraverts for both the amplitude and habituation rate data would appear to support the contentions of Gray[24, 25, 26] and Eysenck[27]

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23 A. Koriat, J.R. Averill, and E.J. Malmstrom, "Individual Differences in Habituation: Some Methodological Issues", Journal of Research in Personality, 1973, Vol. 7, p. 88-101.

24 J.A. Gray, "Strength of the Nervous System, Introversion/Extraversion, Conditionability and Arousal", Behabior Research and Therapy, Vol. 5, 1967, p. 151-169.

25 J.A. Gray, Pavlov's Typology, New York, Pergamon, 1964, p. 248-260.

26 J.A. Gray, "The Psychophysiological Basis of Introversion/Extraversion", Behavior Research and Therapy, 1970, Vol. 8, p. 249-266.

27 H.J. Eysenck, The Biological Basis of Personality, Springfield, Ill., Thomas, 1967, p. 230-242.

and to replicate Eysenck's[28] finding that the Introvert, when compared with the Extravert, is characterized by greater and longer physiological response to sensory stimulation.

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28 S.B.G. Eysenck, and H.J. Eysenck, "Physiological Reactivity to Sensory Stimulation as a Measure of Personality", Psychological Reports, Vol. 20, 1967, p. 45-46.

SUMMARY AND CONCLUSIONS

The central purpose of the present research was to examine the arousal value which a red and a blue hue stimulus has for groups of Introverts, Ambiverts and Extraverts. Based on current evidence in the literature implicating autonomic nervous system involvement with sensitivity to hues of long and short wavelength and recent research indicating that Introverts tend to be more sensitive to hues of short wavelength while Extraverts tend to be more sensitive to hues of long wavelength, speculations were made, relating these two areas of research, that Extraverts were parasympathetically dominant and Introverts sympathetically dominant. From the relationship which has been observed between sensitivity of stimulus intake and the Orienting Reaction, it was hypothesized, using electrodermal amplitude and habituation rate as dependent variables, that Introverts would show greater amplitude of response and longer habituation rates for a blue hue stimulus than for a red hue stimulus whereas the converse would obtain for Extraverts. These hypotheses were not supported.

A second aspect of this research involved a test of the arousal value of a hue of long wavelength versus that of a short wavelength. It was expected, in keeping with theory and the findings of other researchers, that a greater magnitude of response and longer habituation rate would be experienced for the red hue stimulus than for the blue hue stimulus. Contrary to the results of other authors, whose lack of appropriate stimulus control was pointed out, replication was not attained.

An observed trend for Introverts to show a greater mean magnitude of response and a longer mean habituation rate for both red and blue hue stimuli than did Ambiverts or Extraverts appeared to support Eysenck's physiological concept of Extraversion. The results were related to this literature and the relevant research.

The present study would seem to indicate that either the Orienting Reaction, measured electrodermally, is inadequate to reveal the difference in arousal value of long and short wavelength hues for groups differing on the Extraversion dimension when adequate stimulus control is instituted or that there is essentially no difference. By implication, it would seem to be a worthwhile undertaking for clarification purposes to explore this relationship more thoroughly by utilizing a more complete battery of autonomic indices while exploring the range of hues at different levels of value and saturation.

Although not directly derived from the p.esent study, in view of the effect which sympathetic arousal has been observed to have on chromatic sensitivity and the relationship observed between chromatic sensitivity and Extraverted groups, it would seem that an exploration of the effect of sympathetic arousal upon the chromatic sensitivity of groups differing on the Extraversion dimension might possibly provide a worthwhile avenue of exploration in the quest for clarification of the underlying dynamics of this observed relationship.

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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________

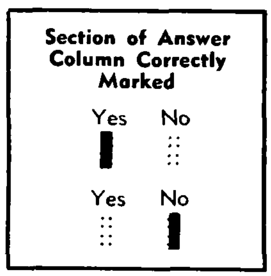
Grade or Occupation____________________ Date________

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.

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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

PLEASE CHECK TO SEE THAT YOU HAVE ANSWERED ALL THE QUESTIONS

APPENDIX 2

RAW *EPI* SCORES AND AGES FOR GROUPS OF INTROVERTED, AMBIVERTED AND EXTRAVERTED SUBJECTS

APPENDIX 2

Eysenck Personality Inventory (EPI), Form B, Extraversion (E) and Neuroticism (N) Scores, and Ages (A) for Subjects Within the Experimental Groups.

Column 1				Column 2			
Subject	E	N	Age	Subject	E	N	Age
Introverts							
1	9	14	26	31	13	17	25
2	8	12	24	32	15	21	18
3	10	14	21	33	15	7	27
4	8	14	22	34	12	11	22
5	10	20	24	35	14	10	28
6	8	10	21	36	15	13	26
7	6	11	28	37	14	7	24
8	9	12	24	38	12	10	27
9	10	9	22	39	13	8	22
10	9	17	24	40	13	13	25
11	5	18	19				
12	9	11	19	Extraverts			
13	10	16	22	41	17	15	23
14	11	2	26	42	19	13	20
15	6	11	24	43	17	8	21
16	7	2	24	44	21	7	22
17	8	15	25	45	18	12	26
18	7	20	27	46	22	7	27
19	10	19	24	47	18	14	24
20	9	12	25	48	17	6	26
				49	18	8	21
Ambiverts				50	21	14	22
21	13	9	28	51	18	17	23
22	15	8	19	52	21	10	24
23	15	18	21	53	19	6	23
24	12	13	25	54	20	9	21
25	13	7	27	55	21	13	20
26	16	12	20	56	22	14	26
27	16	7	26	57	19	5	24
28	13	5	22	58	19	13	21
29	12	17	26	59	17	5	22
30	15	7	25	60	18	10	21

APPENDIX 3

MEANS, STANDARD DEVIATIONS AND AVERAGES OF THE INITIAL AMPLITUDE DATA UNDER THE DIFFERENT METHODS OF QUANTIFICATION

APPENDIX 3

Initial Electrodermal Amplitude Data for Order of Presentation for Introverted (I), Ambiverted (A) and Extraverted Groups.

Group	N	Order 1		Order 2		Average	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Change in Resistance - Raw Scores							
I	20	38.65	43.16	13.15	18.88	25.90	31.02
A	20	23.31	24.68	9.15	17.10	16.23	20.89
E	20	22.15	30.65	6.78	11.02	14.47	20.84
Avg	60	28.04	32.83	9.69	15.67	18.87	24.25
Change in Conductance - Raw Scores							
I	20	.497	.48	.201	.28	.349	.38
A	20	.347	.45	.167	.26	.257	.36
E	20	.243	.27	.071	.11	.157	.19
Avg	60	.362	.40	.146	.22	.254	.31
Change in Log Conductance - Raw Scores							
I	20	5.49	5.11	2.04	2.70	3.77	3.91
A	20	3.45	3.49	1.54	2.59	2.50	3.04
E	20	2.90	3.39	.83	1.11	1.87	2.25
Avg	60	3.95	4.00	1.47	2.13	2.71	3.07
Change in Resistance - Transformed ($\sqrt{X+.5}$) Scores							
I	20	5.328	3.36	2.979	2.24	4.154	2.80
A	20	4.159	2.62	2.367	2.06	3.263	2.34
E	20	4.320	3.96	2.104	1.73	3.212	2.85
Avg	60	4.602	3.31	2.483	2.01	3.543	2.66
Change in Conductance - Transformed ($\sqrt{X+.5}$) Scores							
I	20	.972	.23	.823	.15	.898	.19
A	20	.896	.21	.804	.15	.850	.18
E	20	.849	.15	.753	.07	.801	.11
Avg	60	.906	.20	.793	.12	.850	.16
Change in Log Conductance - Transformed ($\sqrt{X+.5}$) Scores							
I	20	2.207	1.06	1.410	.74	1.809	.90
A	20	1.790	.87	1.242	.71	1.516	.79
E	20	1.619	.87	1.071	.43	1.345	.65
Avg	60	1.873	.93	1.241	.63	1.557	.78

APPENDIX 4

INITIAL AMPLITUDE SCORES FOR INTROVERTED, AMBIVERTED AND EXTRAVERTED SUBJECTS

Initial Change in Resistance Amplitude Scores for the Red and Blue Hue Stimuli Presented in Order Positions One and Two to Introverted, Ambiverted and Extraverted Groups.

#	Introverts		#	Ambiverts		#	Extraverts	
#	Order 1	Order 2	#	Order 1	Order 2	#	Order 1	Order 2
	Red	Blue		Red	Blue		Red	Blue
1	-3.8	0.0	21	39.0	4.0	41	5.5	46.0
2	73.0	26.0	22	48.0	13.7	42	28.0	9.8
3	11.8	14.6	23	8.6	0.0	43	0.5	0.0
4	61.0	44.0	24	4.3	1.6	44	6.6	0.0
5	154.0	6.8	25	30.0	0.0	45	4.3	0.0
6	8.1	2.9	26	5.5	4.0	46	82.0	18.0
7	0.5	0.0	27	12.7	7.0	47	9.3	8.7
8	21.0	35.0	28	8.8	4.1	48	27.0	6.5
9	5.0	0.0	29	12.3	15.4	49	25.0	16.6
10	37.0	6.0	30	54.0	67.0	50	14.8	0.0
	Blue	Red		Blue	Red		Blue	Red
11	64.0	27.0	31	8.9	12.7	51	0.0	0.0
12	1.4	0.5	32	0.0	0.0	52	0.0	0.0
13	35.0	3.6	33	0.0	0.0	53	65.0	11.0
14	102.0	4.2	34	72.0	45.0	54	0.0	0.0
15	113.0	72.0	35	8.1	0.4	55	0.4	0.2
16	13.4	1.0	36	1.9	0.0	56	57.0	12.1
17	12.4	7.8	37	0.0	0.0	57	9.6	5.3
18	33.0	3.1	38	62.0	3.8	58	104.0	1.4
19	0.5	0.1	39	68.0	1.0	59	3.9	0.0
20	23.0	8.3	40	22.0	3.2	60	0.0	0.0

Initial Change in Conductance Amplitude Scores for the Red and Blue Hue Stimuli Presented in Order Positions One and Two to Introverted, Ambiverted and Extraverted Groups.

#	Introverts Order 1	Introverts Order 2	#	Ambiverts Order 1	Ambiverts Order 2	#	Extraverts Order 1	Extraverts Order 2
	Red	Blue		Red	Blue		Red	Blue
1	.042	.000	21	1.902	.325	41	.016	.167
2	1.106	.368	22	.274	.091	42	.385	.067
3	.444	.603	23	.389	.000	43	.315	.000
4	1.507	.918	24	.013	.003	44	.315	.000
5	1.131	.024	25	.077	.000	45	.011	.000
6	.321	.128	26	.041	.037	46	.534	.054
7	.002	.000	27	.833	.525	47	.286	.179
8	.132	.155	28	.019	.007	48	.675	.213
9	.007	.000	29	.630	.702	49	.692	.271
10	.773	.060	30	.789	.810	50	.146	.000
	Blue	Red		Blue	Red		Blue	Red
11	.884	.384	31	1.354	.398	51	.000	.000
12	.082	.023	32	.000	.000	52	.000	.000
13	.316	.018	33	.000	.000	53	.315	.051
14	.374	.009	34	.495	.360	54	.000	.000
15	.296	.498	35	.084	.003	55	.001	.000
16	.352	.010	36	.003	.000	56	.185	.042
17	.065	.064	37	.000	.000	57	.585	.366
18	.826	.044	38	.451	.019	58	.689	.013
19	.002	.000	39	.332	.004	59	.015	.000
20	1.281	.715	40	.262	.054	60	.000	.000

Transformed ($\sqrt{X+.5}$) Initial Change in Resistance Amplitude Scores for the Red and Blue Hue Stimuli Presented in Order Positions One and Two to Introverted, Ambiverted and Extraverted Groups.

	Introverts			Ambiverts			Extraverts	
#	Order 1	Order 2	#	Order 1	Order 2	#	Order 1	Order 2
	Red	Blue		Red	Blue		Red	Blue
1	2.074	.707	21	6.285	2.121	41	2.449	6.819
2	8.537	5.148	22	6.964	3.768	42	5.339	3.209
3	3.507	3.886	23	3.017	.707	43	1.000	.707
4	7.842	6.671	24	2.191	1.449	44	2.665	.707
5	12.430	2.702	25	5.523	.707	45	2.191	.707
6	2.933	1.844	26	2.449	2.121	46	9.083	4.301
7	1.000	.707	27	3.633	2.739	47	3.130	3.033
8	4.637	5.958	28	3.050	2.145	48	5.244	2.646
9	2.345	.707	29	3.578	3.987	49	5.050	4.135
10	6.124	2.550	30	7.382	8.216	50	15.300	.707
	Blue	Red		Blue	Red		Blue	Red
11	8.031	5.244	31	3.066	3.633	51	.707	.707
12	1.378	5.510	32	.707	.707	52	.707	.707
13	5.958	2.025	33	.707	.707	53	8.093	3.391
14	10.124	2.168	34	8.515	6.745	54	.707	.707
15	10.654	8.515	35	2.933	.949	55	.949	.837
16	3.728	1.225	36	1.549	.707	56	7.583	3.550
17	3.592	2.881	37	.707	.707	57	3.178	2.408
18	5.788	1.897	38	7.906	2.074	58	10.223	1.378
19	1.000	.775	39	8.276	1.225	59	2.098	.707
20	4.848	2.966	40	4.743	1.924	60	.707	.707

Transformed ($\sqrt{X+.5}$) Initial Change in Conductance Amplitude Scores for the Red and Blue Hue Stimuli Presented in Order Positions One and Two to Introverted, Ambiverted and Extraverted Groups.

#	Introverts Order 1	Introverts Order 2	#	Ambiverts Order 1	Ambiverts Order 2	#	Extraverts Order 1	Extraverts Order 2
	Red	Blue		Red	Blue		Red	Blue
1	.736	.707	21	1.549	.908	41	.718	.816
2	1.267	.931	22	.879	.768	42	.940	.752
3	.971	1.050	23	.942	.707	43	.709	.707
4	1.416	1.190	24	.716	.709	44	.902	.707
5	1.277	.723	25	.759	.707	45	.714	.707
6	.906	.792	26	.735	.732	46	1.016	.744
7	.708	.707	27	1.154	1.012	47	.886	.824
8	.794	.809	28	.720	.712	48	1.083	.844
9	.712	.707	29	1.063	1.096	49	1.091	.878
10	1.128	.748	30	1.135	1.144	50	.803	.707
	Blue	Red		Blue	Red		Blue	Red
11	1.176	.940	31	.924	.947	51	.707	.707
12	.762	.723	32	.707	.707	52	.707	.707
13	.903	.719	33	.707	.707	53	.902	.742
14	.934	.713	34	.997	.927	54	.707	.707
15	.892	.998	35	.764	.709	55	.707	.707
16	.923	.714	36	.709	.707	56	.827	.736
17	.751	.750	37	.707	.707	57	1.041	.930
18	1.151	.737	38	.975	.720	58	1.090	.716
19	.708	.707	39	.912	.709	59	.717	.707
20	1.334	1.102	40	.872	.744	60	.707	.707

Transformed ($\sqrt{X+.5}$) Initial Change in the Log of Conductance Amplitude Scores for the Red and Blue Hue Stimuli Presented in Order Positions One and Two to Introverted, Ambiverted and Extraverted Groups.

#	Introverts		#	Ambiverts		#	Extraverts	
	Order 1	Order 2		Order 1	Order 2		Order 1	Order 2
	Red	Blue		Red	Blue		Red	Blue
1	1.025	1.151	21	3.506	3.255	41	.953	.707
2	3.578	.707	22	2.341	2.239	42	2.238	1.847
3	1.909	1.923	23	1.736	.858	43	.742	1.455
4	3.690	.707	24	.905	1.770	44	1.575	1.488
5	4.300	1.156	25	1.607	1.012	45	.893	1.362
6	1.647	1.025	26	1.072	.707	46	3.094	.707
7	.734	3.036	27	2.228	.775	47	1.655	.707
8	1.670	2.139	28	1.030	.707	48	2.521	.707
9	.873	2.179	29	2.079	1.426	49	2.492	1.270
10	2.800	.707	30	3.074	1.437	50	1.587	2.076
	Blue	Red		Blue	Red		Blue	Red
11	3.287	1.961	31	1.714	1.034	51	.707	.707
12	.983	.713	32	.707	.769	52	.707	.707
13	2.250	1.002	33	.707	.931	53	2.590	.826
14	2.994	1.212	34	2.948	.707	54	.707	1.553
15	2.904	.799	35	1.279	.707	55	.727	1.217
16	1.866	2.941	36	.773	.742	56	2.225	.716
17	1.315	.880	37	.707	2.454	57	1.938	.707
18	2.768	.924	38	2.785	.707	58	3.477	1.237
19	.733	.805	39	2.649	.707	59	.914	.707
20	2.819	2.218	40	1.948	1.894	60	.707	.707

APPENDIX 5

HABITUATION RATE SCORES FOR INTROVERTED, AMBIVERTED AND EXTRAVERTED SUBJECTS

Habituation Rate Scores for the Red and Blue Hue Stimulus Series Presented in Order Positions One and Two for Introverted, Ambiverted and Extraverted Groups.

#	Introverts Order 1	Introverts Order 2	#	Ambiverts Order 1	Ambiverts Order 2	#	Extraverts Order 1	Extraverts Order 2
	Red	Blue		Red	Blue		Red	Blue
1	2	2	21	20	20	41	2	2
2	20	20	22	20	4	42	20	4
3	20	20	23	17	20	43	1	0
4	20	20	24	2	3	44	3	6
5	6	5	25	16	0	45	2	0
6	11	6	26	5	4	46	3	20
7	1	0	27	20	20	47	3	20
8	5	20	28	14	2	48	20	1
9	11	20	29	20	3	49	20	20
10	13	3	30	20	15	50	3	0
	Blue	Red		Blue	Red		Blue	Red
11	20	20	31	20	1	51	0	0
12	5	1	32	0	0	52	0	0
13	12	20	33	6	0	53	10	8
14	20	20	34	20	20	54	0	0
15	20	20	35	9	1	55	1	0
16	5	1	36	1	0	56	4	6
17	2	4	37	0	0	57	20	12
18	9	5	38	1	1	58	6	1
19	4	4	39	12	20	59	2	0
20	20	20	40	20	7	60	0	0

APPENDIX 6

ABSTRACT OF *Extraversion and Electrodermal Response to Red and Blue Stimuli*

APPENDIX 6

ABSTRACT OF

Extraversion and Electrodermal Response to Red and Blue Stimuli[1]

The present study attempted to investigate the differences between electrodermal response amplitude and rate of habituation to red and blue hues and differences in autonomic functioning which were speculated to be associated with individual differences in Extraversion-Introversion as measured by the Eysenck Personality Inventory, (EPI), Form B. It was speculated on the strength of evidence provided in the current psychological-physiological literature that Introverts were sympathetically dominant while Extraverts were parasympathetically dominant in their autonomic functioning.

Three groups of twenty female subjects selected on the basis of the (EPI) and designated as Introverted, Ambiverted and Extraverted were tachistoscopically presented with red and blue Munsell color samples equated for luminous reflectance and saturation. Electrodermal response was directly measured as Change in Resistance and later converted into Change in Conductance and Change in Log Conductance

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1 Charles W. Pickard, Master of Arts thesis presented to the School of Graduate Studies of the University of Ottawa, Ottawa, Ontario, 1974, p. I-101.

measures. Subsequent square root transformations of the data under the mentioned methods of quantification were performed. Analyses of variance were performed on the raw data, the conversions and the transformed data. In addition to an expected significant Order effect, observed for all methods of quantification, the analysis of variance for the square root transformation of the Change in Log of Conductance scores showed a significant difference for the main effect of Extraversion.

Since Extraverts have been shown to be more sensitive to red than blue while Introverts have been shown to be more sensitive to blue than red and since sensitivity of stimulus intake has been shown to be related to Orienting Reaction magnitude and habituation rate, it was expected that Extraverts would demonstrate greater initial electrodermal response amplitude and longer electrodermal response habituation rate for a red stimulus than for a blue stimulus. The converse was expected for Introverted subjects. Neither of these expectations were supported by analyses of variance of the data, however quantified. It was also expected on the basis of previous research that response amplitude would be greater and that electrodermal response rate of habituation would be longer for a red hue stimulus than for a blue hue stimulus. Neither was this expectation supported. Relative to this, note was made of the careful stimulus control executed in the present study but not in previous research.

A trend was observed for Introverts to consistently demonstrate greater initial amplitude of response to hue stimuli than Extraverts even though only the analysis for the data quantified as Change in Log of Conductance showed significance for the main effect of Extraversion. This plus the fact that Introverts showed a significantly longer rate of habituation to hue stimuli was taken as support for Gray and Eysenck's thesis that Introverts are characterized by greater cortical arousal and greater and longer physiological responding to sensory stimuli than are Extraverts.