HABITUATION OF THE ORIENTING RESPONSE (OR) IN EXTRAVERTS AND INTROVERTS AS A FUNCTION OF STIMULUS INTENSITY

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Habituation Of The Orienting Response (OR)

In Extraverts And Introverts As A Function Of Stimulus Intensity

Master Thesis
Appalachian State University

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts in General-Theoretical Psychology

by

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March, 1978

ACKNOWLEDGEMENT

I would like to express my sincere appreciation and thanks to Dr. Frank Terrant, my thesis chairman, under whose tutilage and guidance my interest in psychophysiology was kindled.

I would also like to thank committee members, Dr. Willard Brignar and Dr. Basil Johnson, for their patience and time.

I would like to thank Dr. William May and Dr. Joyce Crouch for their cooperation. Without their help obtaining experimental participants would have been impossible.

Finally, I would like to thank my wife, Janet, who gave up much that I might have this opportunity. Her support and encouragement was greatly appreciated.

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Abstract

Forty-seven subjects were designated as Introverts or Extraverts, according to their score on the EPI (Form A) personality questionnaire. They were presented with thirty trials of either a 60 or 100 db tone of 2-sec duration. Habituation of the orienting response was ascertained by the trials to criterion measure (three successive non-responses). Magnitude and Latency of response were also recorded. The results indicate: 1) introverts show less variability in OR across intensity levels than do extraverts; 2) Latency of response is a suitable measure for investigating I-E differences; 3) Magnitude of initial response is related more to Neuroticism than to I-E; and 4) the intercorrelations between dependent variables were consistent with previous investigations. The results were considered consistent with the Pavlovian Nervous System Typology more so than with Eysenck's Theory.

Habituation Of The Orienting Response (OR) In
Extraverts And Introverts As A Function Of Stimulus Intensity

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Individual differences can be viewed in two ways. In one, they are random effects acting at a given time and, in an experimental situation, are relegated to the error term. Or individual differences can be considered as systematic constitutional variations. H. J. Eysenck holds the second view, and his theory attempts to identify and quantify these physiological and biological differences. Therefore, Eysenck's theory of personality (Eysenck, 1957, 1964, 1967) can be accurately labeled a constitutional theory.

Eysenck's theory of personality is one of a number of theories which attempt to categorize individual differences (see Lester, 1974). Like the others, it looks to the physiology and neurology of the individual as potentially unifying constructs. By linking observable behavioral differences between people to what is known about the functioning of neurophysiological structures (e.g., autonomic nervous system), it is hoped that a coherent and unified picture of human behavior will emerge.

The beginnings of Eysenck's theory are found in his factor analytic studies done on psychiatric patients during World War II. From these studies emerged the rudiments of his two-factor theory, which gave rise to a theory concerned with the biological basis of personality (Eysenck, 1967). This theory has been the impetus for a prodigious amount of research and controversy. A summary of the putative physiological substrate for the theory and a review of its manifestations in behavioral and physiological indices is presented below.

Eysenck proposes two orthogonal dimensions of personality on which the population is continuously distributed. These two factors are neuroticism-stability (N) and extraversion-introversion (I-E). Eysenck insists the two dimensions are completely independent as demonstrated by factor analysis. The fundamental physiological mechanisms which distinguish between the two factors are stated quite simply: Differential thresholds and levels of activity in the various parts of the ascending reticular activating system (ARAS) underlie extraversion-introversion (I-E), while differential thresholds for arousal in the visceral brain are related to neuroticism (N). (The visceral brain is analogous to the limbic system.)

In this dichotomy, neuroticism (N) is viewed as emotionality, or the tendency toward labile emotional responses. Neuroticism is practically synonomous with anxiety as evidenced by the high correlations between it and the Taylor Manifest Anxiety Scale (MAS) (Eysenck, 1967; Purohit, 1966; Becker & Matteson, 1961). The principal focus of this paper is the dimension of extraversion-introversion (I-E) and its relation to habituation and arousal. Neuroticism, except where it is related to these phenomena or their measurement, is ignored.

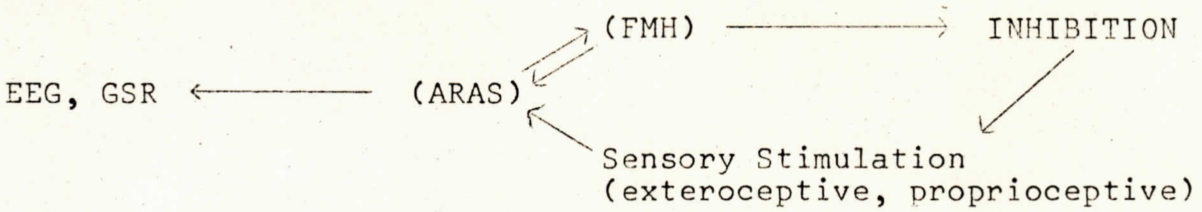
As stated above, the fundamental mechanism underlying I-E is assumed to be the degree of activity of the ARAS, particularly its role in producing cortical arousal. Gray (1970) has elaborated on this mechanism. The revision includes some structures from the visceral brain. His modification includes the ARAS together with the medial septal area, the hippocampus, and the orbital frontal cortex and the interconnections between these structures. Since his revision performs the same theoretical functions as Eysenck's model (1967) while accommodating more recent physiological and anatomical facts, it serves as the basis for the present discussion.

The degree of introversion is hypothesized to correspond to the activity in the frontal cortex-medial septal area-hippocampal system (FMH). The more active this system the more introverted the individual. The basis for this belief is couched in lesion and drug studies. It has been reported that lesions to the septal or frontal cortex areas impair passive avoidance and extinction of once rewarded behavior (Gray, 1972). In other words, the animal fails to inhibit behavior when it would ordinarily. Consequently these areas are viewed as instrumental in the inhibition of behavior. Drug studies employing sodium amobarbital demonstrate similar findings. Sodium amobarbital is a barbituate which depresses the medial septal area. Animals given this drug (in low doses) display more "extraverted" behavior in the sense that active avoidance is enhanced while passive avoidance and extinction are impaired (Miller, 1964). In both types of studies activity in particular regions of the brain is inhibited or abolished completely, resulting in an increase in overt behaviors.

The results of human studies lend further support. Eysenck (1957) reported a lower sedation threshold for extraverts, which is expected if extraverts are assumed to have less activity in the proposed mechanism. Alcohol is believed to act on the same structures, and while it is a depressant, the extraverting effects of alcohol are well known.

Stumpf (1965) provides the link between activity in the FMH system with activity in the ARAS. It appears that a high level of activity in the ARAS will lead to a high level in the FMH system and presumably more inhibited behavior. If this is the case, individuals exhibiting grossly exaggerated extraverted behavior, such as hyperkinetic children, should be expected to show low levels of ARAS activation. This prediction has been confirmed by Satterfield and Dawson (1971) and Gruneward-Zuberbier et al (1975). Thus the paradox of prescribing amphetamines (a reticular formation stimulant) to inhibit hyperkinetic children becomes more understandable when viewed in terms of the ARAS-FMH interaction. However, the relationship between hyperkinetic individuals and Eysenck's extraversion dimension has not been documented.

The physiological data suggest that higher activity in the ARAS and therefore in higher brain centers should be found in the introvert while the extravert should show less activity in this area, and consequently, less in higher centers. Since the discovery of the reticular activating system by Moruzzi and Magoun (1949), many authors have associated arousal with activity of the reticular formation. In light of this, introverts are postulated to be in a higher state of arousal than extraverts. The role of the ARAS, its relationship to arousal and to measurements of the autonomic nervous system are shown diagramatically as follows:



In this schematic, sensory stimulation will raise the level of activity in the ARAS which in turn raises the activity of the FMH system. As the activity becomes greater in the FMH system, behavior becomes more inhibited thus decreasing incoming sensory stimulation and an equilibrium is eventually reached. In terms of this schematic, extraverts are hypothesized to be "stimulus hungry." They will show more motor activity, etc., in order to increase proprioceptive and exteroceptive stimulation and thus maintain an "optimum level of arousal." The introvert, on the other hand, is over aroused because of endogenous activity in the ARAS-FMH system and seeks to avoid further stimulation, in order to maintain his optimum level. While this is a simplified view it would serve to accommodate the incongruity of an"aroused introvert."

The putative physiological differences hypothesized to underlie extraversion and introversion should be manifested by contrasts in behavior and autonomic response indices. Behavioral differences other than sedation thresholds have been documented by Eysenck (1957; 1967). He reports significant differences between introverts and extraverts on perceptual fluctuation, figural aftereffects, reminiscence and classical conditioning. However, the relationship between autonomic response measures (e.g., EEG and GSR) and the ARAS-FMH mechanism illustrated in the schematic must be clarified.

Evidence pertaining to this relationship, particularly that bearing on the psychophysiological distinction between anxiety and arousal is discussed.

The relationship between autonomic measures and I-E is often clouded by the purported relationship of N to autonomic indices. The confusion is particularly acute with regard to the ubiquitous Galvanic Skin Response (GSR). GSR measures have served as dependent variables in literally thousands of experiments. It appears that GSR responses have been used as an index of everything from sexual arousal to sympathetic activation. The problem of greatest concern here is that GSR has been purported to be responsive to changes in anxiety level. Spence & Taylor (1951) are proponents of this view. As mentioned previously, anxiety corresponds to N in Eysenck's theory. Since Eysenck has proposed that N is independent of I-E, the same GSR response measures cannot be used to measure both.

A review of all the research bearing on the issue of what the GSR measures is beyond the scope of this thesis. However, the rationale for using GSR responses for assessing I-E characteristics is germane to this paper and is summarized below.

Ismat (1961) supplies some direct physiological data supporting the relationship between ARAS activity and GSR records. He found that stimulation of the mid-brain reticular activating system in cats facilitated electrodermal activity. Since introverts are hypothesized to have more endogenous activity in the ARAS, they should demonstrate more electrodermal activity.

A study that bears indirectly on this issue is that of Hare (1965). He reported that individuals classified as psychopaths showed less conductance throughout fear (shock) conditioning trials. It has been found that psychopaths score high on neuroticism and high on extraversion as measured by I-E scales (Eysenck, 1957, 1967). The Spence-Taylor hypothesis would predict high GSR activity for those individuals with high neuroticism scores (i.e., this correlates positively with MAS). However, the low GSR activity in conjunction with high extraversion supports Eysenck.

McReynolds, Acker & Brackbell(1966) reported a disassociation between subjective indices of anxiety and autonomic indices (palmar sweat and skin conductance). This is the opposite of what is predicted from the Spence-Taylor hypothesis.

Maltsman & Raskin (1965) demonstrated that "drive" as measured by the MAS was not correlated with high and low orienters as measured by magnitude of evoked GSR.

Edelberg (1967) found inhibition of electrodermal activity with injections of adrenaline. From these studies we can conclude that the GSR is not a good indicator of sympathetic activation which is the principal manifestation of anxiety.

To summarize briefly, Eysenck and Gray have hypothesized that activity in the ARAS underlies the I-E personality dimension as measured by personality inventories. It is further proposed that certain autonomic measures, specifically GSR, are reflections of this activity and are not confounded with anxiety measures. Admittedly the GSR is still an enigma in terms of what it "truly" measures. Nevertheless, it appears that the GSR lends itself to the study of I-E.

The aspect of GSR responding best suited for demonstrating I-E differences appears to be habituation of the electrodermal response. Groves and Lynch (1972) have reviewed evidence which suggests that the Reticular Activating System (RAS) is the structure governing habituation. Habituation measures therefore should be one index of individual differences in RAS activity. Lader & Wing (1964) are reported by Eysenck (1967) to have studied GSR orienting response (OR) habituation in dysthymics and normals. The dysthymics did not habituate, the normals did. Here two groups separated on the basis of one measure, clinical observation, are shown to respond differently on a physiological measure. Since no personality measures were employed the relationship to Eysenck's dimensions are speculative, although dysthymics are usually classified as introvert on Eysenck's scales.

Siddle (1972) has provided evidence linking speed of habituation to arousal. In an investigation of auditory vigilance performance, he found that those whose orienting response to auditory stimuli habituated quickly also displayed a greater rate of vigilance decrement.

If the RAS underlies habituation performance and is also part of the physiological substrate for I-E, then studies of habituation, utilizing GSR measures should reveal something of the nature of I and E. A number of studies have attempted to do this within the context of experiments on conditioning. Marton & Urban (1966) selected subjects on the basis of complex psychological tests. They did not elaborate on this point but did report homogeneous groups of extraverts and introverts. As a preliminary test to their conditioning experiment, habituation of the GSR to a weak sound stimulus was measured. The sound stimulus was a 400 Hz tone, 2 sec in duration presented at 10 - 30 sec intervals. Without specifying the criteria employed, the extravert group is reported to have habituated after 12 - 15 presentations. In the introvert group habituation occurred after 28 - 45 presentations. On the basis of the GSR habituation data and the results of EEG analysis they concluded that the "inhibitory potential" develops faster in persons with traits of extraversion.

A study which attempts to impugn the validity of Eysenck's theory is that of Purohit (1966). The purpose of Purohit's study was: 1) investigate the relationship between GSR conditioning and I-E; and 2) examine the relationships between the numerous dependent variables used to assess I-E. Only the second objective is of interest for the present paper.

Purohit used resistance to GSR adaption (RGA) as one of many variables which he then correlated with the frequency of conditioned GSR's. Habituation of the GSR response was measured in 10 adaption trials. The stimulus used to elicit an OR was the absence of a light. He failed to show any significant correlations between I-E and habituation.

The Purohit study is not directly comparable to the Marton & Urban (1966) study because of the different stimulus modes employed. Marton & Úrban used a weak sound stimulus and Purohit used a light. In addition, there are some methodological problems with Purohit's study which cast doubt on the validity of his findings.

One of the objectives of Purohit's study was to examine possible correlations between numerous psychophysiological variables.

In view of this, employing procedures which decrease the variance or range of a variable is puzzling. His procedure for ascertaining RGA was not conducive to demonstrating a possible relationship between habituation and I-E. Purohit used only ten adaptation trials; in a number of cases this was not enough time for some subjects to habituate. By using only 10 trials, the range of response is truncated and consequently obtaining significant correlations is quite difficult.

A minor point regarding the RGA variable is the criterion measure employed for assessing adaptation. Normally, habituation studies employ a trials to criterion (TTC) approach where habituation is expressed as the last response before three consecutive non-responses (Sadler, Mefferd & Houck, 1971; Coles, Gale & Kline, 1971; Koriat, Averill & Malmstrom, 1973). Purohit did not do this and while TTC is an arbitrary index, it is another variation in his method which makes evaluation of his results difficult.

The lack of criterion values for ascertaining the "reality" of a GSR response are blatantly lacking, and are a more serious matter. Whether this was a result of the experimental reporting procedure or a genuine absence of any criterion is unknown. It appears that every deflection of the pen was a response. The results of this protocol are also difficult to predict. The problems with the Purohit study make it difficult to assess its true effect in impugning Eysenck's theory. At best the results are ambiguous, at worst totally uninterpretable.

A study free from many of the methodological problems of Purohit and which reported no relationship between I-E and habituation is that of Koriat et al (1973). They used a 3 sec, 75 db tone of 1000 H_2 to elicit interstimulus interval (ITI). A response was anything occurring within 10 sec of tone onset.

The most striking feature of all three studies is the diversity of experimental methods and procedures used. Differences between the studies can be found for the stimulus parameters and modalities used, the means employed to assess I-E and the methods of measuring habituation. Because of these differences, interpretation of the conflicting results is difficult, and interest in the area continues.

In all of the studies reviewed here none have utilized GSR response latency as a possible index of arousal. This may be the result of investigators sharing the judgment of Wolfensberger and O'Connor (1967) who concluded that "GSR latency is least sensitive to changes in stimulus conditions and subject differences. Although it is less variable than the other measures it appears to be of little utility." However, other evidence suggests a more useful role for latency data in the investigation of arousal states. O'Gorman (1971) reports large negative correlations between the latency of response to an initial stimulus in an habituation series and rate of habituation. He suggests that a strong inhibitory process may give rise to both long latency and rapid suppression of response with repeated stimulus presentations.

Surwillo (1967) reports significantly shorter GSR latencies when subjects were required to pay close attention to the stimulus. Cowles (1973) submits the notion that "latency along with skin conductance level may be a measure of long term or tonic arousal level." It appears that GSR latency is sensitive to differences in arousal and should lend itself to investigations of Eysenck's dimension of I-E.

The purpose of the present study was twofold: 1) to replicate the Marton & Urban study in an attempt to clarify the relationship between stimulus intensity and I-E; and 2) to determine if all aspects of electrodermal measures (GSR) taken are equally accurate as indicators of habituation and the processes underlying I-E.

According to Eysenck's model, introverts are characterized by a higher level of cortical excitation due to their lower threshold of reticular arousal. Consequently, they should demonstrate higher levels of arousal with low intensity stimulation than do the extraverts. At high intensity stimulation, the levels of arousal should be nearly equal. Eysenck argues that electrodermal activity is related only to I-E not N. Therefore it is predicted that:

1. At low intensity stimulation, extraverts will show faster habituation than introverts.
2. At high intensity stimulation, introverts and extraverts will show similar patterns of habituation.
3. N will show no relation to the electrodermal measures.

Methods

Subjects

The subjects were 23 males and 24 female undergraduate students enrolled in psychology courses at Appalachian State University. Subjects were selected from a group of 91 undergraduate students on the basis of their scores on the Eysenck Personality Inventory (EPI), Form A. The mean score for the 91 students (five classes) on I-E was 12.9 with a standard deviation of 3.9. Subjects scoring in the upper half of I-E (15 - 24) were designated Extraverts (Ex) and selected for the experiment along with those scoring in the bottom half (0 - 11) who were designated Introverts (In). The mean N score for the subjects participating in the psychophysiological study was 10.6 with a SD of 4.5. The correlation between N and I-E was .056. Group mean scores and ranges for subjects in the psychophysiological study are given in Table I.

All students received class credit for their participation.

Apparatus

Skin resistance was recorded by a Grass Model 79B polygraph. Two Ag-AgCl Beckman electrode cups, filled with Beckman electrode paste were used. Tones from a Hewlett-Packard audio-oscillator were presented through Telex headphones. Tone intensity was calibrated by a Simpson sound-level meter to yield a 60 and 100 db tone with a frequency of 1000 Hz. Stimulus durations were controlled by a tape timer.

Subjects sat alone with eyes closed in an armchair in a darkened room adjacent to the recording room.

Design

Tone intensity was the independent variable (H=high, L=low). The present study was a 2x2 design. There were 24 subjects in the Extraverted group (Ex) and 23 subjects in the Introverted group (In). Each group was subdivided into 12 subjects each, except the Introvert-High group which had 11. One group of 12 Ex and 12 In were presented the low tones, the remaining groups of Ex and In were presented the high tones. Subjects were randomly assigned to treatments within their group.

Procedure

The subjects were greeted by the E and comfortably seated in the experimental room. The subject was then fitted for the head-phones, and the palm and back of the left hand were cleaned with alcohol before the electrodes were attached. During this procedure subjects were told that "nothing unpleasant or uncomfortable" would happen. They were reassured that shock was not involved, and that they were only going to hear some tones. Subjects were told to relax, but not to fall asleep, that the experiment would last for about thirty minutes.

After a 5 minute adaption period, a 2 sec tone was delivered at random intervals of 10, 15, 18, 22 and 30 sec for thirty trials.

The L treatment consisted of 60 db tone presentation trials and the H treatment involved a 100 db tone presentation.

Scoring

GSR. An orienting response (OR) was defined as an observable decrease in resistance $\geq$ 1% of baseline resistance, initiated within 1 - 3.5 sec following stimulus onset (Epstein & Fenz, 1970). The following characteristics of the response were measured:

1. Latency: the time between onset of stimulus, and the onset of a response, within the time frame specified above.

2. Magnitude: the difference between the log conductance level at the onset of the stimulus and the maximum level attained prior to a decrease in log conductance level. The data for GSR magnitude was transformed to Δ Log conductance using this transformation:

$$\text{GSR Magnitude} = 1000\ \Delta \text{Log}_{10}\ C = 1000\ \text{Log}_{10}\ \frac{1}{1-p}$$

$$= -1000\ \text{Log}_{10}\ (1-p)$$

$$\text{where } p = \frac{\text{GSR (ohms)}}{\text{Base Resistance (ohms)}}$$

TTC. For each subject, the number of trials taken before three consecutive non-response trials occurred was computed.

Results

Habituation

TTC. Figure I presents the mean square root of the number of trials to habituation for the In and Ex groups at each stimulus intensity. A square root transformation of the TTC data was deemed necessary after a visual inspection of the data revealed marked skewedness and heterogeneity of variance in all groups. A square root transformation was done to achieve more homogeneous variances and more nearly symmetrical distributions (Meyers, 1972).

Figure I reveals an interaction between personality and stimulus intensity. A sharp increase in the mean TTC criteria by the Ex in the high intensity condition as compared to the low intensity condition is shown. In contrast, the increase in TTC demonstrated by the In in the high intensity condition is much less. The results of the analysis of variance for TTC are presented in Table II. The P x I interaction was significant [$F(1,43) = 4.42$, $p < .05$]. This verified the picture in Figure I but also complicated conclusions concerning the highly significant main effect of intensity [$F(1,43) = 13.91$, $p < .001$] and the insignificant effect of personality. As an aid to the proper interpretation of this interaction, tests of simple main effects of intensity at each level of personality and personality at each level of intensity were computed (Winer, 1971). The results are presented in Table III. Only intensity at the level of Extraversion was significant [$F(1,43) = 17.28$, $p < .01$]. Therefore, it was concluded that intensity significantly increased TTC only among the Ex. This conclusion is further supported by the results of multiple comparisons between group means summarized in Table IV. There was a significant difference between the means of the low and high intensity extravert groups but not between the low and high intensity introvert groups.

A comparison of the low intensity stimulus groups using a one-tailed t-test is also presented in Table IV. This was considered justified because of the a priori assumption of faster habituation in *Ex* at low stimulus intensities. This comparison revealed a significant difference, [*t*(23) one-tailed, p .05]. A two-tailed test failed to reach significance.

The TTC data suggest slightly more habituation in *Ex* than in *In* at low intensity stimulation. This difference disappears under the high intensity condition because *Ex* greatly increased their TTC whereas *In* increased only a small, statistically non-significant amount.

Latency. The mean latency of response for blocks of two trials for the low and high intensity *Ex* are shown in Figure 2. The mean latency of response for blocks of two trials for the low and high intensity *In* are presented in Figure 3. A comparison of Figures 2 and 3 discloses a greater effect of intensity across the extravert groups than in the introvert groups. The difference in latency per trial between intensity levels is greater for the *Ex* than for the *In*. This effect, in part, is another manifestation of differences in speed of habituation. As subjects ceased responding, their latencies were given the maximum value of 3.5 sec. Since more of the subjects in the low intensity groups had habituated on any given trial compared to the high intensity group, a greater number had the maximum value and consequently, their mean latency per trial is higher. This effect is more exaggerated in the Ex since intensity had a greater effect on their habituation. For In, about the same number of subjects are responding per trial in the low intensity as in the high intensity group.

However, there is a tendency for the high intensity stimulus to elicit shorter latencies. This can be detected by the difference between high and low intensity groups in the early trials before many subjects had habituated. This effect is also more pronounced in the Ex.

The results of the analysis of variance for latency are presented in Table V. The main effect of intensity was significant [$F(1,43) = 14.01$, $p<.001$]. However, the P x I interaction was also significant [$F(1,43) = 4.48$, $p<.05$]. Therefore, an analysis of simple effects was done and the results summarized in Table VI. The effect of intensity was significant at the level of extraversion [$F(1,43) = 17.18$, $p<.01$]. This indicated that increases in intensity significantly decreased latency for the extravert groups only. There were no significant differences across personalities at either level of intensity. However, at the high intensity extraverts showed a tendency toward faster latencies than In [$F(1,43) = 3.80$, $p<.1$].

The main effect of trials was highly significant [$F(29,1247) = 25.21$, $p<.001$] (Table V). Because of the complicating Trials x Intensity interaction [$F(29,1247) = 2.37$, $p<.01$], an analysis of simple effects for the within subjects variables was computed (Table VI). The effects of trials at both levels of intensity were significant: Trials (L) [$F(29,1247) = 12.09$, $p<.01$]; Trials (H) [$F(29,1247) = 15.50$, $p<.01$]. This demonstrated that latencies increased across trials in both conditions (i.e., habituation occurred) but that the high intensity condition produced shorter latencies across trials than did the low intensity condition.

Table VII contains the group means and multiple comparisons for the latency data. This data paralleled the TTC data in that differences were found between the high and low extravert groups but not between the introvert groups. There were no differences between In and Ex at the low or high stimulus intensities.

Magnitude. Figures 4 and 5 contain the mean magnitude of response for each stimulus group in blocks of two trials, for Ex and In respectively. A comparison of Figures 4 and 5 reveals a pattern similar to that seen in the latency data. The In again showed more homogeneity of response across intensity levels than did the Ex.

Results of the analysis of variance for the magnitude data for individual trials are summarized in Table VIII. The main effect of intensity was significant [$F(1,43) = 9.12$, $p<.001$]. There was no significant P x I interaction [$F(1,43) = 1.82$, $p>.05$]. Consequently, there was no support for believing the pattern seen in Figures 4 and 5 was reliable. The homogeneity of response seen across intensity levels for In most likely was due to chance. In the absence of a significant P x I interaction, it was concluded that the high intensity stimulus produced responses of larger magnitude than did the low intensity stimulus. A comparison of group means for the magnitude data is contained in Table IX. The significant differences found were between the extravert high group and both the extravert and introvert low groups. There was no significant difference between the high and low introvert groups. This finding was similar to the latency and TTC data, but in the absence of a significant P x I interaction it has no import (i.e., the true alpha level is not known).

The effect of trials was significant [$F(29,147) = 24.32$, $p < .001$] (Table VIII). Because of the significant Trials x Intensity interaction [$F(29,1247$_ = 1.85, $p < .01$], an analysis of simple effects of Trials at each level of intensity was done and summarized in Table X. The effect of trials at both levels of stimulus intensity was highly significant: Trials (L) = [$F(29,1247) = 8.25$, $p < .001$] and Trials (H) = [$F(29,1247) = 17.92$, $p < .001$]. It was concluded that magnitude decreased across trials in both conditions, but at a faster rate in the low stimulus intensity condition.

Correlation Between Measures

Tables XI and XII show the results of various correlations (Pearson r) between dependent measures at the low and high stimulus intensity conditions respectively. Latency of initial response and TTC were inversely related at both levels of stimulus intensity as were Magnitude of initial response and Latency of initial response. All correlations for these variables were significant and relatively constant across stimulus intensities. The correlation between Magnitude of initial response and TTC was highly significant ($r = .63$) for the high intensity condition but not at the low intensity condition ($r = .31$, p .14).

Correlations between I-E scores and the dependent variables in the low and high intensity groups are presented in Tables XIII and XIV, respectively. There was a highly significant inverse relationship between I-E score and TTC in the low intensity condition. This meant that the more introverted the individual, the higher the TTC observed. This relationship disappeared at the high intensity condition. There appeared to be no linear relationship between I-E score and magnitude of initial response as evidenced by the near zero correlations found in both the low and high intensity conditions. The correlations between I-E score and latency of initial response were not significant in either condition. However, the reversal from positive to negative seen from the low to high intensity was interesting. This reversal supported the findings of the analysis of simple main effects for personality at the high intensity condition. Though it was not significant, Ex in the high group demonstrated a tendency for shorter latencies compared to In in the high group [$F(1,43) = 3.80$, $p < .1$].

The correlations between N score and the dependent variables for the low and high intensity condition are contained in Tables XV and XVI, respectively. The correlations between N and TTC and N and Latency of initial response failed to reach significance at either intensity level. However, the correlation between N and Magnitude of initial response at the low intensity condition was highly significant ($r = .585$, p .004). The more neurotic subjects showed the largest magnitude responses. At the high intensity condition this relationship was no longer evident, the correlation was now negative and non-significant ($r = -.288$, p .19).

Summary

The data analysis reveal: 1) Significant intensity main effects in all three measures; 2) Significant Trials x Intensity interactions for Latency and Magnitude as well as Significant Trials main effects; 3) Significant Personality x Intensity interactions for TTC and Latency; 4) Significant intercorrelations, both positive and negative, between the dependent variables; 5) A significant negative correlation between I-E score and TTC under the low intensity condition; and 6) A significant positive correlation between N and Magnitude of initial response at low intensity stimulation.

The differences between In and Ex at low intensity showed great variation across the dependent variables. At the low intensity condition Ex and In did not differ in Magnitude substantially, but the Ex showed a lower mean TTC and slightly longer latencies early in habituation. However, these differences were relatively small. The greatest differences between In and Ex were manifested in the stimulus change. As intensity changed from low to high the Ex responded to a much greater degree. From a statistical stand point the In were refractory to the change in stimulus intensity, except for Magnitude. Only Ex showed significant changes with stimulus intensity in TTC and Latency.

The analysis of variance for TTC and Latency indicated systematic differences between In and Ex. The correlations between I-E and TTC and I-E and Latency, though small, paralleled those findings.

Discussion

The results of this study can be summarized as follows: 1) psychophysiological differences between groups of individuals designated *In* or *Ex* solely on the basis of a questionnaire, were demonstrated; 2) the three measures of electrodermal activity that were recorded all manifested habituation, but all were not related to I-E; 3) N appeared related to at least one measure of electrodermal activity; and 4) the significant correlations between dependent variables gave support for the assumption that the experimental procedure provided a valid protocol for evaluating the experimental hypotheses.

Patterns of responding specific to *In* and *Ex* were found on TTC and Latency. These patterns were seen primarily as a function of stimulus intensity. *In* generally showed intermediate responses under both stimulus conditions. In contrast, the *Ex* displayed a greater sensitivity to intensity change. The differences between *In* and *Ex* correspond in part to the general outlines of Eysenck's theory of personality. However, there were many aspects of the data not in agreement with Eysenck, either because his theory does not emphasize some aspect of psychophysiological responding which assumed major proportions in this study, or was directly contradicted by the data of this study.

According to Eysenck's theory *In* should manifest higher electrodermal activity than *Ex* at low stimulus intensities. There was only limited support for that prediciton. The difference between *In* and *Ex* in TTC under the low intensity condition was significant using a one-tailed t-test. This concurs with the results of Marton & Urban (1966) and Lader & Wing (1964), however, the agreement must be viewed with caution considering the dangers of Type II error when using a one-tailed test, particularly when the F ratio for personality on this variable was not significant (Hays, 1973).

The significant correlation between I-E and TTC at low intensity reported here (r = -.48) is additional support for Eysenck's position. Crider & Lunn (1969) report a similar correlation (r = -.45) between I-E, as measured by the MMPI, and habituation. However, the tone intensity employed was 90 db, which does not fit well with the results presented here. This discrepancy regarding the effect of tone intensity might be due to the use of a different I-E scale or the fact that Crider & Lunn used a constant ITI of 1 min. Sokolov (1963) predicts faster habituation with a constant as opposed to a random ITI. If Ex develop more inhibition as Eysenck suggests, the constant ITI may have counterbalanced the effect of the stronger intensity. However, that is pure speculation and until empirical analysis can resolve this, the question of I-E differences in habituation at single intensities remains very much confused.

As stated above the primary difference between In and Ex was seen in the change in responsivity under the different stimulus intensities. At low intensity the In were slightly more responsive than Ex. However at the high intensity, the Ex were slightly more responsive than the In. This reversal occurred because In increased very little under the high intensity and the Ex increased a great deal. There is some confusion as to the extent that this result impugns Eysenck's theory (Stelmack & Campbell, 1974; Fowles, 1977). There is no doubt that Eysenck's emphasis has been on the putative hyper-arousal ability of In, but the potential responsiveness of Ex is acknowledged. This is discussed in his hypothesis concerning the relationship between hedonic tone in In and Ex and strength of sensory stimulation (Eysenck, 1963, 1967). Eysenck proposes that everyone has a preferred level of hedonic tone and to reach that, the individual must achieve an equilibrium between environmental stimulation and his endogenous arousal level. Quite simply, In, because of higher endogenous arousal, will show greater response to low intensity stimulation; in addition, their optimal or preferred level of stimulation will be low. Ex, on the other hand, seek stronger, more intense stimulation since internal levels are low or damped out. From this it might be predicted that as the stimulation becomes more intense, thus approaching the optimum level for the Ex, their responsivity will increase and the In's will decrease. An analogy can be made with the behavioral phenomena of the inverted U relation found between arousal and performance. In and Ex are viewed as in two different arousal populations (see Figure 6).

Eysenck's emphasis in the hedonic tone formulation is on volitional aspects of behavior,not on autonomic responses. Nevertheless, Stelmack & Campbell (1974) have invoked this hypothesis to accommodate their results. They found a significant increase in sensitivity to high frequency sound in Ex, in fact they were more sensitive than the In at the high frequency condition. The results presented here for intensity of sound reveal a pattern similar to that found by Stelmack & Campbell (1974) for frequency (of sound). From this it might be argued that the results of this study concur with Eysenck's theory, however, this aspect of his theory is not well formulated nor emphasized by him.

The importance of intensity in detecting I-E differences was noted in a recent sutdy by Fowles (1977). He found that Ex had higher skin conductance levels (SCL) at high intensity than did In when a stress task preceded the sound. Fowles interpreted his results in terms of Pavlov's Nervous System Typology. Since this conceptualization may help untangle the results reported for I-E differences, a brief description is provided here.

Recently there have been attempts to integrate Eysenck's theory with the work emerging from Russian laboratories based on Pavlovian concepts (Gray, 1964, 1972). The principal gap between the Russian and Western work is the lack of "personality" measures (e.g., questionnaires) employed in the Russian work. This, of course, leaves their data strictly on a physiological level with little link to overt behaviors such as social behavior or clinical syndromes. Consequently, there has been some confusion in the attempts at integration but the thrust has been to link I-E with the Pavlovian concepts of strength and weakness of the nervous system (Gray, 1972, 1967; Eysenck & Eysenck, 1967; Mangan & Farmer, 1967). According to Gray, "the weak nervous system is more sensitive than the strong: it begins to respond at stimulus intensities which are ineffective for the strong nervous system; throughout the stimulus intensity continuum its responses are closer to its maximum level of responding than the responses of the strong nervous system; and it displays its maximum response, or the response decrement which follows this maximum, at low stimulus intensities than the strong nervous system" (1967, p. 153).

This response decrement with increasing intensity is referred to as transmarginal inhibition. Its original application in the Pavlovian laboratories referred to the decrease in CR magnitude observed with an increase in CS intensity. However, there appears to be no compelling reasons prohibiting its application in the present case as was done by Fowles (1977). It then appears that the introverts are more susceptible to transmarginal inhibition than are extraverts (i.e., they reach peak responding sooner).

The Pavlovian Typology has many parallels and similarities to Eysenck's theory. The major difference has been on the emphasis placed on changes in responsivity at higher levels of stimulation. Eysenck has generally ignored this facet of responding. In view of the myriad number of studies bearing on I-E differences which have resulted in no conclusive findings, Eysenck's position may have to change.

Almost all of the studies investigating habituation in In and Ex have employed only one level of sound intensity (Coles et al, 1971; Sadler et al, 1971; Koriat et al, 1973; Purohit, 1966; Marton & Urban, 1966; Crider & Lunn, 1969). The study by Coles et al (1971) is a good example. They used a 65 db tone to elicit an OR and report no significant effect for either N or I-E, which is what the analysis of variance alone would have indicated here. The correlation (r = -.58) reported between Latency of initial response and TTC was similar to that reported here for a 60 db tone. It appears that many features of their data are similar to that reported here yet they conclude that I-E differences are not related to habituation.

Since it appears that the change in responsivity is where the major differences in I-E are manifested, it is not surprising that so many studies have yielded so little in the way of generalizable results.

The lack of a relationship between I-E and Magnitude of response reported here agrees with Eysenck's position and is supported by others who reported negative results (Bronzaft, Hayes, Welch & Koltuv, 1960; Coles et al, 1971). It appears that Magnitude of response is not a suitable measure for detecting differences between In and Ex.

The effect of N was examined because of a possible relationship to electrical phenomena of the skin and it was thought that it might help clarify the ambiguous results reported here and elsewhere. Eysenck insists that at normal levels of laboratory stimulation electrodermal measures are not related to N. However, the evidence is mixed on this issue. The high positive correlation reported here between N and Magnitude of initial response indicates a relationship. This relationship is found only at the low intensity; at the high intensity the correlation was negative and non-significant. Mangan & O'Gorman (1969) reported a negative relationship between N and Magnitude of initial response. The tone intensity used is not known but is assumed to be high. Katkin & McCubbin (1969) observed the largest amplitude responses with high anxious subjects. However, the differences were not statistically significant. They used a moderate intensity sound stimulus to elicit an OR. Koepke & Pribram (1966) used a 94 db tone and reported a low, insignificant correlation ($\underline{r}$ = .16) between the Taylor MAS and Magnitude of first response. Maltzman & Raskin (1965) employed 110 db white noise to elicit an OR. They reported no relationship between Magnitude of initial OR and the Taylor MAS. Purohit (1966) used the mean amplitude of 3 trials to a 120 db tone and reported no correlation (i.e., .04) with N. It appears that stimulus intensity is a crucial variable in the attempts to document relationship between N and Magnitude of response just as it is in I-E. At low intensity a positive relationship may exist but it disappears or becomes negative at high intensity conditions. If a relationship between N and Magnitude of GSR exists at laboratory levels of arousal, it contradicts Eysenck's assertion that electrodermal measures are related only to I-E and not N (Eysenck, 1967, p. 170).

One method of estimating the reliability and validity of data is to compare the relationships and processes observed with those found by other investigators. This was one of the reasons for looking at the intercorrelations between dependent variables, the other was to examine these relationships across stimulus intensities. O'Gorman (1971) and Coles et al (1971) both reported significant correlations between Latency of initial response to a 60 - 65 db tone and TTC. The results of this study extend these findings to a 100 db tone.

The relationship between Magnitude of response and TTC is less well documented. Purohit reports a correlation (Pearson $\underline{r}$), between the mean amplitude of 3 trials to a 120 db tone and his habituation criteria, of .25 which was significant at the .01 level. Nebylitsyn (cited by O'Gorman, 1971) reported a significant relationship between Magnitude of initial response and TTC. The stimulus parameters are not reported. These results agree with those reported here. Further studies on the effect of stimulus intensity on this relationship appear worth while.

The significant relationship found between Latency of initial response and Magnitude of initial response is in agreement with the results of other investigators (Uno & Grings, 1964; Witting & Wickens, 1966; Bull & Gale, 1971, 1973; Koriat, 1973; Martin & Rust, 1976). Lockhart (1972) reports a low insignificant correlation ($\underline{r}$ = -.11), but response to shock was the dependent variable, consequently, this study is not directly comparable to the others.

In general the correlations reported here between dependent variables are similar to those reported by other investigators. Therefore, confidence that the data of the study is representative of real events is increased.

The results of this study speak for the dangers involved in premature attempts to invoke physiology as an explanatory mechanism in personality research. The ARAS-FMH mechanism, because it is loosely formulated, is not directly supported by the present data nor is it directly contradicted. In fact, there is doubt that investigations of this type, on a behavioral level, can support or impugn a theory on a physiological level. The ARAS-FMH mechanism can be elaborated to account for the present data quite easily. The effect observed here can be accommodated by hypothesizing a negative feedback between the ARAS and FMH (see schematic). This loop functions such that as stimulus intensity increases, arousal in the ARAS is increased, thereby increasing activity in the FMH. However, after maximum activation, further increases in stimulus intensity elicit negative feedback from the FMH, thus inhibiting the ARAS. This, of course, is transmarginal inhibition, to use Pavlov's terminology. However, it is not necessary nor advisable to seek an explanation in physiology for I-E differences at this time. When the functional relationships between I-E and stimulus parameters, experimental protocol and psychophysiological measures are more firmly documented, physiological and neuroanatomical theories and explanations will evolve more freely.

The conflicts and the failures to demonstrate I-E differences most probably have their origin in the variety of stimulus parameters, experimental protocols and psychophysiological measures employed. The potential for divergent results as a consequence of slight changes in experimental parameters or scoring has been demonstrated (Kimmel, 1965; O'Gorman, 1973). For example, some studies have used aplitude of GSR rather than magnitude as the dependent variable. This subtle difference in scoring can have quite profound effects on the conclusions reached as shown by Kimmel (1965). He found that the habituation curve for magnitude was totally different from that of amplitude, even though the same data was analyzed. Koriat et al (1973) argues that all GSR measures of habituation do not yield the same result. This may be because different mechanisms underlie habituation of the various components of the GSR (Martin & Rust, 1976). Since studies have employed SCL, TTC, decreases in amplitude and magnitude, total number of responses, mean regression slopes and transformations of these to evaluate habituation, the lack of concordance across studies is not too surprising. In addition, the volatile nature of the habituation phenomena itself was demonstrated by O'Gorman (1973). He found that changing the interstimulus interval to 40 sec was sufficient to obliterate I-E differences found at an interval of 20 sec. If nuances can have such profound effects on the phenomena in question, there is no anticipating the effects of the multitude of procedures and parameters actually employed. Future investigations of I-E will have to acknowledge these potential sources of variation and systematically study them.

Considering the prodigious and flourishing literature on the habituation process, habituation is probably most accurately viewed as a diverse and complex process rather than a homgeneous one. Therefore, it may be an oversimplification to suggest a notion as simple as that which posits faster habituation in some individuals than in others, without specifying in vastly more detail the response system under consideration and the parameters used.

Another problem in investigations of I-E differences is the possibility that N may interact with I-E and consequently obscure some relationships if not controlled. Sadler et al (1973) argue for the later possibility. They report that Ex high in N and In low in N show the largest response Magnitudes. The present study provides some support for this hypothesis. The correlation between N and Magnitude of initial response for Ex only in the low intensity group (same as Sadler) is $r = .757$, $p < .01$. The correlation for In only is $r = .475$, $p < .11$. The significant relation between

Magnitude and N is due to the Ex group as suggested by Sadler et al (1973). This is an area that needs further investigation particularly in studies that use Magnitude of response to discriminate between In and Ex.

The relationship between N and Magnitude of GSR and the greater sensitivity of Ex to stimulus intensity demonstrated here are not consistent with Eysenck's theory as formulated (Eysenck, 1967). These observations are more readily subsumed by the Pavlovian Typology. However, Eysenck's questionnaire successfully discriminated between individuals on a psychophysiological level predicted by Pavlov's Typology. Consequently, efforts directed toward an integration of these two theories would seem worthwhile.

In conclusion, the principal contributions of this study are the indirect replication of Fowles (1977) and the first demonstration that latency of response may be a viable response variable for investigations of I-E.

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TABLE I

MEAN SCORES AND RANGES
OF N AND I-E FOR EACH GROUP

Groups	I-E Score		N Score	
	Mean	Range	Mean	Range
Ex Low	16.8	15-19	10.2	5-19
Ex High	17.3	15-21	10.3	1-15
In Low	8.3	2-11	10.4	4-20
In High	8.7	4-11	11.4	4-19

TABLE II

TRIALS TO CRITERIA: SQUARE ROOT TRANSFORM ANOVA

Source	SS	df	MS	F	p
Total	81.35	46	----	----	----
Intensity	18.37	1	18.37	13.91	.001
Personality	0.10	1	0.10	1	----
Int. x Person.	5.84	1	5.84	4.42	.05
Error	57.04	43	1.32	----	----

TABLE III

SUMMARY OF ANALYSIS OF SIMPLE EFFECTS
OF INTENSITY AT LEVELS OF PERSONALITY
AND PERSONALITY AT LEVELS OF INTENSITY FOR TTC VARIABLE

Source	df	MS	F	p
Intensity at In	1	1.73	1.31	.1
Intensity at Ex	1	22.78	17.28	.01
Personality at L	1	3.97	3.01	.1
Personality at H	1	2.18	1.65	.1
Error	43	1.32	----	----

TABLE IV

t-TESTS COMPARING GROUP MEANS FOR TTC DATA

Group $\bar{x}$	Comparison	Difference	Critical Diff.	p
Ex. Low 1.89	Ex. Low vs. In. Low	.81	.955	ns
	Ex. Low vs. In. Low	.81	.796*	.05
Ex. High 3.83	In. Low vs. In. High	.53	.955	ns
In. Low 2.70	In. High vs. Ex. High	.6	.955	ns
In. High 3.23	Ex. Low vs. Ex. High	1.94	.955	.05
	In. Low vs. Ex. High	1.13	.955	.05

*one-tailed

TABLE V

LATENCY ANOVA

Source	SS	df	MS	F	p
Total:	32,407	1409	----	----	----
Between Ss:	7,866.4	47	----	----	----
Personality (P)	48.6	1	48.6	1	----
Intensity (I)	1,781.1	1	1781.1	14.01	.001
P x I	570.2	1	570.2	4.48	.05
$Error_b$	5,466.5	43	127.1	----	----
Within Ss:	24,540.6	1363	----	----	----
Trials (T)	7,532.78	29	259.75	25.21	.001
T x P	429.67	29	14.81	1.43	.10
T x I	708.19	29	24.42	2.37	.001
T x P x I	360.88	29	12.44	1.20	----
$Error_w$	12,854.92	1247	10.30	----	----

TABLE VI

SUMMARY OF ANALYSIS

OF SIMPLE EFFECTS FOR LATENCY VARIABLE

Source	df	MS	F	p
Between Ss:				
Intensity at In	1	152.35	1.20	----
Intensity at Ex	1	2184.05	17.18	.01
Personality at L	1	135.2	1.06	----
Personality at H	1	483.63	3.80	.1
Error	43	127.1	----	----
Within Ss:				
Trials L	29	124.56	12.09	.01
Trials H	29	159.60	15.50	.01
Error	1247	10.30	----	----

TABLE VII

t-TESTS COMPARING GROUP MEANS FOR LATENCY DATA

Group x	Comparison	Difference	Crit. Diff.	p
Ex. Low 19.15mm (3.19 sec)	Ex. Low vs. In. Low	.87	2.60	ns
Ex. High 15.66mm (2.61 sec)	In. Low vs. In. High	.94	2.60	ns
In. Low 18.28mm (3.04 sec)	In. High vs. Ex. High	1.68	2.60	ns
In. High 17.34mm (2.89 sec)	Ex. Low vs. Ex. High	3.49	3.40	.01
	In. Low vs. Ex. High	2.62	2.60	.05

TABLE VIII

MAGNITUDE ANOVA

Source	SS	df	MS	F	p
Total	489,193.97	1409	----	----	----
Between Ss	141,428.36	46	----	----	----
Personality (P)	2,428.64	1	2,428.64	1	----
Intensity (I)	23,517.30	1	23,517.30	9.12	.001
P x I	4,689.41	1	4,689.41	1.82	----
$Error_b$	110,793.01	43	2,576.58	----	----
Within Ss	347,765.61	1363	----	----	----
Trials (t)	119,603.72	29	4,124.26	24.32	.001
T x P	4,210.55	29	145.19	1	----
T x I	9,115.45	29	314.32	1.85	.01
T x P x I	3,388.71	29	116.85	1	----
$Error_w$	211,447.18	1247	169.56	----	----

TABLE IX

t-TESTS COMPARING GROUP MEANS FOR MAGNITUDE DATA

Group	$\bar{x}$	Comparison	Difference	Crit. Diff.	p
Ex. Low	4.07	Ex. Low vs. In. Low	1.24	10.52	ns
Ex. High	15.87	In. Low vs. In. High	4.26	10.52	ns
In. Low	5.31	In. High vs. Ex. High	6.30	10.52	ns
In. High	9.57	Ex. Low vs. Ex. High	11.80	10.52	.05
		In. Low vs. Ex. High	10.56	10.52	.05

TABLE X

SUMMARY OF ANALYSIS

OF SIMPLE EFFECTS OF TRIALS

AT LEVELS OF INTENSITY FOR MAGNITUDE VARIABLE

Source	df	MS	F	p
Trials at L	29	1399.38	8.25	.001
Trials at H	29	3039.20	17.92	.001
Error	1247	169.56	---	---

TABLE XI

CORRELATIONS BETWEEN DEPENDENT VARIABLES

FOR THE LOW INTENSITY STIMULUS GROUPS

Dependent Variables	r	t	df	p
Magnitude of Initial Response and TTC	.31	1.50	22	.14
Latency of Initial Response and TTC	-.51	2.75	22	.01
Magnitude of Initial Response & Latency of Initial Response	-.48	2.60	22	.02

TABLE XII

CORRELATIONS BETWEEN DEPENDENT VARIABLES

FOR THE HIGH INTENSITY STIMULUS GROUPS

Dependent Variables	r	t	df	p
Magnitude of Initial Response and TTC	.63	3.74	21	.001
Latency of Initial Response and TTC	-.43	2.16	21	.04
Magnitude of Initial Response & Latency of Initial Response	-.41	2.04	21	.05

TABLE XIII

CORRELATIONS BETWEEN I-E SCORE AND DEPENDENT VARIABLES FOR THE LOW STIMULUS INTENSITY GROUPS

Variables	r	t	df	p
I-E and TTC	-.487	2.62	22	.015
I-E and Latency on In. Response	.333	1.65	22	.11
I-E and Magnitude of In. Response	-.042	.19	22	.845

TABLE XIV

CORRELATIONS BETWEEN I-E SCORE AND DEPENDENT VARIABLES

FOR THE HIGH STIMULUS INTENSITY GROUPS

Variables	*r*	*t*	*df*	*p*
I-E and TTC	.110	.509	21	.616
I-E and Latency of Initial Response	-.255	1.20	21	.240
I-E and Magnitude of Initial Response	.125	.578	21	.568

TABLE XV

CORRELATIONS BETWEEN N SCORE AND DEPENDENT VARIABLES FOR THE LOW STIMULUS INTENSITY GROUPS

Variables	r	t	df	p
N and TTC	.148	.670	20	.50
N and Latency of Initial Response	-.31	1.48	20	.153
N and Magnitude of Initial Response	.585	3.22	20	.004

TABLE XVI

CORRELATIONS BETWEEN N SCORE AND DEPENDENT VARIABLES FOR THE HIGH STIMULUS INTENSITY GROUPS

Variables	r	t	df	p
N and TTC	-.135	.610	20	.548
N and Latency of Initial Response	.046	.209	20	.836
N and Magnitude of Initial Response	-.288	1.34	20	.19

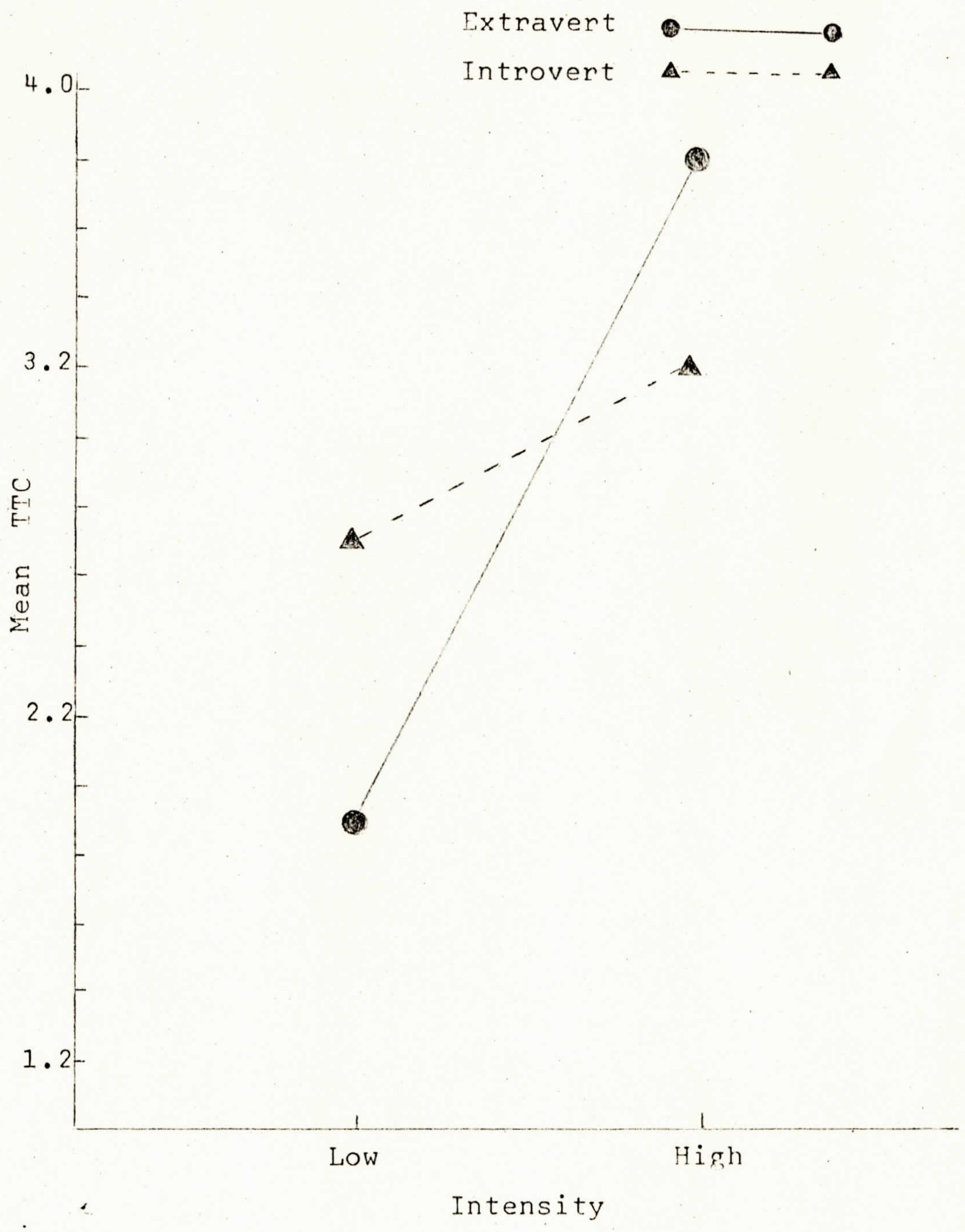

Fig. 1: Mean TTC as a function of Introversion, Extraversion and tone intensity.

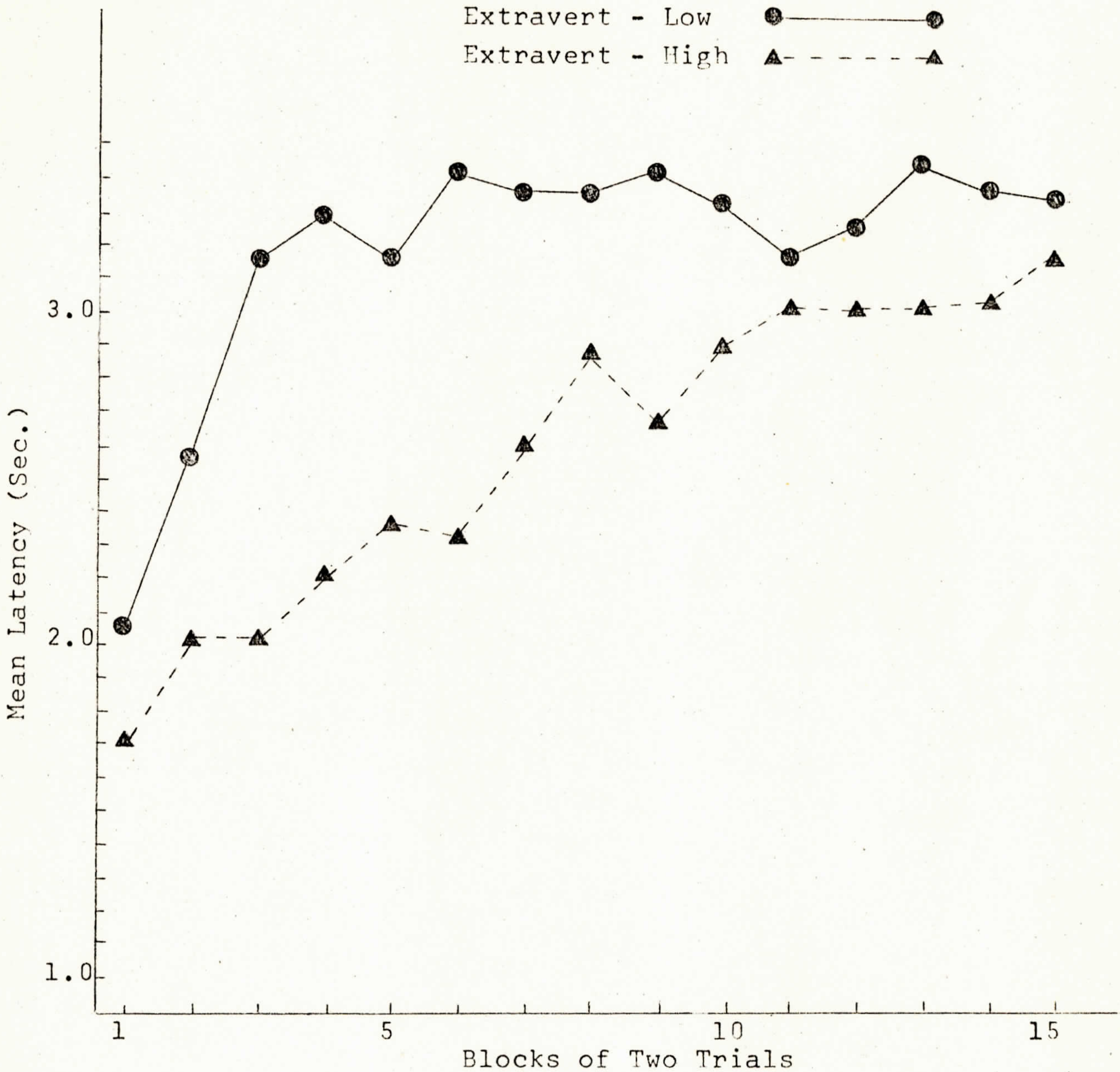

Fig. 2: Mean latency of GSR response as a function of trials and tone intensity for the extravert groups.

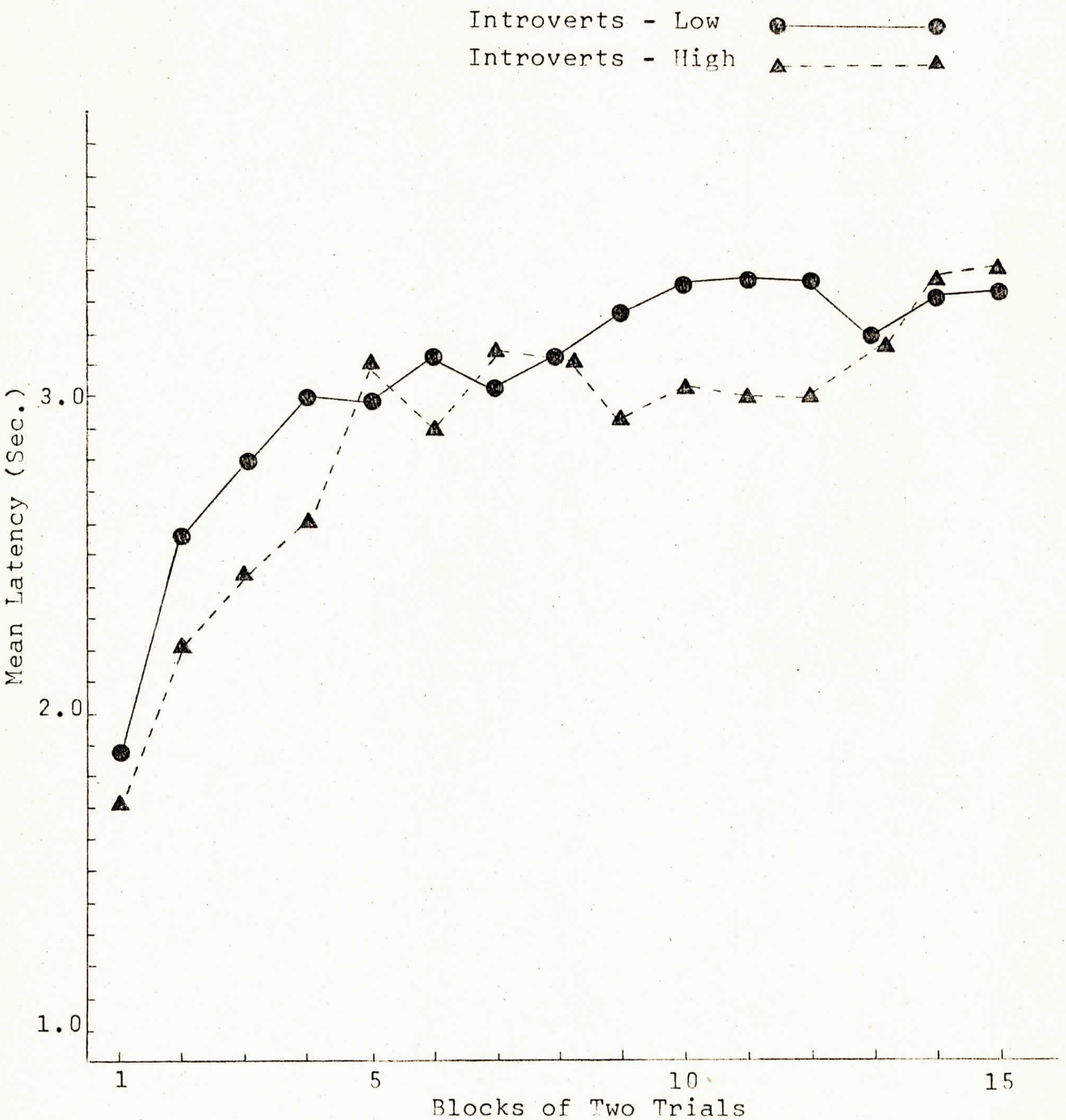

Fig. 3: Mean latency of GSR response as a function of trials and tone intensity for the introvert groups.

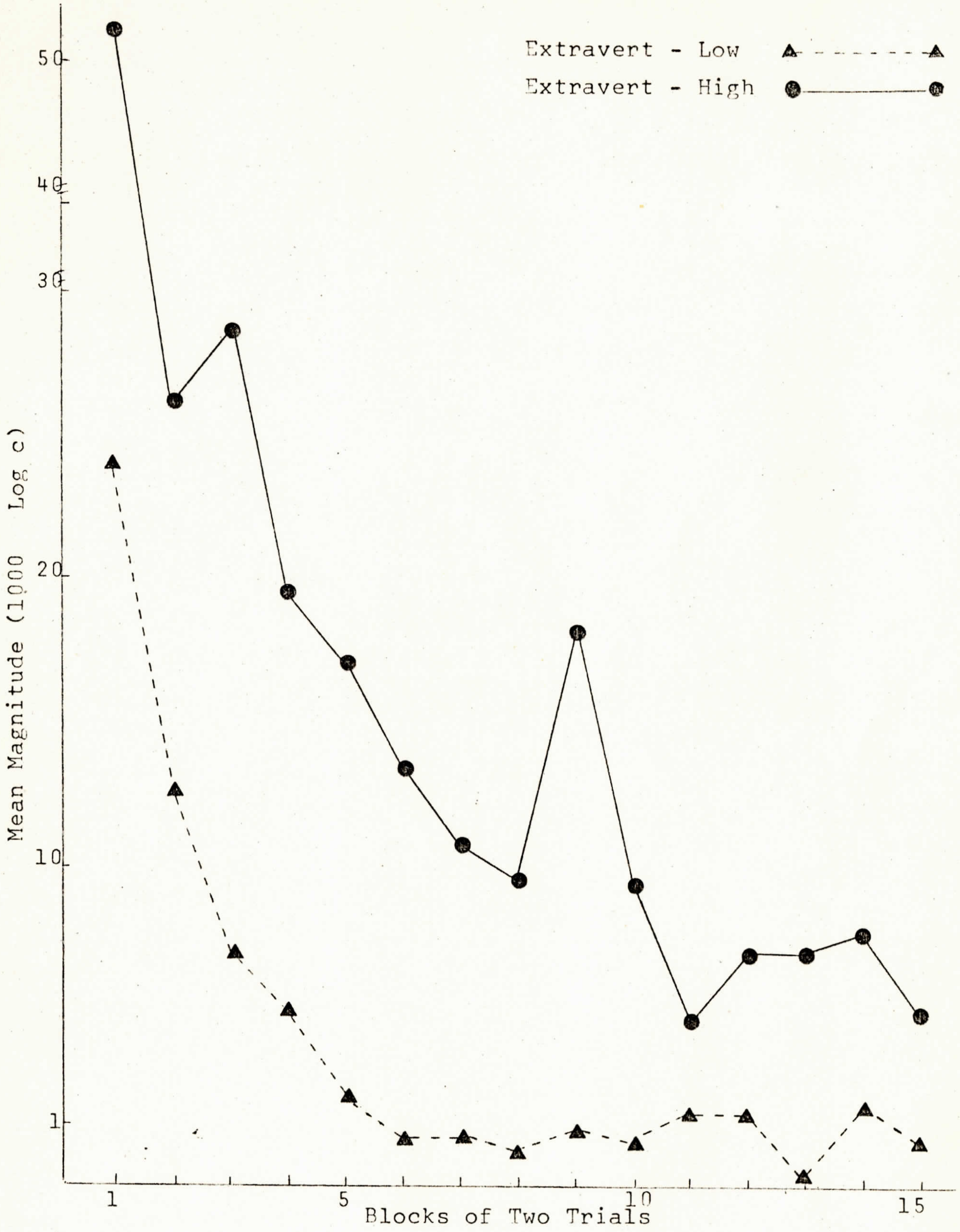

Fig. 4: Mean magnitude of GSR response as a function of trials and tone intensity for the extravert groups.

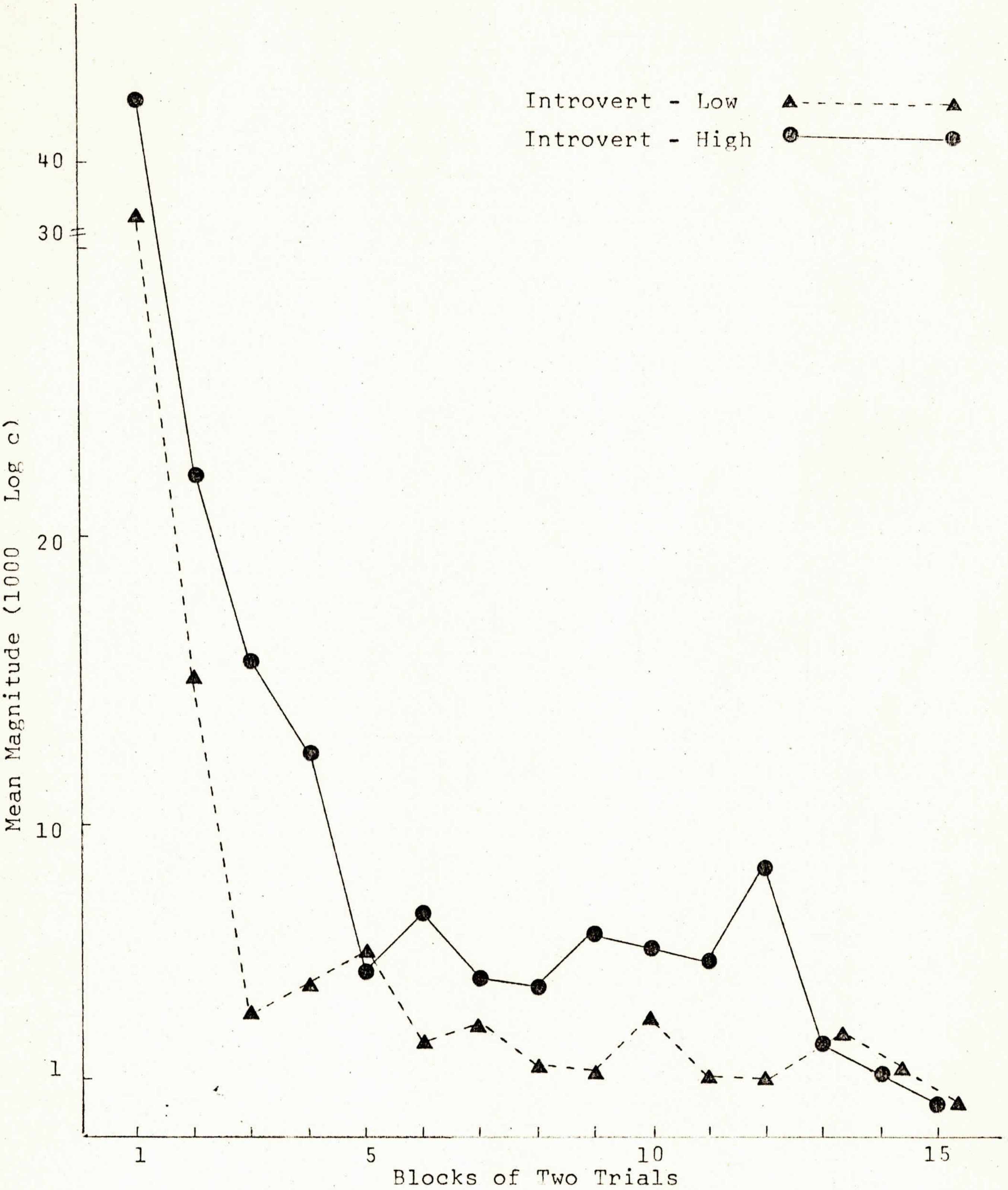

Fig. 5: Mean magnitude of GSR response as a function of trials and tone intensity for the introvert groups.

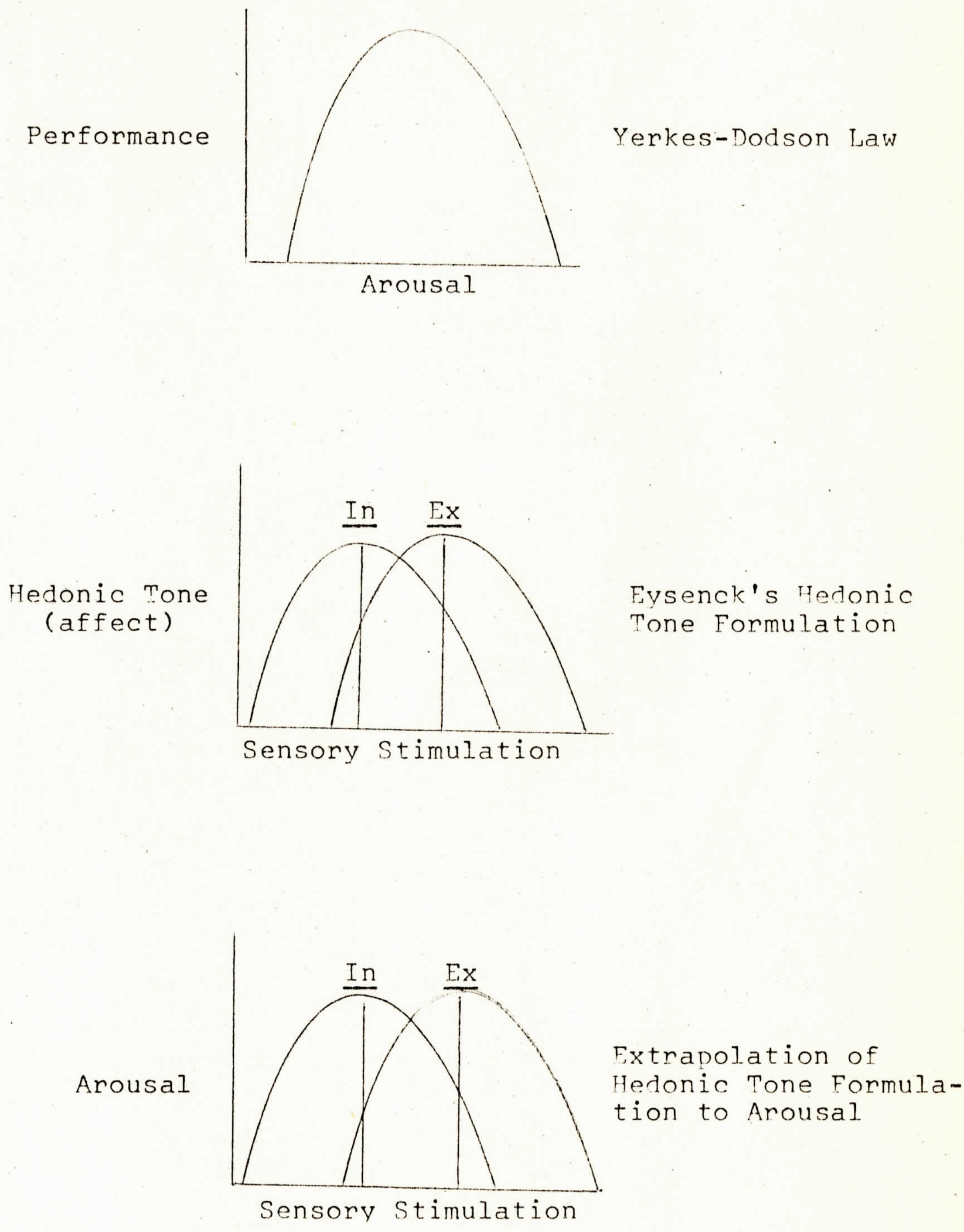

Fig. 6: Analogy of Hedonic Tone Formulation and Inverted U relationship of arousal and performance.

TRIALS TO CRITERION

Extravert Low

Subject	Trials	$\sqrt{}$
1	12	3.46
2	2	1.41
3	6	2.44
4	3	1.73
5	5	2.23
6	4	2.0
7	2	1.41
8	3	1.73
9	2	1.41
10	10	3.16
11	3	1.73
12	0	0

Extravert High

Subject	Trials	$\sqrt{}$
13	15	3.87
14	4	2.0
15	9	3.0
16	9	3.0
17	20	4.47
18	28	5.29
19	2	1.41
20	13	3.60
21	17	4.12
22	20	4.47
23	28	5.29
24	30	5.47

TRIALS TO CRITERION

Introvert Low

Subject	Trials	$\sqrt{\ }$
25	3	1.73
26	17	4.12
27	11	3.31
28	18	4.24
29	12	3.46
30	4	2.0
31	5	2.23
32	11	3.31
33	5	2.23
34	7	2.64
35	2	1.41
36	3	1.73

Introvert High

Subject	Trials	$\sqrt{\ }$
37	2	1.41
38	5	2.23
39	7	2.64
40	13	3.60
41	25	5
42	2	1.41
43	5	2.23
44	30	5.47
45	24	4.89
46	8	2.82
47	11	3.31

TRIALS

Extravert - Low - Latency (mm)

Subjects	1	2	3	4	5	6	7	8	9	10
1	11	11	12	11	11	12	11	21	12	12
2	12	14	8	19	21	21	21	21	21	21
3	11	12	16	21	15	21	21	21	15	21
4	9	9	10	12	21	11	19	21	21	21
5	11	8	21	12	21	21	21	21	21	21
6	11	12	11	21	21	21	21	21	21	21
7	14	21	21	21	21	21	21	21	9	21
8	15	14	21	17	19	21	21	15	21	21
9	12	21	21	14	21	21	21	21	21	21
10	10	12	12	12	12	21	21	11	11	21
11	13	11	13	13	21	21	21	21	21	21
12	11	15	11	21	21	21	21	21	21	21
Total	140	160	177	194	225	233	240	236	215	243

TRIALS

Extravert - Low - Latency (mm)

Subjects	11	12	13	14	15	16	17	18	19	20
1	12	21	21	21	21	21	21	21	11	21
2	21	21	21	21	12	12	21	21	21	21
3	21	21	21	21	21	21	21	21	9	21
4	21	21	21	21	21	21	21	21	21	21
5	21	21	21	21	21	21	21	21	21	21
6	21	21	21	21	21	21	21	21	21	21
7	21	21	21	21	21	21	21	21	21	21
8	21	21	21	21	21	21	21	21	21	21
9	21	21	21	21	21	21	21	21	21	21
10	21	21	11	12	21	21	21	11	21	21
11	21	21	21	21	21	21	21	21	21	21
12	21	21	21	21	21	21	21	21	21	21
Total	243	252	242	243	243	243	252	242	230	252

TRIALS

Extravert - Low - Latency (mm)

Subjects	21	22	23	24	25	26	27	28	29	30	Total
1	21	21	21	21	21	21	21	13	21	21	517
2	21	12	15	21	21	21	21	21	21	21	566
3	7	13	21	21	21	21	21	21	21	21	560
4	21	21	21	21	21	21	21	21	21	9	562
5	12	21	21	21	21	21	21	21	21	16	584
6	21	21	10	21	21	21	21	17	21	21	586
7	21	21	21	21	21	21	21	21	21	21	611
8	21	21	11	21	21	14	21	21	21	21	588
9	21	21	21	21	21	21	21	21	21	21	614
10	12	21	21	13	21	21	21	16	16	21	507
11	21	21	21	21	21	21	21	21	21	21	596
12	21	21	21	21	21	21	21	21	21	21	604
Total	220	235	225	244	252	245	252	235	247	235	6895

TRIALS

Extravert - High - Latency (mm)

Subjects	1	2	3	4	5	6	7	8	9	10
13	7	21	9	8	8	10	8	8	8	9
14	14	12	13	12	21	21	21	13	21	21
15	9	9	11	11	11	21	21	15	21	21
16	10	10	11	12	11	12	21	11	21	21
17	9	11	14	11	9	9	11	9	9	12
18	9	10	11	11	11	10	10	10	10	10
19	12	10	21	21	21	21	16	21	21	20
20	9	12	18	11	12	6	21	21	11	21
21	10	10	9	9	10	11	11	11	10	11
22	10	11	12	21	11	13	10	11	11	11
23	9	11	11	11	12	11	13	10	12	11
24	8	7	8	9	9	8	8	9	8	10
Total	116	134	148	147	146	153	171	149	163	178

TRIALS

Extravert - High - Latency (mm)

Subject	11	12	13	14	15	16	17	18	19	20
13	6	10	10	13	21	21	21	10	11	21
14	21	21	21	21	21	21	21	21	21	21
15	21	13	21	21	21	21	21	21	21	21
16	21	11	21	21	21	13	21	18	21	21
17	10	11	10	10	11	11	11	21	12	21
18	11	10	7	11	21	21	11	10	10	11
19	21	21	21	21	21	21	21	21	21	21
20	21	11	21	21	21	10	21	12	13	21
21	12	11	21	11	10	12	21	21	21	21
22	11	14	13	12	21	21	11	12	12	21
23	10	9	8	21	21	16	10	11	21	21
24	8	21	11	9	8	9	8	8	8	9
Total	173	163	185	192	218	197	198	186	192	230

TRIALS

Extravert - High - Latency (mm)

Subject	21	22	23	24	25	26	27	28	29	30	Total
13	10	21	21	21	21	21	9	21	21	8	414
14	12	21	21	21	21	21	21	21	21	21	580
15	21	21	21	9	21	21	21	21	21	21	550
16	21	21	21	21	21	21	21	9	20	21	526
17	21	21	21	10	21	13	14	21	21	21	416
18	21	8	21	21	11	21	11	21	21	21	402
19	21	21	21	21	11	15	21	21	21	21	588
20	21	21	17	12	21	21	21	21	21	10	500
21	21	21	12	21	21	21	21	21	21	21	464
22	21	21	21	21	21	21	21	21	21	10	468
23	17	16	21	21	10	12	10	12	12	12	438
24	10	8	9	9	9	9	21	9	7	21	295
Total	217	221	227	208	209	226	212	228	237	217	5641

TRIALS

<u>Introvert - Low - Latency</u> (mm)

Subject	1	2	3	4	5	6	7	8	9	10
25	9	10	11	11	21	21	21	12	12	12
26	10	12	21	9	12	12	11	21	11	21
27	12	11	13	13	13	12	12	21	21	10
28	9	6	11	9	11	8	21	9	10	21
29	8	8	9	8	21	9	11	9	21	21
30	11	10	14	21	21	21	21	21	21	17
31	12	15	21	12	21	21	21	21	21	21
32	12	11	13	21	21	12	21	12	21	10
33	11	11	21	11	21	21	21	21	21	12
34	10	12	11	21	21	11	12	12	12	12
35	12	21	21	21	21	21	21	21	21	21
36	12	14	21	21	8	21	21	21	21	21
Total	129	141	187	178	212	190	223	210	222	108

TRIALS

Introvert - Low - Latency (mm)

Subject	11	12	13	14	15	16	17	18	19	20
25	21	21	21	21	21	21	21	21	21	21
26	21	12	11	19	21	10	12	12	12	12
27	21	13	21	16	15	21	13	21	21	21
28	11	21	21	10	11	7	8	21	21	21
29	10	21	21	21	21	21	21	21	21	21
30	21	21	21	21	21	13	21	21	21	12
31	21	21	21	21	21	21	21	21	21	21
32	20	21	21	21	12	21	21	21	21	21
33	21	21	17	21	17	21	21	21	21	21
34	21	21	8	21	21	21	21	21	21	21
35	6	21	14	9	21	21	9	21	21	21
36	21	21	21	21	21	21	21	21	9	21
Total	215	235	218	222	223	229	219	252	240	243

TRIALS

Introvert - Low - Latency (mm)

Subject	21	22	23	24	25	26	27	28	29	30	Total
25	21	21	14	20	13	12	21	16	21	13	522
26	21	21	21	21	21	21	14	10	21	21	520
27	21	21	21	21	21	15	21	21	21	21	525
28	21	21	21	21	21	8	21	21	21	21	464
29	21	21	21	21	21	21	21	21	21	21	535
30	21	21	21	21	21	21	21	21	21	21	581
31	21	21	21	21	21	21	21	21	21	21	606
32	21	21	21	21	21	21	21	21	21	11	554
33	15	8	21	21	21	21	21	21	21	21	564
34	21	21	21	21	11	21	21	21	21	17	563
35	21	18	9	21	21	21	21	21	21	21	560
36	21	21	21	21	21	21	21	21	21	21	589
Total	246	236	233	251	234	224	245	236	252	230	6583

TRIALS

Introvert - High - Latency (mm)

Subject	1	2	3	4	5	6	7	8	9	10
37	8	10	21	21	21	21	21	21	21	21
38	12	10	21	10	21	21	21	21	21	21
39	9	11	12	13	14	11	21	21	21	21
40	14	12	13	11	11	13	15	13	21	21
41	10	9	11	10	11	11	9	16	11	10
42	13	12	11	21	12	21	21	11	21	21
43	13	14	15	15	21	15	13	21	21	21
44	9	8	10	8	10	9	10	15	12	12
45	9	10	10	21	9	10	13	10	21	21
46	8	9	12	8	10	21	10	21	21	21
47	9	7	10	10	21	9	11	9	21	9
Total	114	112	146	148	161	162	165	179	212	199

TRIALS

Introvert - High - Latency (mm)

Subjects	11	12	13	14	15	16	17	18	19	20
37	21	21	21	21	21	21	21	21	21	21
38	21	21	21	21	21	21	21	21	21	21
39	21	21	21	21	21	21	21	21	21	21
40	14	15	21	21	21	21	21	21	21	21
41	11	13	10	21	12	21	10	9	10	13
42	10	21	21	21	21	21	21	21	21	21
43	21	18	21	21	21	21	21	21	16	21
44	14	10	8	11	13	11	21	10	21	13
45	15	12	21	11	21	11	9	21	21	9
46	21	21	21	21	21	21	21	21	21	21
47	21	21	21	21	21	10	10	6	8	21
Total	190	194	207	211	214	200	197	193	202	203

TRIALS

Introvert - High - Latency (mm)

Subjects	21	22	23	24	25	26	27	28	29	30	Total
37	21	21	21	21	21	21	21	21	21	21	606
38	21	21	21	21	21	21	21	21	21	21	599
39	21	21	21	21	21	21	21	21	21	21	574
40	21	21	21	21	21	21	21	21	21	21	551
41	21	12	21	21	21	21	21	21	21	11	429
42	21	21	21	21	21	14	21	21	21	21	566
43	21	21	16	15	16	21	15	21	21	21	559
44	7	20	9	11	11	12	21	11	21	21	379
45	21	15	14	21	21	21	21	21	21	21	482
46	12	10	12	21	21	21	21	21	21	21	532
47	21	7	6	21	21	11	21	21	21	21	447
Total	208	190	183	215	216	205	225	221	231	221	5724

TRIALS

Extravert - Low - Magnitude

Subjects	1	2	3	4	5	6	7	8	9	10
1	87.8	73.1	98.5	104.0	98.0	53.1	104.0	0	21.0	5.7
2	11.9	1.7	4.0	1.7	0	0	0	0	0	0
3	54.5	52.1	38.6	0	15.0	0	0	0	9.3	0
4	7.0	5.2	3.5	1.2	0	1.3	.1	0	0	0
5	51.6	15.5	0	6.6	0	0	0	0	0	0
6	42.9	25.5	15.0	0	0	0	0	0	0	0
7	18.6	0	0	0	0	0	0	0	6.1	0
8	4.0	5.7	0	7.5	3.5	0	0	2.6	0	0
9	7.9	0	0	2.2	0	0	0	0	0	0
10	81.9	23.2	11.0	7.0	5.7	0	0	15.9	11.9	0
11	8.8	7.9	2.2	2.6	0	0	0	0	0	0
12	1.7	1.7	.9	0	0	0	0	0	0	0
Totals	378.6	211.6	173.7	132.8	122.2	54.4	104.1	18.5	48.3	5.7

TRIALS

Extravert - Low - Magnitude

Subjects	11	12	13	14	15	16	17	18	19	20
1	18.2	0	0	0	0	0	0	0	5.7	0
2	0	0	0	0	5.2	8.8	0	0	0	0
3	0	0	0	0	0	0	0	0	7.5	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	18.6	2.6	0	0	0	20.5	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0
Totals	18.2	0	18.6	2.6	5.2	8.8	0	20.5	13.2	0

TRIALS

Extravert - Low - Magnitude

Subjects	21	22	23	24	25	26	27	28	29	30	Totals
1	0	0	0	0	0	0	0	17.3	0	0	686.4
2	0	5.7	2.2	0	0	0	0	0	0	0	41.2
3	18.6	2.6	0	0	0	0	0	0	0	0	198.2
4	0	0	0	0	0	0	0	0	0	3.5	21.8
5	9.3	0	0	0	0	0	0	0	0	6.6	89.6
6	0	0	6.1	0	0	0	0	6.1	0	0	95.6
7	0	0	0	0	0	0	0	0	0	0	24.7
8	0	0	3.1	0	0	1.7	0	0	0	0	28.1
9	0	0	0	0	0	0	0	0	0	0	10.1
10	7.5	0	0	21.4	0	0	0	9.3	8.4	0	244.9
11	0	0	0	0	0	0	0	0	0	0	21.5
12	0	0	0	0	0	0	0	0	0	0	4.3
Totals	35.4	8.3	11.4	21.4	0	1.7	0	32.7	8.4	10.1	1466.4

TRIALS

Extravert - High - Magnitude

Subjects	1	2	3	4	5	6	7	8	9	10
13	36.7	0	13.7	25.9	25.5	6.1	19.5	25.9	12.8	13.2
14	7.9	5.2	5.7	2.6	0	0	0	1.7	0	0
15	64.5	80.3	64.0	14.6	36.7	0	0	7.9	0	0
16	113.5	85.1	45.8	67.5	18.2	24.1	0	24.6	0	0
17	79.4	94.2	39.6	15.9	97.4	44.3	4.4	23.7	34.3	10.2
18	100.7	63.5	43.4	42.9	34.8	63.5	61.0	59.5	56.0	50.6
19	12.3	3.5	0	0	0	0	1.7	0	0	1.7
20	79.8	34.8	13.2	42.9	32.0	64.5	0	0	6.1	0
21	44.8	37.7	33.9	33.9	23.2	12.3	14.6	15.5	12.8	14.6
22	59.5	46.3	26.4	0	27.4	30.2	23.2	28.3	47.2	36.7
23	21.4	15.9	9.7	22.8	12.3	12.8	16.4	16.8	9.7	10.2
24	105.1	45.8	14.1	57.0	86.7	38.6	59.5	64.0	53.5	40.5
Totals	725.6	512.3	309.5	326.0	394.2	296.4	200.3	267.9	232.4	177.7

TRIALS

Extravert - High - Magnitude

Subjects	11	12	13	14	15	16	17	18	19	20
13	6.6	6.6	7.0	7.0	0	0	0	8.8	8.8	0
14	0	0	0	0	0	0	0	0	0	0
15	0	4.4	0	0	0	0	0	0	0	0
16	0	41.9	0	0	0	6.6	0	63.0	0	0
17	15.5	10.6	27.4	39.1	11.0	16.8	30.6	0	5.7	0
18	65.5	39.1	13.2	42.9	0	0	16.4	92.0	73.1	61.0
19	0	0	0	0	0	0	0	0	0	0
20	0	9.3	0	0	0	11.0	0	15.5	4.4	0
21	4.8	14.6	0	22.3	17.3	8.4	0	0	0	0
22	36.2	7.9	12.3	14.6	0	0	7.0	21.4	16.8	0
23	13.7	10.2	5.2	0	0	8.8	11.4	7.5	0	0
24	38.1	0	6.1	64.5	66.0	82.4	93.7	99.6	24.6	37.2
Totals	180.4	144.6	71.2	190.4	94.3	134.0	159.1	307.8	133.4	98.2

TRIALS

Extravert - High - Magnitude

Subjects	21	22	23	24	25	26	27	28	29	30	Totals
13	14.6	0	0	0	0	0	5.7	0	0	8.8	253.2
14	.9	0	0	0	0	0	0	0	0	0	24.0
15	0	0	0	3.1	0	0	0	0	0	0	275.5
16	0	0	0	0	0	0	0	71.6	7.9	0	569.8
17	0	0	0	28.3	0	5.7	7.0	0	0	0	641.1
18	0	32.5	0	0	66.5	0	53.5	0	0	0	1131.6
19	0	0	0	0	11.0	2.2	0	0	0	0	32.4
20	0	0	9.3	3.5	0	0	0	0	0	30.2	356.5
21	0	0	8.8	0	0	0	0	0	0	0	319.5
22	0	0	0	0	0	0	0	0	0	46.7	488.1
23	6.1	7.9	0	0	9.7	0	5.2	0	0	0	233.7
24	11.9	38.6	69.0	46.7	41.9	37.7	0	44.8	22.8	0	1390.4
Totals	33.5	79.0	87.1	81.6	129.1	45.6	71.4	116.4	30.7	85.7	5715.8

TRIALS

Introvert - Low - Magnitude

Subjects	1	2	3	4	5	6	7	8	9	10
25	83.5	55.5	50.1	50.6	0	0	0	10.2	19.5	24.1
26	37.2	20.0	0	33.9	7.5	7.5	38.1	0	23.7	0
27	14.1	1.7	3.5	4.4	2.6	6.1	4.4	0	0	9.3
28	16.8	19.5	4.0	11.9	7.9	11.9	0	15.0	5.2	0
29	75.2	67.5	52.6	69.0	0	22.3	9.3	20.0	0	0
30	35.3	37.7	12.8	0	0	0	0	0	0	22.3
31	16.4	7.0	0	2.2	0	0	0	0	0	0
32	25.0	23.2	5.7	0	0	8.4	0	5.7	0	12.3
33	104.0	31.1	0	55.0	0	0	0	0	0	4.4
34	47.7	26.9	7.5	0	0	6.6	0	0	0	0
35	26.4	0	0	0	0	0	0	0	0	0
36	14.6	4.8	0	0	3.1	0	0	0	0	0
Total	496.2	294.9	136.2	227.0	21.1	62.8	51.8	50.9	48.4	72.4

TRIALS

Introvert - Low - Magnitude

Subjects	11	12	13	14	15	16	17	18	19	20
25	0	0	0	0	0	0	0	0	0	0
26	0	6.6	19.5	10.6	0	3.5	0	0	0	0
27	0	2.6	0	.9	1.7	0	1.3	0	0	0
28	8.4	0	4.4	7.9	4.4	4.8	7.5	0	0	0
29	25.0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	10.6	0	0	0	16.8
31	0	0	0	0	0	0	0	0	0	0
32	2.2	0	0	0	2.6	0	0	0	0	0
33	0	0	6.6	0	12.3	0	0	0	0	0
34	0	0	.9	0	0	0	0	0	0	0
35	13.2	0	15.0	5.7	0	0	24.1	0	0	41.0
36	0	0	0	0	0	0	0	0	19.5	0
Total	48.8	9.2	46.4	25.1	21.0	18.9	32.9	0	19.5	57.8

TRIALS

Introvert - Low - Magnitude

Subjects	21	22	23	24	25	26	27	28	29	30	Total
25	0	0	2.6	7.9	21.0	26.9	0	4.4	0	7.9	364.2
26	0	0	0	0	0	0	6.1	24.6	0	0	238.8
27	0	0	0	0	0	1.3	0	0	0	0	53.9
28	0	4.4	0	0	0	11.4	0	0	0	0	145.0
29	0	0	0	0	0	0	0	0	0	0	340.9
30	0	0	0	0	0	0	0	0	0	0	135.5
31	0	0	0	0	0	0	0	0	0	0	25.6
32	0	0	0	0	0	0	0	0	0	5.7	90.8
33	4.8	12.3	0	0	0	0	0	0	0	0	230.5
34	0	0	0	0	.9	0	0	0	0	2.6	93.1
35	0	8.4	17.7	0	0	0	0	0	0	0	151.5
36	0	0	0	0	0	0	0	0	0	0	42.0
Total	4.8	25.1	20.3	7.9	21.9	39.6	6.1	29.0	0	16.2	1912.2

TRIALS

Introvert - High - Magnitude

Subjects	1	2	3	4	5	6	7	8	9	10
37	4.4	3.1	0	0	0	0	0	0	0	0
38	38.6	69.1	0	76.1	0	0	0	0	0	0
39	29.7	26.4	18.6	5.7	2.6	4.4	0	0	0	0
40	27.4	51.6	24.1	13.2	7.0	11.9	8.8	8.8	0	0
41	91.5	76.2	31.5	40.0	12.8	43.8	53.5	4.0	22.3	36.2
42	44.8	13.2	13.7	2.6	4.0	0	0	3.1	0	0
43	4.8	6.1	1.7	6.1	0	1.7	3.5	0	0	0
44	107.3	63.0	55.0	47.7	62.0	76.7	47.2	32.0	26.9	10.6
45	68.0	57.0	47.7	15.9	46.3	39.6	7.5	55.0	0	0
46	35.3	19.5	5.7	2.6	8.4	0	6.1	0	0	0
47	63.0	37.7	35.3	47.7	0	20.5	16.8	27.8	0	10.6
Total	514.8	422.9	233.3	257.6	143.1	198.6	143.4	130.7	49.2	57.4

TRIALS

Introvert - High - Magnitude

Subjects	11	12	13	14	15	16	17	18	19	20
37	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0
40	5.2	5.2	0	0	0	0	0	0	0	0
41	19.1	4.8	40.5	0	15.0	0	40.0	40.5	47.2	11.4
42	13.7	0	0	0	0	0	0	0	0	0
43	0	.09	0	0	0	0	0	0	3.5	0
44	45.3	24.6	29.7	9.7	32.0	9.3	0	28.7	0	6.6
45	14.1	18.6	0	23.2	0	14.1	14.6	0	0	19.1
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	25.5	10.6	2.6	39.6	0
Total	97.4	53.3	70.2	32.9	47.0	48.9	65.2	71.8	90.3	37.1

TRIALS

Introvert - High - Magnitude

Subjects	21	22	23	24	25	26	27	28	29	30	Total
37	0	0	0	0	0	0	0	0	0	0	7.5
38	0	0	0	0	0	0	0	0	0	0	183.8
39	0	0	0	0	0	0	0	0	0	0	87.4
40	0	0	0	0	0	0	0	0	0	0	163.2
41	0	18.2	0	18.6	0	0	0	0	0	14.6	681.7
42	0	0	0	0	0	7.0	0	0	0	0	102.1
43	0	0	2.2	3.1	1.2	0	4.8	0	0	0	38.8
44	25.5	10.6	68.0	55.0	17.7	7.0	0	23.7	0	0	921.8
45	0	38.1	10.6	0	0	0	0	0	0	0	489.4
46	4.0	11.4	10.6	0	0	0	0	0	0	0	103.6
47	0	4.8	22.8	0	0	14.6	0	0	0	0	379.9
Total	29.5	83.1	114.2	76.7	18.9	28.6	4.8	23.7	0	14.6	3159.2

VITA

Ronald Howard Cox was born in Washington, D. C., on January 11, 1950. He attended elementary school in Kensington, Maryland. He graduated from Good Counsel High School in June, 1968. He entered Frostburg State College in September, 1968, and received a Bachelor of Science degree in Psychology in June, 1972.

In the Fall of 1972, he accepted a job as an Exercise Program Director in Washington, D. C. He left Washington in 1973 to pursue a Master's degree in General Experimental Psychology at Appalachian State University.

In September of 1974, he entered the Graduate Program in Experimental Psychology at the University of Tennessee, Knoxville, to pursue a Ph.D. in psychophysiology. During the course of this work, the requirements for the M.A. degree in psychology from Applachian State University were completed.

He is married to the former Janet Lynn Arseneault of Cheverly, Maryland.