EXTRAVERSION AND NEED FOR SENSORY STIMULATION

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ABSTRACT

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By

Elek John Ludvigh III

The purpose of this study was to test the hypothesis that extraversion and need for sensory input are positively correlated. Fifty-four undergraduates were measured for extraversion using the Eysenck Personality Inventory. The subjects were then deprived of sensory input for fifteen minutes. Immediately after the deprivation period, they were allowed to stimulate themselves with white light and white noise for fifteen minutes. Data from this self-stimulation session were correlated with extraversion scores.

The results revealed that there was no significant correlation between extraversion and amount of self-stimulation preferred. The nature of the self-administered stimuli and the short deprivation and self-stimulation periods used were considered as possible causes for lack of support of the hypothesis.

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TABLE OF CONTENTS

	Page
LIST OF TABLES	iv
LIST OF FIGURES	v
INTRODUCTION	1
Prior Research	6
Discussion of Prior Research	7
Problem and Hypotheses	10
METHOD	15
Subjects	15
Apparatus	15
Procedure	16
RESULTS	18
EPI and Abnormal Arousal Questionnaire Data	18
Subject Classification	20
Self-Stimulation Parameters	21
Hypothesis Testing	23
DISCUSSION OF RESULTS	30
Conclusions	36
REFERENCES	38
APPENDIX A: THE EYSENCK PERSONALITY INVENTORY	40
APPENDIX B: INTERCORRELATION MATRICES	42

LIST OF TABLES

Table		Page
1.	EPI Summary Data for All Subjects	19
2.	Classification of Subjects by Sex and Arousal/Lie	21
3.	Correlations between Extraversion and Self-Stimulation Parameters for Four Subject Groups	24
4.	Button Pressing during PRP versus Button Pressing during RP for All Subjects	25
5.	Differences between Male and Female Subjects on Self-Stimulation Parameters	27
6.	Differences between Normal Internal Arousal Subjects and Abnormal Internal Arousal/Lie Subjects on Self-Stimulation Parameters	29

LIST OF FIGURES

Figure		Page
1.	Relation between level of sensory input and hedonic tone as a function of personality	4
2.	Location of experimental sensory deprivation and experimental pain points on the Level of Stimulation continuum	8

INTRODUCTION

It is apparent that people who are socially active tend to experience greater sensory input than people who are withdrawn. Is it the case that people who are sociable exhibit this extraverted type of behavior at least partly because they enjoy the sensory stimulation associated with it? The purpose of the present study was to determine if there is indeed a positive correlation between extraversion and amount of sensory stimulation preferred.

Working within a theoretical orientation that human personality is largely determined by biological factors, H. J. Eysenck has proposed that one of the most important factors in personality is the introversion-extraversion dimension. Eysenck hypothesizes that extraverted patterns of behavior tend to be developed by individuals as a function of inborn neurophysiological processes.

In order to relate neurological processes to extraversion, Eysenck takes several steps. The first is to define the concept of reactive inhibition presented by the learning theorist Clark Hull (1943). This construct is defined as follows: "Whenever a reaction is evoked in an organism there is left a condition or state which acts

as a primary negative emotion in that it has an innate capacity to produce a cessation of the activity which produced the state" (Eysenck, 1967, p. 77).

Having defined reactive inhibition, Eysenck continues to lay his theoretical groundwork by borrowing another Hullian construct. "Another characteristic of reactive inhibition . . . is that 'each amount of inhibitory potential diminishes progressively with the passage of time according to a simple decay or negative growth function'" (Eysenck, 1968, p. 78). Tying these two constructs together, Eysenck then cites Hull again and suggests that

> ". . . all responses leave behind in the physical structures involved in the evocation, a state or substance which acts directly to inhibit the evocation of the activity in question. The hypothetical inhibitory condition or substance is observable only through its effect on positive reaction potentials" (Eysenck, 1967, p. 78).

Eysenck then broadens the application of Hull's learning theory related constructs by suggesting that ". . . from the behaviorist point of view, perception is in fact a stimulus response connection; thus this general principle [i.e., the last Hullian construct cited above] could apply with equal force to so-called perceptual phenomena" (Eysenck, 1967, p. 78). Finally, Eysenck states two postulates explaining the general relationship he feels exists between personality and inhibition as he has defined it above.

First:

> Human beings differ with respect to the speed with which excitation and inhibition are produced and the speed with which inhibition is dissipated. These differences are properties of the physical structures involved in making stimulus response connections.

Second:

> Individuals in whom excitatory potential is generated slowly and in whom excitatory potentials so generated are relatively weak are thereby predisposed to develop extraverted patterns of behavior. . . . Individuals in whom excitatory potential is generated quickly and in whom excitatory potentials so generated are strong are thereby predisposed to develop introverted patterns of behavior. . . . Similarly individuals in whom reactive inhibition is developed quickly, in whom strong reactive inhibitions are generated, and in whom reactive inhibition is dissipated slowly are thereby predisposed to develop extraverted patterns of behavior; . . . conversely, individuals in whom reactive inhibition is developed slowly, in whom weak reactive inhibitions are generated, and in whom reactive inhibition is dissipated quickly are thereby predisposed to develop introverted patterns of behavior (Eysenck, 1967, p. 77).

Based on the foregoing, Eysenck hypothesizes that the sensory thresholds of introverts are lower than those of extraverts ". . . because of the higher efficiency of performance associated with cortical excitation" (Eysenck, 1967, p. 100). Extrapolating from this hypothesis, "the theory linking introversion with low sensory thresholds (and small j.n.d.s.) has been extended by Eysenck to pain tolerance and sensory deprivation tolerance in the following manner" (Eysenck, 1967, p. 100).

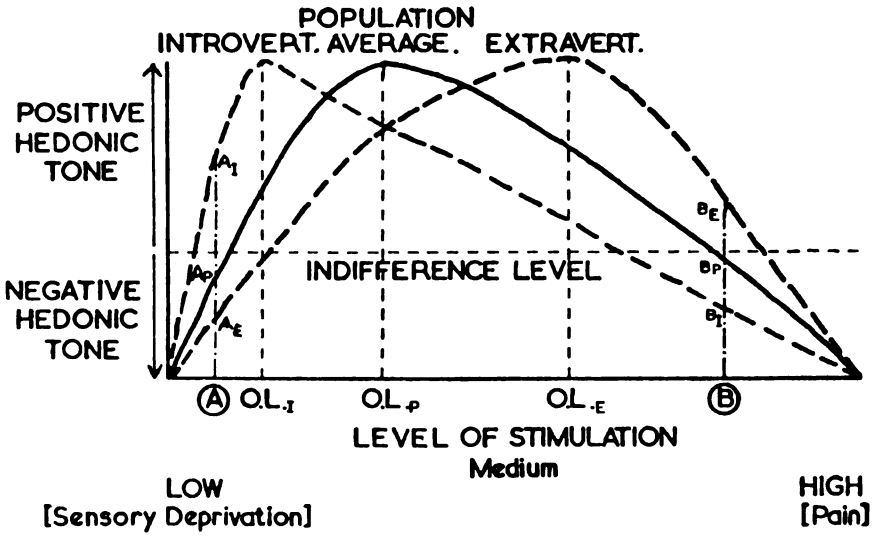

Figure 1. --Relation between level of sensory input and hedonic tone as a function of personality. (Eysenck, 1967, p. 109)

The hypothesized relationship graphed above is explained by Eysenck as follows:

> . . . along the abscissa we have plotted degrees of sensory stimulation, from extremely low at the left to extremely high on the right. Along the ordinate we have plotted the hedonic tone associated with these different levels of stimulation, ranging from strongly negative (feelings of displeasure or even pain; desire to escape, to end the stimulation; abience) to strongly positive (feelings of intense pleasure; desire to prolong the stimulation, or even to increase it; adience). Between the positive and negative hedonic tones there is an indifference level, indicating that stimulation is neither sought nor avoided but is quite neutral to the subject. The strongly drawn curvilinear line in the centre of the diagram indicates the relationship between hedonic tone and strength of sensory stimulation, as derived from random samples of the population. We find that extremely high levels of stimulation produce pain and discomfort and have consequently a high negative hedonic tone (Beecher, 1959). Extremely low levels of stimulation (sensory

deprivation) have also been found to be productive of high negative hedonic tone and to be bearable only for relatively short periods (Solomon et al., 1967; Zubeck, 1964). It is only at intermediate levels of sensory stimulation that positive hedonic tone develops, and this finding is not perhaps entirely out of line with common experience and expectation. In any case, there is ample experimental evidence in the literature for the general correctness of the picture presented in Figure 37 (Berlyne, 1960).

We must now turn to individual differences in excitation and inhibition. Introverts have lower thresholds, and show less adaptation/inhibition to continued stimulation; extraverts have higher thresholds, and show more adaptation/inhibition to continued stimulation. It would seem to follow that any given degree of stimulation would be experienced as effectively higher by introverts than by extraverts. Objectively equal amounts of stimulation, therefore, would not be experienced as equal by extraverts, ambiverts, and introverts; they would appear displaced to the left of the abscissa of Figure 37 for the introvert, and to the right by the extravert. Similarly, if O. L. represents the optimum (or preferred) level of stimulation of a given person, then $O.L._I$ would lie to the left of $O.L._P$, and this in turn to the left of $O.L._E$, where I and E refer to introvert and extravert, respectively, and P to the population average.

Again, consider two points, A and B, on the abscissa, referring to low and high stimulation respectively. If straight lines are drawn through these points, parallel to the ordinate, they will cross the general curve relating level of stimulation to hedonic tone roughly at the indifference level; in other words, for the average person these two stimuli are equally indifferent. For the typical extravert and introvert, however, as already explained, the general curve is not representative and has to be displaced to the left for the introvert and to the right for the extravert. As shown in the diagram, it follows that stimulus A will be positively hedonic for the introvert (A_I) and negatively hedonic for the extravert (A_E), while B will be negatively hedonic for the introvert (B_I) and positively hedonic for the extravert (B_E). In other words, we postulate a certain degree of stimulus hunger (sensation seeking, arousal seeking) in the extravert, and a certain degree of stimulus aversion in the introvert. Conversely, it would seem to follow that extraverts should be more tolerant of pain, introverts of sensory deprivation (Eysenck, 1967, p. 109).

Prior Research

Few researchers have directly tested the Eysenck theory that extraversion is related to a need for sensory input per se. Studies which have examined the relationship between extraversion and stimulus hunger fall into three major groups: (1) those which examined the differences between extraverts and introverts on ability to tolerate sensory deprivation, (2) those which investigated differential pain tolerance between extraverts and introverts, and (3) those which examined the differences in optimum level of arousal for extraverts and introverts.

Sensory Deprivation Studies

Tranel (1962) found that extraverts tolerated sensory deprivation significantly better than introverts. He pointed out, however, that this finding was somewhat doubtful because extraverts tended to minimize the effect of environmental sensory deprivation by deliberately stimulating themselves. Concurring with Eysenck's theory was the finding of Petrie, Collins and Solomon (1960) that introverts tolerated sensory deprivation significantly better than extraverts.

Pain Tolerance Studies

Lynn and Eysenck (1960) found that there was a significantly positive correlation between extraversion and pain tolerance which was supported by similar research carried out by Petrie, et al. (1960). Howarth (1963) found that extraverts performed significantly better than introverts on painful breath holding and leg persistence tasks. Contradicting these studies, however, was the finding of Levine, Tursky and Nichols (1966), that extraversion was not correlated with pain tolerance.

Optimal Arousal Studies

Farley (1967) investigated the relationship between extraversion and scores on the Sensation Seeking Scale developed by Zukerman (1964) and found the two to be significantly correlated in the direction predicted by Eysenck's theory. Weisen (1965) allowed extraverts and introverts to stimulate themselves with multi-colored lights and loud music and found a significant positive correlation between extraversion score and amount of self-stimulation preferred.

Discussion of Prior Research

In his discussion of the relationships graphed in Figure 1, Eysenck explained that points A and B on the abscissa denote levels

of stimulation which the average population (i.e., ambiverts) would find neither pleasant nor unpleasant. Sensory deprivation and pain are both aversive to ambiverts. It is therefore clear that pain and sensory deprivation studies are investigating differences in hedonic tone for levels of stimulation above B and below A respectively. Locations of these points, of course, vary for different studies as a function of what the experimenter defines as his sensory deprivation or pain producing conditions. For purposes of illustration, however, we can label these typical experimental sensory deprivation and experimental pain points A' and B' as shown below.

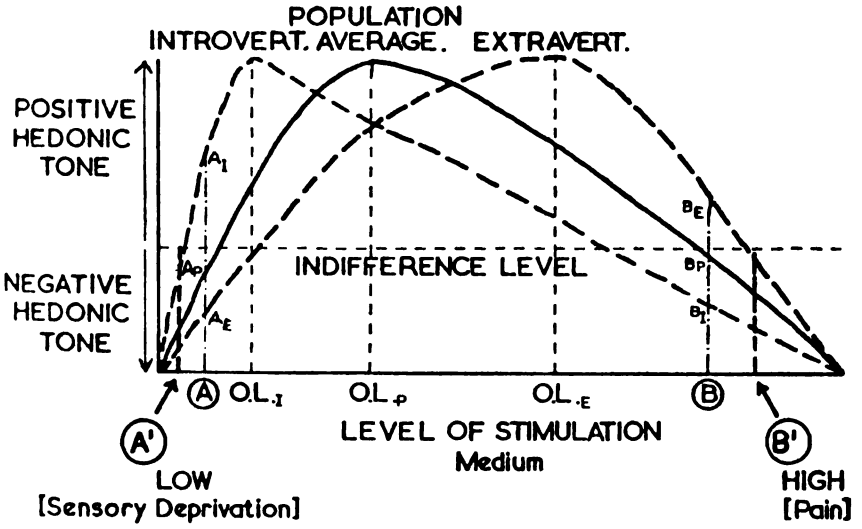

Figure 2. --Location of experimental sensory deprivation and experimental pain points on the Level of Stimulation continuum.

Examination of Figure 2 reveals a problem of both sensory deprivation and pain tolerance studies. That is, both investigated differences in hedonic tone between introverts and extraverts for levels of stimulation where differences are postulated as being almost minimal.

On the other hand, in two studies related to optimum stimulation level for extraverts and introverts, positively biased dependent measures were used. In the study by Farley (1967), the Sensation Seeking Scale, used as a dependent measure, has 23 of its 34 items related to need for social stimulation and has not been empirically validated for need for purely sensory stimulation. Since the Eysenck Personality Inventory (EPI) extraversion scale has 16 of 24 items which are related to need for social stimulation, it is apparent that a significant correlation between these tests may be as much due to similarity of items as to differential stimulus seeking tendencies of extraverts and introverts.

The study by Wiesen (1965) clearly measured a need for stimulation but also had a positively biased dependent measure. It will be remembered that this study enabled subjects to stimulate themselves with colored lights and loud music. It is suggested that the average extravert, because of his social history, would find this type of stimulation rewarding not because of its cortical arousal

function, but because it has been strongly associated with such rewarding activities as nightclubbing and parties. The introvert conversely would be unlikely to have formed such associations. Thus the stimuli may have had different secondary reenforcement characteristics for extraverts and introverts.

A further methodological flaw in all of the above studies was the absence of evaluation of possible abnormal cortical arousal states of individual subjects. While no study considered it, it is probable that any abnormality of a subject's cortical arousal will bias measures of his tolerance or need for external stimulation. For example, because of fatigue or nervousness during the experiment, any given subject might require what is for him an unusually high or low amount of sensory stimulation in order to be optimally comfortable.

Another variable which was not controlled in previous studies was sex. Although Eysenck's theory implies there should be no sex differences, such differences are so common in personality research (Anastasi, 1963) that adequate controls should be considered.

Problem and Hypotheses

Do extraverts differ from introverts in stimulus hunger as postulated by Eysenck (Eysenck, 1964, 1967)? The problem was

to investigate the relationship between extraversion, level of sensory stimulation, and hedonic tone in such a way as to detect existing differences, while simultaneously controlling for possible confounding factors. Because the hypotheses being tested were derived from Eysenck's theory, his test of extroversion, the EPI, was used.

Of the following four hypotheses, it should be noted that the primary hypothesis to be tested was Eysenck's proposition that stimulus hunger is positively correlated with extraversion. The three additional hypotheses were being tested to provide information about the validity of this study and previous similar research.

> Hypothesis 1: There is a positive correlation between degree of extraversion and amount of sensory stimulation necessary to maintain optimum hedonic tone.

The first proposition examines the stimulus hunger-extraversion relationship proposed by Eysenck (1967) and supported by the research of Wiesen (1965) and Farley (1967). Extraverts are assumed by Eysenck to have a greater need for sensory stimulation than introverts. Also, extraversion is presented as being continuously distributed in the population. Thus, although most previous studies have used subjects who were either markedly introverted or extraverted, consideration of the entire range was appropriate.

Hypothesis 2: Given a perceptually restricted environment, stimuli chosen for apparent lack of secondary reenforcement characteristics still serve as reenforcers to all subjects.

To assure that the sensory stimuli used did not have differential reenforcing effects for introverts and extraverts, the study at hand used "neutral" stimuli (i.e., low level white light and white noise). Stimuli such as these have been shown to affect cortical arousal via the ascending reticular activating system as described by Moruzzi and Magoun (1949). For the present study, however, the cortical arousal value of these stimuli was assumed without actually measuring the EEG. While it appeared justifiable to assume the cortical arousal value of the stimuli, research cited by Jones (1964) suggests that the reenforcing value of nonmeaningful stimuli containing little information is slight.

The importance of Hypothesis 2 lies in the fact that its support or lack thereof has much to say about the relevance of the data to Hypothesis 1. If it was observed that Hypothesis 1 was not supported by the data and Hypothesis 2 also was not supported, the results of the study would be equivocal. This is because unless the stimuli used in the study were established as having some sort of reenforcement value to the subjects, their ability to create a significant change in the arousal state of the subjects would be

questionable. In order to be able to speak of the relationship between sensory stimulation and hedonic tone it must be established that the sensory stimuli are potent ones.

The present writer stated that previous research failed to control for variables which potentially could confound results. One such variable suggested was abnormal internal arousal states of experimental subjects. Statistically, such abnormal internal states are considered part of random error variance and as such should not alter the outcome of studies failing to control for them. Nevertheless, in a pilot study by the author, it was noted that almost half of the subjects described themselves as being abnormally drowsy or nervous when in a perceptually restricted environment. With this large a proportion of aberant subjects, any systematic variation could alter the experimental outcome. This observation led to the following hypothesis.

> Hypothesis 3: While in the experimental situation some subjects experience what is for them abnormally heightened or reduced cortical arousal states. Such subjects comprise a separate population than normal subjects and therefore differ from normal subjects in the amount of stimulation necessary to maintain optimal hedonic tone.

No prediction was made as to the direction of the difference. The proposition was simply that due to systematic abnormality such

subjects differ significantly from normal subjects in amount of sensory stimulation necessary to maintain optimum hedonic tone.

Another uncontrolled variable of previous studies was sex. While Eysenck's theory implies that there should be no sex differences related to stimulus hunger, it was decided to control for sex. This was an empirical decision based on the fact that because many personality variables are sex related (Anastasi, 1963), it would be wise to at least investigate possible sex differences. However, since the writer had no concrete reasons for doubting Eysenck's implicit belief that sex is unrelated to stimulus hunger, the following was hypothesized:

> Hypothesis 4: There are no significant sex differences in amount of sensory stimulation necessary to maintain optimum hedonic tone.

METHOD

Subjects

Twenty-seven male and twenty-seven female volunteers drawn from an introductory psychology course served as Ss for this study.

Apparatus

The experimental chamber was a 10' × 8' × 8' windowless, sonically well-insulated room, bare of all decorations, with furniture consisting of a comfortable arm chair and small table placed beside the right arm of the chair. On the table was a 4" × 2.5" × 2" console on which were mounted two spring-return buttons which, when pressed by at least 10 ounces of pressure, operated a 2.5 watt light and an approximately 60 decibel white noise signal. In addition, each key simultaneously operated an Esterline-Angus event recorder which continuously monitored the onset, duration, and offset of pressing for each key. A remote control switch outside the experimental room enabled the experimenter to close or open the circuit between the subject-operated keys and the sensory stimuli. With

the circuit open, subject key pressing operated the event recorder only. With the circuit closed, both the event recorder and the sensory stimuli were activated by key pressing.

Procedure

Ss were individually tested for both degree of extraversion and need for sensory input in a one-hour session. On reporting to the experimental laboratory, the subject was provided with a copy of the EPI, and instructions were given verbally by the experimentas as follows: "The first thing I want you to do is fill out this questionnaire [see Appendix A]. It is quite easy and has the instructions printed on it." When the subject completed and handed in the EPI, he was taken to the experimental room and told the following:

> For the rest of your experimental time, I am going to ask you to help me in determining how much stimulation it takes to make you comfortable. This is a very quiet room which can be dimly lit. In addition, some noise can be provided. Your job is to sit in the chair for 30 minutes. For the first 15 minutes neither the light nor the sound will be connected, so pushing the buttons you see here on the table will have no effect. After the first 15 minutes, however, if you press the right button the light will go on, and if you press the left button the sound will go on. The buttons work only when you actually hold them down. What I want you to do while you are in here is to press either or both of the buttons as much as you want. Your job for me is to press the buttons in such a manner as to make yourself as comfortable as possible in this situation. The door will not be locked, and you can leave at any time; but please stay in the room for the full 30 minutes if possible. Remember that the buttons will be operative only after you have been in here for 15 minutes, but that you can press them whenever you like.

> Please remember also that from the point when you discover the buttons to be operative onwards, until I come into the room at the end of the experiment, your only job is to press the buttons in such a way as to make yourself as comfortable as possible. You can press them continuously or not at all, one, or both, or none; just try to press them in such a way as to be comfortable. Please do not smoke or get out of the chair during the experiment.

When the subject was taken from the experimental room, he was checked for abnormal arousal states during the experimental period by asking him if he was sleepy or nervous during the time he was in the experimental room. As a check of a possible secondary reward function of the light, subjects were also asked whether they were afraid of the dark. If there was any evidence of abnormal arousal or secondary reward it was recorded directly on the back of the subject's EPI answer form. Subjects were then debriefed by explaining the basic hypothesis being tested.

RESULTS

EPI and Abnormal Arousal Questionnaire Data

Before the actual analysis of the data was carried out, the raw data from the EPI and abnormal arousal questionnaire were evaluated. This evaluation was carried out for two main reasons. The first was to check to see if the sample corresponded to the published EPI norms. The published mean extraversion scores for American college students on the EPI was 13.1 (Eysenck, 1968), and the mean obtained for the sample was 12.7 with a range of 3 to 24. This suggested that the sample was similar to Eysenck's standardization sample.

The second reason was to evaluate subject variables which might reduce the correlation between EPI scores and need for sensory stimulation. To determine whether a significant proportion of the subjects were experiencing abnormal arousal states during the sensory restriction period, the abnormal arousal questionnaires administered immediately after the experimental session were examined. Tabulation of the answers to this questionnaire revealed

that, of the 54 subjects tested, 25 were either sleepy or nervous (or both!) while in the sensory restriction period.

Another control for possible intra-subject variables which might reduce the correlation between EPI scores and need for sensory stimulation was the EPI lie scale. This scale revealed a total of 6 of the 54 subjects whose EPI lie scale scores were greater than or equal to one standard deviation above the mean.

Finally, it will be remembered that as a check for a possible secondary reward function of the stimuli (e.g., light) the subjects were asked if they were afraid of the dark while in the experimental room. A total of 5 subjects responded affirmatively to this question. The table below gives a summary of the EPI data described above and additionally breaks it down according to sex.

Table 1

EPI Summary Data for All Subjects

	Mean Extraversion Score	N with 1 or More Yes to Abnormal Arousal Questions	N with EPI Lie Score $\geq + 1\sigma$	N Afraid of Dark
Males (N = 27)	12.2	12	3	2
Females (N = 27)	13.1	13	3	3

Subject Classification

For purposes of subsequent analysis it was decided to eliminate all subjects who were afraid of the dark. This decision was made because these subjects invariably provided themselves with many times the amount of light stimulation of subjects who were not afraid of the dark. Therefore, since the secondary reward function of the light was clearly a prime determinant of their self-stimulation behavior, it was felt their data did not apply to the hypothesis being tested.

Subjects with elevated EPI lie scores presented a different problem. There was no reason to question the validity of their self-stimulation scores, yet because of questionable extraversion scores they could reduce any existing correlation between EPI scores and need for sensory stimulation. Additionally it was noted that because this group of subjects was quite small, separate analysis was statistically impractical.

Interestingly, however, these subjects really represent the opposite side of the coin of the subjects with abnormal arousal states. That is, both types of subjects have questionable data for one half of the extraversion, stimulus hunger relationship being tested. For the subjects with abnormal arousal states the validity of the self-stimulation parameter was questionable. For the subjects with high

EPI lie scores the extraversion score was dubious. Because of this similarity and because of the statistical impracticality of looking at this small group separately, it was decided to combine subjects with elevated EPI lie scores with those in the abnormal arousal category. This combined group will be referred to as the abnormal arousal/lie group. This procedure combined with dichotomization of subjects for the purpose of looking at sex differences resulted in the following classification.

Table 2

Classification of Subjects by Sex and Arousal/Lie

	Normal Arousal	Abnormal Arousal/Lie
Males (N = 25)	12	13
Females (N = 24)	11	13

Self-Stimulation Parameters

It will be remembered that the sensory restriction period was divided into two periods. The first 15 minutes was the pre-reenforcement period (PRP). During this period, the number and duration of the subject's button pressing for both light and sound stimuli was recorded, but button pressing did not activate the stimuli

in the experimental room. During the second 15 minute or reenforcement period (RP), the button pressing-recording procedure was identical to that of the PRP. The only difference during this period was that the stimuli were operative when the buttons were pushed.

It has been established that habituation takes place under conditions of continuous stimulation (Guthrie, 1960). This suggested that intermittent stimulation may have greater cortical arousal value than continuous stimulation, especially where the stimuli used are nonvariable (Guthrie, 1960). Because of this, both duration and number of button presses were considered in the analysis of stimulus hunger. Based on the decision to consider both duration and number of button presses in the RP, it was decided to analyze data from the PRP similarly. The issue of habituation to the stimuli did not apply to the PRP. However, information about button pressing behavior during this period as contrasted with the RP was essential to the evaluation of Hypothesis 2. Thus in all the following analyses eight self-stimulation parameters were considered (i.e., number and duration of presses for light and sound stimuli for both PRP and RP).

Hypothesis Testing

Hypothesis 1 was tested for each of the four subject subgroups. For each subgroup a 9 × 9 Pearson's intercorrelation matrix for extraversion and the eight self-stimulation parameters was computed. The 9 × 9 design was used because such an analysis was actually easier to program into the computer. It should be noted, however, that only the correlations between extraversion and the eight self-stimulation parameters are relevant to Hypothesis 1.[1] The correlations directly relevant to Hypothesis 1 are presented in Table 3. As can be seen from this table, not only does Hypothesis 1 fail to receive support, but many of the correlations are in the direction opposite to that expected. Because of the theorized positive correlation between extraversion score and amount of self-stimulation attempted (PRP) and provided (RP), all correlations for normal arousal subjects in the table on the following page should be positive. As a matter of fact, more than half of them are negative, and for the table as a whole, only 2 of the 32 are both in the predicted direction and significant.

Did Hypothesis 1 fail to receive support because the stimuli somehow failed to have any impact on the subjects? At this point

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[1] For those interested in intercorrelations between such parameters as number of light button presses PRP, and total sound time RP, the complete matrices are given in Appendix B.

Table 3

Correlations between Extraversion and
Self-Stimulation Parameters for Four Subject Groups

	Males, Normal Arousal (N = 12)	Males, Abnormal Arousal/Lie (N = 13)	Females, Normal Arousal (N = 11)	Females, Abnormal Arousal/Lie (N = 13)
Number of Light Button Presses PRP	.18	.16	-.54	.33
Attempted Light Time in Seconds PRP	.17	.20	-.55*	-.02
Number of Sound Button Presses PRP	.32	.09	-.52	.19
Attempted Sound Time in Seconds PRP	.05	.18	-.47	-.13
Number of Light Button Presses RP	-.18	.08	-.34	.53*
Total Light Time in Seconds RP	-.03	-.09	-.14	.30
Number of Sound Button Presses RP	-.11	.13	-.38	.53*
Total Sound Time in Seconds RP	-.02	.08	-.24	.46

*$p < .05$

Hypothesis 2 became relevant. To test this hypothesis, an analysis of variance was carried out for all subjects to determine whether they pushed the buttons significantly more often or longer when the stimuli were operative than when they were not. The outcome of this analysis is presented below in Table 4.

Table 4

Button Pressing during PRP versus Button Pressing during RP for All Subjects[a]

	F Ratio	P
Number of Light Button Presses PRP Minus Number of Light Button Presses RP	2.26	NS
Light Time Attempted PRP Minus Total Time Light On RP	9.99	.003
Number of Sound Button Presses PRP Minus Number of Sound Button Presses RP	4.32	.04
Sound Time Attempted PRP Minus Total Time Sound On RP	5.83	.02

[a]N = 54

These findings suggest that while extraverts and introverts could not be differentiated by the amount of stimulation they provide themselves, the stimuli were reinforcing across all subjects.

Because of lack of support for Hypothesis 1 for any of the four subject subgroups, the testing of Hypotheses 3 and 3 was somewhat anticlimactic for the present study. Nevertheless, because these hypotheses do have relevance for previous research, they were still worthy of examination.

It will be remembered that while Eysenck's theory predicted no sex differences related to stimulus hunger, it was decided to examine possible differences. To test Hypothesis 4 an analysis of covariance using the subject's extraversion score as the covariate was carried out for male and female subjects. F ratios and significance levels were computed for the difference between males and females on each of the eight self-stimulation parameters. The findings of this analysis are presented in Table 5 on the following page. Inspection of Table 5 reveals that Hypothesis 4 was supported. That is, Eysenck's implication that sex is not related to need for sensory stimulation appears to be correct. In no case did a differential need for stimulation between males and females approach significance.

Hypothesis 3 postulated that subjects with abnormally high or low cortical arousal states differ in need for sensory stimulation

Table 5

Differences between Male and Female Subjects
on Self-Stimulation Parameters

	$\bar{X}$ Males (N = 25)	$\bar{X}$ Females (N = 24)	$\bar{X}$ M - $\bar{X}$ F	F Ratio	P
Number of Light Button Presses PRP	1.1	1.9	- .8	.55	NS
Attempted Light Time in Seconds PRP	3.6	6.4	- 2.8	.87	NS
Number of Sound Button Presses PRP	1.4	2.1	- .7	.31	NS
Attempted Sound Time in Seconds PRP	4.1	6.7	- 2.6	.41	NS
Number of Light Button Presses RP	5.5	3.1	2.4	.75	NS
Total Light Time in Seconds RP	33.1	24.8	8.3	.15	NS
Number of Sound Button Presses RP	4.6	2.2	2.4	1.61	NS
Total Sound Time in Seconds RP	26.1	7.8	18.3	1.20	NS

from normally aroused subjects with similar extraversion scores. This hypothesis was tested similarly to Hypothesis 4 above, but using the abnormal arousal/lie group. Again extraversion was statistically held constant by making it the covariate. Again differences between groups were tested for all eight self-stimulation parameters. In this analysis, however, normally and abnormally aroused subjects were compared instead of males and females. The results of this analysis are presented in Table 6 on the following page.

Inspection of Table 6 suggests that subjects with abnormally high or low arousal states or high lie scale scores were not a different population than normal subjects. Note that lack of support for this hypothesis did not imply that abnormally high or low arousal states and high lie scale scores do not affect an individual subject's need for sensory stimulation. The purpose of this hypothesis was to discover whether failure to control for abnormal arousal states would result in any systematic differences in need for sensory stimulation. Thus there is no basis on which to conclude that failure to control for abnormal arousal states and high lie scale scores has confounded previous studies.

Table 6

Differences between Normal Internal Arousal Subjects and Abnormal Internal Arousal/Lie Subjects on Self-Stimulation Parameters

	$\bar{X}$ Normal Arousal Ss (N = 23)	$\bar{X}$ Abnormal Arousal Ss (N = 26)	$\bar{X}$ Normal Ss Minus $\bar{X}$ Abnormal Ss	F Ratio	P
Number of Light Button Presses PRP	2.3	.8	1.5	1.85	NS
Attempted Light Time in Seconds PRP	7.6	3.4	4.2	2.70	NS
Number of Sound Button Presses PRP	2.1	.9	1.2	1.44	NS
Attempted Sound Time in Seconds PRP	8.7	2.2	6.5	2.23	NS
Number of Light Button Presses RP	5.1	3.5	1.6	.29	NS
Total Light Time in Seconds RP	38.9	17.9	21.0	1.78	NS
Number of Sound Button Presses RP	4.7	2.0	2.7	2.34	NS
Total Sound Time in Seconds RP	26.0	7.4	18.6	1.42	NS

DISCUSSION OF RESULTS

The four hypotheses tested were all relevant to examining the relationship between extraversion and need for sensory stimulation. Each, however, had relevance for different aspects of the relationship. It should be noted that Hypothesis 1 was the basic hypothesis being investigated. The other three hypotheses were formulated primarily to evaluate experimental parameters which might have biased the testing of the main hypothesis. Of these three "parameter hypotheses," Hypothesis 2 was relevant only to the findings of the present study, while Hypotheses 3 and 4 had bearing on both the present study and previous similar research. Discussion of the findings related to the "parameter hypotheses" will be discussed by dealing first with the more general Hypotheses 3 and 4.

The possibility of sex differences in need for sensory stimulation was investigated in Hypothesis 4. Support of Hypothesis 4 suggests that need for sensory stimulation is not related to sex, and that previous research on extraversion and need for sensory stimulation did not lose validity by failing to control for sex.

Hypothesis 3 stated that failure to control for individual subject's abnormal arousal states would bias the group correlation between extraversion and need for sensory stimulation. It seemed probable that marked abnormalities in internal arousal while in the experimental situation would affect a subject's need for external stimulation. This assumption is based on the knowledge that cortical arousal can be caused by both internal and external processes. Since this was so, it followed that internal processes could influence need for external stimulation. For example, heightened internal arousal would reduce the need for external sources of arousal. This suggested interaction is worthy of study in itself. However, for studies investigating the relationship between extraversion and need for sensory stimulation, such a relationship is relevant only if it affects the group correlations. Hence it should be noted that Hypothesis 3 was not relevant to individual's internal arousal states as such. It simply investigated the possibility that subjects with abnormal internal arousal states formed a different subject population than normally aroused subjects.

Lack of support for Hypothesis 3 suggests that subjects with abnormal internal arousal states do not as a group differ from normal subjects in need for external stimulation. Thus either subjects with heightened internal arousal were counterbalanced by subjects with

lowered internal arousal, or internal arousal does not affect need for external stimulation.

Hypothesis 2 is a "parameter hypothesis" which was relevant to the present study only. This hypothesis was formulated to test whether the sensory stimuli were potent enough to the subjects to be worth working for. As has been mentioned, the work of Jones (1969) suggested that, irrespective of cortical arousal value, sensory stimuli such as those used in the present study might be ineffective as reenforcers. A pilot study revealed that subjects did repeatedly stimulate themselves. However, because previous research (Jones, 1964) had shown the type of stimuli used in the present study to be weak reenforcers, it was important to confirm the data from the pilot study for the experimental sample.

The support of Hypothesis 2 shows that the neutral stimuli did have some reenforcement value. Also, since the subjects were instructed to press the buttons in such a manner as to make themselves as comfortable as possible, it would appear that the reenforcement value was related to hedonic tone.

Hypothesis 1, the basic hypothesis of interest, was not supported. Lack of support for Hypothesis 1 implies either that Hypothesis 1 was not true or that there were methodological flaws in the present study which prevented an existing relationship from

being observed. The author does not suggest that he knows which of these explanations is most appropriate for the present study and so will simply discuss each in turn. The reader will be left to make up his own mind (or new research design) as he wishes.

The problems of previous research investigating sensory stimulation parameters and extraversion have been discussed at some length by this writer but will be reviewed briefly here. On the one hand, results of both pain tolerance and sensory deprivation tolerance studies have been conflicting. It was suggested that this might have been due to the fact that differences in hedonic tone between extraverts and introverts are theoretically minimal at these levels of stimulation.

On the other hand, results of research attempting to ascertain whether optimum levels of sensory stimulation vary for extraverts and introverts have shown a positive correlation in the direction predicted by Eysenck's theory. Offsetting these positive findings have been the apparently biased dependent variables used in the two "optimum level" studies.

The present study had none of the above problems of previous research investigating the relationship between extraversion, amount of sensory stimulation and hedonic tone. The present study did investigate the relationship where differences are postulated as being

maximal, used unbiased variables, and carefully controlled possible confounding variables. Absence of any significant findings under these circumstances suggested that the correlation between extraversion and need for sensory stimulation is either slight or actually nonexistent.

While the problems of previous research have been cited, it is apparent that the present study was not without flaws. Possible problems which may have caused the present study to fail to replicate the results of the two previous optimum level studies should be considered also.

One possible problem area which has been touched on briefly is that of the potency of the stimuli. The white light and white noise used were nonmeaningful, nonvariable, and had little if any information value. Much research has been conducted which would indicate that stimuli such as these are poor reinforcers. Bexton (1953) found that novel stimuli had greater reinforcement value than familiar stimuli. Jones (1964) found that stimuli which have informational value are more reinforcing than those without. In his conclusions based on an extensive review of the literature on stimulus seeking behavior Jones (1969) states, "Stimuli which are entirely nonvariable, e.g., pure tones of brief duration, serve minimally or not at all as rewards for instrumental activity" (p. 205).

In spite of the foregoing research, it was observed that the experimental subjects did press the buttons significantly longer and more frequently when they knew they would receive stimulation by so doing. Thus, the stimuli were statistically significant reenforcers. The question remains unanswered, however, as to whether the stimuli, while reenforcing, were so mild that they were barely worth working for to most subjects. If this was the case, then it may be that subjects responded at such a relatively low level in general that the extraverts and introverts could not be differentiated.

Related to the foregoing problem is the question of the length of the period of sensory restriction before the self-stimulation period began. A pilot study suggested that some subjects who were in a sensory restriction situation for 15 minutes manifested a considerable stimulus hunger at the end of this time. Because of this, a 15 minute deprivation period and a 15 minute self-stimulation period were used in the experiment proper. It should be noted, however, that Jones, Gardner, and Thornton (1964) found that the response rate for nonmeaningful visual stimuli with informational value increased as a function of deprivation hours. It may well be that the short period of sensory restriction and the low value of the stimuli available <u>combined</u> to prevent manifestation of the greater stimulus hunger of extraverts. To make an analogy:

subjects may not have been starved (sensory restriction) long enough or given tempting enough food (sensory stimulation) to differentiate the endomorphs (extraverts) from the ectomorphs (introverts) on the basis of how much of the unlimited food (stimulation) made available to them was consumed.

A final possibility which may have prevented confirmation of previous optimum level studies was the failure of the present study to control for "unauthorized" self-stimulation on the part of subjects. Tranel (1962) noticed that extroverts undergoing sensory deprivation tend to stimulate themselves kinesthetically by shifting position, wiggling, and so on. No attempt was made in the present study to monitor subject self-stimulation by means other than the light and sound stimuli provided. Hence, there is a possibility that existing differences may have been hidden by unmonitored self-stimulation on the part of more extraverted subjects.

Conclusions

The issue of whether extraverts have a greater need for sensory stimulation than introverts remains an open one. The findings of the present study in conjunction with previous research (Tranel, 1962; Levine et al., 1966) do suggest that if it exists, the relationship is a weak one. More definite conclusions could be drawn

if the present study were replicated with three modifications. The suggested modifications would be to (1) use meaningful but socially irrelevant stimuli, (2) use a sensory restriction period of at least several hours, (3) observe subjects while in the sensory restriction and self-stimulation periods to control for unauthorized self-stimulation. Results of such a study could do much to establish with greater certainty the suggestion of this study that extraversion and sensory hunger are probably unrelated or only slightly related.

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APPENDICES

APPENDIX A

THE EYSENCK PERSONALITY INVENTORY

EYSENCK PERSONALITY INVENTORY

FORM A

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

Name_____ Age_____ Sex_____

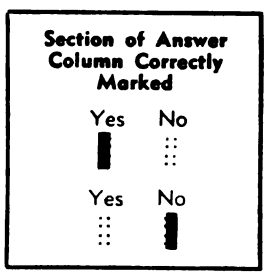
Grade or Occupation _____ Date_____

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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E N L

1. Do you often long for excitement? Yes No
2. Do you often need understanding friends to cheer you up? Yes No
3. Are you usually carefree? Yes No
4. Do you find it very hard to take no for an answer? Yes No
5. Do you stop and think things over before doing anything? Yes No
6. If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so? Yes No
7. Does your mood often go up and down? Yes No
8. Do you generally do and say things quickly without stopping to think? Yes No
9. Do you ever feel "just miserable" for no good reason? Yes No
10. Would you do almost anything for a dare? Yes No
11. Do you suddenly feel shy when you want to talk to an attractive stranger? Yes No
12. Once in a while do you lose your temper and get angry? Yes No
13. Do you often do things on the spur of the moment? Yes No
14. Do you often worry about things you should not have done or said? Yes No
15. Generally do you prefer reading to meeting people? Yes No
16. Are your feelings rather easily hurt? Yes No
17. Do you like going out a lot? Yes No
18. Do you occasionally have thoughts and ideas that you would not like other people to know about? Yes No
19. Are you sometimes bubbling over with energy and sometimes very sluggish? Yes No
20. Do you prefer to have few but special friends? Yes No
21. Do you daydream a lot? Yes No
22. When people shout at you, do you shout back? Yes No
23. Are you often troubled about feelings of guilt? Yes No
24. Are all your habits good and desirable ones? Yes No
25. Can you usually let yourself go and enjoy yourself a lot at a gay party? Yes No
26. Would you call yourself tense or "highly-strung"? Yes No
27. Do other people think of you as being very lively? Yes No
28. After you have done something important, do you often come away feeling you could have done better? Yes No
29. Are you mostly quiet when you are with other people? Yes No
30. Do you sometimes gossip? Yes No
31. Do ideas run through your head so that you cannot sleep? Yes No
32. If there is something you want to know about, would you rather look it up in a book than talk to someone about it? Yes No
33. Do you get palpitations or thumping in your heart? Yes No
34. Do you like the kind of work that you need to pay close attention to? Yes No
35. Do you get attacks of shaking or trembling? Yes No
36. Would you always declare everything at the customs, even if you knew that you could never be found out? Yes No
37. Do you hate being with a crowd who play jokes on one another? Yes No
38. Are you an irritable person? Yes No
39. Do you like doing things in which you have to act quickly? Yes No
40. Do you worry about awful things that might happen? Yes No
41. Are you slow and unhurried in the way you move? Yes No
42. Have you ever been late for an appointment or work? Yes No
43. Do you have many nightmares? Yes No
44. Do you like talking to people so much that you would never miss a chance of talking to a stranger? Yes No
45. Are you troubled by aches and pains? Yes No
46. Would you be very unhappy if you could not see lots of people most of the time? Yes No
47. Would you call yourself a nervous person? Yes No
48. Of all the people you know are there some whom you definitely do not like? Yes No
49. Would you say you were fairly self-confident? Yes No
50. Are you easily hurt when people find fault with you or your work? Yes No
51. Do you find it hard to really enjoy yourself at a lively party? Yes No
52. Are you troubled with feelings of inferiority? Yes No
53. Can you easily get some life into a rather dull party? Yes No
54. Do you sometimes talk about things you know nothing about? Yes No
55. Do you worry about your health? Yes No
56. Do you like playing pranks on others? Yes No
57. Do you suffer from sleeplessness? Yes No

PLEASE CHECK TO SEE THAT YOU HAVE ANSWERED ALL THE QUESTIONS.

APPENDIX B

INTERCORRELATION MATRICES

Intercorrelation Matrix I

Males, Normal Arousal (N = 12)

Variable[a]	1	2	3	4	5	6	7	8	9
1	1.0000	.1827	.1665	.3205	.0467	-.1773	-.0341	-.1193	.0191
2	.1827	1.0000	.5883	.9328	.2239	.0574	.8215	.2453	.8725
3	.1665	.5883	1.0000	.7804	.9083	-.0469	.6332	.0372	.3594
4	.3205	.9328	.7804	1.0000	.4655	.0174	.7806	.1922	.7384
5	.0467	.2239	.9083	.4655	1.0000	-.0683	.4225	-.0544	.0596
6	-.1773	.0574	-.0469	.0174	-.0683	1.0000	.4465	.9788	.4256
7	-.0341	.8215	.6332	.7806	.4225	.4465	1.0000	.5882	.9113
8	-.1193	.2453	.0372	.1922	-.0544	.9788	.5882	1.0000	.5910
9	.0191	.8725	.3594	.7384	.0596	.4256	.9113	.5910	1.0000

[a]Key for Variables:
1--Extraversion
2--Number of Light Button Presses PRP
3--Attempted Light Time in Seconds PRP
4--Number of Sound Button Presses PRP
5--Attempted Sound Time in Seconds PRP
6--Number of Light Button Presses RP
7--Total Light Time in Seconds RP
8--Number of Sound Button Presses RP
9--Total Sound Time in Seconds RP

Intercorrelation Matrix II

Males, Abnormal Arousal (N = 13)

Variable[a]	1	2	3	4	5	6	7	8	9
1	1.0000	.1666	.2038	.0858	.1802	.0774	-.0928	.1338	.0833
2	.1666	1.0000	.8294	.8053	.6720	.0223	.2155	.2914	.2917
3	.2038	.8294	1.0000	.7095	.8723	-.0485	.0049	.2229	.0214
4	.0858	.8053	.7095	1.0000	.8084	.2007	-.0611	.3439	.0272
5	.1802	.6720	.8723	.8084	1.0000	.1903	-.0387	.4381	.0651
6	.0774	.0223	-.0485	.2007	.1903	1.0000	.0655	.8436	.2415
7	-.0928	.2155	.0049	-.0611	-.0387	.0655	1.0000	.4808	.8450
8	.1338	.2914	.2229	.3439	.4381	.8436	.4808	1.0000	.6090
9	.0833	.2917	.0214	.0272	.0651	.2415	.8450	.6090	1.0000

[a]Key for Variables:
1--Extraversion
2--Number of Light Button Presses PRP
3--Attempted Light Time in Seconds PRP
4--Number of Sound Button Presses PRP
5--Attempted Sound Time in Seconds PRP
6--Number of Light Button Presses RP
7--Total Light Time in Seconds RP
8--Number of Sound Button Presses RP
9--Total Sound Time in Seconds RP

Intercorrelation Matrix III

Females, Normal Arousal (N = 11)

Variable[a]	1	2	3	4	5	6	7	8	9
1	1.0000	-.5363	-.5499	-.5200	-.4689	-.3438	-.1431	-.3811	-.2403
2	-.5363	1.0000	.9332	.9485	.6982	.7624	.4687	.7112	.5390
3	-.5499	.9332	1.0000	.8482	.8092	.5377	.4392	.4898	.5196
4	-.5200	.9485	.8482	1.0000	.7862	.6875	.2810	.6535	.6625
5	-.4689	.6982	.8092	.7862	1.0000	.1588	.0262	.1480	.6914
6	-.3438	.7624	.5377	.6875	.1588	1.0000	.7233	.9793	.3985
7	-.1431	.4687	.4392	.2810	.0262	.7233	1.0000	.7201	.2961
8	-.3811	.7112	.4898	.6535	.1480	.9793	.7201	1.0000	.4731
9	-.2403	.5390	.5196	.6625	.6914	.3985	.2961	.4731	1.0000

[a]Key for Variables:
1--Extraversion
2--Number of Light Button Presses PRP
3--Attempted Light Time in Seconds PRP
4--Number of Sound Button Presses PRP
5--Attempted Sound Time in Seconds PRP
6--Number of Light Burron Presses RP
7--Total Light Time in Seconds RP
8--Number of Sound Button Presses RP
9--Total Sound Time in Seconds RP

Intercorrelation Matrix IV

Females, Abnormal Arousal (N = 13)

Variable[a]	1	2	3	4	5	6	7	8	9
1	1.0000	.3305	-.0292	.1973	-.1314	.5391	.3001	.5353	.4605
2	.3305	1.0000	.7020	.9613	.5789	.7649	.4636	.8163	.9055
3	-.0292	.7020	1.0000	.7984	.9853	.2713	.0645	.2662	.5139
4	.1973	.9613	.7984	1.0000	.7091	.6051	.3289	.7444	.8560
5	-.1314	.5789	.9853	.7091	1.0000	.1259	-.0367	.1268	.3915
6	.5391	.7649	.2713	.6051	.1259	1.0000	.7904	.8567	.8853
7	.3001	.4636	.0645	.3289	-.0367	.7904	1.0000	.5917	.5996
8	.5353	.8163	.2662	.7444	.1268	.8567	.5917	1.0000	.9405
9	.4605	.9055	.5139	.8560	.3915	.8853	.5996	.9405	1.0000

[a]Key for Variables:
1--Extraversion
2--Number of Light Button Presses PRP
3--Attempted Light Time in Seconds PRP
4--Number of Sound Button Presses PRP
5--Attempted Sound Time in Seconds PRP
6--Number of Light Button Presses RP
7--Total Light Time in Seconds RP
8--Number of Sound Button Presses RP
9--Total Sound Time in Seconds RP