PSYCHOPHYSIOLOGICAL CORRELATES OF SENSATION SEEKING DURING AUDITORY STIMULATION

by

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ABSTRACT

Behavioral and physiological responses were monitored while extreme high (n=16) and low (n=15) scorers on the Sensation Seeking Scale were presented 10 tones at 60, 80, and 100 dB. In general, no compelling behavioral or physiological differences between the groups were found. Initially, there were no differences between the groups on the behavioral variables. The low sensation seeking subjects reported lower verbal ratings of pleasure and higher verbal ratings of stress than did the high sensation seeking subjects as a result of increased stimulation. Although these results provide support for the hypothesis that high sensation seeking individuals prefer higher levels of stimulation, the interpretation of these data is not that clear-cut since the ratings were done over the blocks. As a result it is not clear whether the subjects are rating their response to the tones, the cummulative effect of isolation, or what.

Although a "biological basis" of sensation seeking has been proposed, the present empirical data do not support this notion. Of the number of physiological variables, the only significant physiological group difference to emerge was with vasomotor activity, with the low sensation seeking subjects being generally more responsive. Although not significant, the high sensation seeking subjects did display the predicted larger skin conductance orienting response on the first presentation of the novel stimuli. The general pattern of increased skin conductance, heart rate acceleration, and vasoconstriction in response to stimulation suggests that the experimental procedure

had similar effects on both groups. Further research with vasomotor activity may clarify the physiological basis of the sensation seeking dimension; however, at this point, the biological basis of sensation seeking remains unclear.

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INTRODUCTION

Zuckerman (1978; Zuckerman, Buchsbaum, and Murphy, 1977) has recently conceptualized the sensation seeking trait in terms of an underlying "biological need" for high levels of stimulation. That is, some individuals are said to have an innate "need" for more stimulation than others. A wide range of physiological components, from certain patterns of electrodermal and cortical activity to levels of chemicals in the blood, are said to demonstrate important differences between high and low sensation seekers. These variables are indirectly related to the activity of the central nervous system (CNS) and have been interpreted to be indicative of an excitable CNS underlying the sensation seeking dimension.

The claim for a biological basis of sensation seeking is quite wide ranging, and if it was supported by the data, it would be very interesting indeed. However, a review of the physiological literature suggested that this proposal is seriously lacking in empirical support. The present research was designed to provide a more comprehensive test of this hypothesis of a physiological substrate of sensation seeking.

LITERATURE REVIEW

A wide range of personality, behavioral, and physiological correlates is said to support the notion of a "biological basis" of sensation seeking. However, the following review of the literature innthese areas indicated that the evidence is not as compelling as it is presented. Therefore, before addressing the major issues of the present research, an overview of the general research findings with sensation seeking is in order.

The Concept of Sensation Seeking

Stemming from the earlier construct of the "optimal level of arousal" (Berlyne, 1960; Duffy, 1967; Scholsberg, 1954), sensation seeking is conceptualized as an individual difference in preferred level of arousal or stimulation (Zuckerman, 1969; Zuckerman, Kolin, Price, and Zoob, 1964). That is, individuals are said to differ in their need for change, variety, and intensity of stimulation in order to maintain an optimal level of arousal (Zuckerman, 1971). Within this theoretical framework, the high sensation seeker is described as an individual who

> "needs varied, novel, and complex sensations and experiences to maintain an optimal level of arousal. His optimal arousal level is assumed to be greater than non-sensationsseekers, although this has not yet been tested. When stimuli and experiences become repetitive, it is assumed that the sensation seeker will become bored and nonresponsive more quickly than most other persons. He is presumed to be more sensitive to inner sensations and less conforming to external constraints" (Zuckerman, Bone, Neary, Mangelsdorff, and Brustman, 1972, p. 308).

Development of the Sensation Seeking Scale (SSS)

The SSS was developed in order to quantify this construct of preferred level of arousal. Originally, the SSS was intended as a predictive instrument of responses to sensory deprivation. However, sensory deprivation proved to be a much more complex situation than originally conceptualized. Subsequently the focus of the SSS shifted to a broader range of "real World" experiences (Zuckerman, 1978). As a result, the SSS has gone through several revisions.

In writing items for the SSS, Zuckerman (1974, 1978) explained that he thought of friends who seemed to embody the extreme of the trait in their preferences, attitudes, and behavior. Specifically, the items reflected a preference for a wide variety of stimulating, exciting, and novel experiences and interests. The first form (II) (Zuckerman <u>et al</u>., 1964) focused on a general trait. It contained a General Scale based on the first unrotated factor.

Subsequent studies (Farley, 1967; Zuckerman and Link, 1968) suggested that the SSS might contain more than one factor. Additional items were written to represent these new hypothesized dimensions (Zuckerman, 1971). Further factor analyses yielded four factors, three of which were reliable across the sexes. As a result, Form IV was constructed, consisting of the General Scale (retained from Form II) and four scales based on these factors. The General Scale was not a total score but partially overlapped with some of the subscales. The subscales were described as follows.

(1) The Thrill and Adventure Seeking Scale (TAS) contains items expressing a desire to engage in risky activities such as parachute jumping, mountain climbing, etc.

(2) The Experience Seeking Scale (ES) contains items reflecting the desire to seek new experiences through the mind and senses by living in a nonconforming life style. This includes activities such as travel, unusual dress, use of drugs, etc.

(3) The Disinhibition Scale (DIS) reflects a hedonistic "playboy" philosophy. The items describe a need to disinhibit behavior in the social sphere by drinking, partying, and seeking variety in sexual partners.

(4) The Boredom Susceptibility (BS) contains items describing a dislike for repetition of experiences, routing work, and predictable, dull, or boring people. Other items indicate a restless reaction when things are unchanging. Unlike the o other subscales, the BS Scale is defined more clearly for males than females.

Although the previous studies have consistently reported four factors, Stewart and MacGriffith (1975) suggested that only 25% of the variance was accounted for by these factors. However, these findings are limited because of the relatively small sample size and the failure to analyze males and females separately.

Recently, Form V was developed, based on factor analyses of Form IV in both American and English samples (Zuckerman, Eysenck, and Eysenck, 1978). Four factors were obtained and defined by those items showing the greatest value for cross-sex and cross-national comparisons. Specifically, Form V contains ten items representing each of the four factors. The General Scale is replaced by a Total Score which is the sum of the four factor scales.

This new form has several advantages. One, it is a much shorter version with little loss in reliability. Two, the inter-scale correlations are considerably reduced. Finally, more selective sex differences are shown. For example, unlike Form IV, males are not higher than females on all the subscales.

Behavioral Studies of Sensation Seeking

Sensation seeking has been associated with a wide range of behavior. Although personality tests and behavioral characteristics have been said to demonstrate important differences between high sensation seeking (HSS) and low sensation seeking (LSS) individuals (Zuckerman, 1974, 1975; Zuckerman, Buchsbaum, and Murphy, 1977), the empirical data is not that impressive.

Personality Correlates. A wide variety of personality traits has been correlated with the SSS. With regards to convergent validity, the SSS has consistently correlated with related scales. These include the Change Seeker Index (Acker and McReynolds, 1967; Farley, 1971; Looft and Baranowski, 1971; Myers, 1972), the Thrill Seeking Scale (Myers, 1972), and the Need Change subscale of the PRF (Pearson, 1970).

Additional validation for the SSS has been provided in studies with other personality traits. The "general trait picture defines sensation seeking as an uninhibited, nonconforming, impulsive, dominant type of extraversion" (Zuckerman, 1974, p. 103). For example, the most consistent correlate of the SSS on the MMPI was the Hypomania Scale which is associated with energy, activity, and impulsivity. This relationship has been reported with college students (Zuckerman et al., 1972; Zuckerman and Link, 1968; Zuckerman, Schultz, and Hopkins, 1967), and deliquents (Thorne, 1971). Other MMPI scales which shown positive correlation with the SSS are the Response Deviance (F) and the Psychopathic Deviate (Pd) which measure lack of communality of response and nonconformity to social mores, respectively (Zuckerman et al., 1972).

Similarly, the SSS is positively correlated with measures of impulsive extraversion (Dominance, Surgency, Adventurous, Uncontrolled) and nonconformity (Weak Super-Ego, Bohemian, Radicalism) on Cattell's 16 Personality Factor Questionnaire (Gorman, 1970). Based on scores on the California Psychological Inventory, Kish (1971) described the HSS individual as being poised, ascendent, self-assured, nonconforming, undersocialized, flexible, and exhibiting masculine characteristics of adventurousness, daring and aggressiveness.

Although Eysenck's (1967, 1970) definition of extraversion includes an arousal seeking component; it does not appear to be a strong correlate of sensation seeking as would be expected. Some studies have found low correlations, ranging from .12 to .47 between these two traits (Farley and Farley, 1967; Zuckerman et al., 1972), whereas other studies have reported near zero correlations (Zuckerman and Link, 1968; Farley and Farley, 1970). However, this has been attributed to the finding that it is the impulsivity aspect of extraversion and not the sociability aspect that seems to correlate with the SSS (Farley and Farley, 1970).

In general, a similar pattern of correlations appear to emerge with the various inventories which appears to be consisent with the definition of sensation seeking. However, the empirical data supporting these relationships is not that strong.

Behavioral Measures. A number of studies has investigated the relationship between the SSS and behavioral manifestations of the trait. Although the magnitude of the correlations is not very high, the findings are consistent with the notion of a "need for stimulation".

Experiments investigatinggself-reported experiences have demonstrated consistent associations between the SSS and various stimulation seeking behaviors. Specifically, the HSS individual reported 1) having engaged in a greater variety of sexual activities (Zuckerman, Neary, and Brustman, 1970; Zuckerman *et al.*, 1972; Zuckerman, Tushup, and Finner, 1976), 2) having experimented more with drugs (Brill, Crumpton, and Grayson, 1971; Segal, 1975), 3) using more alcohol and cigarettes (Zuckerman *et al.*, 1970), and 4) having a preference for stimulating (spicy, crunchy, and sour) foods (Kish and Donneworth, 1972).

Other studies have reported a relationship of the SSS with various activities including the tendency to volunteer for unusual experiments (Zuckerman *et al.*, 1967; Stanton, 1976) and to engage in risky sports (Hymbaugh and Garrett, 1974; and Brown, Ruder, and Young, 1971).

However, in more controlled experimental studies, some inconsistent results have been found. While some studies have reported that HSS individuals attempt to increase stimulation during sensory deprivation (Zuckerman *et al.*, 1967; Lambert and Levy, 1972), the majority of studies has not demonstrated this relationship (Smith and Myers, 1966; Hocking and Robertson, 1969; Kish and Busse, 1971). In fact, Hocking and Robertson (1969) reported that the LSS subjects worked to obtain visual stimulation more than the HSS subjects.

In general, the HSS individuals appear to engage in experiences which are both novel and arousing. Although the SSS appears to have a number of behavioral associations, its ability to predict stimulation seeking behavior is still questionable.

Physiological Basis Of Sensation Seeking

Research on the sensation seeking dimension has been primarily concerned with personality and behavioral correlates. Less is known about its physiological basis, despite much speculation regarding its "biological basis" (ie., Zuckerman, 1974; 1978; Zuckerman et al., 1977). A wide range of psychophysiological and biochemical correlates has been proposed. In general, individual studies in both these areas are limited in number and merely suggestive in nature.

Psychophysiological Correlates. There are very few studies in the literature concerned with the psychophysiological correlates of sensation seeking. Electrodermal and cortical activity have been the two measures most frequently used to explore possible relationships. Cardiac activity, although not previously investigated, has recently received some attention. In these areas, however, the literature is so sparse that the findings remain inconclusive.

Electrodermal Activity. The orienting response (OR) and habituation rates have been used to explore the relationship between electrodermal activity and the SSS. Specifically, the OR is described as "a non-specific reflex evoked by any stimulus change which is perceived by the person and is extinguished or habituated by repetition of the same stimulus" (Neary and Zuckerman, 1976, p. 205). Reliable individual differences in OR amplitudes and habituation rates have been found (Lynn, 1966).

Studies have consistently reported that HSS and LSS individuals do not differ in tonic levels of electrodermal activity (Zuckerman, 1972; Neary and Zuckerman, 1976; Cox, 1977). However, the results with phasic responses are potentially more promising.

Some studies have shown that HSS subjects give larger ORs than do LSS ones in response to novel moderate stimulation. For example, Zuckerman (1972) monitored galvanic skin response (GSR) while extreme scorers on the SSS were exposed to 10 presentations of a simple visual stimulus (a rectangle of light) followed by 10 presentations of a complex visual stimulus (an abstract design). The HSS subjects showed larger GSRs on the first presentation of each stimulus but dropped to the response level of the LSS subjects on subsequent trials. The groups did not differ in habituationsrates.

Neary and Zuckerman (1976) reported similar results in their replication and extension of this work. The first study used exactly the same procedure whereas the second study was extended to include 10 presentations of an auditory stimulus (1000 Hz tone at 70 dB) as well as 10 presentations of a simple visual stimulus (a rectangle of light). In addition, a novel stimulus (a 200 Hz tone at 70 dB or a colored abstract design) was presented on the eleventh trial for each stimulus modality. In both studies the HSS subjects showed larger electrodermal ORs in response to the first presentation of each stimulus, but dropped to the response level of the LSS subjects on subsequent trials. Again no differences in habituation rates were shown.

Cox (1977) did not observe this pattern of electrodermal activity. Subjects, selected for their extreme scores on both sensationsseeking and socialization, were exposed to two intense tones (110)dB), which signalled the beginning of a 70 minute isolation period, and one moderate tone (78 dB), which signalled the end of the isolation period. All tones had slow rise-decay times. Both electrodermal and cardiovascular activity were monitored.

Presentation of the intense tones resulted in the LSS subjects showing larger skin conductance (SC) responses and greater heart rate (HR) acceleration; however, these differences were not significant. Similarly, presentation of the moderate tone resulted in all groups showing increased SC and decreased HR. One exception, however, was the LSS/LSOC group which showed increased HR. Although this study has been cited by Zuckerman et al. (1977) as evidence that HSS individuals characteristically give larger HR orienting responses, the data suggest that there are no differences in the ORs and DRs of the HSS and LSS subjects.

Similarly, in an earlier study, Lambert and Levy (1972) failed to find a relationship between sensation seeking and electrodermal activity. HSS and LSS groups were placed in sensory isolation and visual stimulation was made freely available (subjects could press a button). HSS subjects viewed more slides as a function of their time in isolation than did the LSS subjects; however, electrodermal activity was not related to sensation seeking.

The inconsistencies in the findings may be attributable to a number of methodological problems in the earlier research. First, at no point did the authors (ie., Zuckerman, 1972; Neary and Zuckerman, 1976) state whether the tones were presented with a fast or slow rise-decay time. Several studies have shown that a greater incidence of startle occurs to tones with a fast rise-decay time. Specifically, skeletal-motor and respiratory irregularities have been observed with fast rise-time tones of 66 dB (Gogan, 1970), 70 dB (Oster, Stern, and Figar, 1975), and 90 dB (Gogan, 1970; Oster et al., 1975; Berg, Jackson, and Graham, 1975). Therefore, it is not clear whether these differences between HSS and LSS subjects are in orienting or in startle responses.

Second, there were no indication that the data were checked for conformity with the assumption of compound symmetry. It has been suggested that some psychophysiological data violates this assumption, making the use of "liberal" statistical tests inappropriate. Therefore, results may be reported as representing significant differences when in fact they are not.

Further research is needed to clarify the electrodermal and cardiovascular activity of the sensation seeker in response to moderate and intense stimulation.

Cortical Activity. The augmenting-reducing tendency has been the focus of studies investigating the relationship between cortical activity and sensation seeking. It is defined by the amplitude of the averaged evoked response (AER) to increasing intensities of stimulation. That is, "augmenters" are those who show increasing AER whereas "reducers" are those who show decreasing AER with increasing intensities. Augmenters continue to respond to high intensities of stimulation and lack a natural protective mechanism. With regards to sensation seeking, the findings have been relatively consistent.

In a preliminary study, Buchsbaum (1971) reported that HSS subjects tended to be augmenters whereas LSS subjects tended to be reducers; however, these differences were not significant. Similarly, Buchsbaum, Goodwin, Murphy, and Borge (1971) also reported that manic patients tended to be augmenters whereas depressed patients tended to be reducers. Since the Hypomania subscale of the MMPI has been found to consistently correlate with the SSS (Zuckerman et al., 1972; Blackburn, 1969; Thorne, 1971), mania has been described as sensation seeking out of control (Zuckerman, 1974; Zuckerman et al., 1977). Therefore, it was suggested that these findings provided additional evidence for the augmenting tendency of the HSS individual (Zuckerman et al., 1977).

Later studies confirmed these preliminary findings. For example, in a clinical study, Coursey, Buchsbaum, and Frankel (1975) reported that insomniacs scored low on the SSS and also gave lower evoked potential responses to sound.

Zuckerman, Murtaugh, and Siegel (1974) clarified these findings by comparing the relationship of the subscales of the SSS with cortical augmenting-reducing. They used an eyes open procedure instead of Buchsbaum's eyes closed procedure in order to maximize the occurrence of reducing. In addition, five intensities rather than four were used in order to give more reliable slope measures.

They reported that the Disinhibition subscaleswas the only scale to show a significant relationship with the augmenting-reducing tendency. Subsequent analysis revealed that the high disinhibitors did not differ from the low disinhibitors at low intensities; however, the groups did differ significantly at the highest intensity, the low disinhibitors showing reducing.

Although studies have consistently yielded support for a relationship between augmenting-reducing and sensation seeking, the interpretation of these results are somewhat inconclusive. The reasons are as follows.

One, augmenting-reducing has been found to show a strong relationship with only one particular subscale of the SSS. Since these subscales are not very highly correlated, perhaps this is something very different from sensation seeking.

Two, some of the data provide only indirect evidence based on inference from scales to observable behavior. For example, because sensation seeking consistently correlates with the Hypomania Scale in college students, it is assumed that the augmenting-reducing characteristics of manic patients is also characteristic of sensation seekers. However, the SSS has never been administered to a sample of manic patients.

Theoretical Basis. In an attempt to explain the empirical data and thus describe the physiological substrate underlying the sensation seeking dimension, the hypothesis of an excitable CNS has been proposed. This theoretical formulation stems from Soviet theory which indicates that there is an equilibrium or balance between the excitatory and inhibitory processes of the CNS (Nebylitsyn, 1966, 1972). The speed or facility with which the CNS generates the processes of excitation and inhibition determines the balance.

With regards to electrodermal activity, predominance of excitation would be characterized by large OR amplitudes and slow habituation rates whereas predominance of inhibition would be characterized by the reverse. Based on the finding that HSS subjects showed larger ORs than LSS subjects in response to novel stimuli, Neary and Zuckerman (1976) concluded that HSS individuals have a high balance of excitatory over inhibitory processes in the CNS. The absence of differences in habituation rates was suggested to indicate "that the inhibitory capacities of HSS individuals are not different from the inhibitory capacities of LSS individuals" (Neary and Zuckerman, 1976, p. 210). However, Zuckerman (1972) suggested that the failure to find differences in habituation rates could be attributed to the fact that OR amplitudes are more reliable than slope measures. In any event, Zuckerman _et al._,(1974) suggested that AER provides a more direct test of this hypothesis.

Integrating Soviet and Western theory, a feedback mechanism has been postulated to be the neuronal basis of the equilibrium between the excitatory and inhibitory processes. Specifically, it is hypothesized that a reticulo-corticoreticular negative feedback loop regulates and maintains the level of arousal at an optimal set point or range. This prevents a cortical overload to excessive stimulation. People are said to differ as to the level of reticulo-cortical (excitatory) activation which will trigger the corticofugal (inhibitory) feedback necessary to dampen and control further reticular arousal.

For example, "reducers"are characterized as having a low threshold for intiating the cortifugal inhibitory process. On the other hand, "augmenters" are characterized by a much higher threshold permitting them to accept much higher levels of stimulation. Based on the empirical data, the HSS subjects appear to possess higher thresholds.

In general, both the empirical data on electrodermal and cortical activity are consistent with the hypothesis of an excitable CNS underlying sensation seeking.

Biochemical Correlates. In a limited number of studies, biochemical variables, including platelet monoamine oxidase (MAO) and gonadal hormones, have been found to show a relationship with sensation seeking. Although these data are speculative, they are considered as additional evidence for a "biological basis" of sensation seeking.

MAO Correlates. MAO is an enzyme which metabolizes dopamine and norepinephrine at the neural synapses in the limbic system. A high level of MAO implies a low level of these neurotransmitters at the synapse. The level of neurotransmitters determines the excitability of the brain centers.

Recently, two studies have suggested that sensation seeking is linked to MAO activity. FFor example, Murphy, Belmaker, Buchsbaum, Martin, Ciaranello, and Wyatt (1977) reported that low MAO males scored significantly higher on the SSS; however, no significant relationship emerged for females.

Similarly, Schooler, Zahn, Murphy, and Buchsbaum (1978) reported that low MAO levels in both males and females scoring high on the SSS. In addition to the General Scale, negative correlations were found with all the subscales.

Although these data are consistent with the data on cortical AER, it should be noted that platelet MAO is not the same as brain MAO. It is assumed that high levels of platelet MAO indicates high levels of brain MAO; however, the evidence is no that clear-cut. Therefore, no conclusive statement regarding the relationship between sensation seeking and MAO activity can be made.

Gonadal Hormones. Another biochemical link with sensation seeking has been postulated with sex hormones. The findings that the SSS has a strong relationship to sexual experience and has large sex differences suggested a possible link to the gonadal hormones. Daitzman (1975) reported that HSS individuals have higher levels of both androgen and estrogen. In addition, the Disinhibition subscale showed the strongest and most consistent relationship. This finding is consistent with the hypothesis that gonadal hormones reduce MAO.

Moreover, the evidence for biochemical correlates of sensation seeking is highly speculative. The majority of assumptions are based on evidence from animal studies. In addition, the correlation methods can be criticized for their inability to specify causal relationships. Further investigation is needed to clarify the role of biochemical variables in the sensation seeking trait.

Critique of the Literature. To summarize, the evidence for a "biological basis" of the sensation seeking trait is not very compelling. While some studies have demonstrated a relationship between the SSS and various physiological measures, the evidence is not well documented. Still other studies have not found any significant differences between HSS and LSS subjects. Failure to replicate research findings may be attributed to a number of problems in the research.

One, since the SSS has been revised several times, different studies have used different forms. For example, some studies have used the General Scale whereas others have used the subscales. However, the Disinhibition subscale is the one score which consistently shows significant correlations with the physiological measures. Perhaps it is a unique trait in itself and this may account for the inconsistencies.

Two, the research has been limited by an almost exclusive reliance on single channel recording. However, it has been demonstrated that using one physiological measure may not accurately reveal individual differences in response to various stimulation (Lacey, Bateman, and Van Lehn, 1952). Recording a number of physiological measures simultaneously may prove useful in demonstrating differences between HSS and LSS individuals.

Finally, previous studies have failed to adequately assess the individual's interpretation of the situation he is placed in with respect to absence or presence of stimulation. For example, Cox (1977) suggested that for the sensation seeker "there are many aspects of sensory deprivation which may have the effect of raising his arousal level sufficiently to make the situation quite tolerable" (p. 57).

Similarly, Lambert and Levy (1972) emphasized the need for clarification, by subjective reports, of whether changes in GSR were a reflection of discomfort and fear or some other phenomenon such as excitement or interest.

Although some studies have attempted to monitor subjective reports, they failed to assess the verbal cues of emotion adequately. To do so, studies need to relate to the systematic, conceptual structures in the verbal domain. For example, even though a number of studies (Mehrabian and Russell, 1974) have concluded that pleasure and arousal are two independent dimensions of emotion, this view has not been taken in the physiological studies of sensation seeking. The result of this inadequate assessment is a confounding of pleasure and arousal which may account for the inconsistent findings in the literature.

In light of the problems noted, a comprehensive yet unconfounded study of the psychophysiological correlates of the sensation seeking dimension is warranted. Of primary importance is improved methodology. A second goal is the elimination of possible confounding of subjective experience by adequately monitoring emotional state. A third goal is increased generality which includes the use of a variety of physiological measures and a wide range of stimuli.

In the present study, an attempt was made to eliminate or systematically control some of the procedural problems which may underlie the inconsistencies in the literature. Specifically, it is an attempt to 1) replicate, in part, the Neary and Zuckerman (1976) study of the orienting response in sensation seekers and 2) extend it to include a more comprehensive range of physiological measures and stimuli.

METHOD

Subjects

The subjects (Ss) were 31 male Caucasian undergraduates volunteers from the University of British Columbia. The Ss were selected in the following manner. A week before the experiment proper, packages of questionnaires were passed out to students in first and second year Psychology classes. Each package contained: an explanatory letter (Appendix 1), two semantic differential measures of emotional state (Mehrabian and Russell, 1974), one with instructions to indicate "how you feel right now" and one with instructions to indicate "how you feel most of the time", the Sensation Seeking Scale (Zuckerman, et al., 1978) (SSS), and a form on which those who were willing to participate in a follow-up study could indicate some way of being contacted (Appendix 2).

From the 391 sets of scores obtained, those Ss who did not have complete data for the SSS (ie., all 40 items completed) were deleted. The resulting sample was composed of 337 Ss of whom 155 were males and 182 were females. Since the present research was only concerned with males, only their scores were examined further.

On the basis of their responses to the SSS, two groups of Ss were selected, representing the extreme high (x=29.25, n=16) and low (x=16.13, n=15) scorers. Within the present sample, the HSS group occupied positions above the 80.48 (n=155) percentile rank whereas the LSS group occupied positions below the 38.74

(n=155) percentile rank. The HSS individuals ranged in age from 18 to 26 years (x=21 yrs.) while the LSS individuals ranged in age from 18 to 25 years (x=19.67 yrs.).

Stimuli

The stimuli consisted of 3 blocks of 10, 1000HHz tones.. Each block represented an increasing level of intensity (60, 80, 100 dB). The duration of each tone was 1 sec., with a rise-decay time of 50 msec. These were delivered binaurally through a set of earphones using a single randomized intertrial interval schedule of 30, 35, 40, or 45 sec. The auditory stimuli were generated by a RCA audio generator, WA4AC. The intensity levels were calibrated with a Bruel and Kjaer Type 2203 sound level meter (A Scale), a Type 1613 octave filter set, and a General Radio Type 1560-P83 earphone coupler.

Apparatus

A Beckman Type R Dynograph was used to record palmar skin (SC), heart rate (HR), digital vasomotor activity, electromyographic (EMG) activity, and respiration.

SC (umhos) was measureddirectly by passing a constant voltage of 0.5v through two Beckman Biopotential electrodes placed on the second phalanx of the first and third fingers of the left hand. HR was obtained from two Beckman Biopotential electrodes placed in a standard lead II configuration (one on each wrist). A ground lead was placed on the left ankle. The signal was passed through a cardiotachometer coupler which expressed the output in beats per minute (bpm). Digital vasomotor activity was measured by placing a photocell transducer on the left thumb. The signal was AC coupled, with a time constant of 0.3 sec. Respiration rate and amplitude were recorded by a chest bellow placed around the lower chest. Direct EMG was obtained from two Beckman Biopotential electrodes placed above the eyebrow (Lippold, 1967). These latter two measures were recorded in order to check for artifacts in the other measures.

The contact medium for all electrodes was Beckman electrode paste, with the exception of SC where a 0.5 percent NaCl electrode paste was used. Redux paste was used to prepare the skin areas for HR and EMG placements. Ss were asked to wash their hands in preparation for the SC electrode placements. All electrodes were attached to the skin with Beckman adhesive collars.

Procedure

The scheduling of the laboratory sessions was balanced with respect to the time of day (morning, afternoon, and evening) and the laboratory procedures were carried out without the experimenter's knowledge of group membership.

Upon reporting to the laboratory, each S was asked to go to the washroom and wash his hands. Ss were informed that the experimental procedure was completely harmless but that they could terminate their participation at any point. After signing a statement concerning the "basic rights and priveleges of volunteer subjects", the State Anxiety Inventory (Spielberger, 1968) was then administered.

The S was then seated in a comfortable chair located in a shielded, sound-dampened, air conditioned, dimly-lit room. The recording equipment was located outside the room except for a video camera, which was facing the S, and a two-way intercom which was placed next to the S. The purpose of the latter equipment was to continuously monitor verbal and nonverbal activity of the S and to communicate with him if the need arose.

As the electrodes and transducers were attached, their individual functions were described. The S was asked to familiarize himself with a set a questionnaires which included four sets of semantic differential measures of emotional state (Mehrabian and Russell, 1974) and the Activation-Deactivation Checklist (Thayer, 1967), while the experimenter checked the recordings. Once the polygraph was calibrated and the physiological recordings were of good quality, the following instructions were read to each S:

> "To begin I would like to outline for you what the format of this session will be. Initially, there will be a short period--approximately 5 minutes--after which you will be asked to fill out the first set of questionnaires. There will be another short period after which you will be presented the first series of tones. Shortly after the tones you will be asked to fill out the next set of questionnaires. This will be followed by another brief period. This format will be repeated 2 more times. In total you will hear 3 sets of tones and fill out a set of questionnaires after each set. You should try to relax and engage in a minimum of bodily movement so as not to disturb the electrode placements. There is a two-way intercom through which you can communicate with me at anytime if the need arises. All the instructions which I give you from this point will be given through the intercom. Are there any questions?"

After answering any questions, the experimenter left the room.

The S sat quietly for five minutes and then was asked to fill out the first set of questionnaires describing how he felt at that moment. Another five minutes was allowed to pass before the first series of tones (60 dB) was presented. The S was then asked to fill out the next set of questionnaires describing how he felt during the tones and then to sit back and wait for the next series of tones. Another five minutes was allowed to pass. This procedure (as illustrated in Figure 1) was repeated for the next two series of tones at 80 dB and 100 dB.

The experiment terminated with each S filling out the State Anxiety Inventory (Spielberger, 1968). Each S was then given a package of questionnaires to be completed at home and returned within a week. These included the Socialization Scale (Gough, 1969), the Trait Anxiety Inventory (Spielberger, 1968), and a variety of personality variables (Waters, 1977). Upon returning the questionnaires, each S was given an explanation of the experiment and a brief review of his physiological record.

Data Analysis

Tonic Levels. Tonic levels of autonomic activity were determined for the last minute of the initial and final rest periods as well as the 5 sec. periods prior to presentation of each tone. Mean activity of each physiological measure was obtained.

Phasic Responses. Pre- and post-stimulus periods were defined by the 5 sec. segment prior to each tone and the 10 sec. segment following each tone, respectively. Within these periods the following measurements were obtained.

INITIAL REST
(5-10 min)

INSTRUCT QUESTIONNAIRE
(10 sec)

FILL OUT QUESTIONNAIRE
(3-6 min)

REST
(2 min)

TONES 1-10 at 60 (80, 100) dB
(6 min)

REST
(2 min)

FINAL REST
(5 min)

Tone Intertrial Interval
(40-35-35-45-40-35-45-40-45)

FIGURE 1 DIAGRAM OF EXPERIMENTAL PROCEDURE

a) Skin Conductance. The SC response was calculated as the difference between the pre-stimulus period and the maximum SC during the post-stimulus period. Recovery half-time, scored as the time it took for the recovery limb of the electrodermal response to attain 50 percent return to pre-stimulus level, was also calculated.

b) Heart Rate. HR was scored on a second-to-second basis, so that it was necessary to convert the record from a beat-to-beat basis by averaging those periods when more than one beat occurred within any second.

c) Digital Vasomotor. Changes in finger pulse amplitude were used as an indirect measure of vasodilation and vasoconstriction (as suggested by Lader, 1967). A second-to-second basis was used which involved calculating peak-to-trough amplitude for each pulse. If more than one pulse occurred within any second, an average was calculated. On the other hand, if any period did not contain a peak-to-trough interval, an average of the values obtained for seconds adjacent to that period was calculated.

RESULTS

The results of the analyses of the behavioral and the physiological measures are presented separately. However, before presenting these data, a comparison is made between the data of the present sample and the normative data reported for this revised form of the SSS (Zuckerman et al., 1978). Mean t total scores for males and females in the present study were 20.75 (n=155) and 18.94 (n=182), respectively. These correspond to a T-score of 50 for males and 51 for females in the normative data.

Looking at sex differences, t-tests revealed that the males scored significantly higher than females on the total score ($p<.01$) as well as on the DIS and the BS subscales ($p<.01$), with the difference on the TAS subscale approaching significance ($p<.10$). These are consistent with the normative data where both the American and the English males scored significantly higher than the females on the total score, the TAS, and the DIS subscales (Zuckerman et al., 1978). In addition, the English males scored significantly higher than the English females on the BS subscale.

The alpha reliabilities for Form V of the SSS obtained in the present sample are presented in Table 1. These reliabilities are substantially lower than those reported by Zuckerman et al., (1978). Aside from this difference, the present data seem comparable to those obtained with this measure in previous research.

TABLE 1

Alpha Coefficients for Form V (SSS)

	Males (n=155)	Females (n=185)
Total Score	.80	.68
TAS	.72	.67
ES	.57	.53
DIS	.70	.54
BS	.51	.44

TABLE 2

Pre and Post State Anxiety

Means and Standard Deviations (in brackets)

	HSS	LSS
Pre	37.31 (6.76)	40.07 (8.46)
Post	32.50 (6.30)	35.93 (9.03)

Note: State Anxiety measures were administered prior to and following the experimental manipulations.

Behavioral Measures

In order to determine the comparability of the two groups with respect to their emotional state to and subjective interpretation of the various stimuli, a number of tests was administered.

State Anxiety. The means and standard deviations for the pre- and post-experimental measures of state anxiety are presented in Table 2. In order to assess response to the cummulative effect of the increasing intensities of the tones, a 2 (group) x 2 (time) analysis of variance on state anxiety was performed. No significant group differences were found. However, contrary to expectation, a significant main effect for time ($F=8.12$, $df=1,29$, $p<.01$) indicated a reduction in state anxiety over the experimental period. This would suggest that the groups showed less concern over the procedure as they became experienced with it.

Trait Anxiety. Mean trait anxiety for the HSS and LSS su subjects were 36.13 (sd=8.09) and 39.36 (sd=7.32), respectively. A 2 (group) x 2 (trait anxiety) analysis of variance indicated that the groups did not differ on trait anxiety.

Emotional State. Semantic differential measures of emotional state were scored to yield the three hypothesized dimensions of emotion---pleasure, arousal, and dominance. T-tests, computed onnbaseline reports of these dimensions, indicated that the HSS and LSS subjects did not differ initially in emotional state.

In order to determine changes in emotional state as a result of the presentation of the 60, 80, and 100 dB tones, separate

2 (group) x 4 (time) repeated measures analyses of variance for pleasure, arousal, and dominance were performed. The results will be discussed separately for each dimension.

Pleasure. The mean pleasure ratings given by each group and in response to the three series of tones are plotted in Figure 2. A significant main effect for time ($F=13.87$, $df=3, 84$, $p<.001$) indicated that both groups reported feelings of decreasing degrees of pleasure with increasing sound intensity (or simply with time). A significant trials x group interaction ($F=2.90$, $df=3, 84$, $p<.05$) revealed that the LSS subjects reported higher pleasure ratings initially and in response to the 60 dB tones; however, they found the 80 and 100 dB much more unpleasant than did the HSS subjects.

Arousal. A significant main effect for time ($F=3.39$, $df= 3, 84$, $p<.05$) indicated that both groups reported being increasing aroused as the tones became more intense.

Dominance. No significant differences between groups in feelings of dominance were found.

Activation-Deactivation. Thayer's Activation-Deactivation Adjective Checklist was scored to yield the four hypothesized factors of activation---deactivation, general activation, general deactivation, and high activation. T-tests were computed on baseline ratings of these factors and indicated that the HSS and the LSS subjects did not differ initially in their feelings of activation.

In order to determine changes in activation as a result of

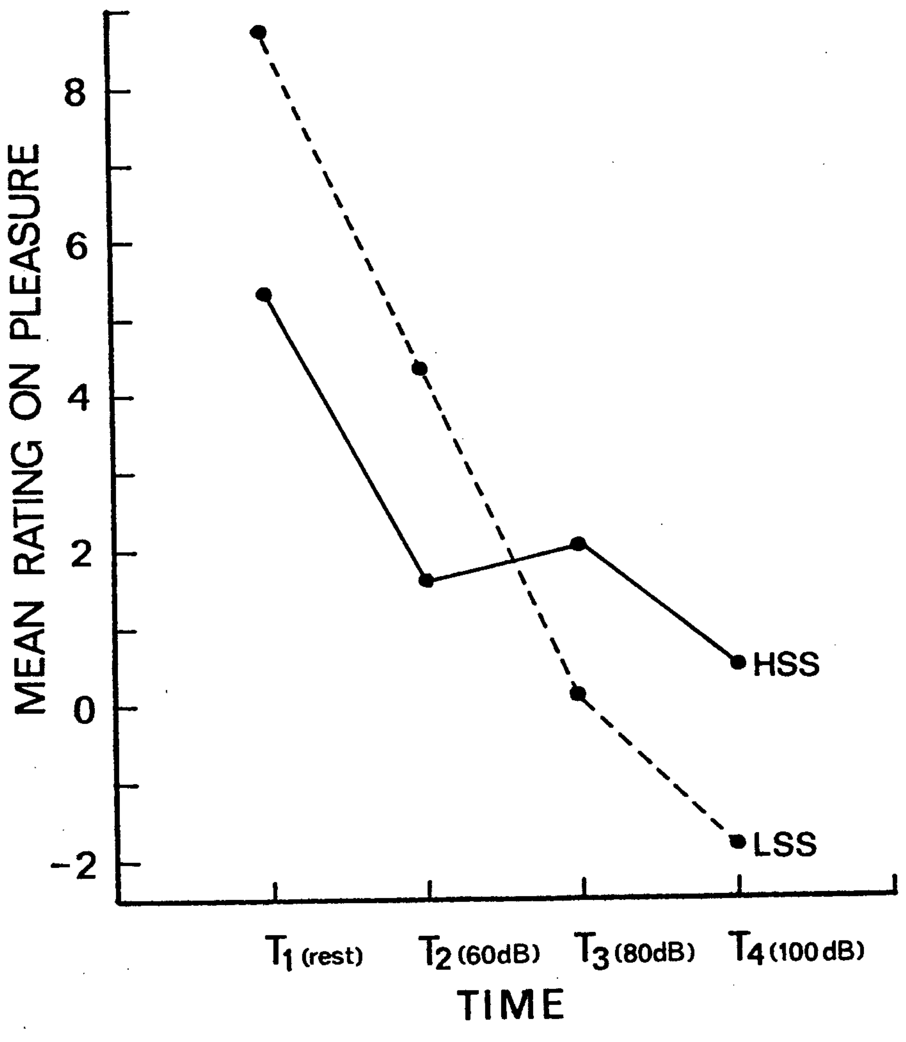

Figure 2 - Mean pleasure ratings given by Groups HSS and LSS for the initial rest and stimulation periods.

the presentation of the 60, 80 and 100 dB tones, separate 2 (group) x 4 (time) repeated measures analyses of variance for each factor were performed. The results will be discussed separately for each factor.

Deactivation. No significant results were found; however, Group HSS reported being more "deactivated" throughout the stimilation periods than did Group LSS, although this difference only approached significance ($p < .10$).

General Activation. No significant results were found.

General Deactivation. Mean ratings given by each group initially and in response to the three series of tones are plotted in Figure 3. A significant main effect for time ($F=7.48$, $df=3, 81$, $p < .001$) indicated that both groups reported increased feelings of stress as the tones became more intense. A trials x group interaction approached significance ($p < .10$) suggesting that the LSS individuals reported increasing feelings of stress to increasing tone intensity. On the other hand, the HSS individuals only reported increased feelings of stress to the 100 dB tones.

High Activation. No significant differences were found.

To summarize, the groups did not differ initially in anxiety or any of the emotion variables. Initially, both groups reported feelings of pleasure and low arousal. However, as a result of stimulation, there was a general increase in feelings of displeasure and arousal as the tones increased in intensity. Specifically, the LSS subjects found the increased stimulation more disturbing than did the HSS subjects. This is consistent with

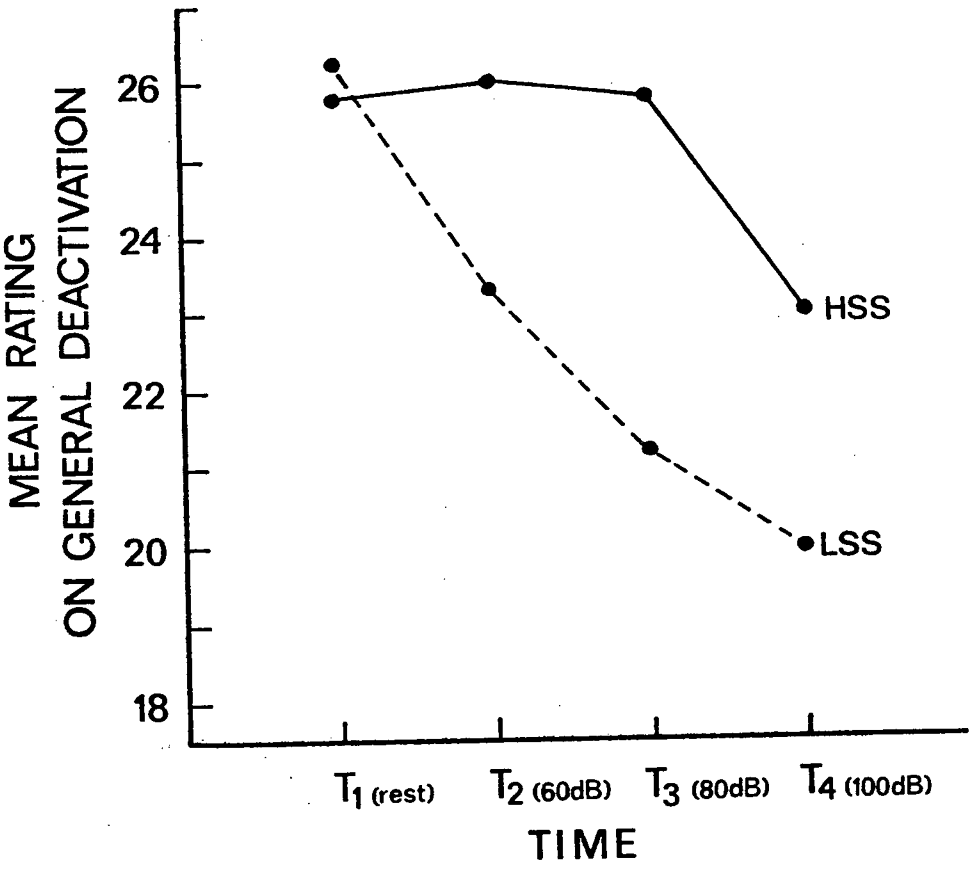

Figure 3 - Mean general deactivation ratings given by Groups HSS and LSS for the initial rest and stimulation periods.

the expectation that the HSS individual would have a more positive response to stimulation.

Physiological Measures

It should be noted that in the following analyses involving physiological measures, a conservative test of significance was used. The reason for this is as follows. In order for the univariate repeated measures analysis of variance to provide an exact statistical F test, the matrices of variances and covariances among variables must satisfy the assumption of compound symmetry (Winer, 1971). Inequality of these matrices results in the ta tabled critical value being too low relative to a critical value appropriate for an abritrary variance-covariance matrix (Winer, 1971). Therefore, when compound symmetry is questionable, the conservative test, which assumes that the F ratio has 1 and n-1 degrees of freedom, provides an approximate test.

In psychophysiological research, the repeated measures design introduces correlation among the variables on which the F is based. Consequently, the assumption of compound symmetry is often violated. For example, Lind (1978) found that heart rate and vasomotor responses for both males and females in response to 80, 100, and 120 dB tones consistently showed strong departures from compound symmetry. Specifically, where measures of change were recorded from second to second, the covariance matrix had relatively large values along the diagonal which decreased in value as one moved away from the diagonal.

Preliminary inspection of the present data for heart rate, vasomotor, and skin conductance responses suggested that they did not meet the assumption of compound symmetry. The Greenhouse and Geiser (1959) eta (which measures the extent to which a covariance matrix departs from compound symmetry) was computed for selected data. Correction values ranging from .2113 to .3850 were found. Moreover, the use of a liberal test, as is frequently done in this type of research, cannot be justified since they do not account for the violation of compound symmetry. Therefore, the use of a conservative test seems more appropriate.

Tonic Levels

Skin Conductance (SC). Mean tonic SC for the initial and final resting periods were 11.80 and 13.48 μmhos/cm^2, respectively, for the HSS subjects and 10.00 and 11.18 μmhos/cm^2, respectively, for the LSS subjects. In order to assess changes in tonic SC in response to the cummulative effect of stimulation, a 2 (group) x 2 (time) repeated measures analysis of variance was performed. Tonic SC showed a significant increase over the experimental period.

Similarly, examination of tonic SC prior to stimulation involved a 2 (group) x 3 (blocks) x 10 (trials) repeated measures analysis of variance. A significant trials effect indicated a general decrease in tonic SC over the 10 trials within each block ($F=30.83$, $df=1, 29$, $p < .001$) suggesting habituation. A blocks x trials x groups interaction approached significance with the HSS subjects showing generally higher tonic SC levels which decreased over trials but increased over blocks.

Heart Rate (HR). Mean tonic HR for the initial and final resting periods were 74.13 and 72.44 bpm, respectively, for the HSS subjects and 84.27 and 85.13 bpm, respectively, for the LSS subjects. In order to determine the change in tonic HR in response to the cummulative effect of stimulation, a 2 (group) x 2 (time) repeated measures analysis of variance was performed. A significant main effect for group ($F=6.25$, $df=1, 29$, $p<.05$) revealed that the HSS subjects displayed significantly lower tonic HR than did the LSS subjects during both the initial and final resting periods. A 2 (group) x 3 (blocks) x 10 (trials) repeated measures analysis of variance revealed that this group difference was consistently shown prior to each stimulation throughout the experiment ($F=5.79$, $df=1, 29$, $p<.05$).

Vasomotor Activity. Mean pulse amplitude for the initial and final resting periods were 9.97 and 4.73 mm, respectively, for the HSS subjects and 8.71 and 3.81 mm, respectively, for the LSS subjects. A 2 (group) x 2 (time) analysis of vairance indicated that the group mean difference was not significant. Both groups showed a decrease in tonic pulse amplitude (vasoconstriction) over the experimental period ($F=47.31$, $df=1, 29$, $p<.001$). A 2 (group) x 3 (blocks) x 10 (trials) repeated measures analysis of variance revealed a significant block effect ($F=22.11$, $df=2, 58$, $p<.001$) indicating increasing vasoconstriction with increasing tone intensity. The LSS subjects consistently showed more constriction; however, this was not significant.

Mean standard deviations for tonic pulse amplitude for these same periods were 2.18 and 1.15mm, respectively, for the HSS subjects and 2.13 and 1.37 mm, respectively, for the LSS subjects. A 2 (group) x 2 (time) analysis of variance gave a highly significant time effect (F=20.46, df=1, 29, $p<.01$), indicating that the variability of pulse amplitude decreased over the experimental period. Similarly, a 2 (group) x 3 (blocks) x 10 (trials) repeated measures analysis of variance revealed a significant block effect (F=6.85, df=1, 29, $p<.01$) indicating that the variability of pulse amplitude decreased with increasing tone intensity.

To summarize, the only difference between the HSS and LSS subjects to emerge from the tonic measures was with HR. In general, the changes in tonic measures across the blocks indicate that the stimuli were effective. Furthermore, the groups appear to have been affected similarly by the procedure on tonic measures.

Autonomic Measures

Skin Conductance Response Size. SC responses were computed by subtracting the prestimulus SC from the maximum SC observed during the first 10 sec. following stimulus onset. The mean SC responses given by each group to the three levels of tone intes intensity over trials are plotted in Figure 4. A 2 (group) x 3 (blocks) x 10 (trials) repeated measures analysis of variance on the size of the SC response indicated that both groups gave significantly larger SC responses the more intense the tones (F=4.70, df=1, 29, $p<.05$). A significant general decrement in response magnitude over the 10 trials within each block

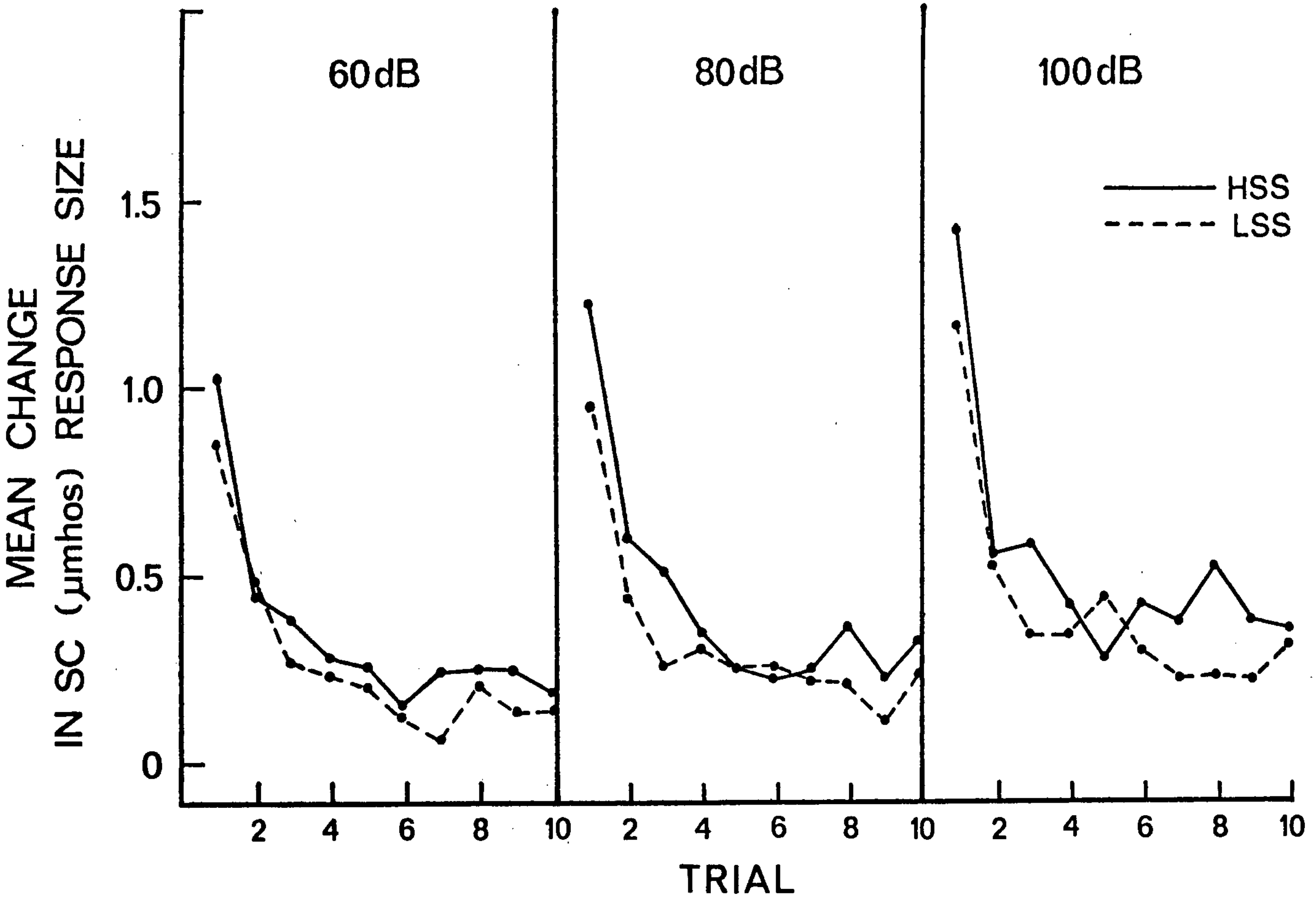

Figure 4 - Mean change in SC response size displayed by Groups HSS and LSS as a result of stimulation (to convert to umhos/cm^2, multiply values by 2.5).

(F=30.68, df=1, 29, $p<.001$) was revealed. Although it appears, as seen in Figure 4, that the HSS subjects initially gave a larger SC response on trial 1 of each block, this group difference was not significant.

Recovery Half-time. This measure was used to assess differences in recovery rates to the tones. A 2 (group) x 3 (blocks) x 10 (trials) repeated measures analysis of variance gave no significant results. The groups did not differ in their recovery rates across trials for the increasing tone intensities. Although larger recovery rates were found with the more intense tones, this difference was not significant.

Heart Rate. HR responses were determined by expressing the mean HR during each of the 10 1-sec. periods following stimulus onset as a deviation from the mean during the 5-sec. period prior to stimulus onset. A 2 (group) x 3 (blocks) x 10 (trials) x 10 (seconds) repeated measures analysis of variance on HR gave no significant results. Additional analyses, performed on more specfic sections of the data, included s 2 (group) x 3 (blocks) x 10 (seconds repeated measures analysis of variance on HR for trial 1 and a separate 2 (group) x 10 (trials) x 10 (seconds) repeated measures analysis of variance for each block. No significant group differences were found.

However, visual inspection of the HR plots revealed some interesting patterns. In response to the 60 dB tones, the LSS subjects initially showed acceleration for the first four seconds followed by deceleration whereas the HSS subjects showed only deceleration on trial 1. The groups gave similar HR responses on subsequent trials with the exception of trial 10 where this difference reoccurred. In contrast, the groups showed similar sec-to-sec HR responses to the 80 and 100 dB tones.

Vasomotor Responses. Vasomotor responses were determined by computing the mean pulse amplitude (PA) during each of the 10 1-sec. periods following stimulus onset as a percentage change from the mean PA during the 5-sec. period preceding stimulus onset. A 2 (group) x 3 (blocks) x 10 (trials) x 10 (seconds) repeated measures analysis of variance on PA change revealed that the LSS subjects were generally more responsive than the HSS, showing more vasoconstriction overall ($F=4.57$, $df=1, 29$, $p<.05$). A significant main effect for blocks ($F=7.78$, $df=1, 29$, $p<.01$) indicated that these vasoconstrictive responses became larger as the intensity of the tones increased. A significant main effect for seconds ($F=68.69$, $df= 1, 29$, $p<.001$) indicated that vasoconstriction increased over the seconds with the response starting to recover around trial 8. A significant blocks x seconds interaction ($F=5.74$, $df=1, 29$, $p<.001$) indicated that the increase in seconds increased with increasing intensity.

To summarize, the only significant group difference to emerge was with vasomotor activity with the LSS subjects being generally more responsive. Although not significant, the HSS subjects did display the predicted larger skin conductance OR. Similarly, they showed more HR deceleration and less vasomotor constriction. However, these trends began to disappear at the more intense t levels of stimulation.

With respect to the treatment effect, both groups showed increasing SC responses, HR acceleration and vasoconstriction with increasing stimulation. The trend for these to start to recover over the trials suggests habituation by both groups.

DISCUSSION

Of prime interest in the interpretation of the present results is the extent to which the behavioral and physiological variables demonstrate significant individual differences between the HSS and LSS subjects. Theoretically, the HSS individuals needs novel and varied stimulation in order to maintain his optimal level of arousal. Although the HSS individual is highly aroused by novel stimuli, he stops responding when stimuli are repeated. Therefore, repetition of stimuli brings him down to a level markedly below his response to novel stimuli. In addition, he appears to lack a natural inhibition of response to intense stimuli.

Based on this theoretical formulation, it was hypothesized that the HSS subjects would 1) prefer higher levels of stimulation, 2) be more arousable on the first presentation of a novel stimulus, and 3) shift to a DR at a higher level of stimulation than would the LSS subjects. Although the groups showed some differences on the self-report measures, their physiological data did not entirely confirm these hypotheses.

Both groups showed some pre-experimental state anxiety and both showed a reduction in state anxiety after the procedures were finished. This is possibly due to the fact that the subjects showed less concern over the procedure as they became more experienced with it. There were no group differences on this measure. These findings are consistent with previous research (Zuckerman _et al_., 1972; Neary and Zuckerman, 1976; Bone, Montgomery, Sindstrom, Fowling, and Calef, 1972) which showed no substantial state and trait anxiety differences between HSS and LSS subjects. This confirms that there were no differences in anxiety which could have obscured or confounded the results of the study. For example, Neary and Zuckerman (1976) demonstrated that low anxious subjects gave greater initial ORs than did high anxious subjects. Similarly, other studies have reported a relationship between anxiety and responsiveness (Lader and Wing, 1966; Roessler, 1973).

The results of the behavioral may provide some support for the hypothesis that HSS individuals prefer higher levels of stimulation. Although there were no initial differences between the HSS and LSS subjects in emotional state, group differences did emerge as a result of stimulation. In general, decreasing degrees of pleasure and increasing degrees of arousal were reported with increasing intensity levels of the tones. Specifically, the LSS subjects reported lower verbal ratings of pleasure and higher verbal ratings of stress than did the HSS subjects as a result of stimulation. This is consistent with the expectation that the HSS individual would have a more positive reaction to stimulation. However, some caution should be taken in interpreting these data. Since the ratings were done over each block, it is not clear whether the subjects were rating their response to the tones, the cummulative effect of being in isolation or what.

Moreover, the interpretation of these valuable ratings is confounded by the mode and timing of their administration.

With respect to the physiological data, the groups did not differ in tonic levels of electrodermal and vasomotor activity; however, the HSS subjects showed consistently lower tonic HR throughout the experimental period. Visual inspection of the video-recordings as well as the experimenter's subjective impression of the subjects suggest that this difference may be related to a more athletic build and better physical conditioning in the HSS subjects. In addition, the HSS subjects often indicated their active participation in sports during the preliminary interview.

The general pattern of increased SC, HR acceleration, and vasoconstriction in response to increased stimulation suggests that the experimental procedure had similar effects on both groups.

Relevant to the discussion of the phasic responses is Lacey's model (1967; Lacey and Lacey, 1974) which proposes that HR deceleration is associated with an increase in cortical arousal and readiness for sensory intake, whereas HR acceleration is associated with decreased cortical arousal and a readiness for sensory rejection. That is, the former is indicative of an OR and increased sensitivity to the environment whereas the latter is indicative of a DR and decreased sensitivity to the environment (Graham and Clifton, 1966).

The only group differnce to emerge as a result of stimulation was in vasomotor activity, with the LSS subjects showing more vasoconstriction with increased stimulation. These differences in vasomotor activity provide further insight into the levels of sympathetic arousal and emotional states experienced by the subjects. The vasoconstriction displayed by the LSS subjects might indicate that they found the higher levels of stimulation more disturbing and thus showed a readiness to reject the stimulation. Furthermore, this is consistent with the expectation that the HSS subjects would be more ready for sensory intake. However, as mentioned above, group differences were not replicated in the SC or HR data.

In general, the groups showed similar responses to the stimulation. Similarly, there were no group differences in the stimulation level at which the response shifted from a OR to a DR.

To conclude, the experimental manipulations appear to have had similar effects on both groups. The suggestion (ie., Neary and Zuckerman, 1976; Zuckerman *et al.*, 1977) that the HSS individuals would show larger ORs to the first presentation of a novel stimulus was not supported by the data. Similarly, group differences did not occur at higher levels of stimulation. That is, there was no difference between the groups in their shift from a OR to a DR. Although it should be pointed out that the data were generally in the expected direction.

Although the procedures used in the present experiment produced reasonably good results, it is possible that some modification in the procedure would increase the chances of observing more clear-cut ORs and DRs. For example, subjective evaluation of the stimuli may be done prior to or after the experiment proper. This would reduce the chances of HR increases being related to cognitive elaboration or whatever processes are associated with having to rate stimuli and prepare to make a motor response (Lacey, 1967).

Moreover, the findings are consistent with the tone of the preceding literature review. The empirical data has not consistently supported the hypothesized relationships between behavior, physiology and sensation seeking. In general, the "biological basis" of sensation seeking still remains unclear. There is a definite need for further research involving not only replication, but additional investigation of the role of the various physiological variables in the sensation seeking dimension. It appears that cardiovascular activity may prove to be useful in defining the physiological basis of sensation seeking.

REFERENCES

Acker, M., & McReynolds, P. The need for novelty. A comparison of 6 instruments. The Psychological Record, 1967, 17, 177-182.

Berg, W., Jackson, J., & Graham, F. Tone intensity and rise-decay time effects on cardiac responses during sleep. Psychphysiology, 1975, 12, 254-261.

Berlyne, D. Conflict, arousal and curiosity. New York: McGraw-Hill, 1960.

Blackburn, R. Sensation seeking, impulsivity, and psychopathic personality. Journal of Consulting and Clinical Psychology, 1969, 33, 571-574.

Bone, R., Montgomery, D., Sundstrom, P., Fowling, L., & Calef, P. The relationship of sensationsseeking and anxiety: IPAT, state and trait, TAS and MAS. Psychological Reports, 1972, 30, 874.

Brill, N., Crumpton, E., & Grayson, H. Personality factors in marihuana use. Archives of General Psychiatry, 1971, 24, 163-165.

Buchsbaum, M. Neural events and psychophysical law. Science, 1971, 1972, 502.

Buchsbaum, M., Goodwin, F., Murphy, D., & Borge, G. AER in affective disorders. American Journal of Psychiatry, 1971, 128, 19-25.

Coursey, R., Buchsbaum, M., & Frankel, B. Personality measures and evoked responses in chronic schizophrenics. Journal of Abnormal Psychology, 1975, 84, 239-249.

Cox, D. Psychophysiological correlates of sensation seeking and socialization during reduced stimulation. Unpublished doctoral dissertation, University of British Columbia, 1977.

Daitzman, R. Personality correlates of androgens and estrogens. (Doctoral dissertation, Univerisity of Delaware, 1975). Dissertation Abstracts International, 1977, 37,

Duffy, E. Activation. In N. Greenfield & R. Sternbach (Eds.), Handbook of Psychophysiology. New York: Holt, Rinehard, & Winston, 1972.

Eysenck, H. The Structure of Human Personality. London: Methuen, 1970.

Eysenck, H. The Biological Basis of Personality. Springfield, Ill.: Charles C. Thomas, 1967.

Farley, F. Social desirability and dimensionality in the sensation seeking scale. Acta Psychologica, 1967, 26, 89-96.

Farley, F. Measures of individual differences in stimulation seeking and tendency toward variety. Journal of Consulting and Clinical Psychology, 1971, 37, 394-396.

Farley, F. & Farley, S. Extroversion and stimulus seeking motivation. Journal of Consulting and Clinical Psychology, 1967, 31, 215-216.

Farley, F & Farley, S. Impulsiveness, sociability and the preference for varied experience. Perceptual and Motor Skills, 1970, 31, 47-50.

Gogan, P. The startle and orienting reactions in man. A study of their characteristics and habituation. Brain Research, 1970, 18, 117-135.

Gough, H. Manual for the California Psychological Inventory. Palo Alto: Consulting Psychologists Press, 1969.

Graham, F. & Clifton, R. Heart rate change as a component of the orienting response. Psychological Bulletin, 1966, 65, 305-320.

Hocking, J. & Robertson, M. Sensation seeking as a predictor of need for stimulation during sensory restriction. Journal of Consulting and Clinical Psychology, 1969, 33, 367-369.

Hymbaugh, K & Garrett, J. Sensation seeking among skydivers. Perceptual and Motor Skills, 1974, 38, 118.

Kish, G. CPI correlates of stimulus seeking in male alcoholics. Journal of Clinical Psychology, 1971, 27, 251-253.

Kish, G. & Busse, W. MMPI correlates of sensation seeking in male alcoholics: a test of Quay's hypothesis applied to alcoholism. Journal of Clinical Psychology, 1969, 25, 60-62.

Kish, G. & Donnenworth, G. Interests and stimulus seeking. Journal of Counseling Psychology, 1969, 16, 551-556.

Lacey, J. Somatic response patterning and stress: Some revisions of activation theory. In M.H. Appley & R. Trumball (Eds.), New York: Appleton-Century-Crofts, 1967.

Lacey, B., & Lacey, J. Studies of heart rate and other bodily processes in sensimotor behavior. In P. Obrist, J. Brener, & L. Dicara (Eds.), Cardiovascular Psychophysiology. Chicago: Aldine, 1974, 538-564.

Lader, M. Pneumatic plethysmography. In P. Venables, & I. Martin (Eds.), A manual of psychophysiological methods. New York: Wiley, 1967, 159-183.

Lader, M., & Wing, L. Physiological measures, sedativesdrugs, and morbid anxiety. Maudsley monograph No. 14. London: Oxford University Press, 1966.

Lambert, W., & Levy, L. Sensation seeking and short term sensory isolation. Journal of Personality and Social Psychology, 1972, 24, 46-52.

Lind, J. Repeated measures analysis of heart rate and vasomotor responses. Unpublished report, University of British Columbia, 1978.

Looft, W., & Baranowski, M. An analysis of five measures of sensation seeking and preference for complexity. Journal of General Psychology, 1971, 85, 307-313.

Lynn, R. Attention, arousal and the orientation reaction. New York: Pergamon Press, 1966.

Mehrabian, A., & Russell, J. An approach to environmental psychology. Cambridge, Massachusetts: MIT Press, 1974.

Murphy, D., Belmaker, R., Buchsbaum, M., Martin, N., Ciarnello, R., & Wyatt, R. Bigenic amine related enzymes and personality variations in normals. Psychological Medicine, 1977, 7, 149-157.

Myers, T. Psychobiological factors associated with monotony tolerance. Report No. 197-015, July 1972, American Institutes for Research, Institute for Research in Psychobiology.

Neary, R., & Zuckerman, M. Sensation seeking, trait and state anxiety, and the electrodermal orienting response. Psychophysiology, 1976, 13, 205-211.

Nebylitsyn, V. Some questions relating to the theory of the properties of the nervous system. In V. Nebylitsyn (Chm), Physiological bases of individual differences. XVIII International Congress of Psychology, Symposium 9, Moscow, 1966, 23-32.

Nebylitsyn, V. Fundamental properties of the human nervous system. New York: Plenum Press, 1972, 131-142.

Oster, P., Stern, J., & Figar, S. Cephalic and digital vasomotor orienting responses: the effect of stimulus intensity and rise-time. Psychophysiology, 1975, 12, 642-648.

Pearson, P. Relationships between global and specified measures of novelty seeking. Journal of Consulting and Clinical Psychology, 1970, 34, 199-204.

Roessler, R. Personality, psychophysiology and performance. Psychophysiology, 1973, 10, 315-327.

Schlosberg, H. Three dimensions of emotion. Psychological Review, 1954, 61, 81-88.

Schooler, C., Zahn, T., Murphy, D., & Buchsbaum, M. Psychological correlates of monoamine oxidase activity in normals. Journal of Nervous and Mental Diseases, 1978, 166, 177-186.

Segal, B. Personality factors related to drug and alcohol use. In D. Lettieri (Ed.), Predicting adolescent drug abuse: A review of issues, methods and correlates. Washington, D.C.: Dept. of Health, Education and Welfare Publication No. (ADM) 77-299, 1976.

Spielberger, C., Gorsuch, R., & Lushene, R. Manual for the state trait anxiety inventory. Palo Alto: Consulting Psychology Press, 1970.

Smith, S., & Myers, T. Stimulation seeking during sensory dep-
r rivation. Perceptual and Motor Skills, 1966, 23, 1151-1163.

Stanton, H. Hypnosis and encounter group volunteers: a validation study of the sensation seeking scale. Journal of Consulting and Clinical Psychology, 1976,444, 692.

Stewart, D., & MacGriffith, G. Factor analysis of Zuckerman's sensation seeking scale. Psychological Reports, 1975, 37, 849-850.

Thayer, R. Measurement of activation through self-report. Psychological Reports, 1967, 20, 663-678.

Thorne, G. The sensation seeking scale with deviant popualtions. Journal of Consulting and Clinical Psychology, 1971, 37, 106-110.

Winer, B. Statistical principles in experimental design. New York: McGraw-Hill Book Co., 1971.

Zuckerman, M. Theoretical formulations: I. In J. Zubek (Ed.), Sensory deprivation: fifteen years of research. New York: Appleton-Century=Crofts, 1969, 407.

Zuckerman, M. Dimensions of sensatiion seeking. *Journal of Consulting and Clinical Psychology*, 1971, *36*, 45-52.

Zuckerman, M. Sensation seeking and habituation of the electrodermal orienting response. *Psychophysiology*, 1972, *9*, 267-268 (Abstract).

Zuckerman, M. The sensation seeking motive. In B. Maher (Ed.), *Progress in experimental personality research, vol. 7*. New York: Academic Press, 1974.

Zuckerman, M. Manual and research report for thessensaation seeking scale, March, 1975. Department of Psycholggy, University of Delaware, Newark, Delaware.

Zuckerman, M. Preliminary manual with scoring keys and norms for form V of the sensation seeking scale. University of Delaware, 1977.

Zuckerman, M. The search for high sensation. *Psychology Today*, February, 1978, 38.

Zuckerman, M., Bone, R., Neary, R., Mangelsdorff, D., & Brustman, B. What is the sensation seeker? Personality trait and experience correlates of the sensation seeking scales. *Journal of Consulting and Clinical Psychology*, 1972, *39*, 308-321.

Zuckerman, M., Buchsbaum, M., & Murphy, D. The biòlggical basis of sensation seeking. Paper presented at meeting of the Society for Psychophysiològical Research, Philadephis, Pa., October, 1977.

Zuckerman, M., Eysenck, S., & Eysenck, H. Sensation seeking in England and America: cross-cultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology*, 1978, *46*, 139-149.

Zuckerman, M., Kolin, E., Price, L., & Zoob, I. Development of a sensation seeking scale. *Journal of Consulting Psychology*, 1964, *28*, 477-482.

Zuckerman, M. & Link, K. Construct validity for the sensation seeking scale. *Journal of Consulting and Clinical Psycho-* logy *logy*, 1968, *32*, 420-426.

Zuckerman, M., Murtaugh, T., & Siegel, J. Sensationsseeking and cortical augmenting-reducing. *Psychphysiology*, 1974, *11*, 535-542.

Zuckerman, M., Neary, R., & Brustman, B. Sensationssseeking scale correlates in experience (smoking, drugs, alcohol, "hallucinantions" and sex) and preference for complexity (designs). Proceedings 78th Annual Convention, American Psychological Association, 1970.

Zuckerman, M., Schultz, D., & Hopkins, T. Sensation seeking and volunteering for sensory deprivation and hypnosis experiments. Journal of Consulting Psychology, 1967, 31, 358-363.

Zuckerman, M., Tushup, R., & Finner, S. Sexual attitudes and experience: Attitudes and personality correlates and changes produced by a course in sexuality. Journal of Consulting and Clinical Psychology, 1976, 44, 7-19.

Appendix 1 - Explanatory Letter

PLEASE READ THIS BEFORE YOU BEGIN QUESTIONNAIRES

You are being asked to fill out three questionnaires as a part of some research to be conducted here at U.B.C. All questionnaires are relatively short and straightforward, however, please read the instructions before beginning each one. Briefly, the nature of this research is concerned with the psychophysiological examination of various levels of arousal. Out of the questionnaires which are completed, a certain number will be randomly selected and asked if they wish to volunteer for the study. By filling out the questionnaries you are in no way obligated to take part if your name is selected. In order to identify yourself it will only be necessary to give your first name and phone number on the last page so that you may be contacted.

With regards to these questionnaires, all participants will be returned feedback describing the theoretical bases and your individual scores on them. Therefore be sure to put some form of identification on the last page.

Your participation in providing me with this data is greatly appreciated.

Doreen Ridgeway

Appendix 2 - Subject Identification

We need to study more thoroughly some persons who have completed this questionnaire. If you would be willing to participate in a follow-up study, please check below and indicate some way we can contact you.

m Are you willing to be contacted? _____Yes

_____No

If so, please give your name and some way we can contact you.

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