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Gender Differences in the Relation Between Locus of Control and Physiological Responses

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ABSTRACT

GENDER DIFFERENCES IN THE RELATION BETWEEN LOCUS OF CONTROL AND PHYSIOLOGICAL RESPONSES

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The relationship between locus of control and the physiological responses of heart rate (HR) and electrodermal activity (EDA) was investigated in 30 males and 31 females during an arithmetic task. The Levenson's Internal, Powerful Others and Chance (IPC) scales (Levenson 1974) were used to assess the various degrees of internality for each subject. Additionally, to determine each subject's physiological Lability or Stability (LS), EDA was measured by recording spontaneous skin conductance responses during a ten minute rest period and to a tone (an Orienting Response (OR) task). Heart rate also was recorded during the ten minute rest period and during performance of the arithmetic task. A majority of the subjects were found to be internal on the IPC scales

relative to the norm for the I scale. For the heart rate measure on the arithmetic task, the results showed no significant differences between males and females. Significant differences were found between baseline heart rate (HRB) and task heart rate (HRT). A simple difficulty effect was found on the performance scores across the three levels of difficulty for all subjects. There was an inverse relationship between the I and C scales and the EDA, but no gender differences were found. Males, however, showed more electrodermal spontaneous fluctuations than females. Results of multiple regression analyses suggest that the best predictor variables for electrodermal reactivity were the OR and LS. Locus of control, gender, OR and LS did not predict heart rate variability.

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Rotter (1964) stated that, "The potentiality of a given behavior or set of behaviors to occur in some specific situation is dependent on an individual's expectancy that the behavior will lead to a particular goal or satisfaction, the value that satisfaction has for him [her], and the relative strength of other behavior potentials in the same situation." This is the basis of the "Social Learning Theory." This theory, which evolved in the early 1950's, has been developed over the intervening years by Rotter and his colleagues in an attempt to explain human behavior in relatively complex social situations.

One aspect of the "Social Learning Theory" deals with how an individual perceives those events which transpire in his/her life. This facet of the "Social Learning Theory" has given rise to its own theories and nomenclature about personality characteristics which can be identified by certain beliefs. The extent to which a person believes (or has an expectancy) that he/she can control what happens to him/herself, Rotter calls belief in internal control of reinforcement (also called internal locus of control).

Conversely, the extent to which a person holds the belief that one is controlled by fate, luck, or powerful others, Rotter calls external control of reinforcement (also called external locus of control). If Rotter's "Social Learning Theory" is indeed correct, such generalized expectancies in individuals may have an important impact on how an individual responds to different kinds of stress found in various social and personal situations, and how he/she copes with them. Consequently, it is important to see what researchers have been able to find about personal beliefs and their relationship to stress and to coping.

Research on Locus of Control

Measures of individual differences in a generalized expectancy or belief in external control as a psychological variable were first attempted by Phares in 1957. Phares developed a scale with 13 items labeled as external attitudes and 13 stated as internal attitudes. James (1957) revised Phares' test and wrote 26 items based on the items which appeared to be most successful in the Phares study, and adding filler items. James' scale, derived from Rotter's social learning theory (1954), assesses the degree to which individuals perceive the events in their life as being consequences of their own actions and thereby controllable (internal locus of control) or as being unrelated to their own behaviors and therefore beyond personal control (external

locus of control) (Lefcourt, 1972, p. 2). The theory of internal-external locus of control also postulates that the effects of reward or reinforcement depend in part on whether the person perceives the reward as contingent on his/her own behavior or independent of it.

For example, Efran (1963) studied the interactions between achievement and the characteristic of external-internal locus of control in high school students. He observed that the tendency to forget failures was significantly related to internal locus of control. Additionally, the results suggested that the external locus of control subjects had less need to repress their failures because they had already accepted external factors as being the determinants of their success or failure to a greater extent than those subjects scoring as more internal on the Internal-External control scale.

Another study by Rotter and Mulry (1965) suggested that there is a stronger motivation for performance accuracy in internal locus of control subjects than in external locus of control subjects. Sixty-one female and fifty-nine male subjects participated in this study. Half of the subjects were instructed that the task was so difficult that the results would essentially be determined by chance, not by skill or effort (Chance Condition). The other half were told that the task was difficult but that previous data had shown that some people were very good at it (Skill Condition). The

task consisted of placing each of 13 matching stimulus cards next to the appropriate choice from 28 possible standard stimulus cards. However, none of the matching stimuli were exact replicas of the standard stimuli; thus, the task was impossible to perform correctly. All subjects were then given eight trials and were told, regardless of whether their answers were correct or not, that they were correct 75% of the time; the remainder of the time, whether they were correct or not, they were told that their answers were wrong. It was found that internals took longer to decide on the task presented under skills conditions than did externals, but took less time to do the task under chance conditions than did the externals. These results demonstrated the greater involvement of internal locus of control subjects in skills conditions and also suggested that they tend to value reinforcement for skills much more than reinforcement based on chance.

Dhawan and Singh (1985) also found that internal locus of control subjects showed greater involvement and persistence in task completion when the task was expected to be easy than when it was expected to be difficult. The results also showed, however, that although internals displayed less persistence in completing a difficult task, they still demonstrated more persistence to all tasks (easy and difficult) than external locus of control subjects.

Health Issues and Locus of Control

In addition to the studies just mentioned which attempted to analyze the general attributes of internal and external locus of control, numerous studies have examined the relationship between health, moods, exercise adherence, and locus of control (McCready & Long, 1985; Dhawan & Sing, 1985; Plant & Ryan, 1985; Wurtele, Britcher & Saslawsky, 1985; Seeman & Seeman, 1983; DeVito, Bogdanowicz & Reznikoff, 1982; and Lefcourt et al., 1981). DeVito, Bogdanovicz and Reznikoff (1982) found that individuals with an internal locus of control tended to collect a greater number of health pamphlets than external locus of control individuals, and generally were more attuned to the functioning of their bodies than were externals.

McCready and Long's study (1985) examined the relationship between exercise adherence and the combined effects of locus of control and attitudes toward physical activity. Internal locus of control subjects had a more positive attitude toward physical activity and were more likely to adhere to an exercise program.

Coping with Stress and Locus of Control

In addition to the relationship between locus of control and health maintenance efforts by the individual, it has also been suggested that there is a relationship between locus of control and stress coping. For example, Krause and Stryker

(1984) assessed the mediating effects of locus of control beliefs in the relationship between stressful jobs, economic events, and physiological well-being. The results demonstrated that individuals with internal locus of control coped more adequately than those individuals with an external locus of control orientation.

Physiological Responsiveness and Locus of Control

The topic of stress and how an individual copes with stress is not a simple one. For example, it has been suggested that the efficacy with which an individual copes with stress is reflected in the individual's physiological responsivity (Lazarus, 1966; Glass & Singer, 1972; Mason, 1975; Seligman, 1975; Frankenhauser, 1983). However, the relationship of perceived control to individual differences in physiological responsivity is far from being understood. (Krantz & Manuck, 1984). Two methods of examining this issue have been through studies of the Orienting Response and through studies of biofeedback.

Orienting Response Studies

Physiological responsivity as a function of locus of control has been examined using the habituation paradigm. Berggren, Ohman, and Frederickson (1977) looked at different levels of habituation of the orienting response (OR) in subjects at the extreme ends of the external-internal locus

of control scale. Briefly, the OR is an increase in attention to a novel or significant stimulus. This orienting response can be physiologically measured by electrodermal or cardiovascular reactivity. The term habituation is used to refer to a decrease in magnitude of a physiological response when the stimulus is presented continually without significant outcomes. Thus the orienting response habituates as an individual loses interest in the stimulus. Berggren et al. (1977) predicted that subjects reporting an external locus of control should show slower habituation of the orienting response to a nonsignal (i.e., insignificant environmental stimulus) than subjects reporting an internal locus of control, because the external subjects have a poorer control of attention. It was not clear why Berggren et al. assumed that externals would display poorer attention control. However, they predicted that internals, again because of their better attention control, should habituate more slowly to a signal (i.e., important environmental stimulus) than a nonsignal stimulus. Externals, on the other hand, should not make that distinction and should habituate to each type of stimulus at an equal rate.

In two experiments, Berggren et al. exposed subjects to a recurring tone of moderate intensity while skin conductance was measured. However, in the second experiment, the signal value was manipulated by having the subjects press a response key at the offset of each tone. The results indicated that

internals habituated more slowly to signal than nonsignal stimuli, while the externals showed no difference between the two conditions. Further, it was found that males and females did not differ in their electrodermal activity response. However, the small number of males, at least in Experiment 1 (15 females and 6 males in Experiment 1 compared to 18 females and 16 males in Experiment 2) make gender comparisons inappropriate. Berggren et al. looked only at electrodermal activity; they did not, however, suggest that heart rate should be examined for differences in physiological activation.

Lobstein, Webb, and Edholm (1979) also looked at the possible relationship between the locus of control and the orienting response. Unlike Berggren et al., they used even numbers of males and females and both skin conductance and heart rate reactivity measurements. Unlike Berggren et al., who selected individuals in the upper and lower third of the sample distribution of the locus of control variable, Lobstein et al. selected their subjects by using the median split of the distribution. In their study, Lobstein et al. looked at deceleration response of heart rate to a novel stimulus, but it is not clear, from their presentation, if any habituation responses were analyzed. They presented the habituation data graphically, but did not report any results other than a nonsignificant tendency for women to habituate electrodermal activity faster than men. Their results also indicated that

heart rate response habituated for internals, but it is not clear if any differences were found between externals and internals. However, the authors cautioned future researchers as to the conditions of their experiment; they stated: "A distinction should be made between the conditions described in this experiment, where subjects sat passively and received tones with little signal value, and situations where subjects may be required to perform some task or make other overt responses. In the latter situation, motivational variables may elicit raised heart rate and palmar sweating levels." This is important to note if one is to study the effect of stress on physiological responsivity.

Biofeedback Studies

One of the earliest studies in the body of research dealing with the effect of autonomic nervous system (ANS) feedback on ANS control was done by Lisana (1958) on the instrumental conditioning of peripheral vasodilation in human subjects. Lisana found that individuals who were unable to produce voluntary vasodilation in order to instrumentally terminate an electric shock were able to produce such voluntary vasodilation when given visual feedback of their vascular system and activity. Research concerning such exteroceptive feedback to facilitate an individual's voluntary control of his/her ANS functions has primarily concentrated on the control of cardiac rate.

For example, Shearn (1962) amplified the sound of his subjects' heartbeats and played the sound back over a loudspeaker. Thus, he enabled his subjects to control their own heart, although he did not specifically focus on sensory feedback as Lisana had. Hnatiow and Lang (1965), however, presented their subjects with a visual display of a pointer whose movements were synchronized with the subjects' own heartbeats, and reinforcement consisted of feedback to each subject on their success or failure in voluntarily controlling their heart rate. These studies indicated that enhancing a subject's awareness of his/her autonomic activity with the use of exteroceptive feedback facilitated his/her ability to modulate or control that activity (Harris & Katkin, 1975). This is the basis of biofeedback research and is explained quite clearly by Green, Green, and Walters (1971):

> "Every change in the physiologic state is accompanied by an appropriate change in the mental-emotional state, conscious or unconscious, and conversely, every change in the mental-emotional state, conscious or unconscious, is accompanied by an appropriate change in the physiologic state" (p. 5).

Human beings, then, respond to both internal and external stimuli, and have the capacity to observe and reflect upon those stimuli. In other words, human beings perceive the world in a particular way, and each human being has their own individual view of their success or failure in their interactions with the world. Studies of locus of control are studies of individual differences coupled with experimental

situations involving varying degrees of control over stressful and/or rewarding events.

Past research has shown that individuals who differ on locus of control characteristics display various levels of cardiac control. For example, internal locus of control individuals, while using biofeedback techniques, have demonstrated skill at cardiac acceleration (Schneider, Sobol, Herman & Cousins, 1978); Logsdon, Bourgeois & Levenson, 1978; and Lang & Twentyman, 1974), while external locus of control individuals who tended to rely on external cues for performance did not. Gatchel (1975), Johnson and Thorn (1985), and Chellsen (1984), however, did not find the results of the previous studies. According to Johnson and Thorn, their results may not have been significant because their study had more task completion sessions than the previous research. It was found that heart rate and locus of control correlated highly if the sessions were limited to about five in number; however, as the number of sessions increased, none of the correlations between heart rate increase during task completion and locus of control approached significance. It was suggested in the Johnson and Thorn study that experience may have influenced the results.

Other studies such as Fotopoulos (1970) and Ray and Lamb (1974) showed internals to be superior at heart rate elevation with feedback whereas externals were superior at heart rate lowering. However, Gatchel (1975) pointed out that both the

Fotopoulos study and the Ray and Lamb study involved only one testing session, and therefore might have confounded physiological responses with individual differences in direct control of heart rate.

Avoiding a Stressor

Another factor to consider in studying how an individuals responds to stress is to what extent the individual will attempt to deal with stress through avoidance. DeGood (1975) studied cognitive control factors in vascular stress responses in 24 internal and 24 external male subjects undergoing aversive shock-avoidance procedures. Half of the subjects were permitted to escape the situation temporarily whenever they wished (situational control condition) while the remaining subjects were not (situational no-control condition). It was demonstrated that the knowledge that an individual had the option of escaping served as a cognitive stress-reducing cue, as measured by systolic and diastolic blood pressure. Although the mean systolic blood pressure was significantly lower for the experimental situational control condition, the internal-external personality factor was not significant. In contrast, the diastolic blood pressure elevations were larger when the actual controllability of the aversive situation was incongruent with the individual's general beliefs and locus of control. In other words, if the subject's beliefs were not in keeping with the reality of the

experimental situations (incongruent), then diastolic blood pressure increased. It is interesting to note, then, that the systolic pressure appears to be highly sensitive to situational factors, whereas diastolic pressure seems to be more responsive to the influence of the individual's personality dimensions.

Lazarus (1966) proposed that an individual who judges himself to have less control in a threatening situation is more likely to cope less adequately. To investigate this hypothesis, in a study of college males, Houston (1972) manipulated his subjects' belief about control by telling one group of subjects they could avoid an aversive shock by doing a task right while the remaining subjects were told that there was no possible way of avoiding the aversive shock. The task consisted of verbalizing digits backward. Contrary to prediction, heart rate increased more for the avoidable shock group than for the unavoidable shock group. This difference did not, however, reach significance, and it was postulated by Houston that the increase in heart rate in the former group may have been caused by the effort the subjects had to make in order to avoid shock. Thus, an individual's response to a stressful situation is more complex than Lazarus hypothesized.

Houston also predicted that externals would be less anxious than internals in the unavoidable shock group and that internals would be less anxious than externals in the

avoidable shock group [the self-report of anxiety was measured by the Zukerman (1960) Affect Adjective Check List, AACL]. However, the interaction between treatments and the locus of control was not significant. The fact that subjects performed behaviorally better in situations in which congruence existed between their beliefs about locus of control in general and their view of the situation in which they worked lends support to DeGood's (1975) results that the personality of an individual must be congruent with an event in order to have adequate coping. It is thus being suggested that the individual's perceived ability to exercise control over environmental stimuli is a major determinant of stress reactions.

Gender Differences

One focus of the present study is the relationship between gender, locus of control, and physiological reactivity to stress. Stoney, Davis, and Matthews (1987) conducted a meta-analysis of studies on gender differences in stress reactivity, published from 1965 to 1986. Two of the findings were that females had higher resting heart rate and higher heart rate increases during challenging situations and that males had higher systolic blood pressure at rest than did females. In an experiment, Manuck, Craft, and Gold (1978) found that for male subjects exposed to a difficult cognitive task, there was no significant difference in the task related

systolic blood pressure elevations when analyzed for the characteristics of internal-external locus of control. However, this study included only male subjects; therefore, possible gender differences could not be addressed.

The studies of Lobstein et al. (1979) and Berggren et al. (1977) described earlier did not find any significant differences between males and females in physiological responsivity. Both studies did, however, find differences in another physiological measure, that being the number of spontaneous fluctuations in the EDA. Spontaneous fluctuations are, according to Wilson (1987), small magnitude fluctuations in skin conductance or resistance exceeding .05 μmhos with an individual seated in a quiet experimental chamber. Since these fluctuations can occur in the absence of any changes in the environmental stimulus, they have come to be known as "nonspecific fluctuations" (Katkin, 1975 and Venables & Christie, 1980), or "nonspecific responses" (Siddle, O'Gorman & Wood, 1979).

In the Lobstein et al. study, it was found that females tended to have fewer spontaneous fluctuations than the males. It was not clear in the Berggren et al. study if a similar gender based difference was found; however, they did find differences between internal and external locus of control, with the externals exhibiting more spontaneous fluctuations than the internals.

Electrodermal Lability

It was not clear from the Lobstein et al. and the Berggren et al. studies whether or not the differences noted in spontaneous fluctuations were significant, although the females tended to show less spontaneous fluctuations than did the males in both studies. However, there have been a number of other studies which have explored spontaneous fluctuations and sought to discover if there is any pattern to spontaneous fluctuations. For example, Siddle and Heron (1976), Crider and Lunn (1971), and Lacey and Lacey (1958) observed that these fluctuations represented a relatively stable individual difference characteristic, with test-retest reliabilities in the range of +.47 to +.91. Additionally, it was found by Hastrup (1979) and Sostek (1978) that the frequency of these nonspecific fluctuations (NSFs) is highly correlated with another index of skin conductance responsivity, that being the speed of habituation to a certain stimulus (i.e., a 500 Hz tone at 85 dB). It has been suggested by Crider and Lunn (1971) that the nonspecific fluctuations positively correlated with rate of habituation represented alternate indices of a "more fundamental underlying dimension called electrodermal lability."

There appears to be a very stable relationship between habituation and spontaneous fluctuations, which may be taken as a measure of arousal level. The Berggren et al. study (1979) lends support to this hypothesis even though it was not

intended to explore the relationship. Their internal locus of control subjects showed a trend toward a greater number of spontaneous fluctuations in the signal condition, where they habituated more slowly, than they showed in the nonsignal condition. Conversely, their external locus of control subjects showed no significant difference in the number of spontaneous fluctuations between the two conditions.

Siddle, O'Gorman, and Wood (1979) examined the effects of electrodermal lability and stimulus significance (stimulus change from a tone-light compound to tone alone) on the amplitude of the skin conductance response (SCR) component of the orienting response (OR) to stimulus change. The subjects were pre-selected in terms of the frequency of nonspecific responses (NSR) exhibited during a period of no stimulation (measuring lability-stability). The results indicated that in subjects with a high rate of nonspecific responses (labiles), stimulus change alone rather than stimulus significance was sufficient to produce an increase in skin conductance levels, suggesting that stimulus significance had no effect on NSRs. Siddle et al. suggest that stimulus significance adds to stimulus change in determing OR strength.

Conclusions

Summarizing the current state of knowledge where discrepancies in the literature indicate a host of methodological differences, it nevertheless seems clear that both

psychological and physiological differences exist between internal and external locus of control individuals. These differences include, to a greater or lesser degree, level of motivation, stress coping, and habituation of the orienting response. And, while it would seem that physiological responsivity varies with gender, it is not clear whether or not that difference is related to locus of control characteristics. While many studies have been done on locus of control and on physiological responsivity, none seem to have specifically addressed the issue of whether or not locus of control, physiological responsivity, and gender are related.

In light of the different foci of the various studies on locus of control and physiological responsivity, it seems appropriate to re-examine this subject. One of the first areas which merits examination is the question of just how to go about determining an individual's locus of control. As previously mentioned, first Phares and then James, both in 1957, developed the first scales for measuring internality-externality. These led to the later development of what has come to be known as the Rotter I-E Scale (Rotter, 1966). Although it was not the only scale extant at the time which attempted to measure an individual's locus of control, the Rotter I-E Scale gained widespread acceptance and was used in a vast quantity of research dealing with locus of control.

As the body of research grew, questions arose about the appropriateness of Rotter's I-E Scale. A major criticism is that Rotter's I-E Scale assumes a unidimensional construct to locus of control. Factor analytic studies of the scale generally have shown control beliefs to be multidimensional rather than unidimensional (Gurin, Gurin & Morrison, 1978). The scale has also been criticized for its relationship with social desirability and its difficult reading level (Finch, Spirito, Kendall & Mikulka, 1981).

Because of these various criticisms, a number of efforts have been made to develop alternatives to the Rotter I-E Scale. These include the North Carolina Internal-External Scale Short Form (Schopler, Langmeyer, Stokols & Reisman, 1973), Levenson's IPC Scale (Levenson, 1974), and the Adult Nowicki-Strickland Locus of Control Scale (Nowicki & Duke, 1974). Rotter has given a qualified endorsement to efforts to develop new scales, even while cautioning researchers about several possible pitfalls (Rotter, 1975). One of his cautions was to avoid thinking in terms of a typology for locus of control. Noting that the mean score of his I-E Scale had risen from eight when it was first developed to somewhere between 10 and 12 in 1975, always with a normal distribution of scores, he pointed out that some subjects who were considered externals in early samples could by 1975 be considered internals, even without changing any of their answers (Rotter, 1975). It seems clear that locus of control

should be thought of as a continuum, going from extreme internals, through weak internals, indeterminates, and weak externals, to extreme externals, rather than as an either/or typology.

For this study, the Levenson IPC Scale has been chosen as the tool for assessing internality-externality. The Levenson IPC Scale was chosen because, in contrast to some other scales, it does not assume locus of control to be a unidimensional construct; rather, it assumes locus of control to be multidimensional. Further, it recognizes that locus of control is not a starkly defined typology, and permits evaluation of where on the internal-external continuum an individual lies.

The Levenson IPC Scale was derived from several items adapted from Rotter's I-E Scale (Rotter, 1966), and is intended to measure three independent dimensions with three separate scales. It has had its factor structure confirmed by a subsequent independent study by Lindbloom and Faw (1982). They analyzed the Rotter I-E Scale (Rotter, 1966), the Adult Nowicki-Strickland Locus of Control Scale (Nowicki & Duke, 1974), and the Levenson IPC Scale to examine the factor structures of the Levenson IPC Scale and to examine the construct validity of the Levenson IPC factors. Lindbloom and Faw concluded that the analysis revealed a factor structure essentially the same as that originally reported by Levenson. The Rotter IE and the Levenson C scales correlated .61, and

the Rotter IE and the Levenson P scales correlated .30. However, no correlation was found between the Rotter IE scale and the Levenson I scale, suggesting that the Rotter IE scale does not necessarily reflect internality of control. Thus, Lindbloom and Faw concluded that the factor structure of the Levenson IP Scale is reliable.

With that in mind, it was the purpose of this study to explore the relationship between the personality characteristics of locus of control, physiological responsivity, and gender. It has already been strongly suggested by a number of previous studies that physiological responsivity differs between internal locus of control individuals and external locus of control individuals. However, these previous studies have usually examined this difference only in male subjects; the present study used both males and females as subjects to determine whether or not the previously reported difference in physiological responsivity is consistent across gender lines. This study used both heart rate and electrodermal activity as indicators of physiological responsivity. Realizing that the dimension of electrodermal lability (Crider & Lunn, 1971) could possibly confound the results, this trait was measured and entered into a multivariate regression analysis as a potential predictor variable.

Method

Subjects

Thirty-six males and thirty-six female subjects between the ages of 18 and 45 years old were recruited by means of an advertisement placed at Old Dominion University. The mean age for male subjects was 24.6 years (range 18-45), while the mean age for female subjects was 25.8 years (range 18-43). The subjects who volunteered were either given extra credit in psychology courses or were paid a minimal fee of $4.00 to compensate them partially for the expense and inconvenience of participating in the study. Each subject's cardiovascular status and caffeine intake were determined by self-report and questioning by the experimenter.

Materials and Apparatus

The Levenson IPC questionnaire (Levenson, 1974) was given to each subject to assess the degree of internal or external locus of control characteristics. The questionnaire, as given to the subjects, is shown in Appendix A. The Levenson IPC questionnaire consists of three separate scales; they being the Internal (I) scale, the Powerful Others (P) scale, and the Chance (C) scale. Each scale consists of eight items in

Likert format, giving a possible range of scores from 8 to 48 on each scale. The eight items of each scale are combined in a random order into a single 24 item questionnaire. The subdivision of the individual items from the full questionnaire into the three specific scales is shown in Appendix B. Specific procedures for administering and scoring the Levenson IPC Scale are given in Appendix C.

Physiological Measurements

The experiment was conducted with the subjects sitting upright in a comfortable chair. The recording equipment (electrodermal activity and heart rate monitors, tone generator, computer, etc.) was located in a separate room in order to ensure that each subject was not distracted or intimidated by the testing equipment. Two physiological variables were measured: heart rate (heartbeats per minute) and skin conductance. Heart rate was determined from a heart rate monitor with a clip-on photoelectric cell which was placed on the middle finger of each subject's left hand. Skin conductance was recorded using a Coulbourn Instrument Skin Conductance amplifier (Model S71). Skin conductance was recorded using Microlyte electrolyte gel and two Silver-Silver Chloride (Ag/AgCl) electrodes attached to the hypothenar eminence of the subject's left hand.

Experimental Tasks

Lability-Stability

Lability-stability was defined by the tabulation of electrodermal responses greater than or equal to .02 μmhos (spontaneous fluctuations). Spontaneous fluctuations were recorded during both the ten minutes of the rest period and during the orienting response task. The greater the number of responses in absolute terms above or equal to .02 μmhos, the more labile the subject, and the smaller the number of responses above or equal to .02 μmhos, the less labile the subject was.

The Orienting Response

The orienting response (OR) is an increase in attention to a novel or significant stimulus. The present study delivered a single two second duration, 85dB, 1000HZ tone (stimulation period) through a speaker while electrodermal activity was monitored. The purpose of this task, as described in Siddle, O'Gorman and Wood (1979), is to determine whether a subject demonstrates the characteristic of lability-stability. Following the procedures of Siddle, O'Gorman and Wood (1979), the electrodermal activity was analyzed for the amplitude of the response which occurred immediately (1-4 second latency) after the tone was presented. The greater the amplitude of the response, the more labile the subject was assumed to be. Thus, for each subject two measures of lability

were determined: 1) by the number of spontaneous fluctuations of electrodermal activity (EDA) during a ten minute rest period, and 2) by the amplitude of electrodermal activity to the orienting stimulus.

Arithmetic Task

The arithmetic task was based on the procedure used by Carroll, Turner, and Hellawell (1986). The mental arithmetic problems used by Carroll et al. were presented to each subject on audio tape in two minute segments with a two minute rest period between each level of the task. There were three levels of difficulty in the arithmetic task: easy, moderate, and difficult (see Appendix D). One level of difficulty was presented within each two minute task. Within each two minute task there were 12 trials which lasted ten seconds each. Of these ten seconds, six seconds were used to present the problem, and after two seconds the subject heard an answer given on the audio tape. During the last two seconds the subject had to decide if the given answer was correct or incorrect, and then respond "right" or "wrong" as appropriate. Each subject was told that the absence of response was recorded as an error.

Procedures

Those individuals who answered the advertisement for subjects were asked to refrain from smoking, drinking

alcoholic beverages, taking medication, or taking caffeinated substances two hours prior to participating in the experiment. All testing was performed between the hours of 10:00 a.m. and 5:00 p.m. Each subject was tested individually. Upon arrival, each subject was comfortably seated in a quiet room and was informed of the general purpose and basic procedures of the experiment. After he/she agreed to participate, he/she was asked to complete an informed consent form. Then each subject was asked to complete the Levenson IPC Questionnaire, which took approximately five minutes.

Once the questionnaire was completed, the subject had two Silver-Silver Chloride (Ag/AgCl) electrodes filled with microlyte gel attached to the hypothenar eminence of their left hand and a clip-on photoelectric cell placed on the middle finger of their left hand. Each subject was then asked to take a deep breath to assess skin conductance reactivity (SCR) and proper equipment function. Prior to the initial instruction period, the subject's baseline skin conductance level (SCL) was taken, and the proper functioning of the heart rate monitor was ensured. Once the baseline SCL was recorded, continuous measurement of SCR was recorded until the end of the experiment. Next commenced a ten minute rest period in which the initial instructions were as follows:

> "Please make yourself as comfortable as possible; try to refrain from excessive movement, talking, or even falling asleep. You are not required to do anything for ten minutes except relax. At the end of the ten minutes, you will hear a tone, but again

you are not required to do anything. After this ten minute period, we will come back into the room to explain to you the next phase of the experiment."

During the orienting response task, heart rate and electrodermal activity were continuously monitored. Lability assessment was initiated by the introduction of a single two second long 85dB, 1000HZ tone into the speaker adjacent to the subject. At the completion of the orienting response task, the subjects were allowed to relax for a five minute period to allow their heart rate and electrodermal activity to return to baseline. The subjects were then given the following instructions on the arithmetic task:

"Very good. Relax. Now you will hear on the tape 12 arithmetic problems and their answers. I want you to listen carefully, and if you think that the answer given is correct, just say 'right,' and if you feel that the answer given is incorrect, just say 'wrong.' There will be a two minute rest period between the three tapes, and each tape will have 12 problems each."

Each subject completed the easy, moderate, and difficult arithmetic problems. The order of presentation of the easy, moderate, and difficult problems was counterbalanced between subjects, and only one level of difficulty was presented in each task period. After the last task was completed for each subject, the electrodes and photoelectric cell were removed. The subject was then debriefed as to the purpose of the study, paid the fee of $4.00 (for 30 minutes of experimental work), or given extra psychology credit, and thanked for his/her participation.

Quantification of Physiological Data

Each EDA trace record was scored by hand. Subjects who failed to provide at least a 0.100 μmhos response to the deep breath stimulus were not used in the analysis. Sixty-one of the 72 subjects met these criteria and were used in the analysis. Only responses with a latency of one to four seconds after stimulus onset were considered in the analysis of the orienting response.

An average baseline HR measure (taken after ten minutes of rest and over a one minute period) for each subject along with an average task HR measure during the arithmetic task (taken immediately upon completion of the two minute task also over a one minute period) was determined. Heart rate differences from the mean baseline in BPM (beats per minute) for each level of difficulty of the arithmetic task were also computed.

Design and Analysis

Correlations and multiple regression analyses were used to assess the relationship between the three subscales of locus of control, gender, lability-stability, and orienting response task as predictor variables and electrodermal activity, heart rate, and performance during each task as criterion variables. As a reliability check on task difficulty, a three-way (easy, moderate, and difficult tasks) within group analysis of variance was carried out on the

performance data. Analyses of variance of the heart rate and EDA data with gender and level of difficulty as the independent measure were performed. An ANOVA was also performed on task performance as a function of difficulty level and gender.

Results

Personality Scales

The sample of this study differed significantly from the sample of students used by Levenson (1974) in the means of the I, the P, and the C scales for both males and females combined (t_i=3.41 p<.05; t_p=6.6 p<.05; t_c=5.65 p<.05) (see Table 1). However, it is not clear as to the reasons why the sample of this study should evidence this characteristic. The norms as reported by Levenson for college students are 35.5 (SD=+/-6.3) for the I scale, 16.1 (SD=+/-7.6) for the P scale, and 13.9 (SD=+/-8.4) for the C scale.

Physiological Measures

Lability-Stability and the Orienting Response

The mean number of spontaneous skin conductance responses equal to or greater than .02 μmhos in the ten minute rest period for determination of Lability-Stability (LS) was 21.77

TABLE 1

MEAN SCORES FOR THE INTERNAL (I), POWERFUL OTHERS (P), AND CHANCE (C) SCALES FOR BOTH MALES AND FEMALES

	MALES			FEMALES		
	I	P	C	I	P	C
MEAN SCORE	38.26	23.00	19.77	38.55	21.97	20.64
SD	5.82	5.83	5.48	4.68	5.82	7.46
RANGE	20-47	10-34	8-35	25-45	10-37	8-41

responses (SD=19.82) for males and 14.84 responses (SD=16.46) for females. A t-test of difference between means for males and females on the LS variable showed them to be significantly different: $t(59)=4.95$, $p<.05$. The mean response for the Orienting Response (OR) task was .82 μmhos (SD=.77) for males and .59 (SD=.61) for females (see Figure 1). A test of difference between means for the OR variable for males and females was performed and was not significant: $t(59)=1.31$, $p>.05$.

Problem-solving Task

Performance

A simple analysis of variance was done on the performance scores (percent correct) across the three levels of difficulty of the arithmetic task. A significant effect was found across the three levels of activity, $F(2,60)=105.22$, $p<.05$ (see Table 2). The means of correct responses (performance) in the three levels of difficulty of the arithmetic task for males and females can be seen in Figure 2.

A Newman-Keuls post-hoc test was performed on the three levels of difficulty. It was found that performance on the difficult task was significantly poorer than on the other two tasks, which did not differ from one another, $F(5,180)=18.42$, $p<.05$ (see Table 3).

TABLE 2

SOURCES OF VARIATIONS FOR PERFORMANCE OF THE THREE LEVELS OF DIFFICULTY OF THE ARITHMETIC TASK FOR ALL SUBJECTS

SOURCE	df	SS	F	P>F
Difficulty Level	2	349.4207	105.22**	.0001
Error	61	163.0819		

**$p<.0001$

TABLE 3

NEWMAN KEULS POST-HOC TEST FOR THE THREE LEVELS OF DIFFICULTY OF THE ARITHMETIC TASK

GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6
Mean Female Cond.	Mean Male Cond.	Mean Female Cond.	Mean Male Cond.	Mean Female Cond.	Mean Male Cond.
3	3	2	2	1	1
8.19	9.13	10.55	11.27	11.97	11.94

$F(5,180)=18.42$, $p<.05$

Physiological Measures

Heart Rate

A 2 X 3 X 2 (gender X level of difficulty X baseline HR vs task HR) analysis of variance was performed on the heart rate. There was a significant difference only between baseline heart rate and task heart rate, $F(1,60)=32.79$, $p<.0001$; no gender based difference was found between baseline heart rate and task heart rate. Table 4 shows the sources of variations for the ANOVA performed.

The mean baseline heart rate (HRB) for all subjects (both males and females) immediately prior to task performance was 80.7 for the easy level of difficulty, 81.5 for the moderate level of difficulty, and 81.3 for the most difficult level of difficulty. The mean task heart rate (HRT) for all subjects (both males and females) on the three levels of difficulty of the arithmetic task (Easy 1, Moderate 2, and Difficult 3) was 85.0, 87.0, and 86.2 respectively (see Figure 3). The means of the heart rate difference between baseline heart rate and the task heart rate for the three levels of difficulty (D1, D2, D3) are summarized in Table 5 (also see Figure 4).

Electrodermal Activity

A 2 X 3 (gender X level of difficulty) analysis of variance was performed on EDA. There was a main effect on skin conductance for the level of difficulty, $F(2,60)=5.02$, $p<.008$. No significant effects for gender or for the gender

TABLE 4

SOURCES OF VARIATIONS FOR THE 2 X 3 X 2

(GENDER x LEVEL OF DIFFICULTY x HEART RATE REACTIVITY) ANOVA

Source	DF	SS	F	p
SEX	1	1566.8747	2.78	.1005
BT	1	1839.2173	32.79**	.0001
LEV	2	164.8962	1.67	.1933
SEX*BT	1	2.0729	.04	.8482
SEX*LEV	2	30.3620	.31	.7364
BT*LEV	2	27.1782	.46	.6294
SEX*BT*LEV	59	61.8436	1.06	.3506
S*LEV(SEX)	118	5838.1516		
S*LEV*BT(SEX)	118	3450.2655		
S(SEX)	59	33209.6279		
S*BT(SEX)	59	3309.7849		

**p<.0001

TABLE 5

MEANS OF THE HEART RATE DIFFERENCE BETWEEN BASELINE HR AND TASK HR (D1, D2, D3)

	DIFFICULTY LEVEL		
	EASY	MODERATE	DIFFICULT
MALES	7.2	2.3	3.6
FEMALES	6.4	4.2	5.1

X level of interaction were found. Table 6 shows the sources of variance of the ANOVA performed.

The mean response (in micromhos) for the skin conductance responses (SC) for all subjects (both males and females) over the three levels of difficulty of the arithmetic task was .3057 μmhos (SD=.29) for the easy level of difficulty, .3818 μmhos (SD=.28) for the moderate level of difficulty, and .4421 μmhos (SD=.26) for the difficult level of difficulty (see Figure 5).

Correlations and Multiple Regression Analyses

Intercorrelations were performed on the IPC scales, LS, OR, HR, and SC variables. Inverse relationships were found between both the I and C scales and the LS variable. That is, the more internal the subject, the less responsive in electrodermal activity ($r=-.3591$, $p<.05$), suggesting that externals are more reactive to external events; in other words, the more a subject believed on chance, the more responsive in electrodermal activity ($r=.2923$, $p<.05$). Strong correlations were found between the OR and LS variables ($r=.5723$, $p<.01$) and between the P and C scales ($r=.4967$, $p<.01$). Skin conductance during the arithmetic task (SCs) was also strongly correlated to the OR ($r[SC1]=.4743$, $p<.01$; $r[SC2]=.3587$, $p<.01$; $r[SC3]=.5281$, $p<.01$) (see Table 7).

Multiple regression analyses were performed using the three subscales of Locus of Control (I, P, and C), OR, LS, and

TABLE 6

SOURCES OF VARIATIONS FOR THE 2 X 3

(GENDER X LEVEL OF DIFFICULTY) ANOVA ON EDA

SEX	1	.0012	.01	.9317
LEV	2	.3158	5.02**	.0081
SEX*LEV	2	.0277	.44	.6442
S*LEV(SEX)	118	3.7149		
S(SEX)	59	9.9780		

**p<.01

TABLE 7

CORRELATIONS

	OR	I	P	C	LS	D1	D2	D3	SC1	SC2	SC3
OR	1.0000										
I	-0.0068	1.0000									
P	0.0271	-0.2952	1.0000								
C	0.0495	-0.5035**	0.4967**	1.0000							
LS	0.5723**	-0.3591*	0.2024	0.2923*	1.0000						
D1	-0.0592	-0.1763	0.0776	-0.0438	-0.0375	1.0000					
D2	-0.0394	0.1882	-0.1552	-0.2118	-0.0522	0.3594*	1.0000				
D3	-0.1304	0.0222	-0.1820	-0.0881	-0.1037	0.2219	0.3802	1.0000			
SC1	0.4743**	0.1346	-0.1165	-0.1950	0.0705	-0.1685	-0.0718	-0.2528	1.0000		
SC2	0.3587**	0.0360	0.0135	-0.1471	0.0774	-0.0630	-0.1632	-0.3171	0.6637**	1.0000	
SC3	0.5281**	-0.0751	0.1085	0.0227	0.1502	-0.0153	-0.2284	-0.1589	0.5859**	0.5264**	1.0000

* $p < .05$
** $p < .01$

gender as predictor variables to determine their relationship to heart rate reactivity (HR) and Electrodermal Activity (EDA) during the main task performance. The six criterion variables comprised three measures of heart rate (differences between baseline HR and task HR) on each of the three levels of difficulty of the arithmetic task and three measures of electrodermal activity for task EDA.

All the predictor variables (I, P, C, OR, LS, gender) failed to account for a significant proportion of the total variance in any of the three outcome measures of heart rate reactivity. The predictor variables I, P, C, and gender failed to account for a significant proportion of the total variance for the three outcome measures of electrodermal activity. The predictor variable OR accounted for a significant proportion of the total variance for each of the three outcome measures of electrodermal activity. The OR task in the SC1 condition revealed an adjusted R^2=.2250; for OR and SC2, adjusted R^2=.1287; and for OR and SC3, R^2=.2790. The predictor variable LS also accounted for a significant proportion of the total variance for two of the outcome measures of electrodermal activity. The LS variable in the SC1 condition showed an adjusted R^2=.0406; for LS and SC3, R^2=.0344 (LS and SC2 did not meet the significance level necessary for analysis).

Discussion

The major hypothesis of the present study was that gender and locus of control would affect heart rate reactivity and electrodermal activity during an arithmetic task comprising three levels of difficulty (easy, moderate, high). The reason this research used three levels of difficulty on the arithmetic task was to examine the effect of different levels of task induced stress as a possible moderating variable on heart rate and electrodermal activity. This study, unlike Lobstein et al. (1979) and Berggren et al. (1977), found significant differences between males and females in physiological responsivity. For example, males were found to be more labile than females. Also, in partial support of the major hypothesis, scores on the I and C scales were found to be inversely related to the LS physiological measures of EDA. The hypothesis relating heart rate reactivity to locus of control was not supported.

There are several possible reasons for the failure of this study to show differences between males and females in heart rate reactivity. Although the subjects were "randomly" selected, the sample contained primarily internal locus of control and college educated individuals. The sample comprised 49 college educated and 12 noncollege educated. The only three extreme external subjects were noncollege educated.

Possibly, the results would have differed had the sample been larger and included more external and/or noncollege educated subjects.

Additionally, in this study, the three subjects who scored on the external end of the continuum (scores of 20, 25, and 26 on the Internal scale) also showed a great deal more spontaneous fluctuations (75, 59, and 46; range of number of spontaneous fluctuations for males was 1-75; range of number of spontaneous fluctuations for females was 1-46; with M=18.31 fluctuations over ten minutes for all subjects). Although the sample was too small to allow drawing any conclusions, this noted tendency for external subjects to exhibit more spontaneous fluctuations than internal subjects is similar to the results of the Berggren et al. (1977) study discussed earlier.

In the present study, the I scale contributed to a very small proportion of the variance $R^2=.0284$ in electrodermal activity (EDA), but not in heart rate reactivity (HR). The P and C scales, however, did not account for any of the variance of either EDA or HR. Variations in heart rate reactivity and electrodermal activity during the arithmetic task were expected to be related to gender and locus of control. However, as in the Berggren et al. (1977) and Lobstein et al. (1979) studies, no relationship was found.

With regard to the Lability-Stability variable (LS) as measured by electrodermal activity, the present study proposed, as did Lobstein et al. and Berggren et al., that females would be less reactive than males and have significantly fewer spontaneous fluctuations than males. This also was found to be the case in this study.

Heart rate increased from baseline to task across all subjects, but no gender based differences were observed. These results contradict Stoney, Davis, and Matthews' (1977) research which found that females displayed higher heart rate increases during challenging situations; however, the results are in agreement with those of Lobstein et al. which did not find significant differences between males and females in physiological responsivity. Again, the reason for this lack of consistency across studies is not clear. Perhaps physiological responsivity is too unstable a phenomenon to be used for generalizations between the sexes.

This study did not support the prediction that locus of control affects the physiological response of heart rate reactivity. These results are contrary to prior studies which have demonstrated that internals controlled their cardiac responsivity better than externals (Logsdon, Bourgeois & Levenson, 1978; Schneider, Sobol, Herman & Cousins, 1978; Frankenhauser, 1983; Krause & Stryker, 1984).

The fact that this study did not find significant differences in heart rate reactivity during task completion

in internals may be due to a phenomenon found by Johnson and Thorn (1984). These researchers hypothesized that their study did not find significant results because they had more task completion sessions than the above mentioned studies. That is, the greater the number of tasks, the less heart rate responses and locus of control were correlated, suggesting the possibility that experience may have influenced the results. Similarly, the present study comprised a higher number of task completion sessions than did the majority of the preceding studies; therefore, it is plausible that there may have been a learning effect which influenced the current results. The fact that physiological responses increased (HR, EDA) on the first task regardless of the difficulty level suggests the possibility of initial anxiety, followed by an habituation effect. This anxiety would tend to mask any task difficulty effect.

In this study, performance, as expected, varied with difficulty level of the arithmetic task, but did not vary as a function of gender. Females did make more errors on the high difficulty level of the arithmetic task than males (68.28% of correct responses for females versus 76.11% of correct responses for males), but this difference was not significant. However, both males and females showed the pattern of responding found by Johnson and Thorn (1984); that is, physiological responses increased at the beginning of the experiment and decreased with experience.

In conclusion, the concept of gender difference in physiological responses and personality characteristics such as locus of control does seem to merit further investigation. Although the findings of inverse relationships between the I and C scales and the electrodermal responses during a task were not affected by gender, it is possible that a larger, more widely based sample could yield different results. Future researchers should ensure that their sample includes an equivalent number of external and internal subjects. Also, considerations should be given to ensuring the subjects reflect a cross-section of social and educational strata to better represent the population at large. The employment of a design which minimizes the expected impact of any possible habituation effect as evidenced in this study and others mentioned in the text should also be considered.

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Figure Caption

Figure 1. Mean responses in μmhos for the Orienting Response task (OR) for males and females and the number of responses equal to or greater than .02μmhos in the ten minute rest period (LS)

ORIENTING RESPONSE (OR)

AND

LABILITY/STABILITY (LS)

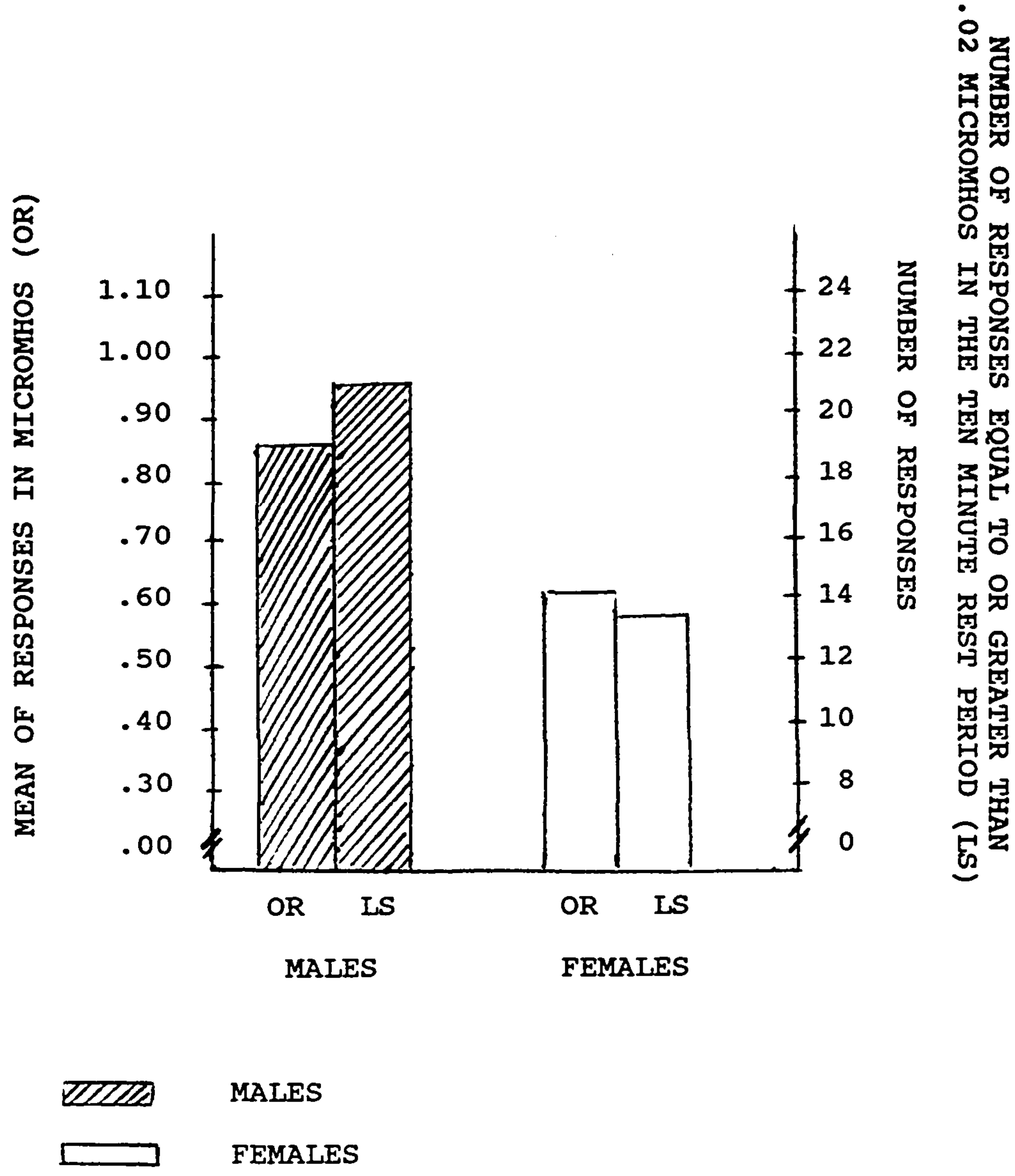


Figure 2. Means of correct responses (performance) in the three levels of difficulty of the arithmetic task for males and females

PERFORMANCE
MEANS OF CORRECT RESPONSES IN THE THREE LEVELS OF DIFFICULTY OF THE ARITHMETIC TASK FOR MALES AND FEMALES

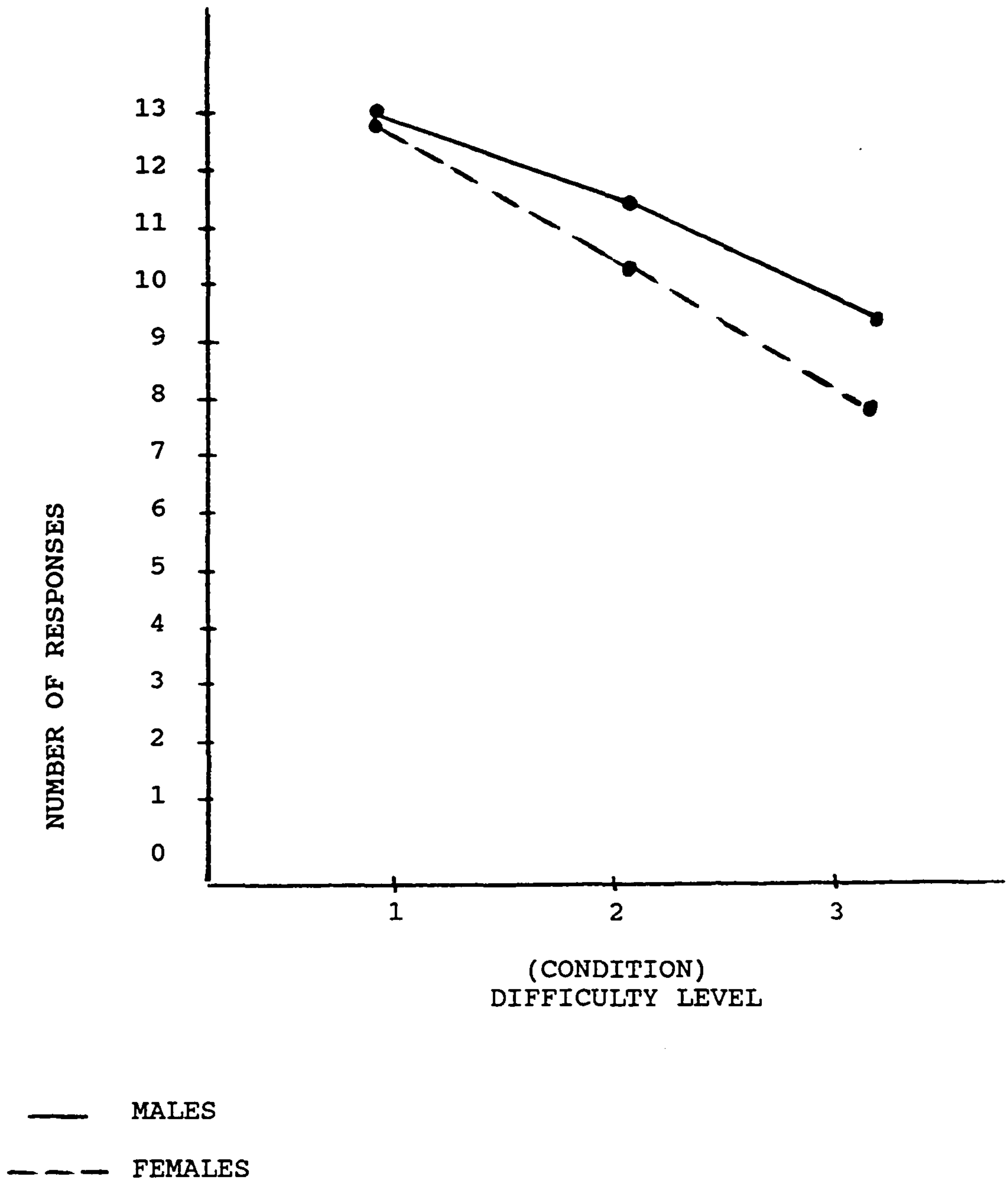


Figure 3. Average heart rate responses for baseline and task in the three levels of difficulty of the arithmetic task for all subjects

AVERAGE BASELINE AND TASK HEART RATE
FOR ALL SUBJECTS

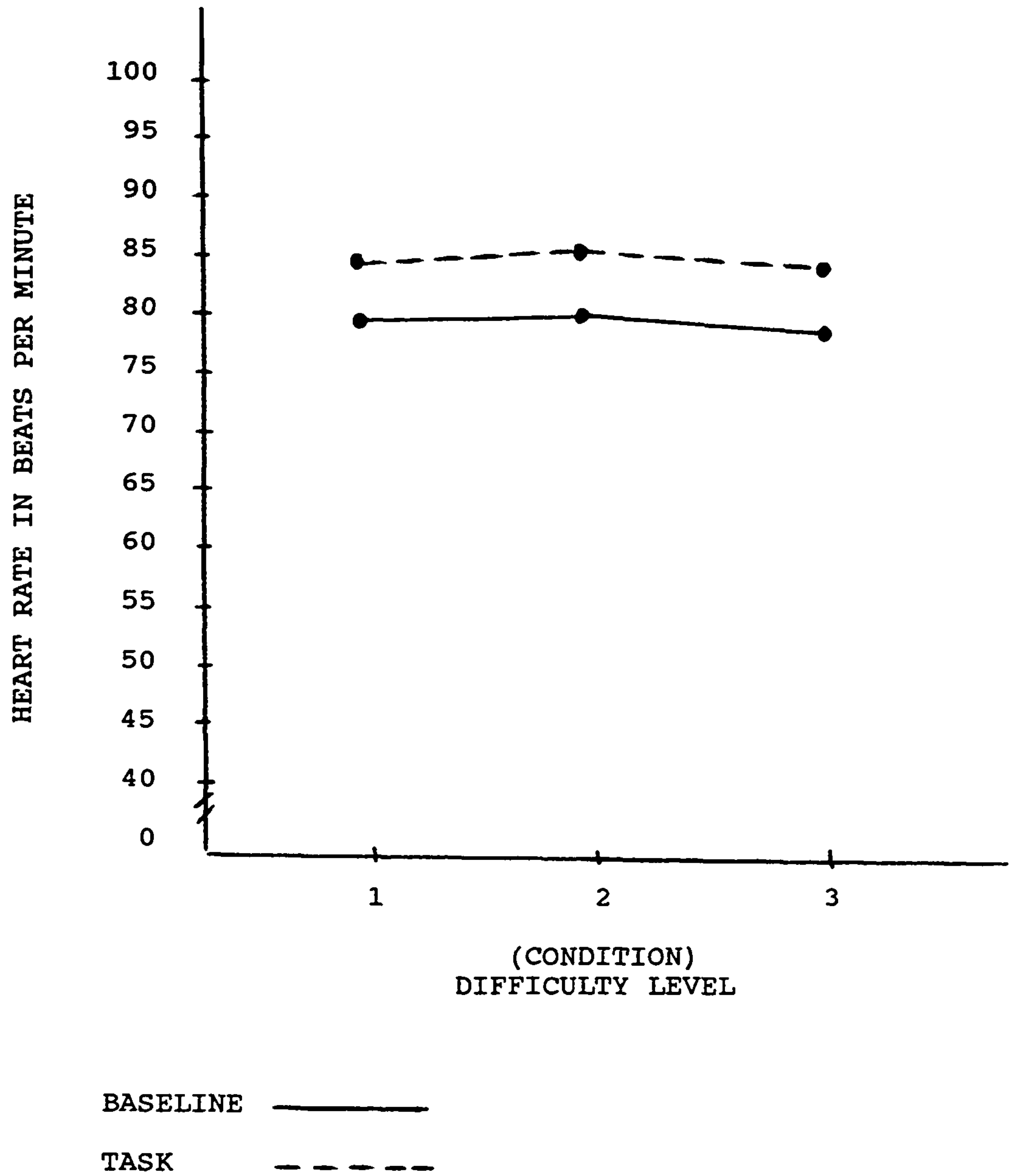


Figure 4. Difference in heart rate between the baseline and the three levels of difficulty of the arithmetic task for males and females (D1, D2, D3)

HEART RATE DIFFERENCE BETWEEN BASELINE AND
TASK DIFFICULTY LEVEL FOR MALES
AND FEMALES
(D1, D2, D3)

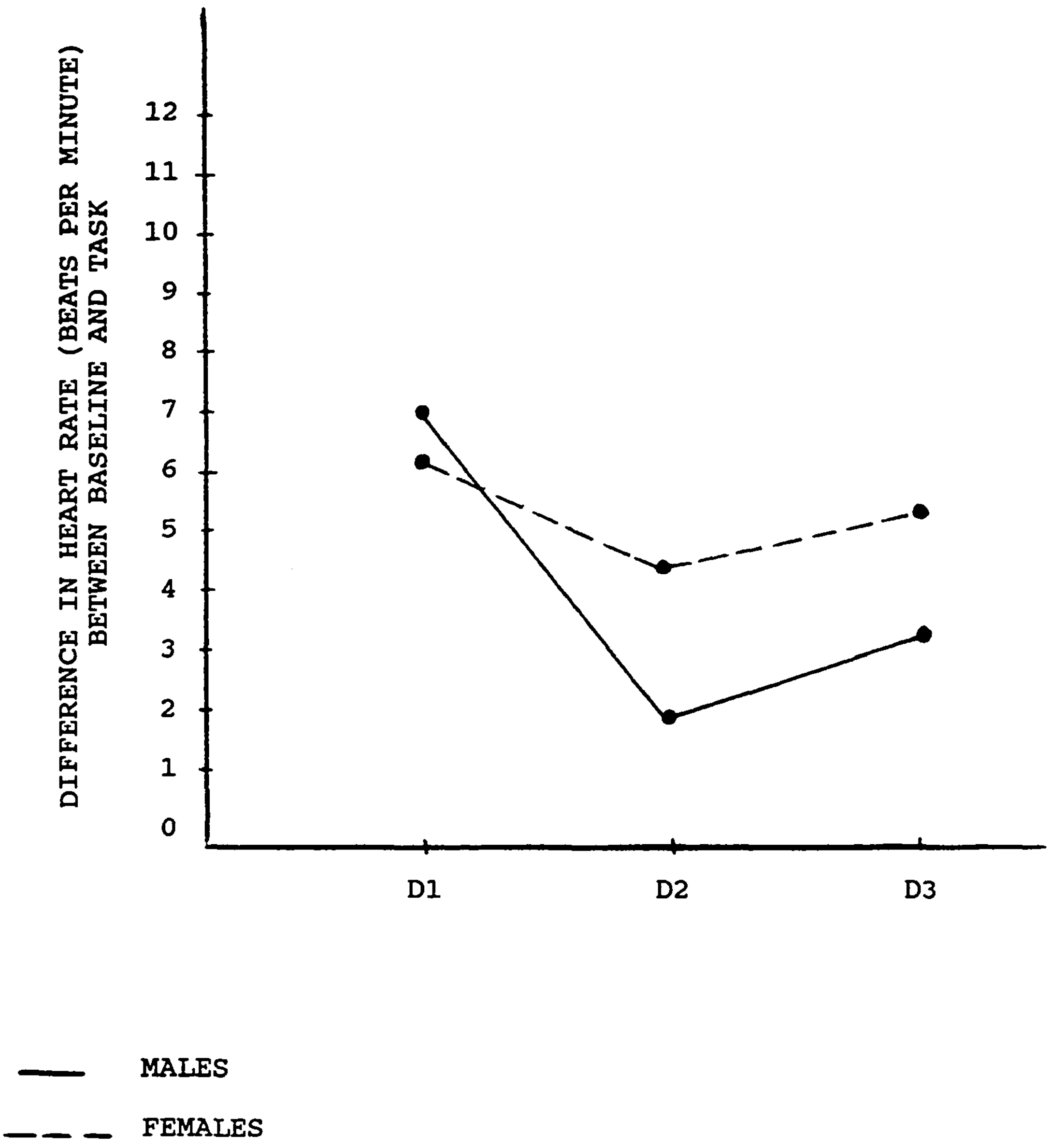
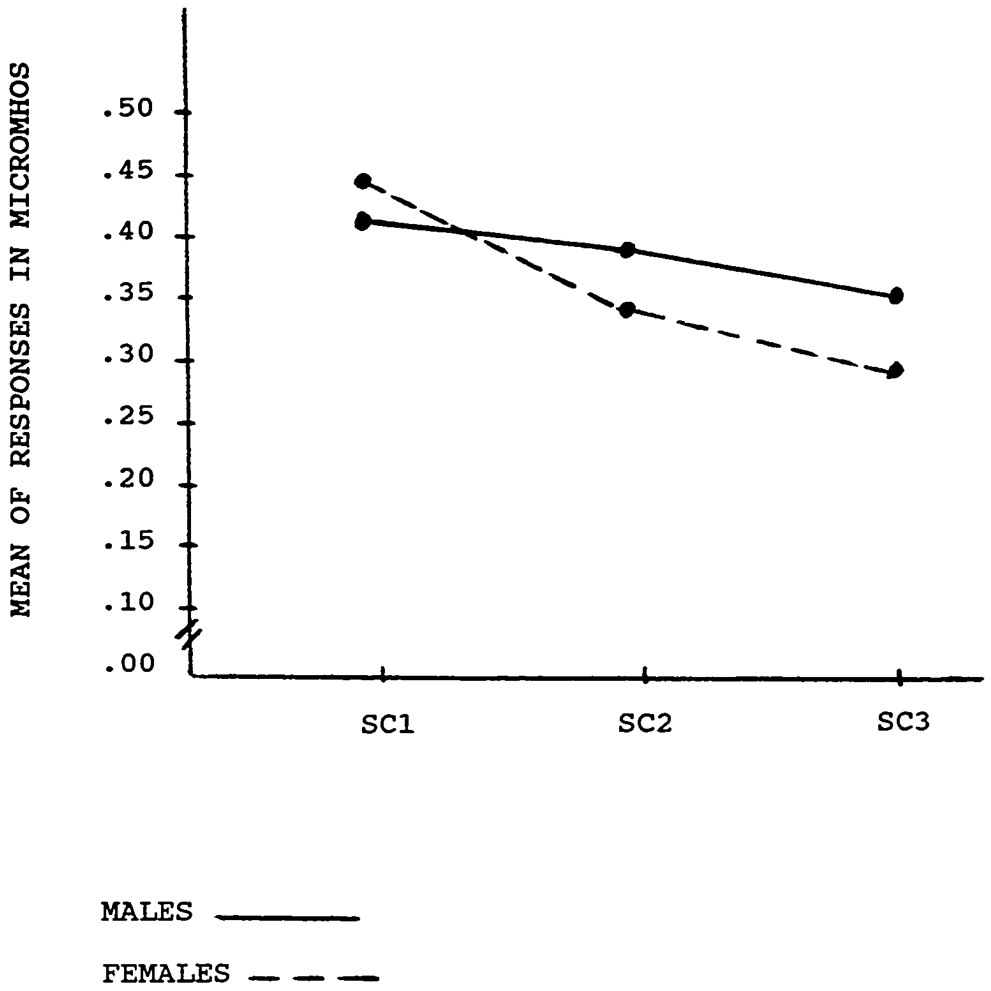


Figure 5. Mean of responses in micromhos for the skin conductance responses (SC1, SC2, SC3) of the three levels of difficulty of the arithmetic task for males and females

SKIN CONDUCTANCE FOR THE THREE LEVELS OF
DIFFICULTY OF THE ARITHMETIC TASK
FOR MALES AND FEMALES
(SC1, SC2, SC3)



APPENDIX A

PLEASE NOTE:

Copyrighted materials in this document have not been filmed at the request of the author. They are available for consultation, however, in the author's university library.

These consist of pages:

60-61,	Questionnaire
63-64,	Internal, Powerful Others, and Chance Locus of Control Scale Items
66-68,	Scoring the Levenson IPC Scale

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APPENDIX B

APPENDIX C

APPENDIX D

ARITHMETIC TASK WITH CORRECT AND INCORRECT PROBLEMS FOR EACH TASK LEVEL

	EASY	MODERATE	DIFFICULT
1.	7-3=4	31-14=16(w)	901+849=1740(w)
2.	8-2=4(w)	80-58=22	768+536=1304
3.	3+6=9	15+11=27(w)	645+659=1310
4.	8+2=9(w)	35+42=77	259-102=161(w)
5.	3-0=2(w)	88-85=3	428+280=700(w)
6.	1-1=0	95+51=144(w)	647+646=1293
7.	8-6=2	57+97=154	194-179=16(w)
8.	9-6=2(w)	95-45=50	590-207=393(w)
9.	2+8=11(w)	81-72=9	969-570=381(w)
10.	6-2=4	53+40=93	291+700=991
11.	3+3=9(w)	66-45=31(w)	615-505=120(w)
12.	6-5=1	83+95=178	666-174=493(w)

*(w) denotes a wrong answer.