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Autonomic Responses of Normals and Depressives to Stress Inducing Stimuli

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Autonomic Responses of Normals and Depressives to Stress Inducing Stimuli

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ABSTRACT

A group of depressed (N=10) and a group of normal (N=10) were presented a series of stressor stimuli to assess several parameters of their physiological responses to these stimuli. The results indicated that the groups did not differ in their relative tendency to show maximal response specificity (consistently responding to stress with a maximum response in the same channel) or pattern stereotypy (the tendency to respond consistently in all physiological channels relative to each other). A multivariate analysis of variance (MANOVA), of the levels of the physiological channels under conditions of rest, anticipation, and stress revealed a significant group effect. Univariate analyses of variance (ANOVA) resulted in significant group effects for skin conductance and heart rate variability. Stepwise regression and discriminant analysis procedures revealed skin conductance as the best single variable predictor of group membership. The inclusion of heart rate variability added little discriminating power.

The results contradict suggestions made by various authors that normal and pathological groups differ along the consistency of their physiological responses. The depressed group was not more disorganized than the normal group in their physiological responses to repeated stress. Group differences were found, however, in tower levels of skin conductance and heart rate variability. The results of this study indicate that the psychophysiological assessment of depression is best approached from a longitudinal perspective examining changes in tower levels of specific physiological channels.

Introduction

Stress and Physiology

The word "stress" is becoming increasingly familiar to those who follow the literature of psychology and medicine. Numerous studies have been conducted linking "stress" to various forms of psychophysiological dysfunction, disease, mental disorders, and socially pathological behavior (Moos, 1976). Despite this great amount of attention, however, "stress" remains a very vague and ambiguous concept, frequently adopted and utilized without definition or clarification. In addition, stress has often been defined in a very narrow and circumscribed manner with various definitions being mutually exclusive; at other times, an author will define stress in its broadest possible terms and fail to make explicit its particular use in the study at hand (Levine and Scotch, 1970). Even when defined, stress has been used to designate different dimensions of processes. For example, it has often been used to refer to environmental stimuli that tend to lead to changes within the organism. Examples of such a dimension have been sustained loud noise (Rosen, 1970), crowded conditions (Hall, 1966), or extremes of temperature (Patton, 1969). In other cases, it has been used to denote the physiological effect of stimulus input, such as an emotional state. Many authors have employed the word "stress" where others have used terms such as "anxiety," "conflict," "frustration," or "defense" to refer to the same phenomenon (Lazarus, 1966). A major reason for these discrepancies in definition is that the concept of stress have been employed by specialists with widely diveggent interests and who represent a broad range of disciplines such as psychology, psychiatry, sociology, physiology, anthropology, medicine, and engineering. These subject areas vary not only in their foci of interest and commonly employed methodologies, but also in the degree to which they are committed to operationalize the phenomenon they are investigating. Thus, the clarity of the concept of stress has become obscured through varying definitions of the phenomena.

Despite the numerous problems in its usage, stress has almost always been linked to some sort of emotional response on the part of an individual both in our vernacular language as well as in the research literature relating to theories of emotionality. The nature of this response, however, has also suffered from the inability of researchers to adequately define it. Such phrases as "the pallor of fear," "purple with rage," "butterflies in the stomach," and "stomach tied in knots" are common verbal descriptions of the effects of stress and emotion. Such phrases have been part of our language since long before the experimental study of emotion first undertaken by William James (Bindra, 1970). James (1890) linked the subjective experience of emotion (anger, fear, etc.) to perceptions of changes in the various organe innervated by the autonomic nervous system (ANS). He contended that this bodily reaction follows directly the perception by the individual of emotion provoking stimulus situations in a relatively automatic fashion. The "mental state" then follows and we "feel sorry because we cry." (Lange and James, 1922). This contention was later challenged by Cannon (1927), who argued that central processes, especially the thalamus, were involved in emotion as well as the peripheral responses. Cannon (1927) stated that the innervation of the autonomic nervous system as well as the production of emotional experience are controlled by subcortical centers which respond directly to sensory input. Despite the diminution of the importance of the peripheral process in Cannon's theory, he did note the importance of the sympathetic and parasympathetic divisions of the autonomic nervous system (ANS) in determining emotionality. Sympathetic excitation, the "fight or flight" reaction, was seen as a response to all emergency situations. The more placid emotions, on the other hand, were characterized by an inhibition of the sympathetic nervous system and a dis-inhibition of the parasympathetic nervous system. The theory, then, suggests that the level of ANS activity can possibly be employed as an index of emotion and that psychophysiological monitoring can prove valuable in assessing emotionality.

Lindsley (1951) conceptualized an emotional response as the mobilization of energy by the body. Extrapolating from electroencephalographic work, he proposed an "activation theory of emotion" which placed an emphasis on bodily arousal in explaining the emotional response. This approach focused attention on the sympathetic portion of the ANS and its function to produce arousal states. More recent work in arousal (Lacey, 1967; Routenberg, 1968) suggests that theories which subscribe to a simple one way (sympathetic) conceptualization of bodily response are incomplete. Lacey (1958; 1967) has demonstrated a "fractionation" of ANS subsystems in response to arousing stimuli. A single stimulus may produce some responses in a sympathetic direction while others may show a parasympathetic pattern. Heart rate, for example, may actually be lowered as a response to certain situations.

The approaches to emotionality discussed to this point have all centered on the physiological manifestations of emotion (commonly referred to as "stress") to the exclusion of the environmental situation or the individuals cognitive interpretation of his external field. More recent work by Schachter and Singer (1962) has implicated cognitions and the environment as being important in the variables emotional response. Working from a physiological view of emotionality similar to that of Lindsley, subjects in this investigation were injected with epinephrine which produced an overall state of autonomic arousal. The subjects were later found to label this undifferentiated physiological state as anger or joy depending on whether they were exposed to an anger or mirth situation these subjects also displayed the overt verbal and motor behavior consonant with the emotional (Wolfook, 1977). The subjective magnitude of the emotion was much less in the absence of the epinephrine injection, or when subjects were provided with accurate information which would allow them to attribute their state of arousal to the effects of the drug. According to Schachter (1964), two factors are necessary for the production of an emotional response: 1) an undifferentiated state of physiological arousal, and 2) the presence of cognitive labels which would direct the state of arousal and associated behavior along emotional lines.

Schachter and Singer's (1962) study served to highlight some of the problems investigations had encountered to date in their study of stress and emotionality. Most theories to this point had emphasized the physiological manifestations of emotion to the virtual exclusion of external events and the individual's cognitive interpretations of there events. These individuals while their physiology was the main focus of attention. This likely contributed to the fragmented picture in considering the literature on stress.

In summary, some researchers have viewed stress as the physiological/emotional response of an organism (Cannon, 1927; Lindsley, 1951). To others it has been represented by cognitive labels attached by most individuals to their physiology; and to still others, it is seen as a class of environmental events which produce aversive states in most organisms. It appears that none of these approaches can be mutually exclusive and that a more productive approach would be to consider overall "stress reactions" which include all three of the above categories in its formulation. Such an approach would provide a more accurate and viable representation of what stress and emotionality are all about. This should include as contributing variables the situational parameters, the cognitive mediating constructs employed, and the physiological parameters.

These three variables interact to produce a stress reaction which is then labeled as an emotion according to how the individual reacted physiologically and the nature of the situational context and his appraisal of it. For example, an individual about to take an important exam may have doubts about his ability to satisfactorily complete it and interpret the situation as threatening to his goal of attaining a high grade in the class. This causes a physiological state which is labeled as fear or anxiety. Another individual may interpret the same situation as an opportunity to demonstrate how well he has incorporated the material and label his physiological state (which might objectively be the same as the former individual's) as excitement or happiness. The emotional label is a post hoc evaluation of the various parameters of the stress reaction.

Various clinicians have some similar conclusions in their practice. Ellis (1962) has emphasized the importance of cognitive interpretations of external situations as being important in resultant emotional distress. The basic premise of Ellis' rational-emotive therapy is that much, if not all, emotional suffering is due to the irrational ways people construe their environment. Ellis (1972) notes that emotional consequences do not directly stem from activating events in people's lives, but rather from their beliefs about these external events. Beck (1976) has proposed that resultant emotions are due to the psychological meaning various events have for the individual. He has contended that the emotional disorders can be distinguished by their cognitive logic in interpreting environmental events. According to Beck (1976), the anxiety neuroses are characterized by a perception of impending danger in the environment by the individual while depression is characterized by a sense of irreversable loss.

Despite the above formulations of stress reactions which appear to be complete in terms of addressing situational, cognitive and physiological parameters, little empirical data is available. An exception to this is the research of Richard Lazarus and his colleagues. Lazarus and Alfert (1964) demonstrated that the levels of autonomic reactivity of subjects exposed to a stress inducing film involving industrial accidents could be reduced or enhanced according to the instructional set administered to him by varying the introductory statement to the film. The authors suggested that the instructional set altered to subjects' appraisals of the film's threat potential thereby cognitively short circuting or intensifying the consequent autonomic arousal. Further evidence of the importance of individuals cognitive appraisals of situations in determining levels of responsivity were offered by Lazarus, Opton, Nomikos, and Rankin (1965) and Koriat, Melkmon, Averill and Lazarus (1972). This research differs from Schachter and Singer's (1962) approach in that the cognitions directly affected the physiological reactions whereas in the previous study, physiological responsivity was held constant while the situations were manipulated. The results from Lazarus' laboratory demonstrate that the same situational context can result in greatly varying levels of physiological reactivity according to the individual's cognitive orientation to that situational context. This underscores the contention outlined above that to thoroughly examine stress and emotion one must take into account the situational parameters, the individual's cognitive orientation to that situation, and the resultant physiological reaction. The Lazarus data also indicates that physiological reactivity levels may be either higher or lower than might normally be expected according to how the situation is cognitively evaluated by the subject. Schachter's (1964) approach would not predict this, since his approach relies on an undifferentiated state of arousal. Individuals apparently may react differently physiologically as part of their stress reaction depending on how they cognitively appraise situations.

A graphic example of the importance of the situational parameters for stress reactions is provided by Werdegar and Sokolow (1967). This study compared readings taken from all day portable blood pressure recorders, with which 125 patients diagnosed as suffering from essential hypertension were equipped, with readings taken from a doctor's office four times over a period of two days. The results showed that the readings taken from the doctor's office averaged 14 milimeters higher systolic and 9 milimeters higher diastolic. Many of these patients had readings which would be considered well within the expected normal range. The results led the authors to conclude that casual blood pressure readings recorded in a physicians office are many times unrepresentative. They suggested that such readings at best provide only a glimpse of the actual average pressure and that the doctor's office, a setting usually unfamiliar to the patient, is a very potent external stimulus, enough to cause a substantial, but temporary rise in blood pressure.

It appears, then, that the study of stress reactions involves the investigation of extremes of biological and psychological functioning brought about by external events which are viewed by the individual as threatening, demanding, or damaging. Examples of life situations which would likely be viewed as stressful would be the loss of a loved one, a change in employment, or an impending marriage or divorce. There are other life situations, however, not as extreme, which may be viewed as stressful depending upon an individual's appraisal of the situation. These might include competition at work, interpersonal relationships, or incidents of class or race prejudice. Varying situations in all these categories can be stressful and possibly the person's physical and mental well being. It is generally accepted that stress in life can be implicated in the development of physical and psychological disease and that the tendency of an individual to worry, to be tense, or to "take things hard," increases one's vulnerability to these diseases (Levine and Scotch, 1970; Alexander, 1950). The specific physiological effects of stress reactions, however, have not been clearly established. While considerable research has been conducted in this area, there is little concensus on what these effects are.

Physiological Effects of Stress

There has been much effort but little success in pursuit of an adequate method of assessing physiological responses. A commonly attempted solution to this dilemma has been to search for a single physiological variable which could serve as an overall index of the bodily state. Studies in this area, however, have generally proven fruitless. Investigators have been unable to uncover a single channel which can reliably discriminate between neutral and fearful material or even between the channel and self reports reliably for groups of people. The possibility of a single channel index of emotion has come to be derisively regarded as an "indicant fallacy." Despite this, many investigators continue to employ a single physiological channel to discriminate arousal between groups. A perusal of a recent issue of a highly respected journal in consulting and clinical psychology revealed two such articles (Cogwell, 1977; Green, 1977). These used finger blood flow and palmar sweat, each to physiologically assess anxiety.

The discouraging results using a single channel has fostered attempts to discover patterns of autonomic responsivity which can distinguish between different emotional states. Alexander (1950) contended that each emotional state had its own physiological syndrome. Despite the apparent truth of this statement on subjective and clinical grounds, experimenters have generally experienced little success in generating evidence to support this hypothesis. An experiment by Ax (1953) is frequently cited as an example of the promise of this area of research. In this experiment, subjects were exposed to staged situations eliciting anger and fear while their autonomic responses were monitored. In the anger situation, a polygraph operator who feigned incompetence handled the subjects roughly while criticizing and insulting them. For the fear situation, subjects received mild shocks concerning which the experimenter feigned alarm, exclaiming about a dangerous high voltage situation as sparks jumped about the subject. Ax's (1953) results showed that reliable patterns of responses were found which could differentiate between fearful, anger inducing, and painful stimuli. While other researchers have replicated these results (Funkenstein, 1955; J. Schachter, 1957), some other investigators have failed to do so. The results, therefore, are not unequivocal. Ax himself (1964) noted that in his 1953 study the variance between individuals was considerably larger than that between emotions. He noted that the method was not adequate to diagnoses an emotional state with any degree of confidence and does not appear to have great utility in assessing an emotional response. Attempts to find characteristic patterns of autonomic responses for other emotions have generally proven fruitless. These discouraging results have led many researchers to conclude that psychophysiological monitoring is inexact and inadequate. There is, however, an area of research which may hold some promise for those investigators interested in psychophysiological assessment. This is the area of physiological response specificity.

Response Specificity Research

Research in the area of response specificity has indicated that while no single channel index of emotion can be found among groups of people, perhaps an index can be found which is accurate for intraindividually across stressor stimuli. The index would be reliable for that individual but not necessarily for another person, for whom another index might be more reliable. The impetus for research in the area of physiological response specificity was provided by Alexander's (1950) theory of organ specificity which stated that individuals tend to respond to stress in one specific organ system but not necessarily in the same system as another individual. This has obvious implications for the genesis of the various psychosomatic disorders.

The first study of response specificity was undertaken by Malmo and Shagass (1949) who investigated the physiological reactivity of patients with various psychophysiologic disorders and the levels of reactivity attained under stress induction of physiological channels related to and not related to the complaint. Of 74 patients included in the study, 47 presented one or more complaints related to the head region (headache, neck tension, tightness in the region of the head) while 34 patients had complaints related to the heart (essential hypertension, tachycardia, palpitations, and pre-cordial pain). Twenty seven of the patients were free from head complaints while 40 were free from heart complaints and 27 had complaints in both areas. Several physiological channels such as muscle potentials, heart rate, and respirations were monitored while the patients were exposed to a fixed series of thermal pain stressors. The results showed that when subjected to the stress situations, the patients with complaints of the head and neck area showed greater disturbance in neck muscle potential scores than other patients free of such complaints. On the other hand, the patients who had a history of cardio-vascular related problems manifested greater disturbance in the records of heart rate and respiration than those who were free of such complaints. However, the patients without cardio-vascular complaints did not differ from patients with such complaints in muscle tension scores. Likewise, patients who did not complain of head and neck problems did not differ from those who did have such problems in the heart rate and respiration scores. These results were obtained despite the fact that only seven of the patients were actively complaining of their problem at the time of the experiment. The authors concluded that psychiatric patients with somatic complaints tend to manifest increased physiological responsivity in a specifiable physiological system or mechanism upon exposure to a stressful event and that the disturbance appears to be specific to the physiological system related to the complaint. It has been found that this can be demonstrated objectively even though the subjective symptom is not experienced at the time of the stress.

A subsequent report from the same laboratory (Malmo, Shagass, and Davis, 1950) sought to extend the above results by investigating the correlation between physiologic events and symptoms in a single subject utilizing a case study rather than a group design. In this study, electromyographic tracings were taken in synchrony with audio recordings of therapy interviews with psychiatric patients. The study was designed to provide details concerning the client's specific physiological reactions to particularly stressful aspects of their life situations. In all three cases examined, discussion of stressful content areas result in concommitant tension in a muscle area related to the client's presenting complaint while unrelated muscle groups evinced no such tension. These cases included a client complaining of headache with consequent frontalis muscle tension, a client complaining of cramps in the arm with an associated increase in right forearm extensor muscle potentials, and a third client who had a tendency to jerk his head, which was associated with neck muscle tension. The authors cited the results as consistent with the previous study. Tension in critical symptom areas were noted in response to the discussion of distressing life situations and these disturbances appeared to be specific in the sense of a lower threshold for disturbance in bodily areas associated with their particular complaint. The authors concluded that these results constituted evidence for specificity of association between overt "principle of symptom specificity," which said that the physiological systems related to a psychosomatic complaint are specifically susceptible to activation by the experience of stress.

A related phenomena was noted by Lacey, Bateman, and Van Lehn (1952) while examining physiological responses to conflictual material in the Rorschach Ink Blot Test. They found that normal college students are likely to show maximal activation in a single autonomic channel across a variety of stress situations. In a subsequent study designed to examine this phenomena in more detail, Lacey, Bateman, and Van Lehn (1953) employed 85 volunteer male college students who were subjected to four laboratory stress tasks such as carrying out mental arithmetic and enduring the pain of the cold pressor test. Measures of palmar conductance, heart rate, and heart rate variability were continuously and simultaneously recorded and examined for evidence of consistency across the different tasks. The data was reported in two modalities: One reflecting the absolute levels of response attained, such as the highest heart rate in response to an arithmetic task, and a second reflecting a measure of change from resting levels to the levels reached during stimulation. These are referred to as autonomic tension scores and autonomic lability scores respectively. The results of this investigation showed that in autonomic tension, 75% of the subjects evinced maximal scores in the same autonomic channel to at least three of the four stressor tasks. In autonomic lability, 70% of the subjects met the same criterion.

These subjects were considered to show a high degree of response specificity. In both cases, there was a marked excess of subjects showing high response specificity when compared to chance expectations, easily achieving statistical significance. Beyond this, the authors found that not only does the maximal score channel tend to be reproduced to the various stressor stimuli, but other channels tend to maintain their relative levels as well. For example, if a subject displayed a certain pattern of channel activation to one stressor, such as heart rate > skin conductance > heart rate variability, this same pattern tended to be displayed in response to other stressors also. Eighty four percent of the subjects responded with the same pattern of tension scores to at least three of the four stimuli, while nearly that amount showed the same tendency in lability scores. These patterns were reproduced despite the fact that low intercorrelations of the channels were computed. Thus despite the fact that the absolute level of responsivity of one channel could not be reliably predicted from the response level of another channel, the relative standing of these channels tended to remain constant. The results led Lacey, et al. (1953) to state a "principle of relative response specificity" as follows:

> For a given set of autonomic functions there exists quantitative variation in the degree to which a pattern of response is stereotyped. Some individuals are so constituted that they will respond with a given hierarchy of autonomic activation whateven the stress; Others will show greater fluctuation from stress to stress, although they will exhibit one

> pattern more frequently than others; Still other individuals randomly exhibit now one pattern, now another. In addition, although the rank order of reactivity remains the same from stress to stress, the quantitative difference between the degree of activation of the different physiological functions will fluctuate markedly.

(pg. 21) This goes beyond the principle of symptom specificity (Malmo, et al. 1950) in that it refers to a normal population rather than being restricted to psychosomatics. Another difference is that it refers to a whole pattern of responses rather than a simply a single maximally activated channel.

A subsequent investigation from the same laboratory (Lacey and Lacey, 1958) was undertaken to test the power and generaliability of the principle of relative response specificity. A different sample of subjects was employed, consisting of adult women aged 25-37 years, rather than the male college population employed earlier. In addition, the physiological measures were extended to include systolic and diastolic blood pressure as well as pulse pressure. The list of stressor stimuli was modified as well. The results confirmed the principle of relative response specificity with scores of both tension and lability achieving statistical significance, although the levels of significance attained were consistently higher for autonomic tension than autonomic lability.

Others have investigated the principle of relative response specificity as well. Schnore (1959) extended the principle by examining individual patterns of physiological activity as a function of task differences and degree of arousal.

New stressor tasks in addition to those previously employed were introducted. These tasks also varied in their arousal value. For example, two arousal levels of mental arithmetic tasks were differentiated by their difficulty. The high arousal problems were not only more difficult to solve, but subjects were heckled by the experimenter if they offered an incorrect answer or if they failed to provide an answer within five seconds. Physiological measures from outside the autonomic nervous system, such as muscle potentials, were included in this study. Schnore's (1959) results clearly supported the principle of autonomic response specificity and demonstrated that the principle could be applied to the skeletal system as well. The idiosyncratic patterns of response held despite the fact that the increases for each physiological channel from low arousal to high arousal conditions varied greatly. Schnore (1959) suggested that these differential increases are a likely cause of the consistent failure to find a reliable relationship between a single indicant of physiological activity and self report measures of emotional traits, such as the Manifest Anxiety Scale (Taylor, 1953); That the failure is expressly due to the unreliability of a single physiological measure as an indicator of general physiological activity for a group and that each individual's unique pattern of responsivity must be taken into account.

Specificity literature was further extended in a study by Engel (1960). The author distinguished between two different types of response specificity. First, individual response specificity was defined as outlined above: When maximal change occurs in the same physiological channel within a subject to a set of stressor stimuli or when consistent rank orders of responses occur within the same subject to a set of stressor stimuli. The concept of stimulus response specificity was introducted as follows: When maximal change occurs in the same physiological function to a given stimulus in a set of subjects or consistent rank orders of responses to a given stimulus occurs in a set of subjects. Stimulus response specificity, then, is similar to the type of research reported above by Ax (1953). Five autonomic functions were monitored while the subjects were subjected to laboratory stress. Results clearly showed evidence for both individual and stimulus response specificity defined both as a consistent channel of maximal activation and a consistent pattern of responses.

The above results may seem to be a paradox to many readers. Individual and stimulus response specificities apparently should be mutually exclusive according to their definitions. The resolution lies in the statistical methods used to determine whether specificity exists. The obtained results are customarily compared to results expected by chance. The chance expectances are usually very small and statistical significance can be achieved in one type of specificity with enough people left over to show the other type of specificity as well. It should be noted also that Engel (1960) ignored scores of autonomic tension and used only lability measures. Previous investigations (Lacey, et al. 1953; Lacey and Lacey, 1958) had consistently achieved lower levels of significance for lability measures. As Engel (1960) observed, however,

> the question of whether one (type of specificity) is more important that the other is meaningless in any absolute sense. If the investigator is interested in delineating individual differences, then individual response specificity is more important for him. If the investigator is interested in differentiating among stimuli, then stimulus response specificity is more important for him. (pg. 312)

The author also speculated about the possible empirical utility of these concepts:

> If the so-called psychosomatic diseases are consequences of disturbances in psychological reactivity to life stresses, then consistent differences should emerge between these patients and non-patients. Whether the differences will be in the degree of individual response specificity or stimulus response specificity is unclear. If the differences are idiosyncratic, patients could show greater ("physiological rigidity") or less ("physiological disorganization") specificity. If the differences are stimulus bound, patients could show greater ("stimulus induced integration") or less ("stimulus induced disorganization") synchrony. (pg. 313)

The research reviewed thus far has implications for the psychophysiological assessment of individuals. First, the original data of Lacey et al. (1953) strongly indicate that people respond idiosyncratically to stress. This suggests that the search for a single reliable indicant of physiological reactivity under stress is fruitless. It appears that if any approach is to prove productive in this area, it must take into account this idiosyncratic nature and focus on individual assessment techniques. It may be, as will be discussed later, that an individual's maximally responsive channel may prove to be the most reliable reactor to stress for him. Beyond this, the fact that all physiological channels maintain their relative positions across stressors indicates that researchers do not necessarily have to rely on absolute levels of reactivity to assess how individuals react. As the Engel (1960) quote above suggests, various forms of pathology may be distinguished by their rigidity or dis-organization and change can possibly be assessed in relation to these in a Pre/Post treatment approach.

The significance of the results in specificity research has not received unequivocal acceptance, however. Wenger, Clemens, Coleman, Cullen, and Engel (1961), using a procedure similar to that employed by Lacey, et al. (1953) found that only 27% of their subjects showed a consistent channel of maximal activity across four stressor tasks. While this easily achieved statistical significance, Wenger, et al. (1961) concluded their paper by cautioning against possible over-generalization of the significance of the laboratory research to that point. Similarly, Oken, Heath, Grinker, Herz, Korchin, Labshin, and Schwartz (1963) examined specificity in response to what they felt were prolonged, personally relevant stresses consisting of staged situations similar to those employed by Ax (1953). Again the principle of autonomic response specificity easily achieved statistical significance but did not maintain a high level of consistency. The authors termed their results as "less strikingly positive than those of Lacey." (pg. 33) They concluded that while autonomic response specificity is a clearly established phenomena, they agree with Wenger et al's. (1961) caution against overgeneralization of their significance.

These dissenting opinions deserve scrutiny. First, it should be noted that Wenger et al. (1961) and Lacey, et al. (1953) employed different criteria in reporting the percentage of subjects who showed specificity. While Lacey et al. (1953) accepted a frequency of three out of four stress reactions showing the same maximal channel as his criterion, Wenger, et al. (1961) chose a frequency of four out of four. A re-examination of Wenger et al's. (1961) data using Lacey et al's. (1953) criterion level reveals that 70% of their subjects showed specificity. This is not radically different from Lacey et al's. (1953) finding of 75%. The crucial issue here, then, is how rigorous the criterion levels should be set. Given the limits of our current technology in transducing biological information, it is perhaps unrealistic to set our levels too high. In addition, Wenger et al. (1961) reported only scores of lability, which, as noted earlier, have consistently resulted in significance of a lower magnitude than tension scores. A third criticism of the Wenger et al. (1961) data is that the authors chose not to correct for the "Law of Initial Values." (Wilder, 1950) The importance of this will be discussed later. The concencus remains that response specificity is a well established principle. The empirical utility of this principle, hinted at in the above quote by Engel (1960) has yet to be realized, however.

Response Specificity in Pathological Populations

Some attempts have been made to investigate response specificity in psychiatric populations. Ferguson (1957) undertook to establish whether response specificity could be unproduced in a group of neurotics whose illness was sufficiently well established to necessitate admission to a hospital. Twenty patients were subjected to alternate presentations of a flashing stroboscope and a loud whistle blast while five physiological channels were monitored. The stimuli were considered by the author to be mildly stressful. Results revealed that 8 of the 20 subjects showed peak autonomic reactivity in the same physiological system as a response to all stressors. This is not terribly different from previous results with a "normal" population. However, the neurotic patients showed a reduced tendency to react with a consistent pattern of total physiological acitivty than the subjects in Lacey et al's. (1953) study, suggesting that neurotics are more physiologically disorganized across stress situations. An attempt to find response tendencies of subclasses of neurotic patients (anger-in vs. anger-out) proved inconclusive, although there was tendency for patients whose personality attitudes were characterized by suppression of anger to react more consistently. It is difficult to draw strong conclusions from this experiment due to its procedure, which did not allow sufficient opportunity for the channel to readapt to a no stimulus condition. The complete recording interview lasted a total of 11 minutes. However, the lack of a consistent hierarchy of response in the neurotic population is suggestive, especially in light of evidence obtained by Reynolds (1961, reported in Lang, 1972) suggesting that discordance of different physiological channel may be a characteristic of personality disorganization and the previously mentioned quote by Engel (1960).

Engel and Bickford (1961) examined the relative tendencies of normal subjects and patients complaining of essential hypertension to show response specificity. Twenty subjects in each group were rigorously screened to be as much alike as possible in demographic data. The procedure followed was similar to that employed by Lacey et al. (1953) with minor modifications. The autonomic variables which were monitored included 3 readings of skin temperature (from the face, finger, and toe) as well as heart rate, heart rate variability, breathing rate, skin resistance, and systotic and diastilic cloob pressure. The results evinced no difference between groups in their relative tendencies to display a consistent channel of maximal activation across different stressor tasks. Both did so to a significant degree. There was a striking difference, however, in the variability of channels in which this specificity occured. Maximal channel specificity in the normal groups was spread among all the physiological channels with five of the twenty subjects responding in either of the blood pressures. In the hypertensive group, however, 15 of the 20 subjects responded consistently maximally in the blood pressure. The groups were also tested for pattern consistentency, sometimes referred to as stereotypy. Results showed that hypertensive patients displayed a significantly greater degree of response stereotypy than the normals. Since the two groups did not differ in their tendency to show maximal channel specificity, the authors concluded that "this must mean that the patients individually show a greater degree of response stereotypy than do the normals in all functions, not just blood pressure." (pg. 485) The tendency of a stimulus to elicit consistent autonomic reactions from each group, called in this study stimulus response specificity, was also examined. The label of this phenomenon has subsequently been changed (Engel and Moos, 1967; Engel, 1972) to denote a special type of individual response specificity called individual consistency, while the label "stimulus response specificity" was used to denote a different phenomenon. As a group, the normals responded maximally in heart rate to two stimuli, in skin resistance to two, and in breathing rate to the other. The hypertensives, as a group, responded maximally to all five stressors in the same channel, that being systolic blood pressure. The authors concluded that the cardiovascular systems of patients complaining of essential hypertension are under greater stress in the course of their day than the cardiovascular systems of their peers and that they are more stereotyped in the way they react to all situations. It would appear that essential hypertensives are more "psychophysiologically rigid" than normals. This is an interesting point when contrasted to Ferguson's (1957) results suggestive of greater psychophysiological disorganization in neurotic subjects who had no psychosomatic complaints.

Response specificity has also been studies in schizophrenics.

Crooks and McNulty (1966) presented stressor stimuli to a group of normals and a group of schizophrenic patients in much the same manner as the earlier investigations of Lacey et al. (1953) and others. This study reported both autonomic tension and autonomic lability scores. Both groups showed a consistently maximally activated channel to a significant degree. Sixteen subjects showed a single maximally activated channel in the normal group while 14 did so in the schizophrenic population. When the two groups were compared in their relative tendencies to show maximal channel specificity, no difference was found. Possible relations between group status and the channels in which specificity occured were also investigated. These frequencies revealed that there was an excess of schizophrenic skin resistance responders while nobody in this group responded maximally in diastolic blood pressure. This latter result can be compared to a frequency of eight, on the other hand, in the normal group. Consideration of patterning of responses across stressors again revealed that both groups departed from chance expectations to a significant degree but that there was no difference between groups in this regard. Schizophrenics were neither more psychophysiologically disorganized or psychophysiologically rigid than the normal group. The results were also analized to compare the magnitude of change for each group from baseline for each of the stressors. This revealed that, in general, schizophrenics displayed less of an increment under stress than did normals. The schizophrenics did, however, show a greater decrease in skin resistance, indicating a greater response in this channel to stress. The authors concluded that while the two groups evinced no differences in their relative degrees of response specificity and patterning across stressors, there did appear to be a relationship between the mode of channeling excitation and group status. Schizophrenics tend more so to be skin resistance responders and less so in diastolic blood pressure. It was suggested by Crooks and McNulty (1966) that one of the differences between normals and schizophrenics is that the latter group may tend to "choose" inappropriate methods for channeling excitation, inappropriate in that they do not facilitate escape from or avoidance of the arousal situation, or do not result in the reduction of fear or anxiety. The key word here is "may" since the data presented clearly does not warrant strong conclusions in this direction without further study. The authors also speculated that due to the schizophrenic's generally higher level of functioning while at rest, what are basically normal situations for others may somehow have acquired abnormal arousal value for them. While the patterning results are disappointing in light of the findings of Ferguson (1957) and Engel (1960), this research does suggest that an individual's ability to cope with stress may be evident in his maximally reactive channel and that this may be employed as an assessment measure if further research confirms this.

While response specificity appears to be a well established principle, research in this area has declined in recent years. This is due mainly to evidence presented by Lacey (1967) that the type of process being undertaken by the organism, such as whether he is attending to an outside stimulus or doing something "in the head," may be a more important area of investigation (Lacey, 1974). It is apparent, however, that the research done thus far in response specificity may be important in itself and that further investigation is warranted to confirm or disprove the various suggestive findings outlined above.

One of the major implications of specificity research is the possibility of psychophysiological differentiation between normal and pathological groups under conditions of rest and stress. Preliminary findings indicate that neurotics may show more "psychophysiological disorganization" under stress (Ferguson, 1957) while psychosomatics display greater "psychophysiological rigidity" to varying situations of stress (Engel and Bickford, 1961). The results of Crooks and McNulty (1966), however, do not appear to support the contention of Reynolds (1961, in Lang, 1972) that increased psychophysiological disorganization is a correlate of personality disorganization. More work in this area should prove valuable to our understanding of abnormal psychophysiology.

An especially intriguing aspect of specificity research is the possible utility of a consistently maximally activated channel in assessment procedures. Apparently as a result of the numerous failures to find a single overall index of responsivity to stress for groups, research in this area has diminished as a result. Specificity research suggests, however, that while no single index can be proven reliable for a group of subjects, it may be possible to find a reliable index for that particular individual. An experiment by

Edelman (1972) is especially suggestive in this regard. Subjects for this study were chosen on the basis of their avowed channel of maximal reactivity as indicated by their responses to Stern's (1969) "Perceived Somatic Reactions to Stress" questionnaire. This questionnaire asks subjects to indicate which of 11 physiological responses constitute their reaction to personally relevant stress. The channels are rank ordered along an intensity and a frequency dimension. This, in effect, produced a subjective estimate of each subject's consistently maximally reactive channel. Subjects were selected on the basis of being either high heart rate and low skin conductance responders (referred to by Edelman (1972) as galvanic skin response) or high skin conductance responders and low heart rate responders. They were also required to complete the Fear Survey Schedule (Wolpe and Lang, 1969) to determine salient fears. From this, a 50 word description of a high fear item and a low fear item were drawn up during an initial interview. In a later physiological recording session, these two scenes were presented to the subject in a counterbalanced ABBA design. The results revealed that only those individuals who had avowed maximal activation in heart rate showed a statistically reliable increase in their heart rate while imagining the stressful scene. There was no such increase in skin conductance for these subjects. Those subjects who had avowed maximal reactivity in skin conductance, on the other hand, did respond differentially to neutral and stressful scenes in the electrodermal channel while failing to do so in heart rate. A third electromyographic measure, also taken for each subject, failed to distinguish between the two scenes for either group. The author concluded that autonomic activation is altered by central states but that such activation is likely to occur only in the autonomic channel that is most labile for that subject. Edelman (1972) reiterated Schnore's (1959) observation that the phenomenon of an idiosyncratic channel of maximal activation serves in large part to highlight the reason why there is not an isomorphic correspondence between autonomic and behavioral measures of anxiety for groups of people.

The above experiment suggests that a single maximally reactive channel can be assessed for an individual and be employed as a measure of reactivity to stress. While this possibility has not been formally investigated, several recent comments by researchers in the area suggest its possible utility in psychophysiological assessment. Kallman and Feurstein (1977), while presenting anecdotal evidence of actual clinical cases, suggest that a maximally reactive channel may be more refractory to habituation than other channels and therefore a more accurate index of the relevance of a stimulus. Two clients being assessed psychophysiologically were exposed to alternate presentations of neutral and psychobiologically relevant stimuli within a single session. One of the clients displayed significant and consistent heart rate increases across three assessment sessions. The other client, on the other hand, showed very little increase in heart rate in the first session and a trend toward habituation across the three sessions.

This second client did, however, show consistent electrodermal reactivity across all three sessions. If only one channel had been monitored, one might have had to assume, if the incorrect channel had been chosen, that physiological assessment could not produce anything but spurious information. This supports the contention that to carry out an adequate psychophysiological assessment several channels should be monitored to discover which best indexes "true" significance of the stimulus.

A reexamination of data obtained by Doverspike (1976) is further suggestive of the significance of a maximally reactive channel. Three physiological channels were monitored in two depressed clients during psychotherapy sessions. As successful psychotherapy progressed, only one of the three variables showed any differency in level, this being an apparently sensitive index of the improvement. This single sensitive channel was different for each client, again suggesting an idiosyncratic channeling of reactivity. It is interesting to note also that the sensitive channel for Doverspike's (1976) depressed clients increased across psychotherapy sessions, contrary to a decrease that might be expected in anxious clients. It appears that these clients learned to show more sympathetic activity as successful psychotherapy progressed, that they became more "sympathetically tuned."

Other investigators have commented on the possible utility of a single sensitive channel. Hersen and Barlow (1976), in discussing psychophysiological assessment techniques, have recommended that several physiological systems be monitored concurrently to ascertain which one of them is the most sensitive indicator of change. They suggested that once this most sensitive channel has been identified, direct or systematic replications can be conducted to assess treatment efficacy. Stoyva and Budzynski (1975) have commented that the course of biofeedback training of physiological channels depends on what they term the "physiological stress profile" of a particular individual. Thusly, the trainee who shows large heart rate increases to stress would receive mainly heart rate feedback training.

While all these recent articles are very suggestive of the possible clinical utility of response specificity research, no direct studies have yet been undertaken. The studies reported above concerning response specificity in clinical populations are suggestive as well but as yet rather inconclusive. Steps should be taken to resolve this disparity in the literature. One especially promising research area in this regard is the psychophysiological reactions in depression, since it is a very common complaint, is a mood disorder, and has been linked to the various stresses of living.

Stress and Depression

A great deal of research in the area of abnormal psychology has indicated a link between "life events" or "life stresses" and susceptibility to physical illness (Holmes and Masuda, 1973). A positive relationship has been found between the frequency and severity of life stresses and various psychosomatic complaints including peptic ulcers (Birely, 1972), respiratory illness (Jacobs, 1971), migraine headaches (Alvarez, 1970), essential hypertension (Finnerty, 1971), and cardiovascular disease (Rahe and Lind, 1971).

These represent only a small sampling of a considerable amount of research in this area. More recently, the link between the life stresses and various psychological problems has also been scrutinized, especially in the area of depression.

The "life events," "life stresses," or "life crises," as they are often called, consist of various milestones of life to which most people can be expected to be exposed at some time in their lives. These include such incidents as the death of a spouse or loved one, marriage, divorce, promotion or demotion, becoming a parent, a child leaving home, and other like events which can be expected to have a significant effect on the physical and mental well being of an individual. A widely employed instrument in the study of these events is the Social Readjustment Rating Questionnaire (SRRQ) developed by Holmes and Rahe (1967). This is a self rating questionnaire consisting of 43 life events to which an individual may be exposed and is designed to provide an estimate of the frequency of life events or the amount of stress in the individual's life over a given period, usually weeks or months, prior to the onset of a physical or mental disorder. There appears to be general agreement among individuals concerning the severity of stress occasioned by the various events listed in the SRRQ with the six most stressful events listed by Coleman (1973) as: Death of a spouse, marriage, divorce, marital separation, death of a close family member, and a major personal injury or illness. Other commonly used paper and pencil measures of a similar vein include the Life Events Inventory (Cochrane & Robinson, 1973), the Daily Events

Inventory (Holmes & Holmes, 1970) and the Schedule of Recent Experiences (Rahe, 1964).

Paykel, Myers, Dienelt, Klerman, Lindenthal, and Pepper (1969) compared the types of life events preceding symptom onset for 185 patients diagnosed as depressed from various settings including a state mental hospital, a general hospital, and a community mental health center. This data was compared to similar information gleaned from a control group of normals matched for such factors as age, sex, marital status, race and social class. The results revealed that the depressed group reported almost 3 times as many events as the controls. Various events which were listed significantly more frequently by the depressed group were: 1) an increase in the number of arguments with a spouse, 2) marital separation, 3) beginning a new type of work, 4) death of an immediate family member, 5) serious illness of a family member, 6) departure from home of a family member, 7) a serious personal physical illness, and 8) a recent change in work conditions. Some events checked more by the controls than the depressives included: 1) engagement, 2) promotion, 3) leaving school, and 4) the birth of a child. Paykel et al. (1969) investigated exists and entrances as being representative of the types of changes involved in the subject's immediate social field. Entrances involved the introduction of a new person to the subject's social field and exits involved the departure of an individual. Exits were found to be strikingly more frequent for depressives than for the controls while entrances were about the same for each group. Other investigators (Sethi, 1964; Levi, 1966) have found a significant excess of events concerning separations in the records of depressed patients. The evidence is not unequivocal, however, as two studies (Forrest, 1965; Hudgins, 1967) did not find such an excess. These two groups did find, however, an excess of events relating to social factors and interpersonal discord. Paykell (1973) suggested that perhaps depressives are more likely to perceive these events as stressful rather than simply being exposed to an excess of them. This statement is suggestive of the likely importance of cognitive situational appraisals in the stress reactions of depressives.

In addition to the research on life events and depression, several other studies have examined the impact of common social stressors and resultant depression. Ilfield (1977) investigated the incidence of depressive symptoms as revealed by psychiatric symptom index and its relation to indications of current social stress as delineated by detailed, open-ended interviews with 175 people. Previous research (Ilfield, 1976) had indicated that "current social stressors" are usually present before symptom onset, supporting a contention that such stressors influence the symptoms more than the symptoms influence them. Ilfield (1976) conceptualized current social stress as circumstances or conditions of daily social roles which are generally considered to be problematic or undesirable, which is different from the conceptualization of "life stresses" employed by most previous researchers. According to Ilfield (1977) social stressors are actually possibly problematic events since not all people find them to be so. His results indicated that current social stressors do, indeed, have a rather strong association with symptoms of depression. These symptoms were significantly related to current social stress for five groups of people categorized according to sex, marital status, and employment. Differing types of events appeared to be especially significant for certain groups. For example, employed, married fathers were greatly affected by stress related to their marital situations but significantly less affected by their parental or job situation. The correlations were obtained even when several variables were introduced as controls such as age, education, and income level. There was also a direct and dramatic relationship between depression and the total number of social stressors experienced by the respondents. Ilfield (1977) speculated that it is the current life events (the current social stressors) that take a significant toll of suffering beyond that of the fortuitous and dramatic life events of the past, which are more commonly implicated. He also asserted that, because they are current rather than past events, they may be more relevant for treatment and prevention programs. Given the magnitude of depressive symptomatology in today's society, this may be a very fruitfull avenue to pursue since such techniques would likely be readily adapted to a community setting.

Weisman, Prusoff, and Pincus (1977) have suggested that the major reason why depression is so prevalent today is an increasing number of disturbances of a minor magnitude being reported due to an increase of community social support services. They assert that the great majority of out patient depressives are not serious enough to require pharmacological intervention, but that little attention has been paid to these individuals when compared to the more severe forms which frequently require hospitalization. Weissman, et al. (1977) undertood to investigate the symptom patterns of the severely depressed and what they termed the "normal" depressed individuals who are more prevalent. The central mood state of depression did not differentiate between the groups. Feelings of "sadness" were reported as just as severe in the "normal" depressed group. This result agrees with previous research by Katz (1970) and Hagarty and Katz (1971) who found that "normal" depressives display a very pronounced mood factor (feelings of lonliness and sadness) when compared to hospitalized depressives. The main difference between the groups, however, was on behavioral indices (agitation, indeceisiveness), rather than mood. In a follow-up after 4 months, the "normal" depressives who had improved attributed their improvement to such events as finding a job or an educational plan and receiving practical help through a very trying transitional period. Weissman, et al. (1977) suggested that the type of client assistance offered by the center where this study was carried out may have hastened their adaptation and obviated the need for more serious psychiatric intervention. This is important since the normal psychiatric treatment for depression is pharmacological and is commonly directed toward relieving symptomatology which differentiates rather than is shared by these two groups. Thus, it would not be the treatment of choice for both groups. The preferred treatment for the "normal" depressives would appear to be a problem solving approach dealing with their appraisals of and methods of dealing with common social stresses.

The frequency of mild depression has been estimated to be about 75% of all depressive diagnoses (Secunda, Katz, Friedman, and Schuyler, 1973). The futility of pharmacological intervention with these individuals is perhaps best expressed in a quote from an article by Schuyler (1976) concerning the pharmacological treatment of depression: "Although they may represent one-quarter of the total (depressives), they (severe depressives) are the most disabled and paradoxically, the most responsive to treatment." (pg. 359) Certainly, alternative methods of treatment should be undertaken and evaluated. Recent evidence has shown that other techniques (in this cae, a semantic approach) can result in significantly greater improvement than pharmacotherapy for outpatient depressives (Rush, Beck, Kovaco, and Hollon, 1977).

The above indications are especially important if this "normal" depression is a possible prelude to a major depressive episode without such intervention. Just such a likelihood is asserted by Lader (1975): "Many serious depressions are undoubtedly an intensification of normal depression. One can envisage a continuum from "feeling blue" to minor depressive reactions."

Early intervention in such a case would be vital. Such intervention requires accurate assessments of change to be effective. Since depression is mainly an affective disorder, an accurate psychophysiological assessment would be an attractive addition to the practitioner's armamentarium. How this should be done, however, has not been established.

Psychophysiology and Depression

Why do some individuals become depressed when faced with stress while others do not? Part of it may be the frequency of the above life events which lead to depression. Some researchers have questioned the assertion that the difference is merely a matter of frequency, but rather point to evidence that most depressed patients show a high degree of genetic and personality vulnerability to stressful events (Winokur, Clayton, and Reich, 1969). The importance of situational appraisals in depression should not be overlooked (Ilfield, 1977). The exact nature of the difference between those prone to depression and those who are not is still a mystery, however.

An interesting approach to investigating the physiological parameters is suggested by Gellhorn (1963), who speculated that a major contributor to depression is an "over corrective" parasympathetic nervous system. While the sympathetic portion of the autonomic nervous system customarily reacts to stressful situations by accelerating the bodily metabolism, the parasympathetic system is antagonistic to this and reacts to bring the bodily processes back to normal. Gellhorn (1963) suggested that in some individuals this mutually antagonistic system can get "out of tune," permitting a regnance of one system over bodily functioning. Those individuals who are sympathetically tuned would be expected to be hyperreactive and likely to complain of anxiety. Parasympathetically tuned persons, on the other hand, would be expected to show hyporeactivity and therefore more likely to complain of depression. Gellhorn conceptualized the process of psychotherapy as the manipulation of cognitive and situational variables for the purpose of modifying autonomic response patterns (Doverspike, 1976). The appropriate "balance" of the sympathetic and parasympathetic systems would be expected to increase as psychotherapy progresses. Psychotherapy is, therefore, essentially a matter of autonomic retraining. Such a view underscores the critical need for an adequate psychophysiological assessment of psychotherapy.

Gellhorn's perspective is especially interesting in light of "autonomic balance" research carried out by Wenger and his colleagues. This work is actually a modification and extension of work by Eppinger and Hess (1915), who originated the concepts of sympathicontonia and vagotonia. According to these researchers, individuals could be found who display a ready response to stimulation of the sympathetic nervous system but only respond sluggishly to parasympathetic stimulation. These people are sympathicontonics while vagotonics react in just the opposite manner. Wenger (1941) proposed that because of differences between the mostly andrenergically mediated sympathetic system and the mostly cholinergically mediated parasympathetic system, one might predominate in function over the other, or display an "autonomic imbalance." In several studies (Wenger, 1941; Wenger, 1942; Wenger and Ellington, 1943) a formula was devised to measure this imbalance using a number of bodily systems which have similar numbers of fibers from both systems. This allowed the researchers to assess the relative standing of individuals in their resting autonomic activity. Wenger (1948) applied this formula to 468 aviation cadets and obtained a normal distribution of autonomic balance. Similar results have been found with other groups and children (Sternbach, 1966). Studies of autonomic balance among pathological groups have shown that very low balance scores, indicative of a sympathetic regnance, is characteristic of individuals suffering from frequent anxiety (Holt, 1956; Parker, 1955; Smith and Wenger, 1965). Wenger (1947) found that for children on the extremes of the autonomic balance distribution, there were significant relationships between the scores and certain personality characteristics. Those with a strong parasympathetic dominance showed more emotional inhibition, less emotional excitability, and a lower frequency of activity than those with a sympathetic dominance. This pattern of activity is similar to those found in reactive depressions. The evidence is at least suggestive that an individual's customary manner of autonomically reacting may in large part determine his predisposition to certain types of psychological and physical disorders.

Patton (1969) has compared the autonomic reactivity of high and low scoring individuals in autonomic balance. Twelve subjects in each group were subjected various laboratory stress conditions while four autonomic channels were monitored. Readings were also taken for resting levels. Sympathetic activity during rest periods, defined as the mean absolute values of each channel, was consistently higher for the "sympathetic" subjects. Autonomic lability scores were also examined for group differences. Results in this area revealed that the "sympathetic" subjects reacted to the stress situations with a higher increment in their autonomic activity. It was also found that, under stress, the "sympathetic" subjects reached higher absolute levels of autonomic acitivity. Patton (1969) concluded that individuals low on autonomic balance (sympathetically tuned) consistently display higher levels of sympathetic nervous system activity during non-stress conditions and, when stress is applied, are more reactive sympathetically to the stress. These differences were tentatively attributed to constitutional differences measured by the autonomic balance formula. If depressives are, in fact, "parasympathetically tuned," they should have similar characteristics to the parasympathetic group above.

Another interesting speculation concerning autonomic balance was proposed by Eysenck (1953), whose theory of personality posits two basic types of individuals. On the one hand there are extraverts, who tend to react impulsively in various situations. On the other hand there are intraverts, who tend to hold back and mull over decisions before acting. Eysenck (1960) has suggested that there personality differences in individuals are due mainly to their autonomic constitution, with extraverts being sympathetically tuned while intraverts are parasympathetically tuned. This thesis has recently been examined (Small, 1976). No connection was found between personality as measured by the Eysenck Personality Inventory (1960) and autonomic activity.

The possibility that depression may be due to parasympathetic regnance of the autonomic nervous system still provides an intriquing possibility for psychophysiological assessment of progress in psychotherapy. This is especially true since depression is classified as an affective disorder and affect is customarily associated with autonomic activity. Despite this, few studies have been conducted to examine the psychophysiology of depression (Fowles, 1975). Many of these have examing electroencephalographic material which is essentially unimportant for the issue of autonomic arousal. Studies of skin conductance changes have shown that, in general, sweat gland activity seems to be depressed in depressives (Bragg and Crookes, 1966; Fowles, 1975). Twenty depressed patients rated on the D scale of the MMPI showed a negative correlation between depth of depression and the galvanic skin responses to auditory stimuli (Greenfield, 1963). Especially salient in light of the sympathetic-parasympathetic distinction are studies of salivary secretion among depressed individuals since this area is innervated by equal numbers of fibers from both systems. Contrary to expectations, most researchers have reported reduced salivary output by depressives, indicative of sympathetic activity (Strongen and Hinsie, 1938; Davies and Gurland, 1961; Palmai and Blackwell, 1965). These investigations have not received unequivocal support, however, as other researchers have found no such correlation (Peck, 1959; Busfield and Wechsler, 1961). No research has investigated patterns of autonomic activity in a depressed population. The reason for this has likely been the disappointing results of single indicant experiments and the low inter-correlations of channels across stressor stimuli.

The Present Investigation

While psychophysiological assessment is increasingly being employed as part of a complete assessment procedure (Hersen and Barlow, 1976; Kallman and Feurstein, 1977), the specifics of how this should be carried out remain to be delineated. The present investigation will seek to test several hypothesis concerned with the psychophysiology of depression which should have implications for assessment and evaluation techniques. Initially, however, because of the tremendous complexity and disorganization of data presentation in the field and the tendency on the part of many researchers to misuse concepts, a few important definitions will be introduced. These are as follows:

1) Maximal channel specificity will be employed to refer to the tendency of a single physiological channel to be consistently maximally reactive in the sympathetic direction across different stressor situations.
2) Minimal channel specificity will be employed to refer to the tendency of a single physiological channel to consistently be the least reactive channel in a sympathetic direction across the different stressor tasks.
3) Patterning stereotypy will refer to a consistent hierarchichal structure of response channels across different stress situations. For example, if an individual shows maximal channel specificity as well as minimal channel specificity, and the channel in between these two tend to maintain their relative

hierarchichal standing across the tasks, that individual can be said to have shown patterning stereotypy.

It should be apparent that the two types of channel specificity and patterning stereotypy are not completely independent of each other. Each has sufficiently different properties and implications for assessment, however, to warrant consideration of them as phenomena in their own right. It is also necessary to define the two modes in which scores will be reported:

4) Scores of autonomic tension refer to absolute levels of channel activity attained during a certain period. For example, if 90 beats per minute was the highest heart rate attained during a stress period, that reading would be accepted as a measure of autonomic tension.

5) Scores of autonomic lability refer to the magnitude of deflection of a channel during one recording period when compared to another period. For example, if an individual's heart rate in 90 beats per minute under rest and this rises to 95 beats per minute under stress, the autonomic lability score for this stressor task is +5.

The decision to employ two methods of measurement is warranted by evidence that absolute levels of a channel under stress depend to an extent on the level of that channel just prior to stimulation. This "Law of Initial Values" was first formulated by Wilder (1950) and asserts that an autonomic channel's response to stimulation is largely a function of its pre-stimulus level. The higher a pre-stimulus level is, the smaller the reaction should be to a function increasing stimulus due to ceiling effects. If the pre-stimulus level is extremely high, there may even be a paradoxical diminution of that channel's activity under stimulation (Sternbach, 1966). For this reason, many researchers have worked arduously to discover a satisfactory statistical method of extricating the base level effects. Several manipulations have been suggested, but the issue is far from resolved. Lacey (1956) proposed an "autonomic lability score" (ALS) which takes into account the correlation between pre-stimulus levels and post-stimulus levels and alters the raw lability score in accordance with this. While widely employed, Lacey's (1956) formula is considered an imperfect solution to the problem. Other proposed solutions to account for the law of initial values several covariance techniques (Benjamin, 1963), percentage of change scores ( ), and techniques involving the correlation between the pre and post stimulus scores and the post stimulus score itself (Oken et al. (1963). Many other solutions have been forwarded and others, including the experiment of Oken et al. (1963) have used no correction at all. In a review of many of these techniques, Sternbach (1966) concluded that Benjamin's (1963) covariance approach represented the most convenient method of LIV correction. It is apparent from close inspection, however, as Benjamin (1963) noted, that Lacey's (1956) formula and her technique are very similar and that the Lacey (1956) formula can, in actuality, be viewed as a special variation of her technique. This variation simply allows for the scores to be expressed in T-fashion. Since it will be desirous in the present experiment to compare physiological channels which are measured in different modalities, the scores must be expressed in some standardized manner. The autonomic lability score, then, appears to be the formula of choice for LIV correction. Since absolute levels of functioning are also of interest, autonomic tension scores will be reported as well. The reader should be aware, however, that no truly satisfactory method of LIV correction has been devised. There simply has been no clearly superior technique to Lacey's (1956) formula.

Several hypothesis can be tested in the present investigation. First, it will be expected that the "normal" control group will evince maximal channel response specificity to a significant degree in response to lab stress. All studies of this phenomena have found this to be the case.

The following hypothesis, then, is stated for scores of both autonomic tension and autonomic lability.

Hypothesis 1 - Under conditions of laboratory and imaginal stress, "normal" individuals will tend to react with a consistent channel of maximal reactivity across stressor tasks.

In all studies thus far (Ferguson, 1957; Crookes and McNulty, 1966) with pathological populations, the principle of maximal channel specificity has been found to hold as well. Therefore, the following hypothesis is stated:

Hypothesis 2 - Under conditions of laboratory and imaginal stress, "depressed" individuals will tend to react with a consistent channel of maximal activation across stressor tasks.

The relative tendencies of the two groups to show maximal channel specificity is also of interest. Some evidence (Reynolds, 1961) suggests that parthological groups should show less specificity than normal groups. Research by Ferguson (1957) appears to support this, while an investigation by Crookes and McNulty (1966) does not agree. The following hypothesis then, will be examined:

Hypothesis 3 - Under conditions of laboratory and imaginal stress, "normal" individuals will show a significantly greater degree of maximal channel specificity than "depressed" individuals.

A less frequently studied phenomenon is minimal channel specificity. The research by Doverspike (1976), however, suggests that depressives, as a group, may be distinguished from normals by a greater tendency to show minimal channel specificity.

Hypothesis 4 - Under conditions of laboratory and imaginal stress, depressives and normals will both show minimal channel specificity. Depressives, however, will show significantly greater minimal channel specificity than normals.

A major drawback of the specificity literature has been its reliance on laboratory methods of stress induction. Little work has been done to establish whether psychologically significant events from outside the laboratory environment can be employed somehow in a laboratory or therapy context to test reactivity. A commonly used method of accomplishing this is to simply have the individual imagine a stressful situation. This procedure has not always proven adequate (Davison and Wilson, 1973; Weitzman, 1967). Preliminary results from this laboratory have indicated that requiring the subject to take his own role in an imaginal situation and make all the verbalizations as he made them in the "in vivo" situation may be a preferred method of "imaginal" presentation. Because this type of stress induction may have more relevance to clinical situations, it will be compared to laboratory methods of stress induction. The following hypothesis, then, will be examined:

Hypothesis 5 - Normals and depressives will evince no difference under laboratory versus imaginal stress in their tendency to show maximal and minimal specificity.

In addition to the maximal and minimal channel specificities, pattern stereotypy will also be examined. All studies conducted thus far have indicated that both normal and pathological groups show pattern stereotypy. Therefore, the following hypothesis will be investigated:

Hypothesis 6 - Under conditions of laboratory and imaginal stress, normal and depressed individuals will show significant pattern stereotypy across stress tasks.

Some evidence has surfaced that indicates depressives may evince more "physiological disorganization" and therefore less significant pattern stereotypy than normals (Ferguson, 1957).

Hypothesis 7 - Under conditions of laboratory and imaginal stress, normal individuals will show significantly greater pattern stereotypy across stress tasks than normals.

Other evidence (Gellhorn, 1963) suggests that depression may be a result of a parasympathetically tuned autonomic nervous system. To test the possibility of this, two hypotheses will be stated:

Hypothesis 8 - Under conditions of rest, alertedness, and stress, normals will consistently show greater sympathetic innervation than depressed individuals.

Hypothesis 9 - Depressed individuals will show significantly smaller increments of autonomic activity (and possible decrements) from rest to alertedness and alertedness to actual stress induction than normal individuals.

The answer to the above hypotheses will provide evidence to help investigators decide which of several possible avenues will be the most productive in pursuing more adequate methods of psychophysiologically assessing the more common depressive states and psychopathology in general.

Method

Subjects

The present investigation employed a total of 20 subjects, selected from a list of students enrolled in introductory psychology courses at Virginia Commonwealth University. They participated to obtain extra credit for that course. The following criteria applied to all subjects:

1. All subjects were female, 18 to 25 years of age.
2. All were willing to allow the recording of several physiological channels and agree to various conditions outlined on a consent form to minimize the possibility of artifact as much as possible. This form is included in the appendix.
3. The participants must have been free from any known longstanding physical illness, such as hypertension, which would bias the physiological data abnormally.

In addition to the above criteria, a control group of "normal" subjects met these criteria:

1. They must have had a negative past history of psychiatric illness and psychotherapy.
2. They must have scored within one standard deviation of the population mean on the Beck Depression Inventory (BDI) (Beck, 1972) which was administered under the title of a "Student Mood Survey."

An experimental group of depressed subjects, in contrast to the control group, met the following criteria:

1. They must have achieved a criterion score of at least 14 on the BDI.

2. They must have reported experiencing depressive episodes of a debilitating magnitude with a frequency of at least once per month. This information was culled through questions fashioned after the BDI questions and added to the test.

The Beck Depression Inventory is a self report paper and pencil instrument covering 21 symptoms of depression including motor, cognitive, and neuro-vegatative signs. It has been shown to correlate highly with psychiatric ratings of depth of depression and has good discriminant validity for depression versus anxiety (Beck, 1972). Only subjects who voluntarily wished to participate were accepted for participation. It was made clear to each subject that he could choose to withdraw from the experiment at any time.

Experimenter

The experimenter was a second year male graduate student in clinical psychology. He was 27 years of age and medium height and build. He followed a standardized procedure to assure that he was of a standard stimulus value to all subjects.

Setting

All meetings between subjects and the experimenter were held in the therapy room of the psychophysiology laboratory of the Psychological Services Center of Virginia Commonwealth University. This room was designed to afford comfortable surroundings for psychotherapy sessions during which physiological measures are recorded. The room has been soundproofed to minimize the influence of external sounds on the subjects. It is also climate controlled and was maintained at a temperature of $75^{\circ} \pm 2^{\circ}$ Farenheit. A comfortable easy chair was provided for the subjects to sit in during recording sessions. The physiological recording apparatus was located in another room adjacent to the room in which the subject was seated. Cables for the polygraph were passed through holes in the wall especially designed for this purpose. The subject was seated with **her** back to this wall. The therapy room was dimly lit with a 100 watt light bulb during the physiological recording sessions.

Physiological Measures

Several measures of autonomic activity were monitored during the recording sessions. These are listed below:

1. Heart Rate (HR) was monitored by means of a GRASS model 7P44B cardio tachograph. This provided a continuous beat by beat measure of variations in HR. The signal was taken from EKG readings which were monitored by a GRASS model 7P6C EKG pulse pre-amplifier. A brass electrode (2" x $1\frac{1}{4}$") was placed on the volar surface of the subject's dominant forearm and a corresponding electrode was placed over the tibia bone on the opposite sided calf. These electrodes were interfaced to the skin with GRASS EC2 electrode cream. Lead selector 11 or 111 was employed depending upon the electrode sites.
2. Heart Rate Variability (HRV) was also monitored continuously from the cardio tachograph record outlined above.
3. Skin Conductance Level (SCL), an exosomatic measure

of electrodermal activity, was monitored through a GRASS model 7P1E low-level DC pre-amplifier. This was recorded by placement of a BECKMAN cup electrode of silver-silver chloride composition on the volar surface of the non-dominant forearm just below the elbow and a second electrode of the same type on the fleshy part of the palm of the same sided hand over the first metacarpal bone. A constant current of 10 microamperes was passed through the two electrodes. These electrodes were interfaced to the skin with SPECTRA 360 electrode gel (.05% sodium chloride) and secured with adhesive tape.

4. Finger Pulse Amplitude (FPA) was also monitored by means of a GRASS model 7P1E low level DC pre-amplifier. A GRASS Model photoplethysmograph was attached to the middle finger of the non-dominant hand and secured with adhesive tape. This allowed continuous monitoring of blood flow to the periphery.

All physiological readings were charted as pen deflections recorded on a GRASS model 7D polygraph. Prior to placing the electrodes on the skin surface, the site was cleaned with alcohol (70% isoprophl) with the exception of the palm and finger tip. The electrodes were then secured to minimize the influence of movement artifact on the physiological recordings.

Procedure

The experimental procedure required two meetings between the subject and the experimenter. An initial meeting was held to delineate three stressful interpersonal interactions between the subject and another individual. This lasted approximately one hour. A second meeting required the subject to be hooked up to the polygraph while several stressor tasks were introduced over a period of approximately $1\frac{1}{2}$ hours. The subject was then debriefed concerning the general purpose of the investigation and allowed to leave.

The initial meeting between subject and experimenter was held in the therapy room described above. The major purpose of this meeting was to delineate a number of interpersonal interactions in which the subject had recently engaged and found to be stressful. At the beginning of this meeting, the subject was handed a form requesting her to list a number of recent interpersonal situations which she found to be stressful. After the form was completed, the experimenter went through each situation with the subject in detail to further clarify the sequence of events and pinpoint aspects of the situation which the subject found to be especially stressful. In addition, three "monologue scripts" of approximately one minute in length each were drawn up of what verbalizations the subject made during each of these interactions. The subject was informed that these scripts were important for the later meeting but was not given further information regarding its usage.

A secondary purpose of this initial meeting was to familiarize the subject with the environment in which physiological recording were later be carried out. The meeting was held in the recording room and was introduced to the subject as such. The subject was encouraged to look around, familiarize herself with the surroundings and ask questions. After the various "monologue scripts" had been satisfactorily outlined, the subject was then shown the electrodes which were to be later attached to **her** and shown where they would be attached. A brief preview of the procedure involved in attaching them was also to be provided. After this, the subject was escorted to the adjacent room and shown the polygraph while the experimenter offered a brief account of how the machine operates. The experimenter strove to answer all questions posed by the subject but refrained from giving specific information concerning what would occur during the recording session and the specific goals of the investigation. This meeting was terminated with the scheduling of the subject for a recording session approximately one week after the first meeting.

Upon reporting for the second meeting, the subject was requested to sit in the easy chair and relax while the electrodes were attached. **She** was then informed of the deleterious effect of movement of physiological recordings and requested to restrict this as much as possible during the entire session. After the electrodes were attached, the experimenter left the room and from the adjoining room read a standardized set of introductory instructions presented in the appendix. The experimenter communicated with the subject by means of an intercom during the remainder of the session. The polygraph was then calibrated while the subject relaxed. An adaptation phase lasted ten minutes beyond the point that the machine was calibrated to allow the subject to become further acclimatized to the experimental situation. After this period was completed, a series of laboratory and imaginal stress tasks along with a "neutral" task was presented in a partially counterbalanced manner. The laboratory stress tasks were as follows:

1. Various mental arithmetic tasks which require the multiplication of a two digit number by a one digit number and the subsequent addition of a two digit number. For example, 14 x 3 + 17 = ? The subject was instructed to complete the problem as quickly as he could and give his answer. As soon as the correct solution was given to a problem, another was quickly presented. The problems were administered at a staccato pace for a period of one minute.
2. A second laboratory stress task was a letter association task, requring the subject to name all the words she could think of beginning with the letter "W." Most people are quite surprised when they exhaust their fund of words well before the end of the one minute period. If the subject faltered, she was urged by the experimenter via intercom to continue trying until the end of the time period.
3. A third laboratory stress task was the digits backwards portion of the Digit Span subtest of the Wechsler Adult Intelligence Scale. The test, however, was continued whether or not the subject faltered until the end of the one minute time period. This test required the subject to repeat backwards a list of numbers which had been related to her. For example, if the experimenter said "7-1-9," the subject should have responded "9-1-7."

In addition to these laboratory stress tasks, the subject was required to imagine each of the three stressful interactions which had been outlined in the initial meeting. When the subject reported that her mental image of a particular situation was clear,she was asked to take the role sheassumed in that situation and make all the verbalizations shemade then in the same manner he made them. Verbalizations of others were simply imagined. The subject was stopped after one minute of each of these "imaginal" stress tasks.

A "neutral" task required the subject to count upward from the number "1," imagining the number in her mind as he related it. This also lasted for a period of one minute. This "neutral" task was included to insure that the reactivity in response to the various "stress" tasks was not simply a matter of verbalizing material.

Before the administration of any of the tasks, the subject was alerted that in one minute she would be required to carry out a mental task. The purpose of this "alerting period" was to reduce the possibility of startle which might result from the abrupt introduction of a task. A five minute resting period followed the termination of each task to allow the subject to readapt to non-stress conditions. For this period, the subject was requested to simply sit back, close her eyes, and relax as much as possible without falling asleep. She had been informed that nothing would be acquired of her without a preceding warning delivered orally by the experimenter. There were seven tasks in total, three laboratory stress tasks, three imaginal stress tasks, and the neutral task. The entire recording session lasted approximately 1½ hours. The subject was then offered a debriefing if she desired it and allowed to leave.

Data Reduction

Physiological readings were noted during each of the seven one minute task presentations outlined above. Readings were also noted during the seven one minute "alerting periods". In addition, a reading was taken during the third minute of the rest period between the third and fourth stressor task. In total, then, there were fifteen one minute periods during which the various autonomic channels were appraised. Readings for each of these periods were reduced in the following manner:

For heart rate, each one minute period was divided into six ten second segments. The maximum level of HR for each of these segments was noted. The readings were then summated and averaged to achieve a representation of that minute's HR activity. The minimum level of heart rate was also noted for each of these segments. The minimum readings were then averaged and the difference between this average and the maximal average represented heart rate variability.

For finger pulse amplitude (FPA), a procedure similar to that used for the HR data was employed. The amplitude was reported in milimeters of deflection from the initial trough to the peak of the wave.

Readings of skin conductance (SC) will be transformed from resistance records to micromho units. The level of SC for a one minute period was the average of the six ten second samples. The lowest resistance reading (highest SC) was noted for each ten second segment.

RESULTS

The Student Mood Survey (SMS) was administered to a total of 291 females during the fall and spring semesters of the academic year 1977-78. Twenty eight of these students met the Beck Depression Inventory (BDI) score criterion of 14 or above. Of these, 18 met the additional criteria of age, frequency, interference magnitude and freedom from persistent physical problems which might affect the physiological recording. The resulting group statistics, along with the population data, are presented in Table 1.

Insert Table 1 about here

The frequency code scores were weighted as follows: a code of 0 corresponded with the statement "I very seldom feel blue." A code of 1 indicate blue periods on the frequency of once per month. A code of 2 indicated once per week, and a code of 3 indicated that the individual felt blue just about every day. For magnitude, a code of 0 indicated that feeling blue posed no problem for the individual in carrying out daily tasks, 1 indicated increased difficulty but eventual success most of the time, 2 indicated frequent failure in accomplishing daily tasks, and 3 indicated total failure. The final selection resulted in two groups, each composed of 6 whites and 4 blacks.

An analysis of the relation between BDI scores and estimates of frequency resulted in a product-moment correlation coefficient of +.48. This indicates a correspondence between these two measures, despite the fact that depression in a college

Table 1

Mean BDI, Frequency, and Interfering Magnitude

Results for Population and Groups

	Total Population		Normal Ss		Depressed Ss	
Measure	Mean	SD	Mean	SD	Mean	SD
BDI	6.8	5.4	5.4	1.1	19.0	3.5
Frequency Code	1.2	.8	1.0	.6	2.2	.42
Interference Magnitude Code	1.0	.6	1.0	.0	1.6	.9

age population is considered by many to be notoriously transitory. The correlation between BDI scores and measures of magnitude of interference was somewhat lower, +.26, indicating a weaker relationship between the inventory scores and the ability to accomplish daily tasks. Moreover, an even weaker relationship was found between the frequency and interfering magnitude estimations (+.18). As a result, the groups were not terribly dissimilar on the interference measure; seven of the depressed group indicated a code of 1 while the other three indicated a 3. All of the normal group indicated a 1.

Maximal Response Specificity-Tension Scores

As noted earlier, maximal response specificity refers to the tendency of an individual to react to varying stressing stimuli consistently with a maximal magnitude of response in the same channel. Other channels may vary in their respective magnitudes of response. It was expected that normal individuals, being more sympathetically tuned than depressives, would display higher degrees of maximal response specificity than the depressed individuals. Tension scores, examine the levels attained in the physiological channels during stress induction.

The comparison of a physiological response in one channel with the response of another channel poses a problem, since each is measured along different scales. To investigate maximal response specificity, it was first necessary to transform the scores of the channels into a common modality. This was accomplished by transforming the channel scores into a standardized T-distribution with a mean of 50 and a standard deviation of 10. A population of response scores to each stressor task was established for each channel which then were transformed along their own distribution. A matrix of an individual's standardized score in each channel to each stressor task was then formulated so that the individual's responses across channels could then be compared. The degree of maximal response specificity was derived by noting the maximum number of times the highest T-score to a) the three laboratory stress tasks and b) the three imaginal stress tasks occurred in the same channel. Three degrees of maximal response specificity were possible: 1) low specificity, in which the subject reacted maximally in a different channel to each of the three stresses, 2) medium response specificity, in which the subject reacted maximally to two of the three tasks in the same channel, and 3) high maximal response specificity, in which the subject showed a maximum reaction in the same channel to all three stressors. Frequencies of subjects displaying each degree of specificity were established for each group to the conditions of laboratory and imaginal stresses. To demonstrate whether the principle of maximal response specificity exists to a significant degree, the obtained frequencies of the degrees of specificity were compared to the frequencies that would be expected by chance, that is, if no specificity existed. The chance frequencies were calculated according to the procedures outlined in Lacey et al. (1953). This technique employed probability calculus to establish that, on the chance hypothesis, the probability of a subject displaying a maximal level of response in the same channel to all three stressors is $(\frac{1}{4})^3$ or 1/64. From the additive theorum, the expected frequency for a group of 10 subjects to show a high degree of maximal response specificity is 4/64 x 10. The chance expectations of other degrees of specificity are calculated in a similar manner with minor adjustments. The application of this technique resulted in chance expectations of .16 for high specificity, 1.23 for medium specificity, and 8.61 for low specificity. The obtained frequencies of the groups under laboratory and imaginal stress conditions are summarized in Table 2.

Insert Table 2 about here

To a-sess whether the obtained frequency distributions could be considered significantly different from the chance expectations, each of the obtained distributions was compared to the chance distribution by means of a Kolmogorov-Smirnov one sample test (Siegel, 1956). This is a "goodness of fit" test which compares the two cumulative frequency distributions and provides an estimate of whether the scores in one distribution can reasonably be thought to have come from a population having the other distribution. The application of this test to the four obtained distributions in Table II established all of them as being significantly different ($\underline{P} < .01$) from chance expectations. The principle of maximal response specificity was established as valid in both groups under each condition.

Having established the principle of maximal response specificity as valid, subsequent comparisons of the obtained frequencies were undertaken employing the Kolmogorov-Smirnov two Sample Test (Siegel, 1956) which operates under the same

Table 2

Degrees of Maximal Response Specificity

By Group and Condition Using Channel Levels

Group	Degree of Specificity		
	High (3/3)	Medium (2/3)	Low (1/3)
Normal (N = 10)			
Laboratory Stressors	5	5	0
Imaginal Stressors	7	3	0
Depressed (N = 10)			
Laboratory Stressors	4	6	0
Imaginal Stressors	3	7	0

rationale as the one sample test but allows the comparison of two obtained frequency distributions. Comparisons were made between groups under each of the stress conditions and between conditions for each group. There was no significant difference between situations for either group. Similarly, the difference between groups for the laboratory stress situation did not attain the level of significance. The normal group showed greater specificity under imaginal stress conditions while the depressives showed less specificity under the imaginal conditions.

Minimal Response Specificity-Tension Scores

Minimal response specificity refers to the tendency of an individual to consistently show a minimal response to stress in the same physiological channel across repeated presentations. It was expected that the depressed individuals, being more parasympathetically tuned, would evince higher degrees of minimal response specificity than the normals. Tension scores examine the levels attained in the physiological channels during stress induction.

The standardized matrices of response scores which were examined for maximal response specificity were also examined for evidence of minimal response specificity. The procedures which were employed to ascertain the existence of minimal response specificity were identical to those employed in identifying maximal response specificity with the exception that instead of noting the number of times a maximal response was noted in the same channel, the minimal response each time was noted. Other statistical and data manipulation procedures were identical.

The obtained distributions of minimal response specificity according to group and condition are outlined in Table 3.

Insert Table 3 about here

Again, all of the obtained frequency distributions achieved significance at the .01 level. The magnitude of change in the specificity distribution of normals from laboratory to imaginal stress was insignificant. The depressed group did not show a significant change in the predicted direction from laboratory to imaginal stress.

Since the differences between distributions were noted to be opposite the direction predicted, a two-tailed test was performed. The differences did not exceed the level of significance. The comparison of groups under conditions of laboratory stress revealed no significant differences. Similarly, the differences between groups under imaginal-role playing stress conditions did not exceed the .05 level of probability. To summarize, the investigation of minimal response specificity, as with maximal response specificity, demonstrated that both groups showed significant degrees of response specificity when compared to chance expectations. There were, however, no significance between group or between condition effects.

Maximal Response Specificity-Lability Scores

Because individuals vary in their customary physiological levels at rest, investigating the respective levels attained by the individual under different conditions may not accurately reflect the true process of an individual's reaction to stress

Table 3

Degrees of Minimal Response Specificity

By Group and Condition Using Channel Levels

	Degree of Specificity		
Group	High (3/3)	Medium (2/3)	Low (1/3)
Normal (N = 10)			
Laboratory Stress	5	5	0
Imaginal Stress	7	3	0
Depressed (N = 10)			
Laboratory Stress	7	3	0
Imaginal Stress	4	4	2

events. Therefore, the change (lability) scores from anticipation to stress induction were inspected also for evidence of maximal and minimal response specificity. It was originally intended that Lacey's (1956) autonomic lability score formula would be employed to mitigate the spurious effects of the Law of Initial Values on the magnitude of change scores. This formula seeks to correct for the poor correlation between pre-stimulus and actual stimulus induction levels. However, the correlations achieved in the present investigations were very high. For example, the lowest correlations for skin conductance and heart rate, respectively, were .93 and .76. The correlations were so high, in fact, that their application resulted in spuriously high lability estimates. For this reason, the autonomic lability formula proposed by Lacey (1956) was discarded and raw change scores were employed.

The results of the procedures employed to examine maximal response specificity are outlined in Table 4.

Insert Table 4 about here

As in previous investigations, all of the obtained frequencies differed significantly from the chance expectations. The groups did not differ significantly under either stress condition. Similarly, there were no significant differences in the distributions to laboratory versus imaginal stress for either group. No comparisons achieved the level of significance in the examination of maximal response specificity with change scores.

Table 4

Degrees of Maximal Response Specificity

By Group and Condition Using Lability Scores

	Degree of Specificity		
Group	High (3/3)	Medium (2/3)	Low (1/3)
Normal (N = 10)			
Laboratory Stress	3	7	0
Imaginal Stress	3	5	2
Depressed (N = 10)			
Laboratory Stress	3	5	2
Imaginal Stress	3	7	0

Minimal Response Specificity-Lability Scores

The obtained frequencies of the different degrees of specificity in this category are presented in Table 5.

Insert Table 5 about here

All of the obtained distributions exceeded the .01 level of probability when compared with chance expectations, with the exception of depressives under laboratory stress which exceeded the .05 level. The groups did not differ significantly under the laboratory stress conditions. Both groups, however, evinced significant increases in specificity from laboratory to imaginal stress conditions. Since these changes were in the same direction, the difference between groups under stress was not significant. No significance between group differences were found.

Pattern Stereotypy

Pattern stereotypy was examined to achieve a better idea of how reactivity in all the channels compared across stress situations. This was performed because of suggestions by various authors that depressives and other "pathological" groups are more disorganized than normals in their physiological responses to stress. To accomplish this, a coefficient of concordance (Siegel, 1956) was computed for each individual according to each type of stress condition. The concordance coefficient is a rank order correlation coefficient applied to instances where more than two sets of rankings are involved. The set of standardized scores for an individual to each

Table 5

Degrees of Minimal Response Specificity

By Group and Condition Using Lability Scores

	Degree of Specificity		
Group	High (3/3)	Medium (2/3)	Low (1/3)
Normal (N = 10)			
Laboratory Stress	4	4	2
Imaginal Stress	3	7	0
Depressed (N = 10)			
Laboratory Stress	2	4	4
Imaginal Stress	3	6	1

stress task was ranked in descending order, then a coefficient was computed for the three sets of rankings for each stress condition, laboratory and imaginal. In addition, a coefficient was computed for each subject under conditions of anticipation of stress. The group results of tense computations are graphed in Figure 1. The normal group evinced steady increases in

Insert Figure 1 about here

concordance from anticipation to laboratory stress to imaginal stress. The effects for the depressed group paralleled the trend of the normal group under anticipation and laboratory stress. Under imaginal stress, however, the depressed group dropped to a correlation of .70 while the normal group rose to .84. While this suggests a general movement toward discordance by the depressives as a whole, a Kolmogorov-Smirnov comparison of the two distributions of correlation values did not achieve the .05 level of probability.

Autonomic Tuning

In order to assess whether depressives, as a group, are "parasympathetically tuned" at rest and evince differential responsivity to stress, a multivariate analysis of variance (MANOVA) was performed on the dependent variables, by groups and conditions. The MANOVA allows an estimate of whether the dependent variables, as a whole, can differentiate between the groups across conditions. It was expected that the groups could be so differentiated by their physiology and that this difference would be along sympathetic-parasympathetic lines.

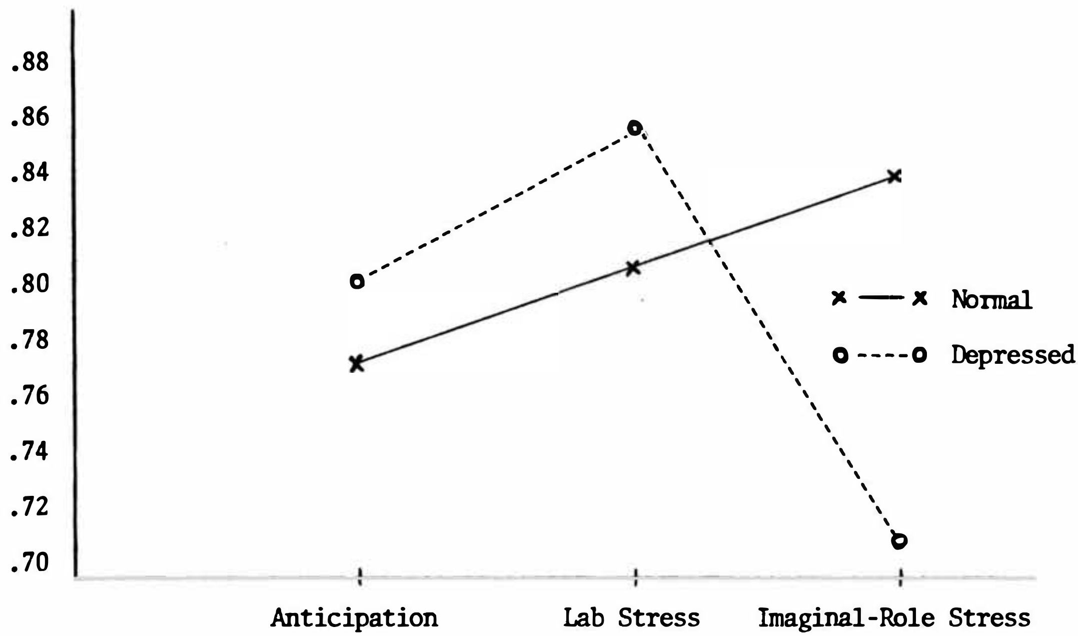

Figure 1

Group Coefficients of Concordance by Condition

Four conditions were included, rest, anticipation of stress, laboratory stress, and imaginal stress.

The MANOVA of channel levels revealed a significant condition effect for the combination of dependent variables, F (12,203) = 4.34 $\underline{P} < .01$. Similarly a significant group effect was found among the physiological variables, F (4, 69) = 3.9 $\underline{P} < .01$). The interaction analysis (group x condition) was insignificant, F (12, 203) = .14 P = .99).

To achieve a better idea of where the significant effects lie in the dependent variables, a series of univariate analyses of variance (ANOVA) were run investigating each physiological variable singly. As expected from the MANOVA results, no significant interaction effects were found for any of the variables. Significant condition effects were found for heart rate, F (3, 72) = 6.43 $\underline{P} < .01$, and for finger pulse amplitude, F (3, 72) = 6.71 $\underline{P} < .01$. Significant group effects were found for heart rate variability, F (1, 72) = 3.98 $\underline{P} < .05$, and skin conductance, F (1, 72) = 9.74 $\underline{P} < .01$. The depressed group evinced greater heart rate variability than [illegible] while skin conductance levels were lower for the depressed subjects. Channel levels for the groups are presented in Table 6. The MANOVA and ANOVA results are summarized in Table 7. Significant group effects are graphed in Figures II and III.

Insert Tables 6, 7 and Figures 2, 3

To arrive at a better idea of how the dependent variables can be employed to assess an individual's group membership,

Table 6

Summary Table of Channel Levels by Group and Condition

	HR(bpm)		HRV(bpm)		SC(Micromhos)		FPA(MM amplitude)	
Condition Group	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Rest								
Normal	86.11	7.79	13.46	2.96	.042	.018	28.03	22.25
Depressed	87.95	11.05	16.77	4.66	.029	.013	23.94	21.01
Anticipation								
Normal	89.36	9.00	14.18	3.18	.041	.018	19.08	12.09
Depressed	89.47	12.87	16.07	4.86	.030	.016	12.90	10.29
Lab Stress								
Normal	96.62	11.47	14.94	4.32	.048	.025	13.82	6.97
Depressed	94.84	12.46	15.90	5.77	.034	.020	7.71	3.46
Imaginal-Role Stress								
Normal	100.57	11.57	16.40	5.49	.052	.026	11.81	6.31
Depressed	102.04	13.45	18.56	5.27	.034	.019	7.74	4.78

Table 7

Summary of MANOVA Results for Channel Levels

Effect	df	SS	MS	F	P > F
		MANOVA			
Group				3.90	.006
Condition		PILLAI'S TRACE		3.35	.0002
Group X Condition				.14	.99
		ANOVA - Heart Rate			
Group	1	3.39	3.39	.03	.87
Condition	3	2486.76	828.66	6.43	.0007
Group X Condition	3	40.47	13.49	.10	.95
		ANOVA - Heart Rate Variability			
Group	1	86.71	86.71	3.98	.04
Condition	3	77.88	25.96	1.19	.31
Group X Condition	3	14.11	4.70	.22	.88
		ANOVA - Skin Conductance			
Group	1	.0039	.0039	9.74	.002
Condition	3	.0009	.0003	.80	.50
Group X Condition	3	.0001	.00003	.10	.95
		ANOVA - Finger Pulse Amplitude			
Group	1	522.96	522.96	3.19	.07
Condition	3	3304.03	1101.34	6.71	.0005
Group X Condition	3	21.43	7.14	.04	.98

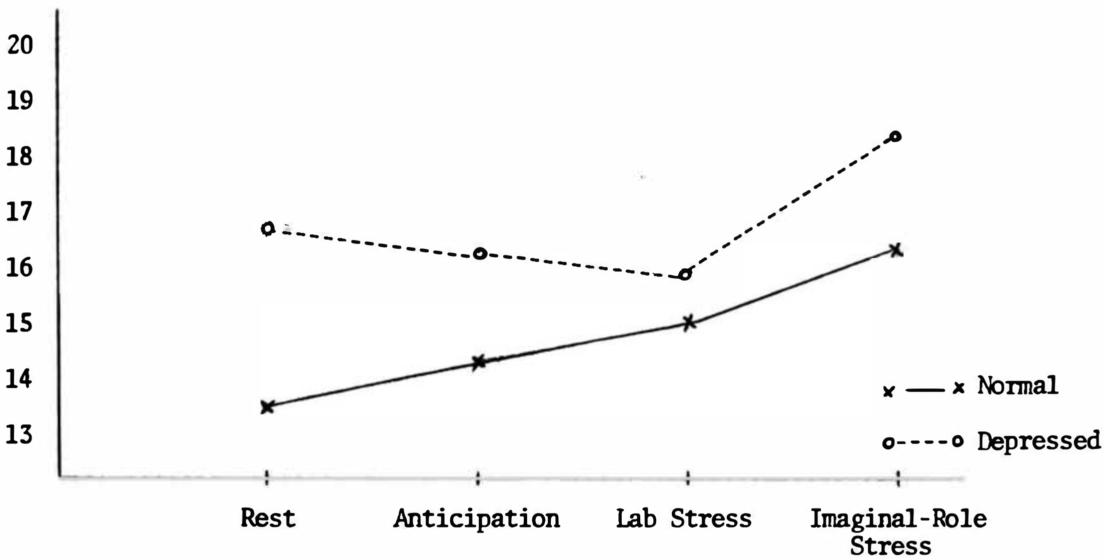

Figure 2

Heart Rate Variability by Group and Condition

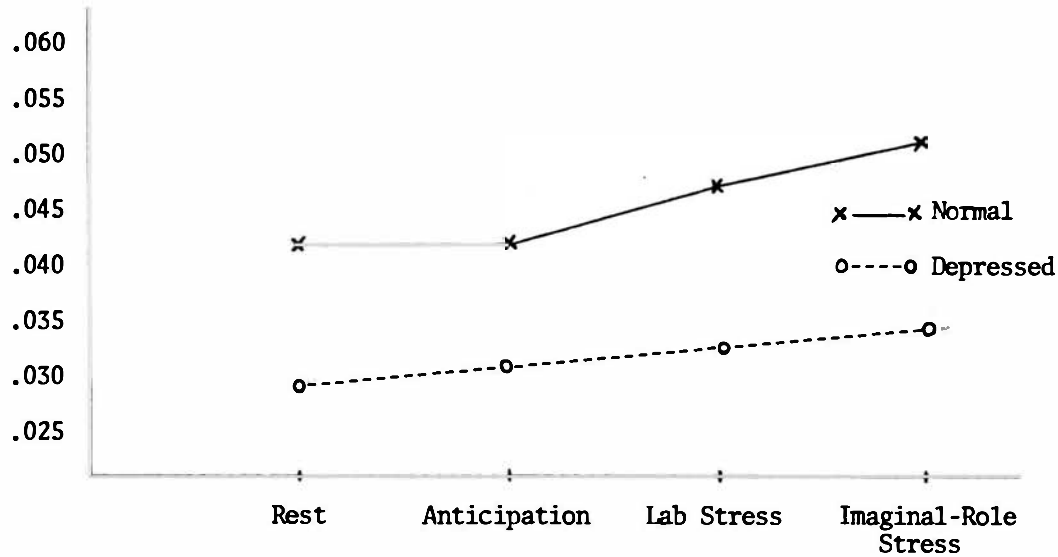

Figure 3

Skin Conductance Levels by Group and Condition discriminant analyses were run for each dependent variable as well as the optimal combinations of these variables. After calculating the optimal discriminant level for the variable or combination of variables, a post hoc group classification was performed on the average score for each subject under conditions of rest, anticipation, lab stress, and imaginal stress using the optimal discriminating level for the variable(s) at hand. The discriminant analysis procedure allows the estimation of the probability of group membership based on a subject's physiological level.

An anticipated from MANOVA and ANOVA results, heart rate did not discriminate well between groups. Finger pulse amplitude correctly classified 77.5% of observations involving depressed group subjects. However, use of this channel with normal group subjects misclassified 55% of them as depressed.

Heart rate variability proved to be a better discriminator for normal group subjects, correctly identifying 72.5% of observations involving them. For depressed group subjects, however, 57.5% of observations were misclassified.

Skin conductance proved the best single variable predictor of group membership as 82.5% of observations involving depressed group subjects were correctly classified and 60% of observations involving normal group subjects were accurately classified.

The best multiple variable combination in predicting group membership was skin conductance combined with heart rate variability. This combination increased the accuracy of the classification process involving depressed subjects to 85% and with normal subjects to 62.5%. The addition of the third best single variable discriminator, finger pulse amplitude, to this combination did not improve the discriminating power. Since there were four observations per subject which were classified, a criterion of 3 out of 4 classifications to a group could be established to assign group membership to a subject. Using this criterion, 90% of the depressed subjects were correctly identified as depressed, while 60% of the normal subjects were correctly identified as belonging to the normal group.

An additional MANOVA was undertaken to scrutinize more closely the change scores from rest to anticipation, from anticipation to laboratory stress, and from anticipation to imaginal-role playing stress. While this is largely redundant in light of the previous MANOVA outlined above, this previous analysis could only compare the levels attained under laboratory and imaginal-role playing stress without regard to their original base values under anticipation. The present MANOVA corrects this deficiency. This was necessary since it was expected that the groups would differ not only in their respective levels of physiological activity, but also in the magnitude of their responses to the various stressors. In this analysis, a significant condition effect was found for the group of dependent variables, $F\ (8, 104) = 5.39\ \underline{P} < .01$. Neither the group or interaction comparisons proved to be significant.

The univariate ANOVA's revealed significant condition effects for heart rate, $F\ (2, 54) = 26.0\ \underline{P} < .01$, and skin conductance, $F\ (2, 54) = 5.84\ \underline{P} < .01$. No other condition, group, or interaction effects were found. Lability scores of the groups are summarized in Table 8. A summary table of MANOVA and ANOVA effects are listed in Table 9. Since no group effects

Insert Tables 8 and 9 about here

were evident, no other post hoc tests were attempted.

Table 8

Summary Table of Lability Scores of Groups Between Conditions

Condition Group	HR(bpm)		HRV(bpm)		SC(micromhos)		FPA(MM amplitude)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Rest to Anticipation								
Normal	3.25	2.83	.71	1.43	-.0004	.0024	-8.94	11.32
Depressed	1.52	2.38	-.70	1.75	.0013	.0033	-11.04	12.74
Anticipation to Lab Stress								
Normal	7.25	5.40	.76	3.55	.0072	.0089	-5.25	10.79
Depressed	5.36	2.64	-.17	3.04	.0034	.0046	-5.19	8.00
Anticipation to Imaginal-Role Stress								
Normal	11.20	4.30	2.22	4.56	.0111	.0122	-7.26	10.95
Depressed	12.56	6.06	2.48	4.98	.0043	.0041	-5.15	6.28

Table 9

Summary of MANOVA Results for Lability Scores

Effect	df	SS	MS	F	P > F
MANOVA					
Group				1.17	.33
Condition		PILLAI'S TRACE		7.75	.0001
Group X Condition				.84	.56
ANOVA - Heart Rate					
Group	1	8.53	8.53	.49	.48
Condition	2	911.49	455.74	26.00	.0001
Group X Condition	2	33.75	16.87	.96	.38
ANOVA - Heart Rate Variability					
Group	1	7.28	7.28	.60	.44
Condition	2	65.59	32.79	2.71	.07
Group X Condition	2	7.53	3.76	.31	.73
ANOVA - Skin Conductance					
Group	1	.0001	.0001	2.68	.10
Condition	2	.0005	.0002	5.84	.005
Group X Condition	2	.0001	.00005	1.99	.14
ANOVA - Finger Pulse Amplitude					
Group	1	.01	.01	.00	.99
Condition	2	253.44	126.72	1.21	.30
Group X Condition	2	44.25	22.12	.21	.81

Discussion

The current investigation represents an attempt to examine and clarify how individuals respond autonomically to stressing stimuli. In particular, our study was directed towards pinpointing various characteristics of the responses of a group of questionnaire-depressed subjects that would differentiate them from a matched group of normals thereby providing an indication of the direction that a psychophysiological assessment of depression should take.

Before analyzing the results, there are some interesting features of the experimental group subjects which should be noted. All too frequently subjects for clinical research are classified into groups without sufficient regard for the mechanics employed to carry out this process. Much of the previous psychophysiological work carried out with a "depressed" group has employed hospitalized individuals who often could not be taken off medication for participation in research. In such cases, the experimenter's desire for exactness has had to be sacrificed for practicality and convenience. The present study employed college students who were not seeking treatment but scored sufficiently high on a valid self report measure of depression and also self reported a relatively high frequency of depressive episodes. While the present experimental group was probably not as severely depressed as groups employed in previous studies it does have a distinct advantage in that there is no problem with chemotherapy effects. Such drug effects would almost certainly alter autonomic functioning. Considerations must be kept in mind when comparing the results of psycho-physiological studies of pathological groups and may account for the prevalence of contradictory results in this area. In any case, the make-up of the present experimental group should be considered when comparing the results of this study with previous work in the area.

Since depression in a college age population is considered to be notoriously labile, data was also obtained estimating the frequency of depressive episodes among the subjects and the degree to which such episodes interfere with the subject's ability to carry out her normal activities. This was done by adding 2 questions at the end of the Beck Depression Inventory (BDI). Estimates of the relation between the total BDI score, which is intended to present an estimate of depression in the present, and the estimates of episode frequency and interfering magnitude were calculated to allow a further understanding of the nature of the experimental group. The correlation of .43 between BDI scores and estimates of episode frequency indicates a moderate correlation between these variables and provides support for the premise that depression in a college age population is more than a fortuitous, ephermeral experience. On the contrary, it appears that individuals achieving a high score on the BDI at some point in time are also likely to score highly when tested later.

Curiously, the relation between BDI scores and estimates of the interfering magnitude of depressive episodes was much smaller (.26). It must be concluded that those individuals scoring highly on the BDI, while they experience depression more often, are able to function as adequately in their daily activities as their counterparts who score lower. A poor correlation was obtained between estimates of frequency and interfering magnitude (.18). It appears that the experimental subjects who were prone to a high frequency of depressive episodes did not experience a greater severity of impairment that might be expected of them. The experimental group, then, was comprised primarily of individuals who experience a relatively persistent condition which seldom abates to any large degree but is not severe enough to seriously interfere with their ability to live their lives adequately. This relatively on-going, persistent condition suggests that endogenous rather than exogenous factors may be contributing to the make-up of the present experimental group. The significance of this factor will become more apparent as the characteristics of group differences are outlined.

The results of the multivariate analysis of channel levels confirms that the two groups employed in this study were differentiated from each other on the basis of the levels of the different physiological channels. The differences of these levels between groups exceeded the .01 level of probability. There were, several features of the univariate analyses which were either unpredicted or opposite from that predicted. Most importantly, the depressed group was not consistently differentiated from the normals on the basis of "parasympathetically tuned" channels. Because of this, hypothesis

8, which predicted that the normals, as a group, would be differentiated from a group of depressives by their greater sympathetic innervation of the channels across stressor tasks was not supported. The groups did not differ at all, for example, in levels of heart rate or finger pulse amplitude. The results in heart rate are particularly noteworthy since previous reports had alternately found higher and lower heart rates in depressed individuals. Perhaps the present experimental group was not as severely pathological to make these differences noted. The depressed group did show a wider range of heart rates across every condition in the experiment. It may be that, the expected differences were not found because the present experimental group was not under medication as has been one case in previously reported studies.

One measure which differentiated between groups was heart rate variability. Curiously, however, the depressed group evinced greater heart rate variability across the different tasks. This was unexpected as it was anticipated that a "parasympathetically-tuned" depressed group would produce smoother records of variability. The reason for this result is difficult to interpret. It is possible that the greater variability is due to an increased antagonistic action on the part of the autonomic subsystems with neither being able to exert dominance over the other. The parasympathetic nervous system tries to quicken the heart rate while the parasympathetic nervous system tries to slow the rate down. Just as likely, however, this effect may be an artifact of group differences in respiration. Respiration normally affects the heart's rate and depressives have, in previous research, been distinguished from normals by irregular rates of respiration. These results, therefore, may have been due more to a parallel effect on respiration. Unfortunately, the respiration channel was not monitored and its effect cannot be accurately gauged.

Skin conductance also proved to discriminate reliably between the groups. The effect for this channel was similar to what was hypothesized. The depressed group evinced lower levels of skin conductance consistetnly across the various conditions, apparently a result of less innervation from the sympathetic nervous system.

The discriminant analyses were undertaken to estimate how reliably the physiological channel levels would discriminate between the two groups. By calculating the optimal discriminant level for a particular variable, an assessment can then be made of the reliability of that channel for discrimination of group membership by noting the number of individuals in each group which are successfully placed in their group using their score in that channel. This process revealed skin conductance level to be the most reliable predictor of group membership. While heart rate variability was a significant discriminator between groups, the discriminant analysis showed that only slightly better than half of the subjects in the experimental group were correctly classified. This characteristic of their data suggests that the significant difference between groups in heart rate variability were biased to extreme scores in about half of the experimental groups subjects. Skin conductance level, on the other hand, correctly identified nine of the ten depressed subjects as belonging in the experimental group, suggesting that it may be a more reliable gauge of depression. This conclusion is supported by the fact that the combination of heart rate variability and skin conductance in a discriminant analysis improved only slightly the discriminating power of skin conductance level alone.

The results of the multivariate analysis of channel level demonstrate that while the two groups employed in this study were differentiated on the basis of various physiological channels, this differentiation was not along sympathetic-parasympathetic lines as was suggested in research by Gellhorn (1963), Wenger (1972), and Patton (1969). The concept of overall sympathetic or parasympathetic tuning as an explanation for a various psychopathological disorder, in this case depression, appears inadequate in light of the present results. While one physiological variable did evince the expected parasympathetic levels expected of the depressed group, the others showed no difference or were opposite from that expected. It is obvious from this that no single physiological variable could be chosen at random and be expected to discriminate between the groups.

The explanation of differences demonstrated in this study require a more complex conceptualization of the contributing factors. Instead of the anticipated parasympathetically tuned physiology, the depressed group showed a tonic fractionation of certain channels. It appears that studies directed toward examining the processes which foster the development of such fractionated patterns will likely lead toward a better understanding of the evolution of depression. Research investigating the physiological patterns resulting from environmental acceptance or rejection (Lacey, 1967) and orientation versus defensive reactions (Sokolow, 1963) are important steps in this direction.

The present study clearly demonstrates, however, that a low skin conductance level is the best physiological index of the depressive state. While definitive research to pinpoint the subject variables which might result in a low skin conductance are lacking, some spectulation is warranted. Lacey (1967) found that a decrease in skin conductance was associated with a tendency on the part of the subject to reject stimulus information in the environment and rather pay attention to covert activity such as mental processes. Consonant with this, several researchers have found that biofeedback treatments directed toward lowering the level of other channels, such as heart rate and EMG, have resulted in unexpected concomitant increases in skin conductance level (Kerkpatrick, 1971; Gatchel, 1976; Gatchel, Korman, Weis, Smith, and Clarke, 1978). These authors have suggested that this increase is due to the heightened vigilance necessary to attend to the biofeedback signal. While these data are far from conclusive, they suggest that an individual with a low level of skin conductance, like the depressed subjects in the present study, may be an individual who is not attending to environmental stimuli, but rather is attending predominantly to self produced covert stimuli. If this description is indeed true of a depressed individual, the goal of psychotherapy with such a person would be to help him to attend to relevant environmental stimuli and regulate his behavior accordingly. If successful, such a strategy would result in a higher level of skin conductance for that person.

The MANOVA employing lability scores provides further evidence that the overall sympathetic vs. parasympathetic perspective is inadequate in assessing the psychophysiology of depressed individuals as stated in hypotheses 9. It was expected that the depressed group, because of a parasympathetic tuning, would show smaller responses to the stressors than normals and that the magnitude of the difference between groups would become greater during higher levels of stress. This was not supported by the present experiment. In the lability MANOVA, no significant group or interaction effects were evident. These results were obtained in contrast to previous research by Patton (1969) which demonstrated that individuals low on autonomic balance (parasympathetically tuned) show smaller responses than normals to stress across channels.

Although the depressed group could be differentiated from the normal group on the basis of the tonic levels of certain channels, there were no phasic differences evident in any of the channels to any of the stress tasks. The differences in channel levels were evident regardless of whether the condition examined was rest, anticipation, or stress. This finding indicates that the physiological correlates of depression are tonic in nature rather than phasic. These findings have important implications for procedures employed to assess the psychophysiological correlates of depression. The present experiment was planned to allow the presentation of several levels of stress which would magnify the expected phasic differences. It was expected that this procedure would prove adequate in establishing a pre-post methodology to demonstrate any changes in phasic activity. The results demonstrate, however, that a longtitudinal assessment approach would be best employed with a depressive, to ascertain changes in tonic level. While tonic level could also be employed in a pre-post therapy manner, continuous monitoring of several channels may help pinpoint critical points in therapy at which the level began to change. This may aid in assessing therapist behaviors which contribute to the alleviation of the depressed state. Biofeedback of skin conductance and other involved channels may prove to be an important adjunct to the therapy process. As mentioned earlier, skin conductance level has proven to be amenable when feedback is provided (Kostes, Rapaport, and Glaus, 1978). If a depressed client reports an improvement in his state and fails to show a higher skin conductance level, the permanence of this improvement may be questionable. Only further research can answer the question of whether the physiological indices provide a more foolproof gauge of improvement.

A critical issue raised by the results outlined above is whether to expect tonic change in physiological variables as a function of therapeutic intervention. The data concerning lowered skin conductance among a depressed individual may indicate a physiological predisposition to depression rather than being a result of depression. If this is so, significant change in this channel may not be expected. Dawson, Catawa, and Schell (1977) found that hospitalized depressives undergoing electro-convulsive treatment evinced behavioral improvement after treatment but showed little change in those aspects of their physiology which differentiated them from normals. Whether this level will change as a consequence of therapeutic intervention, then, is an issue in itself. Again, only longitudinal research designs can answer this question. Current longitudinal research being carried out in this laboratory should provide some preliminary answers to this question (Doverspike and McCullough, personal communication).

The analysis of the relative tendencies of each group to show maximal and minimal response specificity was performed to determine whether a single channel indicant of stress could be found equally well for each group. The results of this part of the investigation revealed that both groups displayed maximal and minimal specificity significantly more than would be expected from chance expectations. While this confirms previous reports for the normal group, (Lacey, Bateman, and Van Lehn, 1953; Lacey and Lacey, 1958) the present study is the first to demonstrate that specificity exists in a depressed population. This result confirms hypotheses 1, 2 and part of hypotheses 4. However, the goal of finding a single physiological channel which was clearly most responsive across was not attained. In each group, there were higher occurrences of medium degrees of response specificity (2 out of 3 trials) than high degrees of response specificity (3 out of 3). This indicates that the process of identifying a physiological variable for monitoring is more a matter of choosing between a few variables which appear to respond equally rather than pinpointing the only channel which responds to stress.

The analyses of the degrees of response specificity shown by groups and conditions did not result in any significant comparisons. There are, however, some intriguing configurations in the data. From their respective levels of specificity under laboratory stress, the groups demonstrated different reactions to the imaginal-role playing stress tasks. The normal group under these latter conditions showed higher degrees of response specificity than they did to the laboratory stressors as revealed in tables 2 and 3. These same tables demonstrate that the depressed individuals tended to show diminished degrees of response specificity. It appears as if the normal group was moving toward more consistency in response to higher level stressors while the depressed group became more inconsistent under these conditions. The effects, however, were not great enough to achieve a significant level of probability. Because of this hypotheses 3 and part of hypotheses 4 must be rejected. The normal group did not evince a significantly greater degree of maximal response specificity nor did it show less minimal response specificity. Hypotheses 5, which predicted that the group tendencies to show each type of response specificity would not differ under the two conditions of stress was confirmed. These results lend further support for the conclusions derived from the MANOVA of channels levels. The assessment of depression does not appear to depend greatly on the phasic effects of varying degrees of stress. The normal and depressed groups did not differ from each other to a significant degree.

It was noted, however, that there appeared to be a possible trend toward significant group differences in specificity under higher degrees of stress. The results of the pattern stereotypy investigation parallel these findings. Since pattern stereotypy takes all channels into account, it should present more accurate evidence of any tendency on the part of the depressed group to show less concordance than the normal group under higher degrees of stress. The data presented in figure 1 shows that while the normal group evinced steady increases in concordance to higher degrees of stress, the depressed group becomes more discordant under the highest stress level. Again, as with the investigation of the response specificities, the analyses of this effect were not significant. If the experimental group had been comprised of individuals who were more severely depressed or had it been possible to pinpoint and present even higher levels of stress, this observation might have been magnified. This is an area for possible future investigation. For the present data, however, while both groups showed significant degrees of pattern stereotypy under each of the conditions, supporting hypothesis 6, there were no significant differences between the groups, which necessitates a rejection of hypothesis 7.

The results of the specificity and stereotypy investigations indicate that the suggestions of Ferguson (1957) and Reynolds (1961) that pathological groups will show greater discordance under stressing stimuli are not supported by the present data. It does appear, however, that some sort of condition by group interaction may be at work. While this did not reach a significant level in the present investigation, further inquiry appears to be warranted. The results do support the findings of Crooks and McNulty (1966) who showed that normals and a pathological group (schizophrenics) both displayed significant degrees of specificity and stereotypy, but found no between group differences.

Summary of Major Conclusions

One major finding of the present investigation is that while normal and depressed individuals could be differentiated on the basis of various physiological channels, the effects were not consistent across channels nor were they all in the predicted direction. This indicates that the expectation that these groups could be discriminated on the overall level of channels considered in terms of sympathetic or parasympathetic tuning is too simplistic an approach to take. Many depressives showed "fractionated" levels when compared to normals. Some showed low skin conductance along with high heart rate variability, some others showed low skin conductance along with low finger pulse amplitude. Skin conductance level was the best single variable discriminator between the groups. Depressed individuals consistently show lower levels of skin conductance.

A second major conclusion of this study is that the physiological assessment of depression should be directed towards tonic changes in the physiological channels than phasic changes to stressful stimuli. While the MANOVA of channel levels found group differences, the lability MANOVA found no group differences. This suggests that a preferred strategy of demonstrating physiological change with a depressed client is to monitor the level of a specified channel(s) over time rather than examining the response of that channel to specified stimuli. A longtitudinal approach to physiological assessment appears preferable. The channel of choice, in the case of depression, would be skin conductance. In specific cases, other channels may be monitored as well. Two likely possibilities are heart rate variability and finger pulse amplitude.

The third major conclusion of this study is that both groups displayed response specificity and pattern stereotypy to a significant degree. This is the first demonstration of specificity and stereotypy in a depressed population. The expected differencies between groups, however, were not found. Despite this, there did appear to ba a possible trend toward greater discordance of physiological channels under high levels of stress. This was not significant, however, and cannot be concluded to exist on the basis of the present data. A more definitive statement in this area must await further study.

Limitations of the Present Study

The results and conclusions outlined above must be considered with several limitations of this study in mind. First, as noted previously, none of the individuals comprising the depressed group were treatment seekers. Because of this, caution should be employed in directly comparing this with other studies employing depressives. It is possible that there is no direct link between mild and severe depression. On the other hand, the utilization of the present experimental group obviated several problems which pervade previous studies, such as the influence of on going chemotherapy. The present study, therefore, can be considered an improvement over previous studies in many ways.

This study employed the laboratory stress tasks as low level stressors against which physiological reactivity of the imaginal-role playing tasks could be compared. A prefered approach might have been to have the subject delineate several neutral or low stress interpersonal situations in addition to the high stress situations. The comparison would then be of a very similar nature and allowed a more robust comparison of the low and high stress tasks.

A problem which particularly affects the specificity and stereotypy results is the low number of presentations of each stress condition to the subjects. The three presentations of each was the minimum number possible to allow a statistical analysis of the data. A more protracted series of presentations would have been preferable to achieve more reliable results. For the present study, time constraints would not allow this.

Another consideration concerns the stress situations themselves. The present study found no group by condition effect for the physiological channels. Subjects were simply asked to delineate stressful encounters they had had. If the subjects in the depressed group had been made aware of the reason that they were chosen for this study and were asked for stressful situations which specifically influenced depression, perhaps a situational effect would have been found.

One limitation concerns the methods employed in determining specificity and stereotypy. All previous studies investigating this area have changed the results of each physiological channel to T-scores to allow a simple comparison across channels. The process of changing raw data to a T-distribution, however, has the effect of normalizing the distribution (Minium, 1970). This, in effect, slightly alters the data in relation to the mean. Since each channel had a distribution formulated for itself and these were then compared to each other for evidence of specificity and stereotypy. Such small alterations in position may alter the rank of one channel in relation to another. Since the rank of a channel was often determined by as little as 1 T-point, this could alter the results to a significant degree. It is difficult to estimate how much this would have changed the results of the present study. It appears that the use of Z-scores as a standard of channel comparison would have circumvented this problem.

Another issue involves the method employed in handling the data for standarization. The present study listed the channel responses of both groups before standardizing the information. It appears, in retrospect, that a better method would have been to simply standardize the channel responses of the normal group and use the mean and standard deviation of the normal group in standardizing the depressed group. This would have maximized the separation of the groups. For example, if the normal and experimental groups had displayed mutually exclusive distributions in a channel to a stimulus, with the experimental group showing consistently lower levels, standardization procedures which consider both groups would yield a T-value of about 48 for the highest score in the experimental group. If the normal group had been first standardized and this group's mean and standard deviation was employed to standardize the experimental group, the highest experimental group score would have been approximately three standard deviations below the mean, or about 20. Since, in the present study, the reactions of the normal group are considered a standard against which the reactions of the experimental group was compared, this alteration in methodology would likely have been preferable. It is difficult to estimate how much this would have altered the specificity and stereotypy results, but, in the example of skin conductance, in which nine of the ten depressed subjects showed low levels, it is apparent that the standard scores of the depressed group would have been much lower and thus this group would likely have shown more minimal response specificity. In fact, high degrees of minimal response specificity was predicted in the depressed group but not found. This procedural problem may be the reason.

Suggestions for Further Inquiry

Several basic issues raised by the present investigation await further examination. One issue, as outlined above, concerns the manipulation of the raw data to compare groups for evidence of specificity and stereotypy. A detailed examination of the methods employed to this point should aid in answering this question.

A second issue is how to employ the methodology used in this experiment to evaluate a single case. The determination of specificity and stereotypy as well as simply identifying a channel as high or low is dependent upon comparing an individual's responses to those of his peers. In a single case design, there would be no standard against which the client's responses could be compared. It is therefore difficult to evaluate how the individual's response is abnormal. How to best solve this dilemma is a worthy goal of inquiry.

A third issue raised by these results concerns the processes which result in patterns of response which vary from what normal groups display. As mentioned above, depressed individuals appear to have tonically low skin conductance, many times with either high heart rate variability or low finger pulse amplitude. The answer to why these differences occur should provide insight into the process of the depressive disorder.

It is possible that the physiological differences between normal and depressed subjects represent a physical predisposition rather than a result of learned methods of dealing with the environment. If so, change in the physiological modality may be much more difficult to foster. The modifiability of the relevant channels may provide an index of the permanence that can be expected of behavioral change. If the individual is physiologically predisposed to depression, the focus of therapy might be different than would be normally taken.

Finally, although the present investigation failed to find any group by-condition interaction effects as anticipated, the imposition of anticipation periods, laboratory stress tasks, and the imaginal-role playing stress tasks resulted in consistent condition effects. This suggests that the "phasic" approach which was employed in this study, while not useful in the assessment of depression, can be useful in the physiological assessment of problems which are more "situationally dependent" in nature, such as the various types of state anxiety. Further research applying this assessment approach with other types of disorders is indicated. With results from such studies, a better understanding of the etiology, process, and change methods which pertain to various disorders can be achieved.

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Appendix A: Task Instructions

A. Introduction

At various times during the next hour and a half, you will be required to perform certain tasks with lengthy rest periods between each task. These tasks will be varied and you will not know what they are until I present them to you. I'll let you know one minute before giving you the instructions for each task. Now please close your eyes and relax as much as poysible without falling asleep. Please remember to try to remain as still as is comfortably possible throughout the session. Are there any questions? We will now begin the first rest period.

B. Warning Instructions

In one minute, you will be required to perform one of the tasks.

C. Laboratory Stress Task Instructions

1. Mental Arithmetic

This task will require you to solve various arithimetic problems in your head. I'll give you a problem and I want you to give me the answer as quickly as you can. When you give me the correct answer, I'll give you another problem. Do you understand? Here's the first problem:

16 x 2 + 12 = ?
15 x 7 + 38 = ?
39 x 7 + 15 = ?
49 x 4 + 17 = ?
67 x 4 + 39 = ?

2. Letter Association

For this task I would like to name all the words you can think of beginning with a certain letter. In a second, I'll give you a letter, then you start naming. Do you understand. Ok, the letter is "W."

3. Digit Span

For this task I am going to say some numbers. After I have finished, I want you to say them backwards. For example, if I say 7-1-9, you would say 9-1-7. Do you understand? Ok, let's begin.

(a) 6-2-9
(b) 4-1-5
(c) 3-2-7-9
(d) 4-9-6-8
(e) 1-5-2-8-6
(f) 6-1-8-4-3
(g) 5-3-9-4-1-8
(h) 7-2-4-8-5-6
(i) 8-1-2-9-3-6-5
(j) 4-7-3-9-1-2-8
(k) 9-4-3-7-6-2-5-8
(l) 7-2-8-1-9-6-5-3

D. Imaginal Stress Task Instructions

During the next minute I would like you to recall one of the interpersonal situations we outlined in our first meeting. You remember that one of those situations involved (outline the situation). I would like you to picture that encounter in your mind right now as clearly as you can and relive it vividly, as if it is happening to you right now. As you relive it, take your own role and say out loud now what you said then, as you said it then. You can simply imagine what the others said and did. Remember to remain as still as comfortable while you do this. I'll tell you when to stop. Try to picture the situation in your mind now and when its clear, say "ready" and I'll instruct you to begin.

E. Neutral Task Instructions

For this task, I would like you to count upwards from the number one, picturing the numbers in your mind as you count. In other words, picture the number two in your mind and say it, and soforth. I'll tell you when to stop. Do you understand? Ok, begin.

F. Instructions at Task End

Ok, that's enough. There will now be another lengthy rest period. Just sit back, close your eyes, and relax as much as possible without falling asleep. I'll give you a one minute notice before I introduce the next task.

Appendix B: Student Mood Survey
(Beck Depression Inventory)

Student Mood Survey

Instructions: This is a questionnaire. On the questionnaire are groups of statements. Please read the entire group of statements in each category. Then pick out the one statement in that group which best describes the way you feel today, that is right now! Circle the number beside the statement you have chosen. If several statements in the group seem to apply equally well, circle each one. Be sure to read all the statements in each group before making your choice.

A. 0 I do not feel sad.
1 I feel sad.
2 I am sad all the time and I can't snap out of it.
3 I am so sad or unhappy that I can't stand it.

B. 0 I am not particularly discouraged about the future.
1 I feel discouraged about the future.
2 I feel I have nothing to look forward to.
3 I feel that the future is hopeless and that things cannot improve.

C. 0 I do not feel like a failure.
1 I feel that I have failed more than the average person.
2 As I look back on my life all I can see is a lot of failure.
3 I feel I am a complete failure as a person.

D. 0 I get as much satisfaction out of things as I used to.
1 I don't enjoy things the way I used to.
2 I don't get real satisfaction out of anything anymore.
3 I am dissatisfied or bored with everything.

E. 0 I don't feel particularly guilty.
1 I feel guilty a good part of the time.
2 I feel quite guilty most of the time.
3 I feel guilty all of the time.

F. 0 I don't feel I am being punished.
1 I feel I may be punished.
2 I expect to be punished.
3 I feel I am being punished.

G. 0 I don't feel disappointed in myself.
1 I am disappointed in myself.
2 I am disgusted with myself.
3 I hate myself.

H. 0 I don't feel I am any worse than anybody else.
1 I am critical of myself for weaknesses or mistakes.
2 I blame myself all the time for my faults.
3 I blame myself for everything bad that happens.

I. 0 I don't have any thoughts of killing myself.
1 I have thoughts of killing myself but I would not carry them out.
2 I would like to kill myself.
3 I would kill myself if I had the chance.

J. 0 I don't cry any more than usual.
1 I cry more now than I used to.
2 I cry all the time now.
3 I used to be able to cry but now I can't cry even though I want to.

K. 0 I am no more irritated now than I ever am.
1 I get annoyed or irritated more easily than I used to.
2 I feel irritated all the time now.
3 I don't get irritated at all by the things that used to irritate me.

L. 0 I have not lost interest in other people.
1 I am less interested in other people than I used to be.
2 I have lost most of my interest in other people.
3 I have lost all of my interest in other people.

M. 0 I make decisions about as well as I ever could.
1 I put off making decisions more than I used to.
2 I have greater difficulty in making decisions than before.
3 I can't make decisions at all any more.

N. 0 I don't feel I look any worse than I used to.
1 I am worried that I am looking old or unattractive.
2 I feel that there are permanent changes in my appearance that make me look unattractive.
3 I believe that I look ugly.

O. 0 I can work about as well as before.
1 It takes extra effort to get started at doing anything.
2 I have to push myself very hard to do anything.

P. 0 I can sleep as well as usual.
1 I don't sleep as well as I used to.
2 I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.
3 I wake up several hours earlier than I used to and cannot get back to sleep.

Q. 0 I don't get any more tired than usual.
1 I get tired more easily than I used to.
2 I get tired from doing almost anything.
3 I am too tired to do anything.

R. 0 My appetite is no worse than usual.
1 My appetite is not as good as it used to be.
2 My appetite is much worse now.
3 I have no appetite at all anymore.

S. 0 I haven't lost much weight, if any, lately.
1 I have lost more than 5 lbs.
2 I have lost more than 10 lbs.
3 I have lost more than 15 lbs.

I am purposely trying
to lose weight by
eating less.
Yes _____ No _____

T. 0 I am no more worried about my health than usual.
1 I am worried about physical problems such as aches and pains, or upset stomach; or constipation.
2 I am very worried about physical problems and it's hard to think of much else.
3 I am so worried about physical problems, I cannot think about anything else.

U. 0 I have not noticed any recent change in my interest in sex.
1 I am less interested in sex than I used to be.
2 I am much less interested in sex now.
3 I have lost interest in sex completely.

V. 0 I very seldom feel "blue."
1 I have periods of feeling "blue" about once per month.
2 I have periods of feeling "blue" about once a week.
3 I feel "blue" almost every day.

W. 0 Feeling blue very seldom affects my performance.
1 When I feel "blue," it's harder for me to get things done, but I usually do them.
2 When I feel "blue," I have to struggle to get things done and many times fail.
3 When I feel "blue," I can't seem to get anything accomplished.

Appendix C: Interpersonal Stress Survey

Stress is customarily defined as a mentally or emotionally disruptive influence or distress. We all are occasionally faced with situations which we can term as stressful. Most people would label an important job interview as a stressful event. Another example might be answering questions in class or an argument with someone. I would like you to take a few minutes to jot down three recent situations which involved yourself and another person interacting and which you found to be stressful. There is no need to write it out in detail, just summarize it in a sentence.

Situation #1

Situation #2

Situation #3

Appendix D: Consent for Physiological Recording and Research Participation concerning the purpose of this project if I so request it.

Participant's signature________________________

Investigator's signature________________________

Date________________

Consent for Physiological Recording and Research Participation

I agree to participate in a project of research that involves the investigation of bodily changes which occur while I perform certain mental tasks. I further understand that I will be requested to delineate three interpersonal situations which I found to be stressful and that confidentiality will be strictly observed in regard to this material. I also understand that during a second session, various electrodes will be attached to my skin and that such bodily activity as my heart rate and skin resistance will be monitored through these electrodes. All of my questions have been answered concerning the physiological recording process at this time and I will feel free to ask further questions concerning these procedures as they occur to me in the future.

Since accurate physiological measurements of bodily activity are crucial in the research project in which I am about to participate, I agree to observe these conditions for two hours before the recording session.

1. I will not smoke cigarettes/cigars/pipe before or during the recording session.
2. I will not eat.
3. I will not drink alcoholic beverages, colas, coffee, tea, or cocoa.
4. I will not drink anything for $\frac{1}{2}$ hour before the recording session.

I also understand that I may voluntarily withdraw from this project at any time I so desire. In addition, I understand that I may receive a debriefing afterward with more detailed information