

AN EXPERIMENTAL INVESTIGATION OF
THE RELATIONSHIP BETWEEN CERTAIN
PERSONALITY CHARACTERISTICS AND
PHYSIOLOGICAL RESPONSES TO STRESS
IN A NORMAL POPULATION

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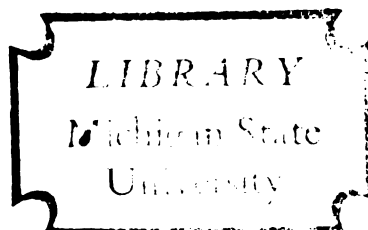
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BETWEEN CERTAIN PERSONALITY CHARACTERISTICS
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By
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ABSTRACT

Problem. Investigation of relationships between personality descriptions and physiological responses to stress situations.

Subjects. A single group of sixty normal males aged twenty-four to fifty-nine.

Procedure. Measures of GSR, heart rate, respiration rate, and EMG's were recorded in response to mild sensory stimulation and psychological stress. Personality tests were the Cattell Sixteen Personality Factor Questionnaire and the Guilford-Zimmerman Temperament Survey. T-scores from twelve derived physiological measures and twenty-six test factors were intercorrelated. Extracted from the correlation matrix were clusters of significant intercorrelations appearing among the physiological measures and between personality and physiological measures.

Results and conclusions. 1. Characteristics summarized as "social introversion," lack of spontaneity or freedom of emotional expression, and a tendency to conduct one's self in a rational, unemotional manner were found to be associated with a tendency to respond to stress with some kind of physiological disturbance.

2. Even though similarities in personality descriptions were associated with both autonomic response tendencies and muscle response tendencies, consistent differences were also found. The autonomic responder may not exhibit overt emotional expression, but he is emotionally sensitive. He tends to be introspective, and his feelings are easily hurt. He is prone to worry, and fears he is not accepted by others. The muscle responder appears to be more effective than the autonomic responder in attempts to deny emotion completely and to approach life in an intellectual, unfeeling manner. He tends to remain isolated from others, but instead of worrying he goes his own way, not caring particularly what others may think of him. He exhibits a lack of concern for social convention and tends to lack inhibition in social action.

3. There were some suggestions that psychological stress was a more potent stimulus for those people who tend to respond predominantly with autonomic changes, and that sensory stress or startle was a more potent stimulus for muscle responders.

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CHAPTER I

INTRODUCTION

The interest in psychophysiological relationships has been a long and persistent one in both psychology and philosophy, as is evident in the centuries-old mind-body problem. The large amount of theorizing centering about this problem has been of varying degrees of generality and has covered a wide range of possible aspects of psychophysical relationships. In most cases it has been in the form of sheer speculation, or a substitute for more precise information, or deductions admittedly based upon few available facts and observations; but all too often hypotheses have been accepted as well-substantiated knowledge. The result is that there are large differences in emphasis and importance attached to one aspect or another on the relationship of "mind" and "body." There are many cases of diametrically opposed views and statements, each of which may appear equally valid. Experimental tests of hypotheses and systematically collected information in this area have been largely lacking. This may be attributable to (1) the lack of testable hypotheses and theories, and (2) inadequate instruments and techniques

for obtaining reliable and quantitative psychological and physiological data.

It is very difficult to define what is meant by "psychophysiological relationships," and it is probable that the choice of the term itself is unfortunate due to the metaphysical mind-body implication which may be associated with it (87). The limits of this relationship as a field of study have been interpreted in many ways. In some cases the field is so broad that it has become synonymous with the whole field of psychology. An attempt to separate the psychological from the physiological is admittedly almost purely arbitrary and most often based upon the immediate focus of interest or nature of measuring instruments employed by the writer considered.

There is considerable speculation about psychophysiological relationships in anxiety and in psychiatric and psychosomatic disorders. Specific examples are theories of emotion such as that of Cannon (22), theories of anxiety as represented by those of Freud and Mowrer, psychomotor aspects of mental disorders (89), Selye's general adaptation syndrome (137), various formulations regarding psychosomatic disorder, typological and factorial theories of personality, and other special interests such as the study of lie-detection.

A primary assumption of nearly all theories about disorders of functioning, whether they be called psychological, psychosomatic, or exclusively physical, is that the disorder comes about as a result of the organism's adaptation to stress. Except for the work of Selye (137) the assumption is only occasionally made explicit, but it is so generally present implicitly that it becomes almost a truism and is not likely to be disputed. In psychosis we refer to the personality as breaking down under stress. In the realm of physical diseases we think of the body as breaking down under stress. Precipitating stress in physical diseases might be in the form of the invasion of a foreign organism as Mycobacterium tuberculosis in the case of tuberculosis. With respect to practically all psychosomatic diseases, reference is made to chronic emotional stress of one kind or another.

Purpose of the Study

Beyond the agreement that stress may produce both psychological and physical symptoms, we know very little about the relationship between personality and the resulting physical symptoms. There has been considerable speculation and some research devoted to relationships found in people already ill.

However, two major problems arise in these considerations. First, little is known about what relationships between personality and physical responsiveness to stress may be found in a normal, healthy person. Second, and what seems to be a more crucial point, little is known about what types of disease processes are most readily superimposed upon particular types of psychophysiological make-up. The present study addresses itself to the first problem. In this study an attempt is made to explore further and to specify the nature of psychophysiological relationships in a normal group of people. This will be done by correlating measurable physiological responses to mild psychological stress with scores obtained on some wide-spectrum personality tests. It is hoped that the results of this study will provide baseline data and will offer leads for attacking the second problem in subsequent studies.

CHAPTER II

REVIEW OF THE LITERATURE

Plan of the Chapter

It is impossible to review all of the vast literature that might be relevant to this problem. Dunbar's (41) review of emotion and bodily changes as they may relate to psychosomatic disorders covers over five thousand references, and many others have escaped her scrutiny. There are widely divergent opinions about the nature of psychophysiological relationships. This is especially true in the writings about personality factors in psychosomatic disorders, where one can find many variously conflicting statements about such relationships. Despite conflicting opinions there are notable trends toward some modal points of agreement. At the risk of implying more general agreement than may actually exist among the various writings, those selected for review will consist largely of findings which contribute to some general trends of agreement. The review will serve to indicate the state of our knowledge about the relationships between personality and bodily changes and to furnish some hypotheses which may be tested. This

body of literature to be reviewed will be arbitrarily divided into four categories.

The first category of literature to be covered deals with experimental findings relative to physiological responses to stress in both normal and various patient groups. A second group of papers to be reviewed will include a sampling of the vast theoretical and speculative writings, as well as some experimental findings about personality characteristics associated with various psychosomatic disorders. The third group of papers in the following review deals more specifically with relationships between personality and physiological responses to stress. The first three areas are closely interlocking, with the findings in each supplementing the others. The first will serve to demonstrate that stress can produce physiological changes, while the second deals with the relationship between personality and disorders related to certain changes in physiological function. The latter group of papers is more pertinent in the discussion of the results of this study, but is included for brief review at this time because findings here supplement trends pointed out in the other two areas. The third group of papers deals with the role of personality in these physiological changes. It is this group of papers which is most pertinent to the present study.

A review of a fourth body of literature, that dealing with the tendency for various physiological systems of the body to respond differentially to stress stimuli, is included because of its relevance to a major factor in the design of this experiment.

Physiological Responsiveness to Stress in Various Groups

The body of literature which deals with the elicitation of changes in physiological functioning in response to stress stimuli must be considered in an attempt to understand the relationship between personality and physical functioning, and, ultimately, the etiologic role personality may play in pathology of physical function and structure. These studies are not directly relevant to the problem of investigating the role of personality factors in physiological responses to stress. However, they are important in bridging the gap between the study of the role of personality factors in physiological responses to stress and the study of personality factors in various disorders. This gap will be filled by a demonstration of the altered physiological functions found in psychosomatic and other disorders and their association with responses to known stress situations.

It is a common observation that various types of stress, including chemical and metabolic stimulation, pain, fear, frustration,

and various other types of psychological stress, may produce alterations in various physiological functions of the body. Mahl (109) demonstrated an increased gastric acidity in dogs when they were subjected to chronic fear arousal. The increased acidity was present when the fear was conditioned as well as when the fear was a direct response to primary pain stimulus. An important observation in this study was the failure to find an elevation of gastric acidity under conditions of acute stress, but the elevation occurred only after prolonged periods of fear-induced behavior. Mahl and Brody (110) compared the fasting gastric acidity level of a group of chronically anxious subjects and a group of symptom-free subjects and found a higher acidity level in the anxious group. The anxious group also tended to show a greater increase in acidity than the control group when stress was induced.

Wolf and Wolff (164) studied the gastric secretions in a single individual over a prolonged period of time and found that under conditions of alarm and acute stress there was no elevation in hydrochloric acid secretion, but rather, at times, an inhibition of secretion. When the anxiety or stress was protracted, significant elevation of hydrochloric acid secretion was noted. In a review of some of the literature on stress and hydrochloric acid secretion Mahl (109) cites several other studies confirming the findings that

hydrochloric acid secretion is particularly associated with chronic anxiety but not necessarily with acute anxiety. Altschule (7) and Selye (137) emphasize the relationship of chronic stress to all types of physiological disturbances. Mahl and Karpie (111) report one of the most clear experimental demonstrations that the source of anxiety or nature of the conflict is not a critical factor concerning whether or not there is increased hydrochloric acid secretion. They obtained repeated gastric samples from two patients during a series of psychoanalytic therapy sessions and found a marked association between the level of gastric acid and the level of anxiety manifested in the sessions. Anxiety was noted to be evoked by any one of a number of different conflict situations including dependency, hostility, sexual themes, and others. There was no association between hydrochloric acid secretions and the mere appearance of dependency or any other needs during the hour. Mittleman and Wolf (123) and Whittkower (161) arrived at essentially the same conclusions from studies of a somewhat different nature.

Rise in blood pressure is perhaps one of the most consistently demonstrated physiological responses to stress. As long ago as 1920, Cannon (21) stated that this was one of the better established phenomena in the physiology of emotions. Funkenstein and associates (56) have found the blood pressure response to chemically

induced stress of mecholyl and epinephrine injections to differ with psychiatric diagnosis, and to be associated with the degree of anxiety present. Clemens (30) has shown that these drugs stimulate other physiological responses in addition to that of blood pressure.

Malmo and Shagass (115) found that psychoneurotics responded to various types of stress situations with a significantly greater and more prolonged rise in blood pressure than did normal controls. The same held true for heart rate, although the difference was less significant. Under conditions of rest, blood pressure and heart rate did not differentiate the neurotics from the normals. Wolf, Wolff, and associates (162, 163) found that hypertensive patients also responded to stress with greater blood pressure changes than did normals. Malmo and Shagass (115) found a psychoneurotic group to show more skeletal muscular responses to stress stimuli than normals when observation of movements was emphasized. This finding confirmed previously reported electromyographic studies showing that neurotic groups produced greater muscle response to stress than normals (116, 118).

From such results one might, at first, conclude that people with emotional disorders simply show a greater physiological lability than normals in response to stressful events. However, when Malmo and Shagass (115) examined intraindividual differences, they

found an inverse relationship between the amount of autonomic reaction as manifested by blood pressure changes and the amount of direct skeletal motor reaction as revealed by muscular responses. Freeman and Pathman (52) offer evidence that this inverse relationship between external and internal responses to stress is also present in normal subjects.

Another study by Malmo and Shagass (113) sheds some further light upon this finding. Their primary purpose in this study was to investigate the relationship between the severity of anxiety and the degree of physiological disturbances under stress. In response to stress stimulation the anxiety group exhibited consistently greater physiological reactions than other patient groups, with the normal controls usually exhibiting the least response. Thus, their findings support the hypothesis that the degree of physiological disturbance is related to the severity of anxiety. Their second finding, which is of particular interest here, was that the disturbance of the skeletal muscles as determined by EMG and finger movement was particularly characteristic of the anxiety-neurotic group. The group classified as manifesting overt anxiety tended to react to the threat or danger represented by the pain stimulation by direct motor response, which in this situation would appear to be an over-response. This point of view, as Malmo and Shagass state, implies an

impairment in motor control or a reduced capacity of the anxious subjects to inhibit actions. No essential difference between the responses of anxiety neurotics, mixed patients, early schizophrenics, or normal control groups was found when they were compared on the basis of heart rate and GSR changes. It would have been of considerable theoretical interest if their sample had included a group of psychosomatic patients or a group considered to have problems with over-control in order to determine whether or not this type of patient might have shown a predominance of internal rather than external responses.

Jurko, Jost, and Hill (86) reported strikingly similar results in a study employing psychological stress instead of physical stress. During the period of stress the neurotics showed over-reactions in all areas of physiological response including muscle potential, blood pressure, respiration, and GSR. The control group responded principally with changes in palmar skin conductance and blood pressure during the stress period, although the changes did not differ significantly from those made by the anxious group, who responded in a generalized fashion. They exhibited little change in respiration or muscle responses during stress. This study would seem to suggest that a normal group is prone to react to stress principally with internal visceral responses while neurotics tend to react with a

generalized energy discharge. A further difference between the reactions of patients and controls, which finds confirmation in other studies, was that the controls were able to effect a more rapid recovery to equilibrium than either neurotics or schizophrenics (51, 52, 84, 85, 91). Their study, like that of Malmö and Shagass (113), lacked an inhibited, overcontrolled group for determining whether or not the reverse relationships might have held for them. The authors, however, speculate that the so-called "internal" visceral discharge becomes the normal habitual way of responding to any and all disturbances. But, they say, it may become excessive with the psychosomatic disorder representing the price paid for maintaining external calm. Freeman and Katzoff (51) found that among normal subjects those rated most neurotic showed a higher degree of emotional response and a slower rate of recovery than did those rated less neurotic. Psychotics responded with a greater internal arousal than normals and in general showed highly variable responses but with less physiological disturbances than neurotics or "neurotic normals" (53). This finding is in agreement with those obtained by other investigators (86, 113, 114) and suggests that perhaps the psychotic has found a solution, even though a deviant one, to his conflicts, while the neurotic continues to struggle and make persistent nonadjustive responses. The anxiety neurotic who is thought

of as "jumpy" and exhibits defective controls may show heightened external responses to stress, while the overcontrolled neurotic, such as the obsessive-compulsive and the psychosomatic, might show heightened internal responses to stress. This hypothesis is suggested by previous studies, but not adequately tested.

However, several reports dealing with the relationship between the presence of various physiological disfunctions and physiological responses to stress shed further light on this problem. VanderValk and Groen (151) studied the galvanic skin reactions of several patient groups and a normal control group under conditions of rest and several experimental conditions designed to resemble real-life stress. They found that, under conditions of rest during the prestress period, the normal group was able to relax but the psychosomatic groups as a whole showed a significantly higher level of autonomic response, apparently because suspense was tension-producing for the latter groups. Their interpretation of this finding was that people with hypertension, peptic ulcers, ulcerative colitis, diabetes, and some vascular diseases--i.e., those showing elevated initial responses--have difficulty discharging emotions in normal actions of speech or activity. Later in the experiment they found these groups exhibiting significantly greater changes in their skin resistance than controls and nonpsychosomatic patient groups when

they were asked to answer emotion-laden questions. This study, then, is in agreement with several others in demonstrating a greater autonomic lability in patients suffering from psychosomatic disorders.

Gottschalk, Serota, and Shapiro (63) found some tendency for rheumatoid arthritic patients to show a greater background level of EMG response to psychological stress than either normal controls or arthritic patients in psychotherapy. Patients with cardiovascular complaints, however, showed similar elevated EMG activity. Multiple electromyographic tracings were the only physiological response measures employed; therefore, it is not possible to determine whether these two groups may have differed on the basis of other types of physiological measures.

Malmo and Shagass (114) present convincing evidence that a relationship exists between physiological lability of an organ or organ system and functional disorders of that system. They found cardiovascular and respiratory responses to stress were significantly greater for the group of cardiovascular patients than the group with head or neck complaints. The patients with head and neck complaints produced significantly greater neck muscle potentials. The significance of the association between the area of greatest disturbance and the area for which there was a history of complaints was further heightened when they found no significant differences in

muscle scores between cardiovascular and noncardiovascular patients who also had no neck and head complaints. The same lack of difference was found when the heart and respiration scores were compared for head and neck complainers and non-head and -neck complainers. The conclusion that psychiatric patients with somatic complaints tend to manifest increased physiological responsiveness in the related physiological system when under stress seems, on the basis of the obtained evidence, to be justified.

Jost, Ruilman, and Gulo (84, 85), in a series of studies involving multiple physiological measurements in a group of hypertensive patients and in several control groups, found with respect to hypertension a similar association between the physiological systems manifesting disorder of function and the system showing the greatest disturbance in response to stress. The hypertensive group showed greater blood pressure changes in response to varying stress stimuli than normals. This group was not differentiated from normals on the basis of any other physiological responses. The hypertensive group actually exhibited less respiration response than the normal control group.

Mittelman and Wolff (122) found that patients with Raynaud's disease, a psychogenic vasocirculatory disorder, tended to respond to emotionally arousing situations with greater reduction of finger

temperature than other groups. An even greater fall of finger temperature occurred under conditions of prolonged apprehension. Peptic ulcer patients whose disorders involve another physiological system, but which are also under autonomic control, failed to show finger temperature changes.

Summary of physiological responsiveness to stress. In summary, this section has pointed out several consistencies in physiological responses to stress:

1. Stresses of various kinds bring about various measurable changes in bodily functioning.
2. Chronic stress seems to produce greater internal physiological responses than acute stress.
3. Physiological changes may result from any type of stress. The specific nature of the conflicting situation does not seem to be an important factor determining what type of physiological response will result.
4. The amount of physiological responsiveness to stress stimuli is positively associated with the level of anxiety.
5. There appears to be an inverse relationship between autonomic and overt muscular responses to stress.

6. Some suggestion is made that overt anxiety and the lack of control of overt behavior is associated with muscular responses while a high degree of control is associated with autonomic responses.

7. Stress tends to produce greater physiological disturbances in systems manifesting disorders of function than in other systems.

The Role of Personality in Disease

Because of the direct relevance that the association between personality and physiological responsiveness has for psychosomatic disorders, a brief discussion of the vast literature relative to the role of personality in disease is included at this time. There is hardly a disease on record, psychiatric, psychosomatic, or purely physical, about which there has not been speculation concerning concomitant and/or predisposing personality factors. Largely due to our lack of precise knowledge, the divergence of opinion is widely varied and conflicting. Some of the agreements will be discussed here.

In discussing the etiology of psychosomatic disorders most writers refer to an accumulation of undischarged tension which becomes channeled into the viscera (5, 6, 38, 96, 133, 144, 154). The primary personality characteristic associated with psychosomatic

disorders, according to these authors, seems to be the inability or restricted ability to relieve tension (2, 144, 165). This general notion is stated or implied in a number of different ways, with various embellishments and modifications. There are also specific exceptions to these generalizations.

Before discussing specific personality characteristics which have been considered to be associated with psychosomatic disorders, some general points of view of various authors should be mentioned. One group holds that there are no special personality features peculiar to psychosomatic disorders. Oberdorff (129), Klein (91), Kubie (96), Altschule (7), Cobb (31), Schroeder (136), and Selye (137) feel that there is little in the personality of those suffering from psychosomatic disorders to differentiate them from neurotics in general. They see no justification for separating personality types of those suffering from different psychosomatic disorders. They are all in agreement, however, that chronic stress is a necessary condition for the development of physiological disfunction which leads to recognized psychosomatic disorders. Even many of the authors who emphasize specific personality factors recognize the importance of chronic, unrelieved tension.

At the other extreme is a position of such authors as Halliday (77), Dunbar (40), Weiss and English (154), and Grace and Graham (64)

who say that each psychosomatic disorder has a unique characteristic personality pattern related to it. They oppose the idea of a grouping of all these disorders and speaking of personality factors characteristic of psychosomatic disorders as a group. Close examination of Grace and Graham's (64) description of the widely varying personality patterns associated with different individual psychosomatic disorders reveals that chronic, unreduced tension is a common characteristic of each of their descriptions but they failed to point out this fact.

Other authors occupy middle ground between these two extreme points of view. They may hold a "generality" position which states that the personality patterns of psychosomatic sufferers as a whole are homogeneous but may be characteristically different from personality in other types of disorders (2, 71, 96, 109, 145, 146). A comparable point of view is the "symptom specificity" position of Alexander and French and many of their followers who hold that, although a characteristic psychosomatic personality may be distinguished, different disorders are associated with varying subclasses of these personality features or different specific conflict situations (5, 6, 36, 61, 88, 123, 144).

Since there is no convincing experimental evidence that personality differs significantly between each psychosomatic disorder,

all such disorders will be considered together when certain personality factors associated with psychosomatic disorders are discussed. This will be done despite the fact that some authors may write concerning only a single disorder and others may feel that each disorder is unique with respect to personality correlates.

Regression to an earlier level, although not correctly classified as a personality characteristic, is felt by a number of authors to be the basic psychological phenomenon associated with psychosomatic disorders (5, 6, 38, 96, 146). Some speak of a simultaneous physiological and psychological regression (119). Reusch (132) feels that instead of regression, an arrested development is the primary factor in all psychosomatic disorders. His thesis is that because they tend to remain socially isolated, the psychosomatic process occurs in immature individuals.

Repression seems to be the defense mechanism most frequently associated with psychosomatic disorders (5, 6, 94, 125, 154). Several of the behavioral descriptions to be listed are related by their authors to this mechanism. Ackerman (2), however, feels that suppression, a more conscious volitional process, better characterizes the psychosomatic personality.

Obsessive-compulsive personality components used both as a behavioral description and as an explanatory construct are frequently

mentioned (5, 38, 40, 61, 77, 134, 154). Halliday (77) lists specific descriptions including never losing one's temper, being clean and tidy, prompt and orderly, always truthful, always busy, always doing one's duty, and always perfect as examples of obsessive-compulsive behavior associated with various psychosomatic disorders.

Passivity and dependency features come in for extensive discussion among both psychoanalytically oriented and nonanalytically oriented writers. Dependency is referred to more often than passivity (5, 6, 18, 33, 36, 61, 88, 105, 112, 123, 130, 134, 154). Daniels (33), Kapp (88), Mahoney (112), and Poser (130) mention both separately, while Modell (124) refers only to passivity. Similar traits which are mentioned are inhibition and lack of assertiveness (61, 112, 134, 135). Submission to authority and lack of aggressiveness are felt by Poser (130) to characterize personality features found in those suffering from psychosomatic disorders. Conformity, conventional behavior, and doing what is expected are similar patterns mentioned by others (61, 94, 133, 134, 135). Self-restriction and control are also suggested by the use of the descriptive terms "stereotyped," "lacking imagination," and "failing to use projective imagery" (94, 160).

Another personality feature frequently associated with psychosomatic disorders seems to be an inability to face problems and

attempt solutions. Grace and Graham (64) and Stevens and Matthews (144) refer to a retreat from the problem with a focusing of attention on the self. Lack of courage, "giver-upper," fearfulness, feelings of inferiority, and feelings of inadequacy are also mentioned in connection with the inability to face problems (18, 33, 61, 105).

Many authors agree that the psychosomatic sufferer keeps his feelings to himself and engages in little overt emotional expression (2, 61, 77, 105, 134, 135). Halliday (77) and Kapp (88) seem to contradict many other descriptions when they describe the psychosomatic as self-assertive, self-sufficient, and overactive. Several others, however, mention these traits as manifestations of superficial cover-up for passive-dependency needs (5, 6, 18, 124, 133).

Two experimental investigations of personality factors in psychosomatic disorders appear to warrant more detailed consideration. Krasner (93) administered the three Guilford-Martin factor inventories along with several other tests to a group of duodenal ulcer patients, a group of ulcerative colitis patients, and a non-psychosomatic control group. He found that when both patient groups were considered together their scores on six of the Guilford-Martin factors differed significantly from those of the control group. In terms of those tests the obtained differences would suggest that the psychosomatic group was more shy, withdrawn, seclusive, socially

passive, lacking in confidence, as well as more emotionally unstable than the nonpsychosomatic group. The colitis group differed from the ulcer group in terms of being somewhat more inhibited and emotionally overcontrolled, and perhaps, more lacking in confidence. Other tests such as the Thurstone Interest Schedule, background information questionnaire, and morphological data yielded nonsignificant differences. There were significant I.Q. differences but these were corrected for in the analysis of the data.

Frankle (48) approached this problem by the use of an inventory of somatic symptoms and complaints in a normal group rather than using a group suffering from some specific disorder. The inventory used consisted of both the somatic and psychic sections of the Cornell Medical Index. When the continuum of emotional repression-dilation was measured by means of the Minnesota TSE Inventory, it was found that the emotionally introverted person showed significantly more somatic complaints than did the extroverted ones. There were, however, no such differences between the "extroverts" and "introverts" with respect to nonsomatic complaints. Although this study left much to be desired in terms of design, it tended as did studies by Krasner and others to point out the existence of relationships between personality and physical symptoms in groups where psychosomatic disorders were diagnosed.

Abrahamson (1) found a group of social offenders to manifest a somewhat more pronounced history of psychosomatic disturbances than did a group of neurotics, although both groups had a higher than average incidence of such complaints. An intriguing result of this study, which is of some theoretical interest, was the finding that in the group of social offenders antisocial acts were often found to be absent during those periods of time when psychosomatic complaints were present. On the other hand, there appeared to be a tendency among the neurotic subjects to use projective defenses when psychosomatic complaints were absent.

Summary of the role of personality in disease. In summary, there is considerable evidence presented in observational reports and experimental studies that a much greater than chance relationship exists between the presence of physical disorders which can have a psychogenic basis and the inability to gain overt emotional release. Most of the personality descriptions refer to severe emotional control, keeping one's feelings to oneself, and a lack of assertiveness or overt effort to solve problems. This body of literature suggests that susceptibility to psychosomatic disorders is inversely proportional to the tendency to "act out" and discharge tension into the external musculature. Some of the more speculative writers

make explicit their feelings that at the opposite end of this personality continuum are such disorders as overt anxiety and psychopathy (3, 46).

There is notable lack of agreement as to what role personality factors play in the etiology of psychosomatic disorders.

Personality and Physiological Reactions

The third group of studies to be reviewed directly concerns the relationship between descriptions of personality or patterns of behavior and physiological responses to stress situations. These are the reports most directly related to the present investigation. The full significance of the contributions of these studies to the theoretical considerations about the relationship between personality and physical functioning is, however, not obtained except when they are considered in conjunction with the previously reviewed topics of investigation.

Among the earliest and most extensive group of studies dealing with the role of personality in physiological functioning are those conducted over a period of years by Jones (81, 82, 83). His primary interest was an investigation of the relationship of external and internal processes in the expression of emotions. Galvanic skin response was the only reported measure of internal emotional expression

used in the studies, although in a later discussion he referred to various other polygraph measures which were obtained but not yet analyzed (83). Measures of external expression were made by various observational methods, psychological tests, and behavior rating scales.

The first study was an investigation of the responses of a group of infants to a series of stress stimuli (81). The group as a whole, when compared with older subjects, were less easily aroused to produce GSR responses, and, when responses were obtained, they tended to be of low magnitude. He found that children who tended to cry or react with bodily movement showed less skin response than those who exhibited no external response to the stimuli. He also found that when GSR did occur the response was often reduced or eliminated when the child began to cry, even when the crying was induced by intensification of the stimulus.

Another study by Jones (82) consisted of an investigation of responses made by a group of preschool children to a wide variety of stress stimuli. For the group as a whole the correlations were high between GSR and overt responses to any stimulus. Therefore, no stimulus appeared to elicit one type of response more than another although there were differences in the arousing value of different stimuli. When correlations between external and internal reactions

were determined for each individual's response to the various stimulating conditions, the average correlation dropped to low, but still positive, values. Three rather distinct individual patterns of responses were recognized. "Externalizers" were represented by those who displayed marked overt body reactions, but little GSR; "internalizers" showed the reverse of this relationship; and "generalizers" showed about equal levels of external and internal response. Most individuals demonstrated fairly consistent patterns of response from one stimulus to the next. The obtained patterns also appeared to be stable characteristics of each child. This was demonstrated when the group obtained high reliability coefficients upon retest.

In the third study of this series, polygraph measures of responses to psychological stress were obtained from a group of adolescents (83, 127). On the basis of independent psychologists' ratings of behavior made over a long period of time, the group of lowest GSR reactors showed significantly more attention-seeking behavior, talkativeness, animation, and assertiveness than did the group of high-reactors. At somewhat lower levels of significance the low-reactors were also judged to be more excitable, irritable, impulsive, and to behave in a more irresponsible fashion than the "highs" who, on the other hand, were rated as more calm,

deliberate, good-natured, cooperative, and responsible. The high internal reactor group also appeared to exhibit a greater constancy of mood.

Peers were in essential agreement with the psychologists in that their ratings of attention-seeking, talkativeness, restlessness, and "bossiness" also significantly differentiated the high and low reactor groups. In most of these cases where there were significant differences the behavior rating scale T-score values obtained by the low reactor group showed greater deviation from the mean of the group as a whole than did the behavior ratings of the high reactor group.

This group of children was given ratings on certain motivational factors by another group of psychologists who studied them over a period of several years (54). The group who produced the lowest GSR's were rated to have significantly greater drives for aggression, dominance, recognition, and drive for escape. The last was described as a tendency to evade tensional situations, project failures onto others, and escape into immediate pleasures rather than to attain future goals.

A later follow-up of these randomly selected normal children into adulthood has not yet been reported. The obtained results, however, suggest some interesting trends. The first study showed

infants, whom we know to be impulsive and without much learned control of wants or behavior, to exhibit little internal response to stress. However, even at that early age, there appears to be some inverse relationship between overt response tendencies and physiological disturbance in response to stress. At a somewhat later age immediate responses to mild stress are greatly reduced while GSR responses have increased but the responses tend to show some relationship, in the same direction, to characteristics of expressiveness. Jones believes that the increased inner responses occur when the child learns that immediate overt response to certain wants may be punished. The relationship between characteristic modes of behavior and physiological responsiveness to stress which appears in early childhood tends to become more distinct as the child grows into adulthood. These studies suggest that the response pattern of the "normal" individual consists of a certain minimal level of internal response and inhibition of external responses, yet retaining the ability to discharge overtly emotions in the appropriate situations or when stress is severe. At the extreme of the low internal responders, Jones found adolescents who were uninhibited and were sometimes behavior problems in school; some were already showing qualities resembling those of the psychopath. The internalizers were much more socially controlled, and, in some cases, might be thought of

as inhibited or overcontrolled. It is too early to tell whether the high internal reactors may be paying the price of psychophysiological disorders for their socially desirable overt behavior. These data offer some basis for the speculation that, since the behavior of the low internal reactors deviated most from the group norm, psychopathic behavior problems may develop earlier in life than psychosomatic problems. This is given further support by several other findings that internal autonomic disturbances are most often associated with prolonged chronic stress (7, 109, 137, 164) and would therefore tend to go through a longer incubation period before becoming pathological.

A number of studies lend support to the hypotheses suggested by Jones's studies as well as offer further suggestions. Landis (101) found that those groups of delinquents who showed signs of overt emotional expression such as becoming frightened, angry, or crying while performing a series of difficult motor tasks exhibited less GSR responses than the average of the total group. Since this experimental group consisted of social behavior problem children, many of whom could be presumed to show psychopathic trends, it would have been of considerable theoretical value if their average GSR level could have been compared with that obtained from a normal group.

The hypothesis that internalized responses may replace more direct external ones during childhood development, because of fear of being punished for overt responses, is given some support by King's (90) findings of a significant relationship between various heightened cardiovascular responses to experimental stress and the subject's perception of being dominated by the father's discipline.

Funkenstein, King, and Drolette (57) found very significant relationships between the direction of anger and the degree of physiological responsiveness to stress in a normal group. They found that the group whose most frequent emotional response consisted of turning anger inward produced significantly greater autonomic responses to stress than those who reacted by turning anger outward onto the experimenter and other subjects. Those who showed predominant anxiety signs also showed greater physiological responses than those who turned anger outward. The "anger-in" group differed significantly from the "anger-out" group in four of the six measures of physiological responsiveness used, and the "anxiety" group differed from the "anger-out" group in a like direction in five out of the six measures. With respect to three of the measures, the "anger-out" reaction deviated from the resting levels in the direction opposite those made by the "anger-in" and "anxiety" groups. Similar results were obtained from a group of psychiatric

patients studied by Funkenstein (55). He found that patients who directed their anger inward obtained an epinephrinelike or autonomically excited pattern of physiological responses to stress, while those whose anger was directed outward produced a nonepinephrinelike, or autonomically tranquilizing pattern of responses.

Funkenstein (57) found that a group of normal students exhibited physiological responses to injections of epinephrine more like those exhibited by the "anger-in" and "anxiety" groups in response to psychological stress than those who turned expression of anger outward. He did not report any relationships between different degrees of response and behavior patterns or personality characteristics. But a similar study by Funkenstein and associates (56) which employed psychological stress tends to suggest that subjects classified as internalizers on the basis of description of overt behavior would show a greater autonomic response than externalizers. These studies from the Funkenstein laboratory tend to point out, each in its own way, the positive relationship between increased autonomic responsiveness to stress and a lack of external emotional expressiveness on one hand and a relationship between few autonomic responses and unrestricted behavioral expression of feelings on the other hand. The normal pattern, as was suggested by Jones, tends to lie more in the direction of internalization and autonomic

responsiveness along the direction of externalization and few autonomic responses.

The results of a study by Bockoven, Greenblatt, and Solomon (16) offer some indirect contradiction to the hypothesis that the person who responds with sympathetic discharge tends more to internalization of emotional expression than the one who may react with parasympathetic discharge or little physiological disturbance. They studied the physiological responses to chemical and sensory stimuli of a group of chronic schizophrenics in whom they found a significant association of sociometric ratings of organized, constructive, and friendly activity with low autonomic responsiveness. Patients described as engaging in unfriendly, disorganized, and nonconstructive activities reacted to stress with increased sympathetic activity, or autonomic tension. A later report from the same laboratory written by Greenblatt (68), which is based on an integration of three separate studies, clears up this seemingly earlier contradictory finding with results more in line with most other studies. In this group of studies, psychological tests, sociological ratings, and physiological measures were obtained from a group of chronic schizophrenic patients as part of a larger investigation of schizophrenia (69). He found, in addition to the association of organized, constructive, and friendly activity with an absence of marked internal tension,

that this group of patients also maintained an ability to overtly express dissatisfaction in a social situation and to react vigorously to stimuli. He found poor abstraction and integration and a low level of social interaction to be associated with marked sympathetic reactivity. A third group of schizophrenics with the poorest treatment prognosis showed neither integration and social responsiveness nor internal tension.

Boyd and DeMasico (17) attempted to relate social behavior and autonomic physiology by means of a study of social interaction and physiological responses of a single individual during a psychiatric interview. Their results indicate that expression of negative effect, as determined by the Bales system ratings of social interaction, was accompanied by reduced internal sympathetic tension. At the beginning of the interview, which followed the lines of a "stress interview," the patient showed a high level of sympathetic activity which tended to decline throughout the hour except at those times when he expressed positive affect. Due to the nature of the interview one might speculate that these internally disturbing positive expressions may have been a socially acceptable cover-up of his true feelings.

Block (15) contributed further evidence on the relationship between physiological responsiveness and the suppressive-expressive personality continuum when he examined the GSR responses of a

group of medical school applicants in a lie-detection type of stress situation. Those classified as GSR "reactors" were rated on psychological evaluations as having significantly greater directing of tension inward, protecting of those close to them, seeking of reassurance, withdrawing in the face of frustration, having easily aroused guilt feelings, moralistic and strict, and ethically consistent. "Non-reactors" received significantly more frequent ratings as expressing hostility directly, valuing of personal autonomy, being skeptical and critical, overcompensatory in their handling of fears, rebellious, masculine, and having unconventional thought processes. Reactors were found to score significantly higher on the Depression and Psychasthenic scales of the Minnesota Multiphasic Personality Inventory while nonreactors scored high on the Hypomanic and Ego Strength scales.

Hsu (79) reported a study in which he presented a series of emotionally laden words, words which might be related to personal problems, to a group of normal subjects while obtaining GSR measures. Ratings were made by the subject of the degree of emotional disturbance associated with each word. The only significant relationship between factor analytically derived clusters of words reacted to by GSR and clusters of words rated as disturbing indicate that the greatest GSR occurred in response to a group of words

rated by the subjects as being emotionally disturbing. These were passive words suggestive of being at the mercy of others. Thus, the only case in which a relationship between physiological and psychological factors was found in this study occurred when the subjects who worried about passivity and being at the mercy of others were reminded of this problem. These findings give some focus to the early findings of Crossland (32) that greater GSR responses were associated with general lack of personal adjustment.

A very extensive factor analytic study by Terry (147) involved twenty-two measures of physiological activity derived from polygraph recordings of skin resistance, skin potential, heart cycle, and blood pressure as well as measures of personality (the Guilford-Zimmerman Temperament Survey, self-ratings, and other measures). This revealed only limited association between personality and autonomic reactivity to mild frustration stress. Of eighty-seven correlations between personality variables and factorially derived clusters of physiological responses only a chance number of four were significant. However, despite few significant correlations, it seems hardly chance that these four correlations are all found to be in line with previous findings. The first consisted of a negative correlation between the Guilford-Zimmerman measure of general activity and a physiological factor composed mostly of GSR reactivity. A second

correlation showed a relationship between social friendliness or agreeableness and heart rate responses to stress. The other two significant correlations are between self-rated "sensitivity" and "phlegmatic temperament" and a complex blood pressure response factor. In each of the cases the correlations suggest a relationship between a high degree of autonomic responsiveness and some deficiency in overt expression of emotions.

Several other studies tend to confirm the results of those already reviewed but suggest in a somewhat more direct fashion that physiological responses to stress are related to a psychological continuum of restraint or control. Cattell (28) reported that a large GSR response to various types of stimuli was one of the most consistently reported phenomena associated with the personality trait of "restraint-timidity," one of eighteen postulated invariant personality factors as determined by an integration of a number of his and other like studies. In another more extensive review of the literature relative to correlations with basic personality traits, Cattell (27) concludes that emotional control itself constitutes a stressor in many cases. Such control, according to him, often results in increased physiological as well as psychological stress reactions and may eventually lead to possible chronic physical disorders such as heart disease. Eysenck (45) found introversion and feelings

of depression accompanied by sympathetic excitation and extroversion associated with a more quiescent physiological state. Wolf and Wolff (164) found that physiological responses to stress, as manifested by disruption of gastric activity, were associated with such behavioral descriptions as few bodily movements, little aggressive drive, and little show of feelings. Those who were observably tense and restless and met problems in a forthright aggressive manner showed less gastric responses to stress stimuli.

Calloway and Thompson (20) have approached the problem of the relationship of personality and physiological stress reactions in a somewhat different way by means of a study of visual perception and physiological responses. They came to the conclusion that when overt behavior cannot reduce stress, increased physiological activity is accompanied by a type of introversion which is manifested by a decreased awareness of external stimuli. They discuss the adaptive value of this type of response and relate its operation to negative feedback circuits.

One of the few direct contradictions of the trends pointed out in this section arose from the Eppinger and Hess (43) differentiation of sympathetic and parasympathetic response patterns. Their association of sympathetictonic type of autonomic reaction with an active, impulsive, domineering, and explosive personality, and vagotonic

reactions with hesitation, depression, and apathy is almost diametrically opposed to most of the other findings cited here. From these conclusions they formulated the hypothesis that each branch of the autonomic nervous system functions in a discreet and bipolar fashion. This, as will be seen in the following section, has been extensively disputed.

Summary of personality and physiological reactions. In summary, some consistencies in relationship between personality characteristics and physiological responses have been pointed out in this section:

1. The studies suggest a positive relationship between autonomic reactions to stress and inhibition of free expressiveness.
2. There is somewhat less clear evidence to suggest that lower than average autonomic responsiveness is associated with impulsivity.

The studies considered individually often give little more than a tentative suggestion of a relationship between personality and physical responsiveness. It is the presence of similar trends among several studies that offers more convincing demonstration that these factors are related. The failure to find more extensive relationship between personality and physiological activity may be due to the

restricted nature of measuring instruments and certain weaknesses of design which will be discussed later. Since a large number of other postulated relationships are based upon the assumption of the presence of certain relationships between normal personality and physiological responsiveness, this area warrants further investigation.

Specificity of Physiological Responsiveness

Before proceeding with the design of the experiment there remains one further area of literature that must be considered. This area deals with the specificity of physiological responses to stress. Specificity, as the term is used here, suggests that within a single individual there may be a greater propensity for some organ systems to respond to stress stimulation than for other organ systems. For example, in the startle response to a pistol shot, a person may show a greater than average increase in heart rate, while respiration may continue relatively unchanged. This means that each physiological process or system may exhibit responses to stress in a manner relatively independent of each other one. This "response specificity" should in no way be confused with the Alexander and French (6) concept of "symptom specificity" which postulates that each type of emotional conflict has a characteristic organ response associated with it.

One reason why there has been a lack of consistency, as well as a frequent lack of any definite results, in the findings with regard to relationships between personality factors and physiological activity seems to rest in the oftentimes very limited nature of the measurements of total autonomic activity. The majority of the studies up to this time have employed only a single measure of autonomic activity, whether it be GSR, blood pressure, respiration, or some other.

An opinion originating with Cannon (21), and which has prevailed for a long time among many of those studying emotion, is that the autonomic nervous system acts as a whole in a relatively generalized fashion. Many of the studies dealing with physiological responses to emotion-arousing stimuli have been implicitly based upon the assumption that one measure is sufficient to sample what is happening in the autonomic nervous system as a whole. Another point of view formulated by Eppinger and Hess (43) holds that there are two types of response in the autonomic nervous system and that each response is a unitary reaction to stimuli appropriate to either the sympathetic or parasympathetic branch of the autonomic nervous system.

Other authors have explicitly stated for one reason or another that they believed some one measure of physiological responses was better than other measures (102). Until the recent advent of apparatus

which makes possible simultaneous recordings of several such variables, it has been very difficult to qualify these assumptions. Recent polygraph studies involving simultaneous recordings of a number of physiological responses cast much doubt upon the tenability of such assumptions. It would seem from such studies that there is a wide individual variability in the "oneness" with which the autonomic nervous system responds.

A series of studies by Lacey and associates (97, 98, 99) most adequately point this out. Lacey and VanLehn (99) repeatedly administered the cold pressor test as a stress-inducing experience to children between the ages of six and eighteen while recording GSR, blood pressure, heart rate, and heart rate variability. They found a definite hierarchical relationship among the physiological responses within each individual which was reliably reproduced upon retest. There did not seem to be any one particular ordering of the response relationships among the various individuals. That is, there was no single physiological system among the group as a whole which reflected a consistently more marked response to stress than any other system. Such a hierarchy within an individual was found to be more consistent for the magnitude of the response than for response variability, although it occurred in both with very significantly greater than chance expectancy.

In a more extensive follow-up Lacey, Bateman, and VanLehn (98) confirmed and further amplified these findings. They administered four stresses to a group of college students: mental arithmetic problems, hyperventilation, letter association, and the cold pressor test. The same physiological measures were used as before. The results were analyzed in terms of autonomic tension, defined as the maximum level a physiological function reached during stress, and autonomic lability, defined as the maximum displacement a physiological function exhibits during stress. They converted all response measures into T-scores in order to facilitate interindividual and intraindividual comparisons of the various physiological responses. When the different physiological reactions were expressed in such equivalent terms they found that each individual showed differential responses within himself. For one physiological function he might be markedly overactive, for another, average in reactivity, and for still another, markedly underactive. There was no tendency for the group of subjects to exhibit one particular pattern of response function more than any other pattern, nor did any particular stress call out one pattern more than any other. In general, an individual tended to maintain the same pattern of response scores from stress to stress and from test to retest. Some deviated from their usual pattern occasionally while there were a few who varied haphazardly in

their pattern of autonomic arousal. They found, as in their previous study, that the tendency to show response specificity was more marked for autonomic tension than for autonomic lability. They postulated the principle of relative response specificity to account completely for their data. This principle states that,

For a given set of autonomic functions there exists quantitative variations among individuals 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 whatever 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, quantitative difference between the degree of activation of the different physiological functions will fluctuate markedly [98, p. 21].

The authors are careful to say that they do not know whether such a relationship will hold if different stresses are used or if different physiological measures are recorded.

Jones (83), in a study reported several years prior to those of Lacey, also found relatively consistent patterns of responsiveness of different physiological systems within each individual, but with no particular pattern being more common than any other and no particular pattern associated with any specific type of stress stimulus. His classification of people according to the nature of their physiological response to stress as "internalizers," "externalizers,"

or "generalizers" very closely parallels Lacey's principle of "relative response specificity."

Lacey, Bateman, and VanLehn (97) demonstrated in a rather limited study that such physiological response specificity must be taken into consideration if a relationship between physiological responses and psychological factors are to be demonstrated. In a group of college students emotionality was measured by the Rorschach Form Color Index. This index reflects the relative presence or absence of form elements in Rorschach color responses. It is based upon a widely accepted assumption among Rorschach workers that a predominance of uncontrolled color responses (CF and Pure C) reflects emotional lability. Using this as their personality measure they found no significant correlation with responses in any of the individual physiological variables considered singly or as a group. However, when only each subject's peak physiological response was used in calculating the correlations, disregarding whether it reflected changes in skin conductance, heart rate, or heart rate variability, or in which of the four stress periods it occurred, the correlation between this personality test measure of emotional lability and the maximum T-score value of physiological responses became significant at the .02 level. There may be disagreement as to the meaning of this particular measure of personality, but the study is

important in demonstrating that only through the use of the concept of physiological response specificity was a significant relationship between physiological variables and personality variables found.

Malmo and Shagass (114) demonstrated physiological response specificity in a somewhat different manner while at the same time showing that different patterns of physiological responses are closely related to symptom complaints of a person. They found that susceptibility to headache was associated with a specific tendency to respond to stress with increased neck muscle tension, and cardiovascular symptoms were associated with the tendency to respond to stress with a preponderance of cardiovascular changes over other physiological changes. Without the multiple recordings and without taking into account different degrees to which each physiological system might exhibit a response, it is doubtful if there could have been demonstrated a significant relationship between physiological responses and reported subjective experiences.

Ax (9) confronted a group of normal subjects with an "anger producing" and a "fear producing" situation while recording seven simultaneous physiological variables with a modified Grass electroencephalograph. These variables were pulse, ballistocardiogram, respiration, face temperature, hand temperature, skin conductance, and electrical potentials from the frontalis muscle. Among his

findings were very low intercorrelations between the physiological variables measured. Of the forty-two intercorrelations among the measures which reliably distinguish between anger and fear, none were statistically significant, most being less than plus or minus .20. He took this as evidence supporting his hypothesis of marked uniqueness among individuals in physiological expression of emotion. A significantly larger between-subjects variance as compared with the within-subject variance lends further support to the hypothesis of individuality of expression. That these individual patterns of response are reliable and not wholly related to the nature of stress was evidenced from the self-correlations of each variable in the two different stress situations. The average self-correlation was .51 and all, with the possible exception of respiration rate, were significantly greater than chance. When individual profiles were compared he found very significant profile differences between the responses of fear and anger, which, he states,

. . . provides further evidence for the psychophysiological unity of the organism in the sense that even the finest nuances of psychological events may be found to have a corresponding differentiation at the physiological level [9, p. 441].

This study provides not only a convincing demonstration that all physiological responses to stress within an individual are neither undifferentiated nor gathered into neat bipolar clusters, but also

illustrates that consideration of the specificity of the individual physiological response permits more efficient means of comparison with psychological factors. A large number of other investigators including Ax (9), Jost (84, 85), Malmo and Shagass (113, 114, 117), Terry (147), Ford (47), Williams (159), and Sines (141) have confirmed that relatively different tendencies do exist among the various physiological factors in a given individual for response to a given stress stimulus. But as Sines (141), Mahl (109), and others point out, these different tendencies do not bear a necessary relationship with the nature of the stress stimulus or the nature of the subject's principal area of psychological conflict. Whenever multiple recordings of physiological activity have been obtained, some degree of response specificity was found almost without exception. However, this finding was not always used to advantage in attempts to determine what factors such as personality might be related to physiological responsiveness.

As was stated in the early part of this section, one factor which may account for conflicting findings regarding psychophysiological relationships was the use of a single measure to represent the physiological responses of each of a group of people. Another factor accounting for the paucity of knowledge about psychophysiological relationships is the tendency to treat multiple physiological

measures in the same way as isolated individual measures and to ignore the unique pattern of relationships among the measures which each individual might exhibit. If, for example, each individual in a group responded maximally to a stimulus with a single physiological response out of a sample of several areas measured, and produced responses of a lower magnitude than the mean of the group in other physiological systems, and if the systems manifesting peak responses in each individual were distributed randomly within the population, then, by considering the mean responsiveness of each individual, one might find little systematic deviations from the mean of the group when, in fact, marked deviations might be present.

By considering all measures together those not contributing only serve to reduce the efficiency with which small but consistent relationships with other events may be isolated. It is readily seen that if a person has a particular response lability in an unforetold area, lumping that area in with all other areas to obtain a mean score is little more efficient or has little higher discriminate function than, say, measuring only one response out of six possible areas of response. If the peak responses were randomly distributed in the sample among GSR, respiration, muscle tension, et cetera, then by using a single measure it would be subject to measurement in only one-sixth of the data obtained. If one had foreknowledge of

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which area would show each individual's maximum response liability, then only the response in that area would need to be measured, thus automatically eliminating the attenuating influence of noncontributory response measures in the analysis of the data obtained. At the present state of our knowledge we have no means of obtaining this foreknowledge. It is possible, however, by means of polygraph recordings, to pick out each person's peak mode of response, or at least come nearer to identifying the peak mode by this means, if in addition, several stress stimuli are employed. This would increase the chances that each person will be subjected to a situation that is especially stressful to him.

There have been several polygraph studies of recent date which afford the opportunity to pick each person's peak response for use in determining the relationship between physiological responsiveness to stress and personality factors. They did not, however, take response specificity into consideration or follow the suggestions by Lacey that this is the most efficient means of identifying psychophysiological correlations. In many cases the failure to do this may have contributed to their not finding more relationships between personality and physiological manifestations of emotional responses. The study reported by Terry (147) is one in which it appears that this

might have permitted better identification of relationships between temperament and autonomic reactivity.

It must be pointed out that the concept of relative response specificity which appears to have been demonstrated beyond question is not yet universally accepted. Wenger, who strongly defends the Eppinger-Hess position (43, 155, 156), has produced the only study so far which disputes this concept (158). While recording a wide sampling of diverse physiological activity by means of a twelve-channel polygraph he subjected a group of normal people to four stress situations consisting of mental arithmetic problems, word association, cold pressor test, and hyperventilation. The response scored was the greatest change initiated by stimulation. He found no significant differences in average response to the four stressors. No evidence was found for response specificity, neither when measured by consistency of maximum response variable, nor by high correlation of the response scores for the various stressors. He felt that only one subject seemed to demonstrate response specificity by satisfying his criterion, a correlation of .80 or above between the peak responses for the various stress situations. Wenger believed that some of Lacey's results were obtained because he failed to correct for the correlation between response level and resting base level. It is difficult to see how this would increase the significance of the

relations Lacey reported. In another report he suggests that if Lacey had used a larger variety of response measures the chance variation among the different physiological reactions would have canceled out, and the so-called response specificity would not have appeared (157). Wenger's report of a lack of significantly larger responses during stress than during the so-called stimulus-free rest periods cast some doubt upon how well he was measuring responses to specific stress stimuli. Ax (10) questions whether the periods between stress may not have been nearly as stressful as the stress stimuli themselves. Several other authors have recognized that unoccupied, free periods might be equally stressful and sometimes more stressful than the administered stimulus (147, 159). If the rest period was almost as physiologically stressful as the test period, then Wenger's conclusion based upon a lack of differential response might not be wholly justified.

Summary of the Literature

The literature relative to psychophysiological relationships gives some relatively consistent trends in spite of many contradictory findings. We have seen ample demonstration that various situations defined as stress situations elicit responses which include measurable changes in physiological activity mediated both by the

central nervous system and the autonomic nervous system. No particular measures have been agreed upon as best reflecting these changes. Among those most commonly used are GSR, pulse, respiration, and electromyograms. Other physiological changes such as hormonal and biochemical changes have not been considered in this review because of their less direct relationship to stimulating conditions. Multiple measures appear to be superior to measures of a single physiological activity. This is because most people seem to have differential response tendencies among various types of physiological activities. Furthermore, there seems to be some relationship between certain physical symptoms and reactivity of related physiological systems. There is also suggestive evidence that there may be a reciprocal relationship between autonomic and central nervous system type responses. These different patterns may have significance in personality comparisons.

The extent of our knowledge of relationships between personality or overt behavior tendencies and physiological activity remains limited. However, there is considerable agreement that autonomic responsivity to stress is positively correlated with restraint and control of overt emotional expression. The obverse of this, that there exists a positive relationship between reduced autonomic response and heightened skeletal muscular response to stress, is only

tentatively suggested. That these relationships as well as others yet unknown may play a role as predisposing factors in later organ pathology is suggested by some observations in patients with psychosomatic diseases. Most authors agree, although the descriptive terms may vary considerably, that control and inability to reduce tension by open expression is a major personality factor in psychosomatic disorders. Overt anxiety and psychopathic behavior disorders show some tendency to be associated with reduced control and lower than average autonomic responses. A necessary condition for psychosomatic disorders is disturbed functioning of some of the same physiological activities whose stress responses were shown to be related to personality patterns similar to those found in groups with manifest psychosomatic disorders.

The nature of possible relationship between personality and physiological reactions to stress, except for a few suggestive trends, remains unclear.

CHAPTER III

THE PRESENT STUDY

Statement of the Problem

The purpose of the present study is twofold. The first is to test some of the hypotheses suggested by the review of the literature on psychophysiological relationships. The second purpose is an exploratory one represented by an attempt to find other empirically derived relationships which can provide hypotheses for more intensive investigation in succeeding studies.

The theoretical and experimental literature suggests significant relationships between personality or behavioral descriptions of people and their physiological responses to stressful situations. One is that the degree of physiological responsiveness is associated with control and inhibitory features of the personality. There is evidence, also, to suspect that there may be an inverse relationship between autonomic and skeletal muscular reactions to stress. The literature further suggests that the control and inhibitory aspects of personality may be positively associated with autonomic responsiveness, and,

conversely, "acting-out" or lack of restraint may be positively associated with overt muscular responses to stress.

This study is limited to an attempt to investigate these possible relationships as they may exist within a normal population. There are several reasons for the selection of such a population for study. Primary among them is the need to have detailed information available regarding relationships between personality structure and physiological mechanisms in a normal group before using such a group as a control against which to evaluate these factors in various patient groups. It is also important to know the nature of such relationships in a normal group in order to make etiologic predictions about the development of disorders found in patient groups.

Hypotheses

The specific hypotheses to be tested in this study are as follows:

1. There will be found some significant associations between measures of personality and the total amount of physiological response for each individual. The total amount of response is to be determined by summing the standard scores of the response level in each system across all stimuli. It is predicted that this hypothesis will be supported but not as strongly as the following hypothesis

where only the peak level of response in each individual is considered instead of his gross physiological mobilization.

2. There will be a significant association between certain measures of personality and the person's peak level of physiological response regardless of the system in which it appears or the stimulus that initiates it.

3. Among the significant associations between personality test scores and physiological responsiveness will be a positive relationship between those personality measures related to control or lack of expressiveness and measures of physiological responsiveness.

Stress

Stress may be of many kinds, and is, in fact, defined in many different ways. It is usually thought of as a stimulating situation which produces discomfort for the subject or disrupts the general homeostatic balance in some way (14, 131, 137). There is little uniformity of stress-producing agents currently used in experimental investigations. They fall into two broad categories: physical stress and psychological stress. Physical stress may be induced by injection of drugs designed to disrupt the autonomic balance such as mecholyl or epinephrine (16, 30, 56); by the use of pain-producing stimuli such as faradic shock, heat, and other strong sensory stimuli

(11, 12, 16, 37, 53, 63, 81, 82, 84, 110, 113, 114, 115); and by cold pressor test, hyperventilation, and other similar techniques (16, 84, 98, 99, 158).

Psychological stress has been divided by Williams (159) into three types: impersonal, interpersonal, and personal. His example of impersonal stress was a motion picture entitled "Killing the Killer" which depicted a battle between a cobra and a mongoose. This type of stress-inducing material has not been widely used.

Interpersonal stress might consist of any number of experimental frustration procedures, including "failure," stress interview, and problem-solving, or specifically devised fear-arousing or anxiety-arousing situations (9, 15, 17, 57, 63, 84, 85, 97, 98, 111, 115, 117, 122, 147, 158, 159). Heath (78), however, questions the stress value of problem-solving situations and suggests that this kind of activity involves higher levels of thought which are virtually devoid of emotion.

Personal stress, William's third type of psychological stress, is less of a stress situation by definition than the others. It is stress of this nature which is to be employed in the present study. In the case of physical stress a known stressful stimulus is administered. For example, with respect to pain as a stimulus, it is assumed that all people are sensitive to pain-producing stimuli,

although, of course, there may be varying degrees of sensitivity and of response. In the personal type of psychological stress no assumption is made that any specific stimulus will be stressful to all people. Such stimuli are meant to have no inherent "stress" value as has been assumed for most of the other stimuli discussed. These personal stress stimuli are only meant to serve as "cues" for the elicitation of certain previously acquired patterns of response. Therefore, the stress value is assumed to be a function of an individual's perception of the stimulus and the meaning of it to him rather than of the stimulus per se. This requires the presentation of an objectively neutral stimulus which at the same time may be emotionally arousing by tapping possible problem areas of the subject. Stress in this sense is thought of as a threat to the psychological integrity of the individual, an "ego-threat." A stress stimulus would then consist of a cue representing a situation in which the subject had not achieved an entirely satisfactory adjustment.

The use of personal stress has one major disadvantage in that it cannot be readily labeled and identified with a specific laboratory operation. However, this disadvantage may be more apparent than real. We may speak of stressors or stress-agents as readily definable objects or situations, but "stress" is a hypothetical construct

employed to account for an unseen psychophysiological state of affairs within the body. Baschowitz cautions that,

We should not consider stress as imposed upon the organism, but as its response to internal or external processes which reach those threshold levels that strain its physiological and psychological integrative capacities close to or beyond their limits [14, p. 288].

What is implied is a state of disequilibrium of homeostasis which will require adaptive action of the body (131). As yet there has been no way of determining the relative stress value of the various stress situations which have been described. The cold pressor test may well produce greater vasoconstriction of the affected extremity than the threat of losing the approval of a loved one. On the other hand, we know that the cold pressor test will produce some minimum amount of response in everyone, but we do not know whether stimuli related to the threat of loss of love will produce a response in any particular person. However, the latter situation might be much more stressful in terms of the disruption of total psychological and physiological equilibrium and in terms of the adaptive mechanisms employed.

This less easily identifiable psychological stress is used in the present investigation by virtue of its more direct relevance to current personality theories. In psychoanalytic theory persisting conflicts are believed to bring about neurotic behavior. The presence of

conflict implies stress. However, momentary laboratory-induced stress, according to this point of view, might not elicit neurotic responses unless it was related to the source of some ongoing psychological conflict.

In Gilbert's (60) broadly based psychosocial theory of personality the essential element of all behavior pathology is stress which threatens the security of the person. He states that ego-involvement and ego-identification are essential to feelings of security. The crucial conflicts might arise from almost any facet of living but would have to involve the needs and value systems or the "self-concept" of the person concerned before one could refer to stress as it is defined by Gilbert.

Practically all the psychosomatic theories deal with stress in a similar manner, differing primarily in the content of the conflicts which are related to various psychosomatic conditions. The essential elements of these theories imply persisting psychological conflicts.

As was noted in the review of the literature in the early part of this paper several authors presented explicit evidence that the chronic nature of stress was a major factor in production of physiological disturbances (7, 109, 137, 164). These personal types of stress stimuli are more directly related to chronic stress reactions

than other more frequently used stress stimuli. The use of this cue-type of stimuli is given further support by Heath's (78) observations that stress in man, except during the existence of realistic catastrophe, is initiated largely by past memory experiences. Among the few other studies that have employed stress stimuli of this type are those of Freeman (53) and Williams (159) who used word associations, Jurko (86), who used the Rosenweig Picture Frustration Test cards, and Gottschalk and associates (63), who asked their subjects to imagine themselves in certain emotional scenes which were described.

The problem arises as to what type of situations are stressful or involve threat to the security of each person tested. This might be determined if a detailed case history were available or if an extensive battery of psychological tests were administered. Obtaining information of this nature is laborious and is especially difficult when dealing with normal volunteer subjects. A substitute solution of this problem is to present each subject with a range of stimuli which are frequently associated with problems of adjustment. In the use of this procedure not every stimulus would necessarily be a stress stimulus for each subject. Different subjects would be expected to react to different stimuli with varying degrees of response. It is also conceivable that none of the stimuli would be

stressful to some of the subjects. Where only group averages and group differences are the subject of study an increase in the size of the sample would compensate for the failure to select a population homogeneous with respect to sensitivity to the stimuli used.

The rationale for the stress stimuli used in this study is derived from projective test theory. The stimuli selected are pictures which stem directly from the Thematic Apperception Test, a test designed to reveal areas of conflict by showing the subject a series of sketches depicting various situations which may be interpreted as involving adjustment problems. In the use of the TAT-like cards it is assumed that, if the subject has problems similar or related to the ones depicted, the cards will act as cues to rearouse in part the conflicts. The validity of stimuli of this sort as stress agents is largely that of face validity. They have been widely accepted in diagnostic situations, not expressly as stressors, but as cues for the production of responses which would reveal stress or conflict. This type of stimuli was chosen because of its generally assumed validity and because it satisfies the experimental requirement of being easily manipulated. Such stimuli do not require activity on the part of the patient which would further complicate response measurement. Time of presentation and removal of the stimulus is easily controlled and response latencies are short

enough to insure as much as possible that the responses measured result from the specific stimulus objects presented.

The set of personal type psychological stress stimuli used in this investigation consisted of four pictures on cards, two of which have been chosen from the TAT series (126), and two of which resemble the TAT pictures but were selected from other sources. These stimuli were assembled and first used by Sines (141) in an investigation of the physiological responses of a group of ulcer patients to stress. Sines has called the cards "neutral," "hostile," "passive," and "sexual" stimuli, names descriptive of the type of situation each card depicts.

The "neutral" picture is a glossy photographic print of card 12BG from the TAT series. The scene is on a wooded bank of a lake or stream with a small boat pulled up under a tree. This card is used for determining the level of physiological activity in each subject in a relatively nonstressful situation against which the level of response to stress cards can be compared for control purposes.

The "hostile" stimulus is a glossy print of a photograph of a pencil sketch drawn by artist Dirk Gringhaus. The picture consists of two figures, one quite indistinct seated in the lower left corner. The other is a large muscular man with manacles on his wrists.

He is about to bring them down on the seated figure. The aggressing figure has an enraged expression on his face and his muscles are tense.

The "passive" stimulus is a similar glossy photograph of card 6BM from the TAT series. This is a picture of a young man and an elderly gray-haired lady. She is standing facing away from him. He is standing with his head somewhat bowed and holding his hat in his hands. The scene is suggestive of some sort of tension between them.

The "sexual" stimulus consists of a glossy photograph of a sketch taken from Esquire Magazine (44). It portrays a young woman lying on a bed or couch. Her body is covered from the waist up by a gown which falls open from the waist. She is wearing a pair of white briefs but her bare legs are clearly visible and her hips are clearly outlined. Her arms are outstretched to a young man with somewhat indistinct features who is seen standing over her.

These cards were found by Sines to be both valid and reliable stimuli for the arousal of autonomically mediated physiological activity in persons with emotional conflicts of the types represented by the respective cards. He selected patients on the basis of having been described in routine psychological reports, in psychotherapy

reports, or both, as having a primary focus of conflict in one of the three areas represented by the cards. When these three groups of patients were presented with the stimulus pictures, it was found that increased physiological activity was significantly greater following presentation of the stimulus picture which was selected for its relationship to the conflict hypothesized for each group. Similar results were reliably reproduced when a portion of this group of patients were again tested at a later date.

Physiological Responses

The results presented in Chapter II seem to point up the sampling nature of the task of recording the physiological activity of the body and emphasize the desirability of making simultaneous recordings from as many physiological systems as is practical. To detect and measure all the physiological responses to a stress stimulus, or any stimulus, would be a nearly impossible task. Several factors governed the response systems selected for measurement.

In a study of this nature responses must be selected which are reasonably discrete and have short enough latencies in order that they may be related in a more or less direct fashion to a specific stimulus. Therefore, such phenomena as biochemical changes would not be considered even though they might be adequate indicators

of stress. A further limitation in the selection of particular responses to be measured was the practical one of availability of suitable apparatus.

All the physiological recordings in this study were made simultaneously by means of a polygraph. The polygraph used was a specially constructed one patterned after several others used for similar purposes (9, 10, 11, 84, 114, 158). It employed a Grass 8-channel Model III-D electroencephalograph for its basic amplifier and ink writing oscillograph (67). Supplementary devices were incorporated into various channels where needed to record particular variables. The machine was so constructed as to permit the activity in the various physiological systems to be simultaneously recorded via a set of parallel pens upon a continuous strip of time-calibrated paper. All electrodes with the exception of the ones for GSR measurement, which will be discussed later, were made of flattened solder pellets (59) and attached with bentonite electrolytic paste (150).

The following description of the apparatus includes a discussion of the physiological phenomena selected for measurement as well as the measurement techniques employed.

Channel 1. Signal marker. This marker consisted of a one and one-half volt flashlight battery coupled in series with one megohm of resistance which was connected via the conventional electrode

board to the EEG machine. The experimenter could actuate the signal at any time by a push-button switch connected to the device by means of a long extension cord. This cord permitted the experimenter unrestricted movement about the room. By means of this marker the exact time of presentation of each stimulus, its duration, and time of removal was recorded on the polygraph tape simultaneously with all physiological responses. All stimuli were easily identified by the use of a predetermined system of coded marker signals.

Channel 2. Galvanic Skin Response. GSR was measured by means of the determination of the resistance of the skin to an externally applied current (Fere effect; 102, 107). This required the use of a Grass Converter-Demodulator Model CD-1 (66) as the current source. This device also served to modify the fluctuating direct current after it passed through the hand of the subject in order that it might be detected and amplified by the AC type EEG amplifier. The output of the Converter-Demodulator fed directly to the preamplifier of Channel 2 and thence to a special high efficiency power amplifier with which this channel was equipped, thus bypassing the electrode board and selector switches. The electrodes, attached to the palmar and dorsal surface of the left hand, consisted of pure silver disc electrodes to which a coat of silver chloride was applied

after the method outlined by Walter (153). Contact with the skin was by means of a commercial calcium chloride type of electrode paste. This silver-silver chloride electrode arrangement is recommended for maintaining electrode stability and for keeping electrode polarization effects at a minimum (19). The electrodes were mounted in special plastic electrode holders which were made to conform to the curvature of the hand. They were attached to the hand by means of a heavy rubber strap which provided the electrode with a constant pressure against the skin (167).

There are many ways of measuring GSR and there is little agreement as to which measures are best (80, 100, 107). The method employed in this study takes into account both the maximum deflection in response to a stimulus and the speed of recovery in much the same manner as does Freeman's Recovery Quotient (49, 50). A planimeter (39) was used to measure the area under the curve made by a deflection of the polygraph pen for the twenty seconds following presentation of a stimulus.

Channel 3. Heart Rate. A modification of the conventional electrocardiograph lead II was used by attaching electrodes to the left arm and right leg of the subject. The electrical activity of the heart was recorded directly through the EEG machine by means of appropriate filter settings. Heart rate was obtained by a count of

the R-wave spikes. The heart rate response to the stimuli was obtained by calculating the difference in heart rate between the 20-second period preceding and the 20-second period following a stimulus.

Channel 4. Respiration. Breathing was measured by means of a pneumograph tube strapped about the subject's chest which actuated an electrical strain gauge in a Grass Model PT-5 strain gauge pressure transducer (65). The strain gauge wheatstone bridge was powered by a six-volt storage battery. The output of the strain gauge was fed via the electrode board into the EEG machine which was adjusted to EKG response characteristics. Respiration responses were obtained by comparing the heart rate obtained during the 20-second period preceding a stimulus with that for the twenty seconds following the stimulus.

Channel 5. Jaw Muscle Tension. The electromyogram from the masseter muscle was obtained by attaching one electrode over the muscle slightly in front of and slightly below the ear. The neutral electrode was attached over the cheek bone (superior maxilla). Conventional EMG settings of the machine were employed. The paper speed was slow enough for the muscle responses to appear on the record as a modulated A-C envelope. The area occupied by this envelope was a function of both the duration and amplitude of electrical discharge of the muscle. The area covering the 20-second

periods immediately prior to and following the administration of a stimulus were measured by means of a planimeter. The difference between these two areas represented the change in muscle activity which could be attributable to the stimulus. This measure resembles but is somewhat more exact than the microvolt-second index of EMG activity reported by Gottschalk (63). The measurement of the activity of each of the following muscles was made in the same manner.

Channel 6. Neck Muscle Tension. An electrode was attached over the sternocleidomastoid muscle approximately one inch to the left of the dorsal midline of the neck and about one and one-half inches below the mastoid process. The neutral electrode was attached over the mastoid process.

Channel 7. Forearm Muscle Tension. The active electrode was attached over the extensor muscles of the right forearm and the neutral electrode over the ulna bone on the lateral surface of the forearm.

Channel 8. EEG. The standard monopolar left parietal lead was obtained. This measure will not be considered further since its analysis was too laborious to be included in the results of this experiment. For a discussion of the relationship between EEG and personality factors, see Ellingson (42).

Psychological Testing

Selection of tests. Several criteria guided the search for psychological measures used in this study. First, the techniques must require as little of the subject's time as possible and be as unlikely as possible to generate resistance. Second, in a study of this type it is especially important that the results be in objective form so as to lend themselves to necessary statistical treatment. This requirement immediately ruled out most of the projective-type tests which do not give data readily susceptible to statistical manipulation. Third, since little prior information was available concerning what areas of personality might be significantly related to physiological activity, it was deemed essential that the measures cover as broad a spectrum as possible. The method of satisfying this requirement seemed to lie in the use of tests developed by means of factor analytic techniques. Relatively independent and functionally unitary factors or traits can be identified and measured by means of this kind of instrument. Adherence to a "trait" theory of personality structure is not necessarily implied, but rather, it is felt that an approach of this kind can provide a means of extracting order from a mass of abilities, attitudes, feelings, and modes of action. Techniques of factor analysis or, for that matter, any other

fac

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a

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fa

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c

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s

factor-identifying techniques can only measure what has been sampled. Therefore, the more research involved in the development of a test, the more likely it is that important or meaningful areas of personality functioning have not been missed. A final consideration in the selection of specific psychological tests was that the data or factors obtained from them be of such a nature that they could be related to various previous research findings and that they yield certain psychological descriptions comparable to those which have been hypothesized to be important in psychophysiological relationships.

There are two extensive and long-term personality measurement projects that have produced tests which more or less satisfactorily meet the requirements of this study. These are the researches of Guilford (73, 74, 75, 92, 104, 128) and Cattell (24, 25, 27, 28, 121).

Guilford-Zimmerman Temperament Survey. The Guilford-Zimmerman Temperament Survey (76) is a revision of three Guilford-Martin personality tests: the Guilford-Martin Inventory of Factors GAMIN, the Guilford-Martin Inventory of Factors STDOR, and the Guilford-Martin Personnel Inventory. This test is the most recent product of twenty years of continuous development of the personality

measurement device by Guilford and associates. The test consists of the 300 most discriminative items selected from a total of 511 items which composed the three previous tests. There are only ten factors measured as compared with a total of thirteen factors measured by the combined three previous tests. Three factors were eliminated because they were found to be too highly correlated with other existing factors to be considered independent. Some of the factors have been renamed in the present edition. This test is set up in such a manner that there are thirty questions contributing to each of the ten factors. Each question can be answered by indicating a "yes," "?," or "no."

This revision of the Guilford-Martin battery of tests has resulted in increased reliability and lower intercorrelations between factors. Norm data were obtained from 523 male and 389 female college students with a mean age of twenty-three. Estimates of the total score reliabilities were made in various ways with the best estimates of the reliability coefficients of the various separate factors ranging from .75 for Factors O and F to .87 for Factor S. In general, the intercorrelations between the trait scores were low. Half of them were below plus or minus .25. Only two of the forty-five intercorrelations were above .60, and in each of these cases one score accounts for less than half of the variance of the other score.

All personality inventories are found to be lacking in specific validity coefficients stated in terms of correlations of the scores with acceptable outside criteria. This inventory is no exception. The problem which invariably arises is what constitutes adequate criteria for judging statements about personality. The validity evidence for this test can best be summarized in the authors' words:

The internal validity or factorial validity of the scores is fairly well assured by the foundation of factor analysis studies plus the successive item analyses directed toward internal consistency and uniqueness. It is believed that what each score measures is fairly well defined and that the score represents a confirmed dimension of personality and a dependable descriptive category. Evidence of practical validity based upon correlation studies with practical criteria of adjustment has accumulated. The evidence which arose in connection with corresponding studies in previous inventories can be applied with confidence to the scores in the present study [76, p. 6].

Stephenson (143) considers this inventory better than most similar inventories and says that its data and supporting norms are all adequate, thorough, and factually oriented. Shaffer (139) calls it the outstanding omnibus instrument based primarily on factor analysis and considers it useful as a research tool.

Studies reported by North (128) and Lovell (104) which were based on the earlier versions of this test suggest that several of the factors, especially those relating to emotional control, can be grouped into meaningful clusters.

The ten personality trait factors for which measures are obtained are:

Factor G. General Activity. This factor purports to measure energy and the amount of overt activity exhibited by a person. Personality characteristics related to a high score on this variable are strong drive, energy and vitality, rapid pace of activities, production and efficiency, hurrying, and enthusiasm. A low score would suggest such qualities as slow and deliberate pace, fatigueability, inefficiency, and low productivity.

Factor R. Restraint. High scores are indicative of serious-mindedness, deliberation, persistent effort, and self-control. Low scores tend to be found in persons described as happy-go-lucky, carefree, impulsive, and excitable.

Factor A. Ascendancy. High scores are found in persons who are said to stand up for their own rights, have qualities of leadership, are conspicuous, and mix with others. Low scores are related to suspiciousness and habits of following.

Factor S. Sociability. At the high end of this continuum may be found such qualities as having many friends and acquaintances, entering easily into conversation, seeking the limelight, and seeking social contacts. At the low end are found such qualities as having few friends and acquaintances, being shy, and avoiding social contacts.

Factor E. Emotional Stability. High scores are in the direction of evenness of moods and interests, optimism and cheerfulness, composure and feelings of good health. Low scores suggest fluctuating moods, pessimism, daydreaming, excitability, feelings of ill health, and feelings of guilt or worry.

Factor O. Objectivity. High scores indicate a person who is "thick-skinned" and "insulated," and able to view others in a detached, impassionate manner. Low scores suggest hypersensitivity, self-centeredness, suspiciousness, and hostility.

Factor F. Friendliness. This factor was formerly called agreeableness. Toleration of hostile action, acceptance of domination, and respect for others are reflected by a high score. A low score indicates belligerence, hostility, desire to dominate, and contempt for others.

Factor T. Thoughtfulness. High scores are indicative of reflectiveness, meditateness, interest in thinking, observation of self and others, and showing mental poise. At the other extreme is an inclination for overt activity, a dislike to think things out, as well as feelings of mental disconcertedness.

Factor P. Personal Relations. To obtain a high score on this trait would suggest a toleration of people, faith in social institutions, and an ability to get along smoothly with people. Persons

with low scores are apt to be hypercritical and fault-finding, suspicious of others, and have feelings of self-pity.

Factor M. Masculinity. High scores reflect masculine interests, being 'hard-boiled,' fearless, and inhibiting emotional expression. Low scores reflect interest in feminine activities, emotional expressiveness, fearfulness, feelings of sympathy, and romantic interests.

Cattell Sixteen Personality Factor Questionnaire. The second test included in the personality measurement battery is the Cattell Sixteen Personality Factor Questionnaire, Form A (26). It, like the Guilford-Zimmerman, was developed by means of factor analytic techniques and is designed to take cognizance of the total personality. While items on the Guilford-Zimmerman can be traced back through earlier Guilford-Martin inventories to sources in many of the well-known personality tests of a number of years ago, the sources of the items for this test are not made explicit but seem to have been constructed to reflect 'source traits' or 'factors' derived from various experimental and real-life situations.

Since some of the factors identified by this test seem practically identical with some of the Guilford-Zimmerman factors, certain cross checks between the two tests can be made.

As the test is described in the manual it does not appear to be as well standardized as the Guilford-Zimmerman. The author is not specific but the adult standardization group appears to consist of 1,033 subjects. He refers to a large number of reliability and validity studies, but few such data are included in the manual. Corrected split-half reliability coefficients for each of the sixteen factors range from .50 to .88. The test, however, appears to be outstanding in the independence of the traits measured. Of the 120 intercorrelations between factors, none exceeded .40 in the sample reported and four-fifths of these were of a magnitude of less than .15. No specific validity data are provided in the manual, but recently published studies suggest that it is relatively high for this type of test (27, 28). These studies, which deal with a much larger body of data than just the 16-PF, include many correlations with real-life situations, various behavioral descriptions, and other questionnaire material. Since it is difficult to isolate data relevant only to the 16-PF in this report, adequate evaluation of the test cannot be made until some of the specific reliability and validity studies to which he refers are published.

The principal reason the test was selected for inclusion in this study was because it is included by Cattell and associated as part of a large body of research directed at describing many facets

of personality structure including the identification of psychophysiological relationships.

Another reason for using this test in the battery was that it contained a measure of intelligence. This factor is of importance primarily because there have been some suggestions from previous studies that responses to psychological stress are to some extent related to intelligence (93). In view of the fact that this relationship does not appear to be a strong one, a highly refined intelligence test was not warranted.

A brief description of the factors or traits is as follows:

Factor A. Cyclothymia versus Schizothymia. The dichotomy described is good-natured, easy-going, cooperative, attentive, trustful, adaptive, and warmhearted, versus spiteful, griping, critical, obstructive, cruel, aloof, rigid, and suspicious. The author reports that persons with high scores on this variable are more interested in people and more readily form active social groups while low scorers are inclined to be more interested in ideas and "things."

Factor B. General Intelligence versus Mental Defect. Scores on this factor are obtained from answers to thirteen analogy items. It is included with the personality traits because some of the personality traits have been found to be related to intelligence. This

trait is designed to determine intelligence with a refinement equal to that of the other traits measured by this test.

Factor C. Emotional Stability or Ego Strength versus Dissatisfied Emotionality. This factor has been described as one of dynamic integration and maturity as opposed to general emotionality. Some of the terms used to describe elements composing it are emotional maturity and stability, calmness, passiveness, realistic about life, and absence of neurotic fatigue. General emotionality, lack of frustration tolerance, changeability, worrying, evasiveness, and neurotic fatigue characterize those obtaining low scores. Cattell says that a person with a low C score is easily annoyed and dissatisfied and shows generalized neurotic responses in the form of phobias, psychosomatic disturbances, sleep disturbances, and hysterical and obsessional behavior. He found in neurotics that a low C score was associated with poor muscle tone and an increase in neurotic symptoms during periods of stress (23). He reported another such study which suggests a rise in the C factor under conditions of reduced conflict such as prefrontal lobotomy and successful psychotherapy.

Factor E. Dominance or Ascendence versus Submission. Descriptive adjectives listed are assertive, self-assured, independent, hard, solemn, tough, and attention-getting versus submissive,

dependent, soft-hearted, expressive, conventional, and easily upset. It is suggested that this factor is highly correlated with leadership and free participation in group procedures.

Factor F. Surgency versus Desurgency or Depressive Anxiety. The surgent end of this scale indicates a person who is talkative, cheerful, placid, frank, and quick and alert. The desurgent end indicates a silent, introspective, depressed, anxious, uncommunicative, and languid person. This factor in combination with Factors A and H make up a more general "surface trait," best described as extroversion. Cattell hypothesized that a low F represents fearful inhibition and is related to physiological factors and symptoms such as headaches, anxiety states, and irritability (23).

Factor G. Character or Superego Strength versus Lack of Internal Standards. This factor might be described in psychoanalytic terms as reflecting "superego strength" while the superficially similar Factor C could be described as measuring "ego strength." Associated with positive scores are terms such as persevering, responsible, emotionally mature, well ordered, and conscientious. Persons with high scores have been described as viewing themselves as guardians of manners and morals, cautious, able to concentrate, and interested in analyzing people. Low scores may suggest persons who are "quitters," fickle, undependable, irresponsible,

demanding, and impatient. Psychopaths, the author notes, tend to score particularly low on this variable.

Factor H. Adventurous Autonomic Resilience versus Inherent Withdrawn Schizothymia. The low H factor probably represents the withdrawn, careful, well-behaved person who reports himself to be intensely shy, convinced of his inferiorities, and is slow and impeded in expressing himself. Other descriptive terms associated with a low H score are cautiousness, retiring, low interest in the opposite sex, conscientiousness, coolness, and aloofness. Factors which make up an H score are gregariousness, sociability, boldness, marked interest in the opposite sex, abundant emotional response, and strong artistic or sentimental interest. This factor is of particular interest in the present study because of its demonstrated relationship to GSR and other physiological factors (27, 28, 121). Cattell states that this is one of the best defined of the factors he has isolated and feels that it reflects ability to withstand repeated emotional stress. He hypothesizes that it is a basic variable in determining behavior and may represent some large constitutional factor which gives rise to social, sexual, and emotional orientation and a susceptibility to fatigue and punishment.

Factor I. Emotional Sensitivity versus Tough Maturity. This factor seems to be aptly described by the well-known concept of

tender-mindedness and tough-mindedness. Positive loadings consist of demanding, immature, dependent, introspective, gentle, emotional labile, and sympathetic as opposed to emotionally mature, independent, smug, self-sufficient, responsible, and lacking in artistic feelings. Distinct cultural and sex differences have been found to be related to this factor.

Factor L. Paranoid Schizothymia versus Trustful Altruism. High scores are associated with proneness to jealousy, shyness, bashfulness, suspiciousness, hardness, rigidity, and lack of concern for other people. A person who obtains a low score on this factor might be described as free of jealous tendencies, composed, trustful, cheerful, adaptable, and concerned about other people. People who earn high scores have been found to have long reaction times and tend to be slow and deliberate. The author suggests that these people tend to be unwilling to share information with others and are much concerned with their own accomplishments and beliefs. The high scores on this factor are closely related to features revealed by low scores on Factors A and H, all of which have been labeled schizothymic factors. These factors have in common the suggestion of persons who are unresponsive, self-contained, and chronically tense because they have little outlet for external emotional expression and relief from frustration. This cluster of factors is of

interest in this study because of its relevance to the hypotheses which are to be tested.

Factor M. Hysteric Unconcern (or "Bohemianism") versus Practical Concernedness. Among the adjectives describing this factor are unconventional, sensitively imaginative, undependable, placid exterior, and occasional hysterical emotions versus conventional, practical, logical, easily concerned, expressive, and given to using one's head in emergencies. The title given this factor is admitted to be temporary and not adequately descriptive of the factor measured. It is hypothesized that a positive M score represents a dissociative tendency to be used as a defense against anxiety. People with high scores may walk and talk in their sleep, do not hesitate to make demands on others, are not concerned with conventions, do not worry, and tend to make emotional scenes. Limited samples of hysterics and psychopaths have been found to score high on this factor (26).

Factor N. Sophistication versus Rough Simplicity. The factor loadings consist of polished, cool, aloof, and fastidious versus clumsy, awkward, attentive to people, and easily pleased. This factor is said to be of lesser weight in the total personality than most of the others and is primarily related to intellectual leadership and a rational approach to things.

Factor O. Anxious Insecurity versus Placid Self-Confidence.

It consists of anxious worrying, suspiciousness, and brooding, versus placidity, toughness, and given to simple actions. According to earlier research this factor is more related to what a person says about himself than to what he does. The high O person tends to describe himself as feeling downhearted, often remorseful, subject to phobias, avoiding people, and worrying. Probably more than anything else it is an indication of the level of free-floating type of anxiety.

Factor Q_1 . Radicalism versus Conservatism. This, and the following factors, are the most recent ones extracted by Cattell, and have not yet been validated by their appearance on behavior ratings as have all the previous factors described. This factor seems to be largely an attitudinal factor rather than a strict personality factor. A radical person is described as interested in intellectual matters and fundamental issues, is more introspective, is well informed, less inclined to moralize, and more inclined to experiment with life generally.

Factor Q_2 . Independent Self-Sufficiency versus Lack of Resolution. This factor, like the other Q factors, seems to have primarily face validity in terms of what the person says about himself on the questionnaire. Positive loadings are suggestive of

persons who are not necessarily dominant in social relations but tend to go their own way. The low scores are associated with persons who like social approval, are conventional, and prefer to work in company with others.

Factor Q_3 . Will Control and Character Stability. The following description of this factor is found in the manual:

This factor has some relation to the C and G factors described above, yet it is not very evident in behavior ratings and is still listed and defined primarily as a factor in the questionnaire responses for mental interiors. Individuals high in this factor show, according to the questionnaire responses, strong control of emotions and of general behavior. They are inclined to be considerate, careful, conscientious, but also obstinate [26, p. 11].

Factor Q_4 . Nervous Tension. It is said that this factor resembled the common description of what distinguishes the hypertensive person; that is, the one who is constantly tense, excited, restless, and always driving to get something done despite over-fatigue. It has been found to be high in neurotics and negatively related to leadership ability.

Population

The experimental population sample consisted of a group of sixty normal males, forty-two from personnel of the Department of Physical Medicine and Rehabilitation and eighteen from the Psychiatric

Aide Service of the Veterans Administration Hospital, St. Cloud, Minnesota. Their ages range from twenty-four to fifty-nine years. Education of members of the group ranges from completion of the eighth grade through five years of college. This group of people was chosen as a normal population sample for this study because they represented a reasonable approximation of a general adult male population with respect to age, education, intelligence, occupational levels, and variety of occupational interests. Representative occupations included are: administrative, clerical, teaching, machine shop, carpentry, arts and crafts, farming, mechanic, unskilled hospital aides and laborers, and various technicians with a wide range of training and skill. A complete breakdown of data relative to the composition of the population sample is included in the Appendix.

A single relatively heterogeneous normal sample such as this was selected because the object of this study is to demonstrate relationships within a normal group which might be compared with later nonnormal groups. The age, education, and occupational interests of this group are comparable to that found in hospitalized veteran groups.

Procedure

At the first testing session all subjects were informed of the general nature of the procedures and apparatus they would encounter during the study and were given assurance that anonymity of individual results would be preserved.

The Guilford-Zimmerman Temperament Survey and the Cattell Sixteen Personality Factor Test were administered according to standard procedures to all subjects. Due to schedule requirements some tests were administered in groups of ten to twenty and others were administered individually.

Following completion of the personality tests each subject was seen individually for a period of approximately one hour at which time the stress stimuli were presented and the physiological measurements made. The experimental room was a plainly furnished hospital EEG room equipped with an enclosed and electrically shielded booth in which the subject remained during all measurements. The booth was bare except for a chair upon which the subject sat and a bed. The apparatus except for electrodes attached to the subject's body was not readily observable by him.

The arrangement of the room permitted the experimenter to monitor the controls of the apparatus and to present the stimulus

material through an open door to the booth without distracting the subject. The hospital electroencephalographer assisted in the operation of the control panel, but remained quiet and out of the view of the subject.

After all leads were attached and controls adjusted, continuous physiological recordings were obtained until the end of the experimental hour. The following experimental periods may be identified.

1. Initial period of silence. Instructions for this period consisted of reassuring the subjects that they had nothing to do but relax and remain as quiet as possible. They were asked to clear their minds and think of nothing in particular. Reassurance was repeated as needed until the period began, after which complete silence ensued.

This initial period, lasting from three to ten minutes, was to provide time necessary for the subject to relax, thus establishing a baseline for the physiological measurements. This period continued until little variability could be observed in any of the physiological functions.

2. Initial period of music. Instructions preceding the music were as follows:

In order to help you further clear your mind and make it easier to relax I am going to play some music. It is nice, quiet, relaxing music. I think you will enjoy it. Just listen

to it and relax as much as possible. Thoughts tend to affect the measurements I am trying to make, so let your mind go blank and don't think of anything. Remain as quiet as possible and try to sit back and relax.

Since several studies have shown that silence and waiting can be stressful, a period of soft music was provided in order that a further baseline measurement of physiological activity might be made (10, 147, 151). A selection from Bizet's L'Arlesienne Suite No. 1 was played for approximately three minutes, sometimes longer if the subject had not yet produced a stable baseline. This composition is generally regarded as peaceful and relaxing. It was used for a similar purpose in a study by Terry (147).

The music was ended with the following instruction: "That is all of the music for now. Just continued to relax and remain as quiet as you can."

3. General picture instructions. Following the end of the music, when all the measurements appeared to become stabilized, usually in one to two minutes, the following instructions were given:

In order to help you narrow down the number of different thoughts you have, I am going to show you some pictures in a few moments. Each picture is on a separate card which I will hold in front of you for a few seconds. I want you to imagine yourself in each scene. Put yourself in the picture as best you can. I want you to think about each picture but don't say anything until I ask you. Remember, I will hold each picture for a short time. I would like you to look at each picture; think of yourself in it but don't say anything. And, of

course, remain as quiet as possible. In a few moments I will show you the pictures.

4. Individual picture presentation. Each picture was held for a period of twenty seconds. Sufficient time was allowed between stimuli to permit physiological activity to return to the established baseline or as near to the baseline as possible within a reasonable time. The time between cards varied from two to five minutes.

The "neutral" card was presented, accompanied by the statement, "Imagine yourself in a situation like this--it's a nice summer day when you can relax and really take it easy."

The statement made with the presentation of the "hostile" card was: "Put yourself in this fellow's position--your feelings are breaking loose, you can't control yourself any longer, and you're going to do something that you have wanted to do for a long time."

With the presentation of the "passive" card the subject was asked, "Think of yourself as this kind of a fellow--always depending on your mother for help."

As the "sexual" card was presented to each subject he was instructed: "Put yourself in this man's position--you have yourself all set up and whatever you do now is entirely up to you."

5. A word association series was presented at this point. Because the results of this portion of the experiment are not included in this report, details are not given.

6. Poststimulus silence. This period in which a baseline was again being determined lasted approximately three minutes. Instructions were essentially the same as for the pretest period of silence.

7. Poststimulus music. This consisted of playing another part of the same selection for approximately three minutes. This period served in making further baseline determination. Instructions were similar to those given previously.

8. Hand clap. This mild sensory stimulus was included at the end of the series. It was administered by means of a relatively loud clap of the hands made outside the subject's field of vision. Recordings were continued for approximately sixty seconds following this stimulus.

Treatment of Results

In order to facilitate comparison of various types of scores, all with unknown but likely very different distributions, the first step in statistical analysis was to convert all scores obtained from both the psychological tests and from the physiological measures into McCall's T-scores (106). Such a transformation fixes a mean of a distribution of scores at 50 and the standard deviation at 10. This procedure leads to comparable units in all distributions of scores. This results in a system of units with similar meaning for all

measures, both psychological and physiological. For example, if a person obtained a raw score of 14 on one of the psychological factors, an increase of four heart beats per minute, and a 2 percent decrease in palmar resistance in response to stress, each of which yielded a T-score of 50 in its respective distribution one would immediately know (1) that with respect to the particular population his response is comparable for each measure, and (2) his response is exactly average in each case. Similarly if each of the T-scores was 60 we would know that his response placed him one standard deviation above the average of the group for all three measures.

There has been shown to be a significant relationship between the base level and amount of response to stress in most of the physiological systems under consideration (93, 99, 100, 102, 107). Therefore, calculation of response scores followed a method outlined by Ax and Wenger (13) which not only removes both rectilinear and curvilinear regression on the base level but also assures homosceasticity of the T-scores as well. This consisted of ranking all resting scores for each physiological variable and dividing them into quartiles. The T-score values of the response to the stimulus condition were then calculated from each quartile separately. By this type of correction a 5 percent change of GSR by a person with a low baseline might receive the same T-score value as a 2 percent

change for a person with a high baseline, which, in effect, corrects for the phenomenon of physiological limits. It was the response scores derived in this manner from which the all-physiological response score for each individual was selected.

On the basis of the evidence of response specificity recently discussed the T-score indicating a person's maximum autonomic and maximum muscular responses to stress were selected for comparison with the T-scores on each of the psychological factors. This selection of the peak scores was accomplished by an inspection of the T-score values for change from the base level in GSR, heart rate, and respiration rate across all stimulus conditions in the case of autonomic measures. All other scores were ignored in favor of a single score which takes into consideration the most effective stress stimulus and most labile response system. The measures of muscle response were treated similarly, but separately. The separation of autonomic responses from external muscle responses was made on the basis of theoretical and limited experimental evidence of a possible negative relationship between the two and therefore it was hypothesized that they may be differently related to psychological factors (52, 83, 86, 113, 115).

In order to test the suggestion of Lacey that the use of peak scores is the better for revealing the existence of psychophysiological

correlations a somewhat more conventional measure consisting of the average T-score of both the autonomic response and muscle responses were calculated. As a further check on the relationship between autonomic and muscle responses and their relationship to other factors both the average T-scores and the peak T-scores for all physiological responses considered together were determined. Both the lowest T-score selected from the autonomic responses and the lowest T-score selected from the muscle responses were determined in order to provide further information regarding the significance of physiological hyporesponsivity. The use in this study of psychological stress stimuli whose stress value was assumed to stem largely from cues to past experiences was based upon the assumption that it was stress of this nature which may be largely responsible for production of pathological physiological functioning in various psychophysiological disorders and in this study might be most efficacious in demonstrating psychophysiological relationships. In order to gather further evidence regarding these assumptions the peak autonomic and peak muscle response T-scores for both the psychological stress stimuli (Hostile, Dependent, and Sexual cards) and the sensory stimulus (hand clap) were computed.

These twelve selected T-scores representing various measures of physiological responses for each person were placed in a

correlation matrix with the twenty-six psychological factor scores and age of each subject (see Table I). This 39 by 39 correlation matrix yielded 741 intercorrelations. A cluster analysis, a technique which approximates an unrotated factor analysis was performed upon this set of correlation coefficients (149). It involved first selecting from the matrix all those correlation coefficients which were significantly greater than zero at the 5 percent level of confidence. By placing all the significant intercorrelations in a new matrix it was determined which variables were significantly interrelated and probably represented some communality among the variables.

Clusters consisted only of those correlations which were all significantly intercorrelated with every one of the others. A determination of what a commonality of factors represented was made by analysis of the nature of the factors of which it was composed. It is well known that some of the psychological factors are not independent and would tend to show up in certain clusters. However, the relationships between other of the factors were unknown, such as the relationships between the factors in the two separate psychological tests. Again, it may be assumed on the basis of meager evidence that there would be between-test factor relationships. Indeed, it was hoped that this would be so in order to facilitate a more adequate

TABLE I
VARIABLES INCLUDED IN THE CORRELATION MATRIX^a

1. Age of subjects	
2. Factor A. Cyclothymia versus schizothymia	Cattell
3. Factor B. General intelligence versus	16 P.F.
mental defect	"
4. Factor C. Emotional stability or ego strength	
versus dissatisfied emotionality	"
5. Factor E. Dominance or ascendance versus	
submission	"
6. Factor F. Surgency versus desurgency, or	
depressive anxiety	"
7. Factor G. Character or super-ego strength	
versus lack of internal standards	"
8. Factor H. Adventurous autonomic resilience	
versus inherent, withdrawn schizothymia	"
9. Factor I. Emotional sensitivity versus tough	
maturity	"
10. Factor L. Paranoid schizothymia versus	
trustful altruism	"
11. Factor M. Hysteric unconcern (or "Bohemian-	
ism") versus practical concernedness	"
12. Factor N. Sophistication versus rough	
simplicity	"
13. Factor O. Anxious insecurity versus placid	
self-confidence	"
14. Factor Q ₁ . Radicalism versus conservatism	"
15. Factor Q ₂ . Independent self-sufficiency versus	
lack of resolution	"
16. Factor Q ₃ . Will control and character	
stability	"
17. Factor Q ₄ . Nervous tension	"
18. G. General activity	Guilford-
19. R. Restraint	Zimmerman
20. A. Ascendance	"
21. S. Sociability	"
22. E. Emotional stability	"
23. O. Objectivity	"

TABLE I (Continued)

24. F. Friendliness	"
25. T. Thoughtfulness	"
26. P. Personal relations	"
27. M. Masculinity	"
28. Average T-score of all physiological responses across all stimulus conditions.	
29. Average T-score of only the autonomic responses across all stimulus conditions.	
30. Average T-score of only the muscle responses across all stimulus conditions.	
31. Peak T-score selected from all physiological responses across all stimulus conditions.	
32. Peak T-score selected from only the autonomic responses across all stimulus conditions.	
33. Peak T-score selected from only the muscle responses across all stimulus conditions.	
34. Low T-score selected from only the autonomic responses across all stimulus conditions.	
35. Low T-score selected from only the muscle responses across all stimulus conditions.	
36. Peak T-score selected from the autonomic responses to the sensory stimulus (hand clap).	
37. Peak T-score selected from the muscle responses to the sensory stimulus (hand clap).	
38. Peak T-score selected from the autonomic responses to the psychological stress stimuli (cards no. 2, 3, 4).	
39. Peak T-score selected from the muscle responses to the psychological stress stimuli (cards no. 2, 3, 4).	

^aAll values entered are expressed in T-score form except age, which is expressed as the actual age of the subject.

sample of elements composing the more broad factors which, it was hypothesized, this analysis would yield. The relationship between physiological reactivity and personality factors was determined by examination of clusters in which either the autonomic or muscle measures appeared.

This analysis will not exhaust the possible information contained in the data collected. It was felt, however, that the analysis just outlined would most adequately answer the main question of this study, whether there exists a relationship between personality and physiological reactions to stress. These are several thousand inter-correlations which may be readily extracted from the data. There are, as well, different methods of measuring and codifying the data, and in addition, several other types of statistical analyses possible, all of which should be performed to exhaust the data. All of the analyses are beyond the province of the present thesis. However, it is planned that many of these analyses will be made before continuing follow-up studies.

Summary of the Experimental Design

The study has been designed to determine some relationships between personality test factors, especially those relative to emotional control, and physiological responses to psychological stress stimuli.

The experimental population consisted of a single group of sixty normal subjects. The stress stimuli consisted of four pictures, one so-called neutral picture and three others depicting different conflict situations. A mild sensory stimulus was also employed. Physiological responses measured on a polygraph consisted of GSR, respiration, heart rate, and muscle action potentials. Personality measurements consisted of twenty-four factor scores derived from the Guilford-Zimmerman Temperament Survey and the Cattell Sixteen Personality Factor Questionnaire. Both the average physiological response T-score for each individual and the peak response T-scores representative of various autonomic, muscular, and gross physiological responses were correlated with all test factors in order to determine the nature of the relationships between personality and physiological responses to stress.

CHAPTER IV

RESULTS

The Pearson product-moment intercorrelations of the thirty-nine variables measured are reported in Table II. For these correlations based upon sixty pairs of scores an r of .33 was required to reach the .01 level of significance, an r of .25 was required for the .05 level, and an r of .21 was required for the .10 level (103, p. 212). When clusters of intercorrelations were extracted, the criterion for the inclusion of any variable in a cluster was that it correlate significantly with every other variable in the cluster at or beyond the .05 level of significance. A correlation coefficient which did not reach significance at the .05 level but exceeded the .10 level was occasionally included in a cluster matrix provided all other correlations involving the affected variable reached significance at the .05 level of confidence. This occasional less stringent level is more apparent than real because the probability that three or more variables showing intercorrelations at the .10 level actually becomes much less than one in ten that the relationships are chance. The actual probability is unknown and although it is smaller than the individual probabilities it is not as small as their products. This is

TABLE II
CORRELATION MATRIX^a

Variable ^b	Code	Age	A
Age	Age		
Cyclothymia	A	-01	
Intelligence	B	-14	-05
Emotional stability	C	-03	02
Dominance	E	-15	03
Surgency	F	-06	-14
Character strength	G	-13	03
Adventurous autonomic resilience	H	-29	12
Emotional sensitivity	I	25	-05
Paranoid schizothymia	L	-02	-04
Hysteric unconcern	M	-04	-12
Sophistication	N	19	17
Anxious insecurity	O	23	04
Radicalism	Q ₁	07	-12
Independent self-sufficiency	Q ₂	15	-08
Will control	Q ₃	12	-08
Nervous tension	Q ₄	06	-03
General activity	G	-30	-05
Restraint	R	04	-04
Ascendance	A	-14	19
Sociability	S	-05	21
Emotional stability	E	-12	-08
Objectivity	O	-17	-10
Friendliness	F	-07	00
Thoughtfulness	T	07	05
Personal relations	P	01	-08
Masculinity	M	-23	-19
Average physiological	AVP	12	-18
Average autonomic	AVA	17	-15
Average muscle	AVM	-07	-16
Peak physiological	PP	-02	-19
Peak autonomic	PA	05	-15
Peak muscle	PM	-02	-13
Low autonomic	LA	03	-16
Low muscle	LM	-01	-06
Clap: peak autonomic	CPA	03	05
Clap: peak muscle	CPM	-03	-13
Stress: peak autonomic	SPA	03	-16
Stress: peak muscle	SPM	-08	-12

^aDecimal points and plus signs are omitted. Levels of significance based on 58 degrees of freedom: .01, $r = .33$; .05, $r = .25$; .10, $r = .21$.

^bSee Table I for more complete title of each variable.

TABLE II (Continued)

Code	B	C	E	F	G	H	I	L	M
Age									
A									
B									
C	16								
E	07	10							
F	-21	08	26						
G	-10	07	-07	-26					
H	01	17	32	23	24				
I	00	09	-07	-25	31	-08			
L	-02	-25	14	19	-15	-05	10		
M	-06	-30	17	19	07	13	23	33	
N	-05	-13	09	-07	-01	-15	-33	00	-03
O	-03	-04	-14	-08	-06	-42	12	32	35
Q ₁	00	-02	20	13	03	-07	-11	06	08
Q ₂	09	04	06	-24	-07	-50	07	-25	00
Q ₃	19	13	-29	-45	19	-03	18	-26	-30
Q ₄	-16	-27	17	28	-19	-21	02	50	40
G	-08	-03	17	09	15	36	-04	-05	07
R	12	19	-28	-35	11	-08	08	-38	-06
A	-13	04	32	25	19	54	-05	-07	03
S	03	22	02	02	29	63	03	-23	-14
E	11	23	06	03	03	34	-22	-33	-23
O	02	12	-01	01	-03	22	-25	-47	-25
F	00	25	-06	-33	06	04	03	-48	-30
T	03	08	00	-12	33	-09	20	-14	-03
P	21	31	13	12	-16	19	-23	-43	-27
M	12	02	16	18	-12	02	-45	-19	-17
AVP	-04	-13	10	-05	-14	-22	02	02	14
AVA	-01	-17	10	-03	-03	-18	06	15	14
AVM	-04	27	14	-12	-16	-22	-09	08	-01
PP	02	-02	17	12	-14	-18	-06	09	05
PA	05	-16	00	-09	-22	-19	02	08	03
PM	-09	05	23	04	-05	-12	-09	00	02
LA	00	-01	24	11	-12	00	01	14	05
LM	-17	-05	-14	00	-16	09	01	28	-04
CPA	-07	-32	-10	-04	-10	-20	27	19	05
CPM	06	01	26	16	13	10	-10	04	22
SPA	02	-02	-08	-13	-12	-17	18	00	-03
SPM	00	08	03	-19	-21	-25	-08	-07	-14

TABLE II (Continued)

Code	N	O	Q ₁	Q ₂	Q ₃	Q ₄	<u>G</u>	<u>R</u>	<u>A</u>
Age									
A									
B									
C									
E									
F									
G									
H									
I									
L									
M									
N									
O	17								
Q ₁	40	03							
Q ₂	13	20	16						
Q ₃	-27	-18	-40	08					
Q ₄	23	61	21	-03	-62				
<u>G</u>	-14	-17	-13	-24	-04	-17			
<u>R</u>	-08	-14	-03	-03	20	-34	23		
<u>A</u>	-05	-32	-02	-45	-04	-23	48	13	
<u>S</u>	-19	-41	-22	-42	26	-50	47	28	65
<u>E</u>	-13	-60	-17	16	31	-71	34	35	40
<u>O</u>	-07	-53	-04	-15	24	-63	47	49	42
<u>F</u>	-07	-43	-10	01	32	-55	17	50	14
<u>T</u>	06	12	02	05	-09	08	41	36	33
<u>P</u>	00	-41	08	-10	18	-43	25	36	36
<u>M</u>	06	-28	01	-03	02	-25	25	18	34
AVP	31	26	21	12	-09	21	-02	06	-02
AVA	33	27	29	04	-18	21	04	08	-01
AVM	22	10	06	24	10	07	-09	06	-06
PP	21	19	21	19	-10	15	04	-05	04
PA	20	21	08	09	-07	12	00	00	-01
PM	18	-04	14	30	02	03	01	02	04
LA	16	03	28	-03	-11	10	-10	08	-06
LM	05	-01	-10	-26	07	05	-10	05	-09
CPA	35	16	00	05	-13	13	01	-19	00
CPM	00	05	12	16	-01	11	-01	00	12
SPA	07	26	11	07	-08	14	04	10	03
SPM	25	03	13	26	03	-03	-02	13	-13

TABLE II (Continued)

Code	<u>S</u>	<u>E</u>	<u>O</u>	<u>F</u>	<u>T</u>	<u>P</u>	<u>M</u>	AVP	AVA
Age									
A									
B									
C									
E									
F									
G									
H									
I									
L									
M									
N									
O									
Q ₁									
Q ₂									
Q ₃									
Q ₄									
G									
R									
A									
S									
E	63								
O	51	77							
F	37	60	63						
T	28	03	06	08					
P	49	61	66	58	17				
M	14	44	54	27	13	45			
AVP	-28	-19	01	-09	00	-08	02		
AVA	-25	-22	00	-10	07	-06	05	86	
AVM	-28	-10	05	-02	-04	-11	04	76	41
PP	-19	-08	04	-13	05	-04	07	80	63
PA	-13	-17	-04	-09	04	-03	03	69	67
PM	-17	03	14	-02	05	-04	12	65	35
LA	-21	09	05	-06	-21	10	02	44	52
LM	-05	-14	-11	-11	-13	-22	-17	27	14
CPA	-22	-12	-11	-21	00	-17	11	50	50
CPM	01	13	08	-08	14	-01	17	33	24
SPA	-03	-24	-04	00	16	00	-05	60	57
SPM	-27	-07	15	07	-06	-04	05	60	30

TABLE II (Continued)

Code	AVM	PP	PA	PM	LA	LM	CPA	CPM	SPA
Age									
A									
B									
C									
E									
F									
G									
H									
I									
L									
M									
N									
O									
Q ₁									
Q ₂									
Q ₃									
Q ₄									
G									
R									
A									
S									
E									
O									
F									
T									
P									
M									
AVP									
AVA									
AVM									
PP	73								
PA	42	73							
PM	83	79	32						
LA	16	24	12	18					
LM	36	15	23	-01	21				
CPA	34	47	62	18	-01	20			
CPM	35	47	04	59	15	-17	15		
SPA	38	63	81	34	06	11	23	-02	
SPM	81	61	38	74	14	17	13	-04	45

because there is a finite number of variables and not all variables can be assumed to be completely independent. It is believed that this procedure results in clusters which reach significance at the .01 level or better. Further reason for occasional acceptance of the .10 level of confidence as significant was that this is in large part an exploratory study and the risk involved in possible identification of a few false positives is not as serious as when testing very specific hypotheses. Unless otherwise specified the criterion of significance for single-linkage correlations between only two variables may be assumed to be at the .05 level or better.

When such large numbers of intercorrelations as these are derived one may expect some to appear statistically significant purely on the basis of chance. A much greater than chance number of significant correlations were obtained in all cases, however. Of the 741 correlations in the complete matrix, 104 were found to be statistically significant at or beyond the .01 level as compared to seven expected on the basis of chance alone. At the .05 level or better 158 were found to be significant as compared to 37 expected by chance. At the .10 level 213 correlations were found to be statistically significant when only 74 might be expected on the basis of chance. These chance expectancies are based upon the assumption of complete independence among the variables. Since there was

foreknowledge that not all the variables were completely independent as was the case among the physiological measures the obtained number of significant correlations is actually not as much greater than chance expectancy as is implied. However, the number of significant correlations would appear to be greater than chance even though the exact chance number is not known.

Relationships were found to exist between measures of personality and measures of physiological responsivity. As was expected, not all personality variables were found to be related to physiological responsivity. The personality test variables relating to one or more of the physiological measures at or beyond the .05 level were:

- C - Emotional stability or ego strength versus dissatisfied emotionality.
- E - Dominance or ascendance versus submission.
- H - Adventurous autonomic resilience versus withdrawn schizothymia (negative loading).
- I - Emotional sensitivity versus tough maturity.
- L - Paranoid schizothymia versus trustful altruism.
- N - Sophistication versus rough simplicity.
- O - Anxious insecurity versus placid self-confidence.
- Q₁ - Radicalism versus conservatism.

Q_2 - Independent self-sufficiency versus lack of resolution
(both negative and positive loadings).

S - Sociability (negative loading).

Some additional personality factors were related to the physiological variables at the .10 level but will not be discussed except as they are found in cluster relationships. These factors, as they are presented here, are only suggestive of the general nature of the personality variables which may be of importance in psychophysiological relationships. Examination of these factors reveal them all to relate to interpersonal relations, emotion, and the nature of its expression and control. Test factors correlating significantly with each physiological measure are reported in Table III.

This list of factors only serves to illustrate in a general way the areas of personality which may play a role in physiological responsiveness to stress. The specific nature of the psychophysiological relationships found in this study can be determined only by examination of the various significant clusters in which both physiological and test variables appear because there were differences in the way various measures of psychophysiological responsivity related to personality. Only those clusters which appeared within the physiological measures and those which occurred between physiological and personality measures were considered. No clusters were considered which

TABLE III

PERSONALITY TEST FACTORS CORRELATING WITH
PHYSIOLOGICAL MEASURES AT OR BEYOND
THE .05 LEVEL OF CONFIDENCE

Physiological Measure	Test Factor	Correlation
Average physiological	N - sophistication	.31
	O - anxious insecurity	.26
	<u>S</u> - sociability	-.27
Average autonomic	N - sophistication	.33
	O - anxious insecurity	.27
	Q ₁ - radicalism	.29
	<u>S</u> - sociability	-.25
Average muscle	C - emotional stability	.27
	<u>S</u> - sociability	-.28
Peak muscle	Q ₂ - independent self-sufficiency	.30
Low autonomic	Q ₁ - radicalism	.28
Low muscle	L - paranoid schizothymia	.28
	Q ₂ - independent self-sufficiency	-.26
Clap: peak autonomic	C - emotional stability	.32
	I - emotional sensitivity	.27
	N - sophistication	.35
Clap: peak muscle	E - dominance	.26
Stress: peak autonomic	O - anxious insecurity	.26
Stress: peak muscle	H - adventurous autonomic resilience	-.25
	N - sophistication	.25
	Q ₂ - independent self-sufficiency	.26
	<u>S</u> - sociability	-.27

were contained entirely within the personality measures since these clusters contribute no data relevant to the purpose of this study.

Table IV reports the first cluster of intercorrelations all significantly greater than zero in which both personality factors and physiological factors appear together.

TABLE IV
CLUSTER 1

Variable	Code	AVP	AVA	AVM	N	<u>S</u>
Average physiological . . .	AVP					
Average autonomic	AVA	.86				
Average muscle	AVM	.76	.41			
Sophistication	N	.31	.33	.22		
Sociability	<u>S</u>	-.28	-.25	-.28	-.41	

This may be considered the most general psychophysiological relationship found in that it encompasses all the average measures of physiological responses where no provision was made for specificity of response. On the physiological side it may be considered as a general physiological lability. On the psychological side is the characterization of people who are socially introverted and shy. Such people would tend to remain cool and aloof and are likely to have few friends and acquaintances. They are generally unsentimental and rational, probably having a carefully thought-out intellectual reason

for most things they do. These psychological qualities might be summarized as lacking in spontaneity and an inability to enter into free social interchange.

In Cluster 2, reported in Table V, it may be noted that the average of all physiological responses and the average of the autonomic response remain but the average of the muscle responses fails to appear.

TABLE V
CLUSTER 2

Variable	Code	AVP	AVA	N	Q ₁
Average physiological	AVP				
Average autonomic	AVA	.76			
Sophistication	N	.31	.33		
Radicalism	Q ₁	.21	.29	.40	

Factor N remains in the cluster, but Q₁ replaces S. On the physiological side this remains something of a general factor, but with a tendency for autonomic responses to be predominant. In addition to the intellectual rationalism and lack of spontaneity of Factor N is a tendency toward introspection, an interest in fundamental issues, and a more direct interest in intellectual matters as indicated by Factor Q₁. This is a cluster somewhat difficult

to place in relationship to the others physiologically. It is suggestive of a tendency to react to stress with generalized physiological disturbance with some emphasis on internal autonomic disturbances. Associated with it is a picture of people who lack spontaneity, tend to be introspective, and attempt to reduce all problems to a carefully controlled intellectual task. They appear to have difficulty relaxing and probably cannot find satisfying social outlets.

Cluster 3, reported in Table VI, appears to be the first cluster involving psychophysiological relations of a more specific nature. The clusters up to this point have tended to identify more or less broad and gross psychophysiological relationships.

TABLE VI

CLUSTER 3

Variable	Code	AVP	H	O	<u>S</u>
Average physiological	AVP				
Adventurous autonomic resilience	H	-.22			
Anxious insecurity	O	.26	-.42		
Sociability	<u>S</u>	-.28	.63	-.41	

The nature of the physiological responses in this cluster is nonspecific and is consistent in favoring neither the autonomic nor musculature type of responses. Where the previous cluster tended

to identify personality factors that may be associated with one of several physiological response tendencies, this cluster seems to identify the factors associated with the physiological response pattern which Jones (83) termed the "generalizer." The negative H and S loadings tend to give rather heavy weight to qualities of shyness, withdrawal, lack of social interests, and an inability to fit into social groups. These loadings are suggestive of people who are careful, well behaved, have difficulty expressing themselves, and tend to avoid emotional involvement. Along with this appears Factor O, again indicating an inability to enter into free interchange with other people, but more strongly emphasizing the constant tension that these people appear to feel. They tend to experience a free floating type of anxiety, worry a great deal, and have difficulty finding solutions to their problems largely because they are never sure of just what is the problem. This cluster, then, identifies the physiological generalizer with one who has difficulty with emotional expression, cannot enter into free social interchange, is tense, anxious, insecure, and tends to worry.

Cluster 4, reported in Table VII, identifies the personality factors associated with the average of all the autonomic responses to all stimuli.

TABLE VII

CLUSTER 4

Variable	Code	AVA	O	Q ₄	<u>S</u>	<u>E</u>
Average autonomic	AVA					
Anxious insecurity	O	.27				
Nervous tension	Q ₄	.21	.61			
Sociability	<u>S</u>	-.26	-.42	-.50		
Emotional stability	<u>E</u>	-.22	-.60	-.71	.63	

The restless, worried, unhappy, free floating anxiety of Factors O and Q₄ described in the previous cluster reappear here. The negatively loaded Factor S, which appears in nearly all clusters, is also found here. The negatively loaded Factor E in this cluster emphasizes the moodiness, gloominess, pessimism, and introspective tendencies. The autonomic responses are thus associated with a pattern of shyness and limited social relations, tenseness, anxiousness, insecurity, and introspective pessimism accompanied by a general lack of emotional stability. This pattern differs from the previous one in placing less emphasis on an unemotional withdrawal and more emphasis on unstable emotionality and a worried pessimistic outlook. The main difference seems to lie in a shift from a state of attempting to deny all emotion in the case of the generalized responder to a state of subjectively experiencing feelings and

emotions but unable to express them in an overt fashion in the case of the autonomic responder.

Inspection of Cluster 5, reported in Table VIII, reveals the average of the muscle responses to all stimuli and the peak muscle response to only the three psychological stress cards are related to the same set of personality factors.

TABLE VIII

CLUSTER 5

Variable	Code	AVM	SPM	Q ₂	<u>S</u>
Average muscle	AVM				
Stress: peak muscle	SPM	.81			
Independent self-sufficiency . . .	Q ₂	.24	.26		
Sociability	<u>S</u>	-.28	-.27	-.42	

This cluster includes the negatively loaded Factor S, as have the previous clusters, but in a context implying a markedly different significance. In the present cluster there is found a dislike for social activities and an avoidance of social contacts which appears to result not so much from shyness and insecurity but from a resolute independent self-sufficiency. Such a person is one who goes his own way, not particularly caring what the reactions of others may be.

Factor C failed to intercorrelate with each variable in this cluster to a sufficient degree to be included in the cluster, but because it correlated significantly beyond the .05 level with the average muscle response and is consistent with the interpretation of the cluster it is mentioned here. This factor suggests qualities of being emotionally stable, well integrated, and not easily ruffled. It is interesting to note that Cattell reports criminals were among those scoring highest both on Factors Q_2 and C.

The next significant cluster of correlations is Cluster 6, reported in Table IX. It is one involving low muscle response or the greatest degree of muscle relaxation that a person was able to achieve in face of any stimulus. It may mean either an ability to relax or it may mean a general lack of muscle tonus. On the psychological side is the characterization of one who is fastidious and interested in things of an aesthetic nature, is introspective in an imaginative manner and tends to be impractical in his behavior. He is quick to find fault with other people and social institutions, and makes demands on others in an immature, impatient manner. Such a person reacts in a manner which might be termed narcissistic, is rarely self-evaluative, and unwilling to assume social responsibility.

TABLE IX
CLUSTER 6

Variable	Code	LM	L	P
Low muscle	LM			
Paranoid schizothymia	L	.28		
Personal relations	P	-.22	-.43	

In an extreme degree such behavior would tend to be labeled psychopathic. It is interesting to note that a significant negative correlation between low muscle and Q_2 appears. While it fails to be included in the cluster and must therefore be interpreted with caution it is suggestive that although people who fall within this cluster are self-centered they need responses from others in order to achieve satisfaction. This factor was included in the previous cluster, Cluster 5, where it received a positive loading in association with positive muscle responses. Thus it might be speculated that the high muscle responder goes his own way and has little need for other people while the low muscle responder also goes his own way but needs to elicit responses from other people. It may be somewhat difficult to fit this cluster into a final analysis because of the unclear meaning that a low muscle response may have.

Cluster 7, reported in Table X, is one of two clusters containing the peak autonomic response to the hand clap stimulus.

TABLE X
CLUSTER 7

Variable	Code	CPA	C	<u>F</u>
Clap: peak autonomic	CPA			
Emotional stability	C	.32		
Friendliness	<u>F</u>	-.21	.25	

The personality constellation found in this cluster consists of being emotionally stable, making a realistic approach to things, and not being easily upset. Such a person described by this cluster tends to have a limited number of friends and acquaintances and does not enter into free social interchange because of hostility and resentment and a desire to dominate those about him. Such behavior tends to prevent others from becoming closely associated with him.

The other cluster containing the peak autonomic response to the hand clap is Cluster 8, reported in Table XI. The personality descriptions include being fastidious, impatient, demanding, and seeking attention. Such a cluster would also characterize a person as appearing sophisticated and cool to others and approaching things in a rational and unemotional manner. The personality description

TABLE XI
CLUSTER 8

Variable	Code	CPA	I	N
Clap: peak autonomic	CPA			
Emotional sensitivity	I	.27		
Sophistication	N	.35	-.34	

might be summarized as indicating one who is immature and self-centered and has little emotional rapport with others. This cluster is somewhat difficult to interpret since both Factors I and N correlate positively with the physiological variables but negatively with one another.

The specific significance of the relationship between the peak autonomic response to the hand clap stimulus and personality variables is not completely clear. There seems to be little doubt that this kind of a response is definitely related to personality factors. The question is whether there are two constellations of personality factors which predispose one to make physiological responses of this nature or whether these two obtained clusters are actually a single loosely organized cluster. There is some evidence to favor the latter alternative. First, the elements of the second cluster do not appear to be sufficiently complementary to warrant standing alone

as a single unique cluster. Second, the general descriptions of the two clusters are such that they could be slightly different aspects of the same thing. Both tend to describe a person who is self-centered, cool to others, and approaches things in a rational, unemotional manner. The main difference seems to be that Cluster 7 characterizes a person as being somewhat more emotionally mature and stable than is apparent in Cluster 8.

Cluster 9, reported in Table XII, associates the peak autonomic response to the stress stimuli with a rather specific factor of worry and dysphoric mood. Included in the descriptions of Factors O and E is a tendency for fluctuation of moods and emotional sensitivity.

TABLE XII

CLUSTER 9

Variable	Code	SPA	O	<u>E</u>
Stress: peak autonomic	SPA			
Anxious	O	.26		
Emotional stability	<u>E</u>	-.24	-.60	

Although such a person may easily have his feelings hurt instead of doing or saying anything he may ruminate about such an

incident and tend to feel sorry for himself. These people are socially retiring and feel that they are not accepted.

Cluster 10, which appears in Table XIII, is one of two closely interrelated clusters of correlations which contain the peak muscle response to the three cards designed to have stress value of a strictly psychological nature.

TABLE XIII

CLUSTER 10

Variable	Code	SPM	H	Q_2	$\underline{S}$
Stress: peak muscle	SPM				
Adventurous autonomic resilience	H	-.26			
Independent self-sufficiency . . .	Q_2	.26	-.50		
Sociability	$\underline{S}$	-.27	.63	-.42	

The core of the psychological elements of this and the following cluster are identical. The present cluster is also very similar to Cluster 5, which contained both the peak muscle response to stress and the average muscle response to all stimuli. Cluster 5 may be considered to represent a general case of all muscle responses, and Cluster 10, a specific instance within this general case. The characterization in Cluster 5 of people who go their own way, withdraw from social relations, and are not particularly concerned

with other people applies here. The additional factor in the present cluster tends to suggest that such people keep their distance from others because of shyness and feelings of inferiority and an inability to express themselves around others.

Inspection of Cluster 11, in Table XIV, reveals the presence of the negatively loaded Factors H and S, which also appeared in the previous cluster.

TABLE XIV

CLUSTER 11

Variable	Code	SPM	G	H	<u>S</u>
Stress: peak muscle	SPM				
Character strength	G	-.21			
Adventurous autonomic resilience	H	-.26	.24		
Sociability	<u>S</u>	-.27	.29	.63	

Thus, shyness, feelings of inferiority, and withdrawal from social contacts appears to be a commonality between these two. The difference seems to be in how the persons characterized handle their poor relations with others. The appearance of the present Factor G in place of Q_2 suggests that people described by this factor instead of rather unconcernedly going their way appear to be left without any guiding standards. They tend to be troublesome,

irresponsible, and demanding. They are distractable and give up easily with a "don't care" attitude. Cattell reports that such a factor loading of G is particularly characteristic of psychopaths (26).

Clusters 10 and 11, although closely related, appear to characterize two separate groups of people, both of whom show a predominance of muscle responses in a psychologically stressful situation.

Five of the twelve physiological response measures failed to be associated with personality variables in cluster relationships. These were peak physiological, peak autonomic, peak muscle, low autonomic, and peak muscle response to the hand clap stimulus.

Peak physiological, the measure consisting of a person's single greatest physiological change in response to any one of the five stimuli presented appeared to yield one of the lowest associations with personality measures of all the physiological measures employed. It had been predicted that this variable would yield some of the highest relationships with personality. There appeared to be some tendency for it to cluster with N, Q_1 , and negatively loaded $\underline{S}$, but with less than the required degree of interrelationship. This highly tenuous grouping appears to resemble Clusters 2 and 3, both containing the measure of average physiological response. It thus

appears to be consistent with other measures where both autonomic and muscle response had an equal opportunity of appearing.

The measure employing the peak response among the three autonomic variables yielded neither significant single-linkage correlation nor cluster tendencies when compared with personality measures.

The peak muscle response consisting of the greatest response to any one of the five stress conditions made by either of the two muscles measured yielded a significant single-linkage correlation of .30 with Factor Q_2 (independent self-sufficiency), and a near significant correlation of .23 with Factor E (dominance). Again these sorts of relationships must be viewed with caution but they appear to emphasize personality characteristics of independence, lack of concern for social convention, and lack of inhibition in social action which have tended to appear in varying degrees with all other measures of muscular response tendencies.

The peak muscle response to the hand clap stimulus yielded a statistically significant correlation of .26 with Factor E (dominance), and a near significant correlation of .22 with Factor M (hysteric unconcern). These correlations provide another small bit of confirmatory evidence concerning the general nature of personality associated

with the tendency to respond to stress with an increase in muscular tension.

CHAPTER V

DISCUSSION

This study offered substantial confirmation that there are associations between psychological descriptions of a person and his tendency to respond to certain stress situations with certain changes in physiological activity. Such associations have been assumed by many observers in various contexts but confirmed by only a few previous experimental investigations.

In the design of the present experiment one of the reasons entertained to account for the failure to demonstrate experimentally this generally agreed upon association was that previous experiments had not taken into account the possibility that the level of response in each physiological system to a particular stimulus might be relatively independent from the level of response in other systems. The work of Lacey (97, 98, 99), Malmo and Shagass (113, 117), and others has demonstrated the presence of such uniqueness of response tendencies. It was hypothesized that when such a possible uniqueness was taken into account by selecting for comparison the peak standard score of responses regardless of the system in which it appeared or the stimulus which initiated it, correlations

with personality variables, if they existed, would be greater than when the average of all physiological responses was used.

The obtained results failed to support this hypothesis. The measure of peak physiological response not only failed to show greater relationship to personality measures than the measure of average physiological response, but it was among the measures showing the least association with personality. This finding does not, however, offer evidence against the concept of relative response specificity upon which the use of this particular measure was based. On the contrary, an examination of the relationship between the various obtained measures of physiological response tends to lend support to this concept. The concept of generality or equivalence of all measures of physiological responsivity, the usual alternative to specificity, could not be accepted on the basis of the obtained data. It must be kept in mind, of course, that this experiment was not designed to provide a highly discriminative test of these concepts.

What appears to be the major reason for the failure to find the peak physiological response relating to personality appears to stem from the unreliability of the peak physiological response as a measure. The average physiological response is a score based upon thirty replications while peak physiological response consists

of a single unreplicated score. One way in which the concept of specificity might be better employed in future research of this nature would be to include repeated measures of the response to the same stimuli or equivalent stimuli. In such a case several measures of the response within each system could be obtained and the average response of each system to each stimulus then used to provide the scores from which the peak response measure might be selected.

The selection of peak responses from less heterogeneous groups of scores was fruitful in the present study. When peak scores were selected from the muscle responses and autonomic responses separately such measures yielded correlations with narrow areas of personality functioning which helped to give focus to the more broad areas of personality to which the more reliable, but less specific, measures of average autonomic and average muscle responses each related. Thus they aided in identifying differences between autonomic responders and muscle responders by helping to identify the unique personality characteristics associated with each over and above those associated with physiological response tendencies in general. This suggests that there were consistent differences in the ways in which autonomic and muscular measures related to personality which prevented the peak

physiological response measure from yielding a score representative of both. The relationships between measures of peak physiological responses and personality were increased when the heterogeneity of scores from which such measures might be selected was further reduced by calculating measures of peak autonomic and peak muscle responses to specific stimulus conditions rather than selecting a particular measure from among all conditions.

Withdrawal from interpersonal relations, a tendency to remain cool and aloof from others, an inability to express one's self freely, a lack of spontaneity or freedom of emotional expression and a tendency to conduct one's self in a rational, unemotional manner are personality qualities associated with a general tendency to respond to stress with some kind of physiological disturbance. Descriptions of having few friends and acquaintances and avoiding conversation and social activities, all aptly summarized by the term "social introversion," were the most consistent personality qualities associated with physiological responses. This included both autonomic and muscular responses to strictly psychological stress as well as to sensory stimulation. This points to perhaps a factor of sensitivity which might be dealt with in further research.

Not only do these results confirm the hypothesis that appearing among the personality factors related to physiological

responsiveness would be personality measures related to emotional over-control and lack of expressiveness, but the results suggest that the types of physiological responses obtained here are almost exclusively related to these qualities. The nature of a person's social relations, which appear in most of these clusters, seems to be dependent largely upon how one handles his feelings and emotions.

The results of this study suggest that the person who responds to stress primarily with autonomic disturbances has, in terms of personality organization, much in common with the person who responds with overt muscular disturbances. However, there appears to be certain important personality qualities which differentiate people who may respond to stress with disturbances primarily in one system or the other. The main difference seems to lie in how they deal with emotional expression. Both groups lack emotional rapport and free give and take interchange with others. The autonomic responder may not exhibit overt emotional expression but he is emotionally sensitive. His feelings may be easily hurt, but instead of showing overt action at such times, he tends to be introspective about it and ruminate and brood. He is a worrier and feels he is not accepted by others. He attempts to deny emotional expression but feelings and emotions play a large

part in his social behavior. He seldom feels comfortable around other people.

The muscle responder also fails to exhibit overt emotional responses. He is more effective than is the autonomic responder in denying emotion completely and approaching things in an intellectual, unfeeling manner. He tends to be isolated from other people, but instead of worrying and introspecting he goes unconcernedly his own way, not particularly caring what others think of him. He tends to ignore the wishes and feelings of others and often behaves in a troublesome, demanding, and irresponsible manner. Such persons may try to manipulate others to satisfy their own wants and are usually rather self-centered and strong willed. They exhibit a lack of concern for social conventions and tend to lack inhibition in social action. The psychological test variables which differentiate the muscle responder from the autonomic responder were variables which Cattell had found were responded to in a similar manner by psychopaths and criminals.

These findings tend to support the observations of some previous investigators that overt muscular responses may be associated with a lack of inhibition and that internal autonomic responses to stress may be associated with lack of expressiveness. These data do not suggest a simple inverse relationship between the

personalities of autonomic responders and muscle responders. These two groups have too much in common for such a relationship to be true. There are, however, some measures relevant to emotional expression where the scores from these two groups tend to be associated with opposite ends of a personality continuum. The only suggestion of a direct inverse relationship with personality which appeared in this study was when peak muscle responses and low muscle responses were compared. Peak muscle responses were significantly associated with independent self-sufficiency and low muscle responses with a lack of resolution, each found at opposite ends of the same continuum.

The study provides some suggestions that the nature of the stress situation may play a role in determining which personality factors may be associated with physiological responses. Two distinctly different kinds of stress were employed in this experiment. Stress cards 2, 3, and 4, the "hostile," "dependent," and "sexual" stimuli respectively, were designed to produce stress of a strictly psychological nature by virtue of the cards' cue values for possible past conflict situation or problem areas existing in a particular subject. The hand clap or sensory stimulus receives its stress value from the element of surprise or startle. The "neutral" or control card from the psychological stress series may also be

considered as a stress stimulus in this particular situation. It was always presented first in the series and its stress value stemmed from its presentation representing a new and strange situation which had to be dealt with. As a stressor it may be classified as the "problem" or "difficult task" type. The responses to this card were not analyzed separately, but inspection of the polygraph records suggests that it had a stimulating value similar to the other more generally recognized stress stimuli. It was for that reason responses to this card were included in obtaining the general stress response measures.

The autonomic responders to the hand-clap appeared somewhat more independent, self-centered, and hostile than autonomic responders in general. The personality descriptions of the autonomic responders to the psychological stress stimuli tended to further emphasize the introspective, worried, dysphoric qualities already identified with the autonomic responder in general. The quality of dominance was emphasized in the muscle responder to the sensory stimulus. Shyness, feelings of inferiority, as well as irresponsibility, were included in the descriptions of the muscle responders to psychological stress.

The breakdown into these subgroups suggests that the autonomic responder is most closely identified with responses to

psychological type stress and persons described as muscle responders are particularly sensitive to sensory type stress. This is given support mainly by the association of the psychological factors most clearly differentiating the autonomic responders with the autonomic responses to the psychological stress stimuli. Psychological factors most clearly differentiating muscle responders appearing in association with the muscle responses to the sensory stimulus. The autonomic responses to the sensory stimulus appear to be associated with personality descriptions tending to show similarities to the characteristics of the muscle responders. The muscle responders to psychological stress conversely showed some slight tendency to resemble the autonomic responders in general.

These findings with respect to differentiation of variations of psychophysiological relationships among subtypes of stress are not as well substantiated as the main body of the findings previously discussed. They can only be considered as tentative suggestions which may provide leads for future research.

The results of this study are highly suggestive of certain relationships between physiological responses to stress and personality descriptions. These are in particular the relations between a general physiological ability and social isolation, poor communication with others, and problems of emotional control. Both

similarities and consistent differences were found between personality descriptions of autonomic responders and muscle responders. Other quite tentative relationships were found that must await further investigation for more definite confirmation or refutation.

The principal value of this study was an exploratory one which provided more in the way of suggestive trends and possible leads for future research than it did in the way of answering specific questions or testing specific hypothesis. These findings should provide guideposts and suggestions for the design of future experiments with which more specific hypotheses about psychophysiological relationships may be tested.

This experiment provides a body of data concerning physiological stress reactions and their relationships to personality descriptions in a normal group which can be used to provide comparisons in future studies with data obtained from various patient groups. The present data can be useful as control data for the purpose of determining whether certain patient groups differ from normals in response to similar stress situations. It can be even more useful from a theoretical standpoint in providing some basis for predictions about the nature of physiological responses to stress which may be found in patient groups. The introspective, conscientious, socially isolated person appears to be particularly susceptible to

stress consisting of "ego-threat" of threat to the psychological integrity of the individual when such threat is related to past experiences of the individual. The physiological reactions of this kind of person appear to be predominately autonomic. On the basis of the obtained data, the prediction is offered that such a person's reactions to chronic psychological stress may be of such a nature as to predispose him to psychosomatic disorders involving disturbance of functioning of the autonomic nervous system such as peptic ulcer or hypertension, all other things being equal.

There are suggestions that muscle responders, while also socially isolated but not so constricted or introspective, are not so much concerned by psychological threat as they are by possible physical threat. On the basis of the obtained evidence, one might predict that they would be more likely to become involved in interpersonal conflict and if they developed psychosomatic diseases might tend to develop such disorders as headache and rheumatoid arthritis which may more directly involve malfunctioning of external musculature.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This study was designed to investigate possible relationships between personality test factors, especially those relevant to control of emotional expression, and physiological responses to stress situations. The experimental population consisted of a single group of sixty normal subjects. Psychological stress stimuli defined in terms of cues relating to possible past conflicts or existing problems in a subject and mild sensory stimulation were the stress stimuli employed. The psychological stress stimuli consisted of a series of four pictures on cards descriptively labeled 'neutral,' 'hostile,' 'dependent,' and 'sexual.' A fourth picture, a so-called 'neutral' picture, was presented in the series and appeared to have stress value of the 'problem-situation' type. The sensory stimuli consisted of an unexpected hand clap. Physiological responses to these stimuli, measured by a polygraph, consisted of galvanic skin response, respiration rate, heart rate, and muscle action potentials from the sternocleidomastoid and masseter muscles. Personality measurements consisted of twenty-four factor scores

obtained from the Cattell Sixteen Personality Factor Questionnaire and the Guilford-Zimmerman Temperament Survey.

All physiological responses, corrected for correlation with base level, and all psychological test scores were converted into T-scores. Twelve physiological response measures were derived after T-scores were determined. These consisted of average physiological response, average autonomic response, average muscle response, peak physiological response, peak autonomic response, peak muscle response, low autonomic response, low muscle response, peak autonomic response to only the psychological stress stimuli, peak muscle response to only the psychological stress stimuli, peak autonomic response to only the hand-clap, and peak muscle response to only the hand-clap. The T-scores of the twelve physiological measures, twenty-four psychological test factors, and raw scores of age were all intercorrelated. The intercorrelations of these thirty-nine variables yielded a matrix of 741 Pearson product-moment coefficients of correlation. Correlation clusters were extracted from the correlation among the physiological response variables and from the correlations between physiological response and psychological test factors. No clusters were extracted which were contained entirely within the personality measures since these clusters contribute no data relevant to the purpose of this study.

The criterion for inclusion of correlations in a cluster was that every variable in a cluster intercorrelate significantly with every other variable in that cluster. Twelve clusters were extracted.

The conclusions based upon analysis of these clusters were:

1. There was a significant interrelationship among most of the physiological measures but not sufficiently high or consistent to reject the concept of relative physiological response specificity.
2. Withdrawal from interpersonal relations, a tendency to remain cool and aloof from others, an inability to express one's self freely, a lack of spontaneity or freedom of emotional expression, a tendency to conduct one's self in a rational, unemotional manner, and other characteristics roughly summarized as "social introversion" were personality qualities found to be associated with a general tendency to respond to stress with some kind of physiological disturbance.
3. There was much similarity in the personality descriptions associated with autonomic response tendencies and muscle response tendencies. There were also consistent personality differences between the autonomic responder and the muscle responder.
4. The autonomic responder may not exhibit overt emotional expression, but he is emotionally sensitive. He tends to be introspective and to brood. His feelings are easily hurt. He attempts

to deny emotional expression, but feelings and emotions play a large part in his social behavior. He is a worrier and feels he is not accepted by others. He seldom feels comfortable around other people.

5. The muscle responder is more effective than the autonomic responder in attempts to deny emotion completely and approaching life generally in an intellectual, unfeeling manner. He tends to remain isolated from other people, but instead of worrying and introspecting he goes his own way not particularly caring what others may think of him. He exhibits a lack of concern for social conventions and tends to lack inhibition in social actions.

6. There are some suggestions that psychological stress is a more potent stimulus for those people who tend to respond precominantly with autonomic changes and that sensory stress or startle is a more potent stimulus for muscle responders.

7. These findings are expected to provide leads and guideposts for future investigations of more specific hypotheses about physiological responses to stress and their relationship to personality. This study may also provide control data for similar investigations of various patient groups.

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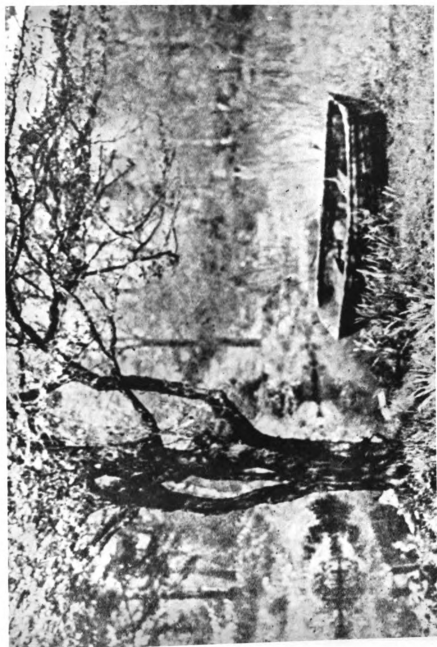
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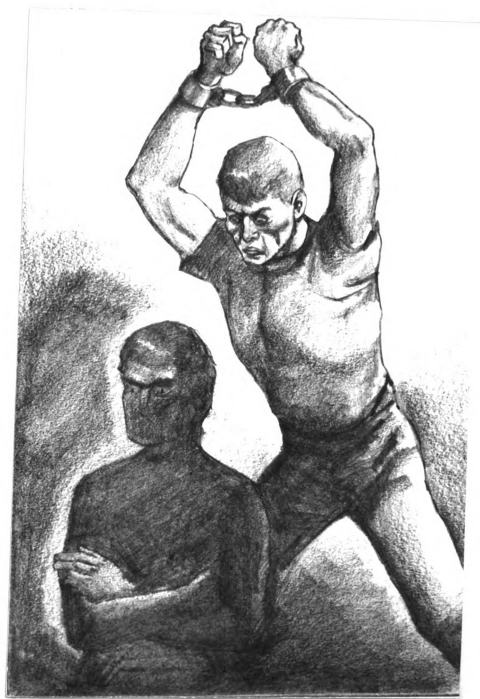
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APPENDIX



Card No. 1. "Neutral" stimulus.



Card No. 2. "Hostile" stimulus.



Card No. 3. "Dependent" stimulus.



Card No. 4. "Sexual" stimulus.

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