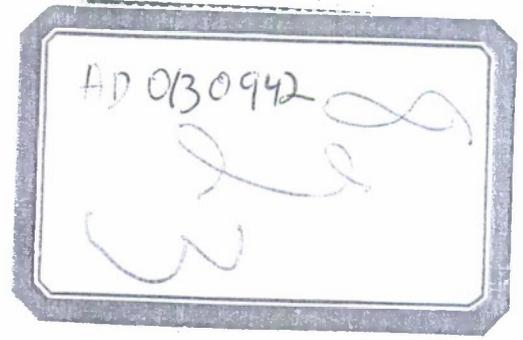


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PSYCHOLOGICAL STRESS
AS A THEORETICAL CONCEPT

W. DEAN CHILES

AERO MEDICAL LABORATORY

JULY 1957

WRIGHT AIR DEVELOPMENT CENTER

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PSYCHOLOGICAL STRESS
AS A THEORETICAL CONCEPT

W. DEAN CHILES

AERO MEDICAL LABORATORY

JULY 1957

PROJECT No. 7193

WRIGHT AIR DEVELOPMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

FOREWORD

This report was prepared by the Psychology Branch of the Aero Medical Laboratory, Directorate of Laboratories, Wright Air Development Center, under Research and Development Project No. 7193, "Operator Performance Under Stressful Environmental Conditions," with Dr. W. Dean Chiles acting as Project Scientist.

ABSTRACT

An examination of some typical treatments of psychological stress is carried out in this paper. The approach of construing stress in analogy to physical and physiological concepts is rejected since these approaches have not led to quantifiable insights into the action of stress with respect to human behavior. A systematic approach, based on the presentation of J. S. Brown and I. E. Farber, is suggested along with the framework for the quantification of psychological stress as a theoretical concept. Some of the implications of this approach with respect to performance variables are discussed.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:



JACK BOLLERUD
Colonel, USAF (MC)
Chief, Aero Medical Laboratory
Directorate of Laboratories

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INTRODUCTION

The individual embarking on investigations in the field of psychological stress is inevitably struck by the extent to which this area is isolated from the general framework of systematic behavior theory. Not only is it necessary that stress, as a concept, must ultimately be compatible with the behavior theory in vogue, but it is also quite likely that a successful attempt to integrate stress into current behavior theory will be of value in terms of the rate of progress in this field. At the present time, each bit of knowledge gleaned from experimentation stands more or less in isolation with no tie-ins with behavior theory, nor with other experiments on stress for that matter.

The two papers which follow summarize the thinking of the author on this general subject over the past four years. The first of these, Section I, offers a brief analysis of a few typical examples of the number of papers which were read with the hope of uncovering some clue as to a starting point for a "Theory of Stress". As it will be noted, they did not provide the sought after base.

Section II outlines an attempt on the part of the writer to provide a schematization of a "Theory of Stress". It is felt that this will serve two beneficial purposes: First of all, it represents an articulate coordination of stress as a theoretical concept with the Hullian behavior theory, thus providing for increased generality of experimental results. Second, it provides a framework which can serve to integrate the experimental program being carried out by this Laboratory on the problem of operator performance under stressful environmental conditions.

SECTION I: AN EXAMINATION OF SOME TYPICAL TREATMENTS OF STRESS

The following are quotations from Brown and Farber (4), the first of which originated with E. G. Boring (3).

Whatever exists as reality for psychology is a product of inductive inference - usually from experimental data. To say that these realities are hypothetical constructs is not to alter the truth. The atom is a construct and a reality. Its validity is attested by its power of physical subsumption. The realities are always tentative and have to make their way and prove their worth. They are as temporary as all truth. There is no other scientific meaning for reality.

The second of these quotations is attributable to Brown and Farber themselves.

To summarize: a theory of emotion, stripped of its nonessentials, is simply a series of guesses as to the manner in which emotions are presumed to result from environmental events (past and present, internal and external); guesses as to how they may resemble, differ from, and interact with

other hypothetical states or processes within the organism; and guesses as to how different emotions or differing degrees of the same emotion may affect behavior differentially. It is furthermore stipulated that these various guessed-at relationships be stated specifically enough to assure their susceptibility to experimental test.

These two quotations set the stage with respect to the manner in which the writer tends to regard the problem of the isolation of the effects of psychological stress on performance. And the second quotation, along with the next few paragraphs, constitutes the author's criteria for evaluating any theoretical treatment of stress.

It appears that it might be useful, on heuristic grounds, to proceed as though a theory of stress were being sought. The rationale of seeking this objective is: In taking the position that a theory is being developed, one is provided automatically with an orientation which is directed at the isolation of environmental (stimulus) variables, performance (response) variables, and the postulation of the variables intervening; the problem then, in directing the procedure toward Air Force problems, lies in the selection of the performance measures and the environmental manipulations to be investigated.

One of the first requirements in building a theory concerning any aspect of behavior is that meaning must be given to the particular concepts with which the theory is to deal. This does not refer to the mere attachment of a tag to those concepts; there are two additional demands which are called meaning₁ and meaning₂ by Bergmann (2). The first of these demands is: the concept must be given some sort of empirical referents, i.e., a factual status which will permit its being reproduced at will. This, of course, is directly related to the requirements laid down by the operational approach to science. In brief, some technique must be established whereby anyone can construct a situation and, in doing so, state that "this is a stress producing situation." The second of these demands is of the nature of a prediction or hope with respect to the future of the construct which has been established by the first procedure; this is meaning₂ (Bergmann) which refers to the extent to which the concept enters into empirical laws. It is upon the realization of this requirement that a concept is retained or discarded. This, of course, bears the implicit assumption that one is interested in obtaining useful information, either for theoretical or practical purposes.

The treating of psychological stress as a hypothetical variable intervening between situation and performance is in no way to be interpreted as a deprecation of the physiological approach to the problem; i.e. if one talks about hypothetical states or changes in hypothetical states, he is ultimately referring to physiological, neurophysiological or biochemical changes. However, the psychological theorist needs in no way to concern himself with the "actual" physiological referents of his concepts (cf. Bergmann).

One of the major points in favor of following the physiological approach to a definition of stress has been that it is believed (a better word might be hoped) that the measures available to physiology are more accurate than those available to psychology. The writer would subscribe to this statement if pre-ci-se were substituted for accurate; he would use the term precise to refer to

the assignment of the number of decimal places or significant figures with certainty and use the term accurate to refer to the property of validity. There are certainly good grounds for believing that the physiological measures are at least potentially more precise, but, it is yet to be shown that the physiological measures possess any greater ultimate validity than do the psychological measures. Furthermore, if one defines validity in terms of correspondence to the practical, it may well be that psychological measures are the more valid. The critical feature seems to be the use to which the desired information is to be put. However, this point is entirely a question of fact, and there are no grounds on which an a priori decision can be made.

The major reason for the writer's suggesting the "behavior-theory oriented" approach, as compared to a lesser emphasis on the physiological approach, derives directly from the above stated requirements of meaning. As yet there is no commonly agreed on statement which gives meaning₁ to the physiological factors supposedly underlying stress. The two approaches, by the nature of the problem, must start at the same point; that is, initially both approaches will use situations in which a subject reports that he is uncomfortable, or the experimenter decides on rational grounds that the subject should be uncomfortable. Unfortunately, most previous physiological investigations in this area have been concerned with the finding of the function, physiological measure equals f (situation) to the exclusion of functions such as behavior equals f (situation) which are sought directly by the intervening variable approach. It is to be emphasized that once the physiological functions are found, the behavior functions are not immediately given but must be arrived at through repetition of the physiological test situations with behavior measures included.

Keeping in mind the cautions and suggestions pointed out above, let us turn to a consideration of some of the past attempts at the systematization of the area of psychological stress.

Grinker and Spiegel (6) consider psychological stress to be strictly analogous to the physical concept of stress, physical stress being defined as the restorative forces exerted by an elastic body when an external force deforms that body. This approach, though it provides a somewhat satisfying feeling in the minds of some types of thinkers, does not lend itself readily to the problem of systematization. There grow directly out of this definition not even any rules of thumb for recognizing a stressful situation. And when viewed in this context, the researcher would be compelled to rely on his own subjective evaluations of situations with respect to whether or not a particular environmental configuration would be expected to require the organism to exert "restorative forces."

Although it was probably not meant to provide more than a way of thinking about psychological stress, the notion that psychological stress is analogous to physical stress could not be considered to be a theory of stress without further elaboration of the concept regarding its growth and presumed effects.

Darrow and Henry (5) and Haggard (7) define stress (and this is the present writer's simplification) as a condition under which the subject or individual behaves with responses or actions which are out of proportion to or inappropriate

to the circumstances in which he is placed. This approach, though it might evolve into a technique for recognizing situations as being stressful, would not in and of itself lead to a workable theory of stress (as theory is herein defined).

The thinking of Selye (12) and his colleagues, though it has led to a fruitful analysis of the physiological aspects of basic physiological stress, does not provide the necessary relationships for predicting the course and effects of stress with respect to behavior. Lazarus, Deese and Osler (10) think of stress as being best thought of as an intervening variable. When the attainment of a sought after goal is prevented, or threatened, stress is said to develop. They predict that certain areas of endeavor will be likely to pay off in the study of stress, although these predictions do not apparently arise directly from their treatment of stress as being an intervening variable. At any rate, their presentation was undoubtedly not meant to be construed as a theory of stress.

A later unpublished treatment of stress by Lazarus and Deese (not available to the writer) is discussed briefly by Katchmar (9). Katchmar states that Lazarus and Deese consider the basis of stress to be (a) the thwarting of a motive (in the clinical or psychoanalytical sense). (b) The thwarting, or more specifically the threat of thwarting, must be recognized by the organism; thus previous experience (cognitions, habits) plays an important role in stress situations. (c) A third class of variables is that of the affective aspects of stress. These are apparently the variables which an experiment in the area of stress would be likely to attempt to assess.

Katchmar synthesizes his own definition of stress, thusly: "To summarize ...we can say that stress is an internal process of the organism, manifested as an equilibrium seeking response, occurring in the psychological context when the objective situation is cognitively evaluated as one involving a goal, the attainment of which is thwarted, or interpreted as being thwarted." Elements of definitions from several sources are readily recognized in his statement.

Bass, Hurder and Ellis (1) state, "In order to define stress adequately it is necessary to consider the interaction of stimulating conditions, organismic ability and organismic motivation. One way of doing this is to conceive stress in terms of cost of performance to the organism." They regard the key to the measurement of stress to be the assessment of energy expenditure, this assessment to be achieved primarily through the application of physiological measures. As a definition of stress this leaves something to be desired, and it certainly was not meant to qualify as a theory of stress.

Miller (11) presents a summary of a general theory of stress which, though it might provide a framework for discussion, appears to be otherwise barren. Essentially, he takes the position that stress is the disruption of homeostasis, but it is not clear from the writing whether he is referring to psychological or physiological homeostasis or perhaps to a combination of them both. In the context of the characteristics of the stress situation, Miller states, "As a working definition, we may say that stress is any marked increase or decrease in some characteristic of the environment which affects the individual. This may be a very strong stimulation or threat . . ." Although it contributes little beyond the usual common sense treatment of stress, the presentation does provide

one with a reasonable though by no means complete technique for recognizing stressful situations. It is of interest to note that the entire presentation ignores the type of criticism given by Lazarus and Deese, i.e., that at the present time at least, we have no satisfactory means whereby we may define or recognize any empirical referents to the concept, psychological equilibrium.

The treatment presented by Miller, though admittedly only a summary, appears not to be likely to fulfill in any significant measure the criteria of a theory of stress which have been adopted for the purposes of the present paper.

Schaffer (13) presents a "Neurophysiological Hypothesis" concerning stress in which he proposes that stress should be considered as being the "functional decortication" of the organism. First of all he states that a "stressful situation may be regarded as essentially one in which a major disruption of the relationship between an organism and its environment has taken place." The implication is that, normally, a homeostatic relationship exists between the organism and its environment; this relationship can be disrupted in three general ways. (1) The organism may be "overwhelmed by an external stimulus for which it has no adequate adjustive response available and from which it has no means of immediately escaping." This he calls the traumatic origin. (2) The satisfier of an aroused drive may be withdrawn or otherwise made unattainable. This he calls the frustration origin. (3) Conflict may be produced by the competition of two equally strong drives the means for satisfaction of which are mutually incompatible.

An implication of Schaffer's position is that it would be possible to produce, in terms of behavior, a chronically stressed organism, i.e. a decorticate organism. Although the evidence cited by Schaffer tends to support the supposition that subcortical mechanisms dominate under stress, he suggests that direct test of the hypothesis is lacking. He also points out that there is some question as to the physiological propriety of assuming such a breakdown of communication between the cortex and the lower centers. Schaffer recognizes but is unable to account for the observed phenomena of degrees of stress.

The extent to which the decortication analogy will prove to be useful, though eventually merely a question of fact, is at present strictly a function of the level of knowledge about the roles of the lower brain centers insofar as they may influence or effect behavior patterns. The position of the present writer is that, although this approach is (on any a priori grounds) as likely to achieve success as any other, the subcortical dominance hypothesis is of only very limited usefulness in the systematization of stress. In general it may be said that Schaffer has failed to satisfy the criteria for a theory of stress which have been adopted in the present paper.

These attempts at the systematization of stress have obviously fallen short of the mark set by the criteria outlined for the development of a workable theory of stress. First of all, none of the reports viewed by the present writer carried the problem beyond the point of working out some sort of definition of stress, and in general these definitions failed to present an adequate satisfaction of the meaning requirement. No attempt was made to specify in any precise manner the way in which stress develops in a situation, i.e. in none of these presentations was stress stated to be a mathematical or quantitative function of some situational or environmental variables.

Very little consideration was given to the role of other states of the organism or the relationship of stress to these states. Lazarus and Deese state that cognition is an important factor, but only in that the individual must be aware of the nature of the situation in order for that situation to be evaluated as constituting a threat to his well-being or security. Lazarus and Deese also consider motivation to be an important factor in the development of stress, but they treat motivation as a nonquantitative variable in this respect.

None of the treatments offered suggestions which emanated directly from a theoretical treatment with respect to specific influences of stress on behavior.

In general it may be said that insofar as these presentations attempted to define stress, they were qualitative and far removed from being able to satisfy the meaning₁ requirement of stress as a concept. Insofar as the presentations attempted to systematize stress, they were at best only programmatic.

SECTION II: A SUGGESTED SYSTEMATIC APPROACH TO STRESS

It is felt by the writer that the greatest promise in the systematization of stress lies in the approach demonstrated by the treatment of frustration by Brown and Farber (4).

First of all, in a treatment of any behavioral area, it is necessary to establish that a genuine, unique phenomenon is being defined.

As is suggested by the material considered above, there is much historical precedence for using the notion stress. On the other hand, it would be extremely difficult for one to define a class into which all of the previous uses of the term would readily fit. In view of this extreme ambiguity which exists with respect to its use, there would seem to be considerable justification for eliminating stress from the vocabulary of psychology and substituting for it some neutral fabrication and perhaps thus avoid the assignment of personal interpretations and connotations on the part of the listening or reading audience. Contrariwise, it is perhaps true that only in isolated instances will refusing to acknowledge the presence of an object insure its eventual disappearance. Ultimately, the difficulties seem to hinge on an error in thinking which is pointed out quite cogently by Brown and Farber (4). This error is seen to evolve from the tendency of some types of thinkers to reify such concepts as stress. As is pointed out by Brown and Farber, this leads to a host of difficulties and frequently to the posing of essentially meaningless questions.

The situational characteristic most often observed in descriptions of stress has been that of the blocking of a response. However, casual reflection on this usage of the term suggests that this would not distinguish stress from what have frequently been labeled as being frustration-producing situations. On the other hand, it has been suggested that the most profitable usage would be to consider stress as being a generic term covering fear, anxiety, frustration and conflict.

Since, as is commonly agreed upon by logicians, definitions vary only along the parameter of usefulness, a salient consideration in arriving at a definition

of stress would be the function which the term would be expected to serve. More specifically, is there a describable class of situations or events which the term could be used to organize or explain? Stress could be conceived of as being sufficiently broad that it would subsume the entire area commonly thought of as emotional behavior, or, on the other hand, it could be restricted to a rather narrowly delimited class of behavior. Inasmuch as there are no clearly described subcategories of emotional behavior to be integrated, it is the opinion of the present writer that the most profitable usage of the term stress would be the more restricted application. However, an expected development from taking this position is that, since it represents a patently arbitrary decision, confusion would arise from the inception of this usage with respect to the meanings implied by former, broader applications of the term stress. Broadly conceived, the selection of a particular name for a concept is customarily based on its utility in the context of the communication of ideas, i.e. a name is ordinarily selected because the meanings or connotations associated with it are those which the author of the name wishes to convey or arouse. From this point of view the use of the term stress would seem to be a definite mistake, for there are few words the present writer can think of which arouse such rich and varied reactions as does stress. Therefore, for the purposes of this presentation, we will deal with a symbol instead of a word and hope that it will be clearly understood that nothing more is meant when this symbol is used, than is contained in the defining statements to be outlined subsequently.

In order to clearly demonstrate that the concept to be employed is both genuine and unique, it will be necessary to introduce a partial definition. It would seem to be of value to consider a class of situations or events which might be characterized as involving the competition of two types of response or behavior tendencies, that of approach and that of avoidance. It will be postulated that, in conjunction with the realization of such a situation, there develops within the organism a condition (hypothetical state, if you please) which will be identified by the symbol X_d. This type of situation seems to be identical with a particular type of conflict situation described by Underwood (14), which immediately raises a question as to why the other types of conflict situation described by Underwood are to be ignored. Rather than get into a rationalization which promises that it would get extremely complex, the present writer will resolve the problem by a simple, though perhaps valorless, ruse. Namely, the class of situations defined by the approach-avoidance paradigm is of considerable interest, and an approach capable of thoroughly organizing the area would be of considerable value. If it should prove that such an approach could conveniently subsume other behavior paradigms, fine. Or if it turns out that the present paradigm could be integrated into a more advanced analysis and thereby lose its identity, still, in a sense, the effort would not have been wasted. For at the present there is nothing to be integrated by our suppositional advanced analysis. It is apparent, then, that a dissenter could make a vigorous (and perhaps rigorous) defense of the position that this paper is not really concerned with "what I and many people before me consider to be stress." However, the present writer submits that our fictional antagonist would be hard put to it to come forth with the positive side of his case, i.e. to give substance to an approach that could easily be shown to subsume all previous uses of the term stress. It is the (philosophical) position of the writer that the yield in knowledge of an approach, if it be worth anything at all, is in direct proportion

to the extent to which it is, or can be, made explicit. The "narrower" approach, to be espoused here, is chosen because of its amenability to being made explicit as opposed to the broader conceptualization of the area, a conceptualization which apparently defies the assignment of usable structure.

Thus the quality of uniqueness is provided for the new concept by definition and postulation, the definition that X_d develops from the competition between approach and avoidance tendencies and the postulation which will follow.

From this point on, the position of the present paper shall be very obviously parallel to that of Brown and Farber. The similarities which may have been noted previously were partly a mark of concurrence and partly a result of the two presentations having evolved from the same general intellectual climate. It would perhaps be most accurate to state that X_d should be conceived of as being a special case of the formulation brought forth by Brown and Farber.

The Development of X_d

Whenever an organism is confronted with a situation, some aspect of which it has learned to approach and the same or a different aspect of which it has learned to avoid, there develops within the organism an hypothetical state to be identified by the symbol X_d . Roughly speaking, the organism is said to have learned to approach the situation if it has been - or in principle can be - demonstrated that there exists a greater than chance probability that the organism will approach that situation (object or event). Similarly, the organism has learned to avoid a situation if there exists a greater than chance probability that he will avoid that situation. The exact manner in which these tendencies develop and are measured is specified by the formulations of Hull (8). To repeat, for emphasis, X_d refers to the state which develops in the organism, as opposed to either of the two responses or the situation itself.

Certain a priori (crystal ball) considerations suggest that the strength of the X_d should be directly related to the strength of the avoidance tendency and indirectly related to the approach tendency. Further non-systematic considerations suggest that increases in s_{ER} approach should not be postulated to result in (direct) increases in the value of X_d . These relationships would be represented by the following equation:

$$X_d = \frac{f(\text{avoidance tendency})}{f(\text{approach tendency})} \quad (a)$$

It will also be postulated that the strength of the avoidance tendency has greater weight in determining the value of X_d than does the approach tendency. Equation (a) thus becomes

$$X_d = \frac{(s_{ER} \text{ avoid.})^n}{(s_{ER} \text{ appr.})^{n-k}} \quad (b)$$

Therefore, the exact form of the curve will be determined by the specification of "k" and "n". For no readily defensible reason, the value of n will be set at 2 and that of k at 1, which will be seen to yield the form of equation specified by Brown and Farber.¹ This yields the equation

$$X_d = \frac{(S_{ER} \text{ avoid.})^2}{(S_{ER} \text{ appr.})} \quad (c)$$

In the development of their formulation, Brown and Farber state: "In writings on frustration and conflict two rather frequent, though by no means always explicit, suggestions may be found as to the manner in which frustration or conflict might vary with the strengths of two competing tendencies. It has been assumed (1) that frustration increases as the difference between the strengths of the tendencies is reduced, being maximal at the point of equality, and (2) that if the two tendencies are equally strong, then the greater their absolute strengths, the more intense the frustration." These considerations, and one other, provide the basic reasoning (in the opinion of the present writer) for the selection of their equation. First, the equation which they specified provides for these two assumptions; and second, by keeping the smaller (squared) term in the numerator, the values of F are made to vary between "0" and 1. This second provision permits the concept to be more readily integrated into the Hullian behavior theory. An additional consequence is that, since S_{ER} is assumed to vary between the limits 0 and 1, there is by definition a maximum value which F can achieve. It should be pointed out that this is not a maximum value beyond which something happens in the behavior realm to prevent increases, but it is, rather, "physically impossible" - because of the form of the equation - for F to exceed this maximum.

In departing from the Brown and Farber equation, the writer has thus raised a new set of questions which must be handled. The first two of these questions, which deal with the differences between the S_{ER} strengths and with their absolute strengths respectively, may be answered by the analysis of the equation for X_d . The effect upon X_d of an increase in the difference between the two strengths of the two behavioral tendencies depends upon the initial direction of that difference.

¹The specific form of equation employed by Brown and Farber to define the concept of frustration is:

$$F = \frac{S_{ER}^2 \text{ (weaker)}}{S_{ER} \text{ (stronger)}}$$

Therefore, in a given situation, a particular S_{ER} will appear in the numerator or the denominator depending upon its strength relative to the competing S_{ER} . Among other things, this means that, if in a given situation the weaker of the competing S_{ER} 's is being systematically increased in strength, a point will be reached at which - for computational purposes - the numerator and denominator will be interchanged. If this formulation were used as-is, increases in the strength of the approach response could result in increases in X_d .

If initially the strength of S_{ER}^{appr} approach is the greater, the increase in the magnitude of the difference between the two would result in a decrease in the value of X_d . On the other hand, if S_{ER}^{avoid} avoidance is initially greater, an increase in the difference would result in an increase in the value of X_d . The second condition, when the two S_{ER} 's are of equal strengths, will result in the same relationship described by Brown and Farber, viz., an increase in their absolute magnitudes will result in an increase in X_d . A further characteristic of equation (c) is that there is no maximum value of X_d established by the nature of the equation. As S_{ER}^{appr} approaches zero, the value of X_d approaches infinity; thus there is an infinity of infinite values for X_d maximum, the particular maximum being determined by the value of S_{ER}^{avoid} . And obviously whenever the value of S_{ER}^{avoid} is greater than the value of S_{ER}^{appr} the value of X_d is greater than one. The implications and further qualification of this characteristic will be dealt with in the next section of this presentation.

The Relation of X_d to Systematic Behavior Theory (Hullian Theory)

It is immediately apparent that permitting a concept such as X_d to approach infinity, or even to exceed 1, is a rather gross deviation from the usual expectation in behavior theory. However, it is readily demonstrated that this poses no real problem for the majority of the situations which one is likely to encounter. The Hullian behavior theory (Corollary xiv) states that in a given situation, of two incompatible response tendencies, that which is dominant, i.e. stronger, will occur if the strength is above the reaction threshold, S_{LR} . Thus it follows that in any given situation, a practical maximum of X_d is set at the point at which the two competing S_{ER} 's are equal; whenever the strength of the avoidance response tendency is stronger than that of the approach tendency, escape from the situation will result; and, consequently, the stimulus complex appropriate to the elicitation of the two responses will be removed. The only area, then, which will lead to any marked deviation from Hullian behavior theory is the area involving situations from which there are no direct means of escape. More will be said about this aspect of X_d subsequently.

Let us now turn to the basic properties of X_d which relate X_d to behavior theory in general and which "demonstrate its usefulness" as an explanatory and as a heuristic device.

1. It will be postulated that the role of X_d in behavior theory is that of an irrelevant drive. It will thus affect the over-all motivational level of the organism in accordance with the formula

$$D = \frac{\bar{D} + \dot{D}}{\bar{D} + 1}$$

where D is the effective drive,
 \bar{D} , the relevant and \dot{D} the irrelevant

2. It will be postulated that there are unique drive stimuli (SD's) associated with the X_d state, and that the magnitude of these stimuli is directly proportional to the magnitude of X_d .

The role of X_d as an irrelevant drive is defined by the characteristics attributed to irrelevant drives in the Hullian behavior theory, i.e., X_d , by contributing to the over-all level of motivation increases those behavior tendencies (S_{ER} 's) present. The motivational level of the organism determines the strength of the behavior tendency according to the formula $S_{ER} = S_{HR} \times D$. Since the X_d arises from the competition of two S_{ER} 's, these S_{ER} 's themselves would be increased by the introduction of or increase in X_d . This positive feedback implies the production of a spiral increase to a maximum in any situation in which X_d were present in whatever amount. This implication, which is also present in the Brown and Farber presentation with respect to frustration, is handled by them through the introduction of the assumption that the level of frustration in a given situation is uniquely determined by the initial levels of the S_{ER} 's of the competing variables. Although there are certain obvious objections to this simplifying assumption, its utility in getting out of a difficult situation warrants its use. It is to be understood that if and when a more satisfying technique is dreamed up for handling this problem, the present assumption will be replaced.

The other intervening variables of the Hullian Theory will be assumed to play their normal roles. However, it might be well to point out specifically the function of V , the stimulus intensity dynamism. This states that the value of the S_{ER} of a given response tendency is directly a function of the magnitude of the intensity along the appropriate physical dimension of the indicated conditioned stimulus. Thus if the conditioned stimuli are not present the associated S_{ER} 's are effectively at zero, and, therefore, it follows that, in a given situation, the stimuli associated with the two competing response tendencies must be present in order for X_d to develop.

In order to provide for technical completeness, two more postulates will be introduced.

3. It is postulated that the build-up of X_d , when two appropriate S_{ER} 's of given adequate strength are introduced in competition, will follow a time course suggested by work done on neural recruitment.

4. It will be postulated that the time course of the decay of X_d will be that which obtains for the decay of any gross autonomic disturbance.

Behavioral Implications of the "Presence" of X_d

Assigning the role of an irrelevant drive to X_d means that when it is present, X_d will serve the same function as other drives, viz., it will have an

energizing effect on S_{HR} 's which may be present. Within the limits to be specified below, this energizing effect will lead to increased probability of response, increased amplitude of response, decreased latency of response, and increased resistance to extinction.

It was postulated that there are unique drive stimuli (SD's) associated with the Xd state. Through the history (controlled or otherwise) of the organism, these stimuli will have been elicited in numerous situations and will have presumably become associated with various types of responses. In accordance with the role of V (stimulus intensity dynamism) in the Hullian behavior theory, as the magnitude of these stimuli increases, the probability of their associated responses increases. Thus as the magnitude of Xd in a given situation increases, the elicitation of these usually irrelevant responses would be expected to increase.

The increase of Xd would also be expected to increase the absolute number of S_{ER} 's which were above the reaction limen, and would thus, through the action of the behavioral oscillation function and stimulus generalization, be expected to decrease the probability of the appropriate responses (cf. Hull).

Since the Xd state is assumed to decay as a function of time, these effects on behavior would be expected to persist, the time of persistence being a function of the terminal level of Xd.

These factors, the irrelevant responses to SD's and the S_{ER} 's associated with other stimuli along the stimulus generalization continuum, would interact with the energizing effects of Xd in such a way that the increases in measured response strength noted above would reach a maximum and then decline as the number and intensities of the irrelevant responses increase.

As was described previously, the equation for Xd does not in and of itself provide for a maximum value of that concept, although it will be recalled that a practical maximum was imposed by the fact that escape would occur at the point at which S_{ER} avoid. is greater than S_{ER} appr. This suggests that the situation from which there is no escape presents a problem in "abnormal" psychology. There are numerous reports in the literature of so-called experimental neuroses being produced in the classical leg flexion conditioning experiments in which the flexion response does not prevent the occurrence of the unconditioned stimulus (shock etc.). These considerations lead to the making of the assumption that if and when the value of Xd should exceed 1.0, "abnormal behavior" will result, though no attempt will be made here to specify the expected nature of this abnormal behavior.

Within the framework of reinforcement theories of learning, there are additional implications of the fact that Xd is given the status of an irrelevant drive. Inasmuch as the general or strong reinforcement position asserts that reductions in drive yield learning or, conversely that learning is dependent upon some sort of drive reduction, the reinforcement theorist would require that a reduction in the strength of Xd by whatever means would lead to the adoption of that means of reduction. Examination of equation (c) suggests two direct ways of reducing the value of Xd; (1) an increase in the value of S_{ER} appr. would

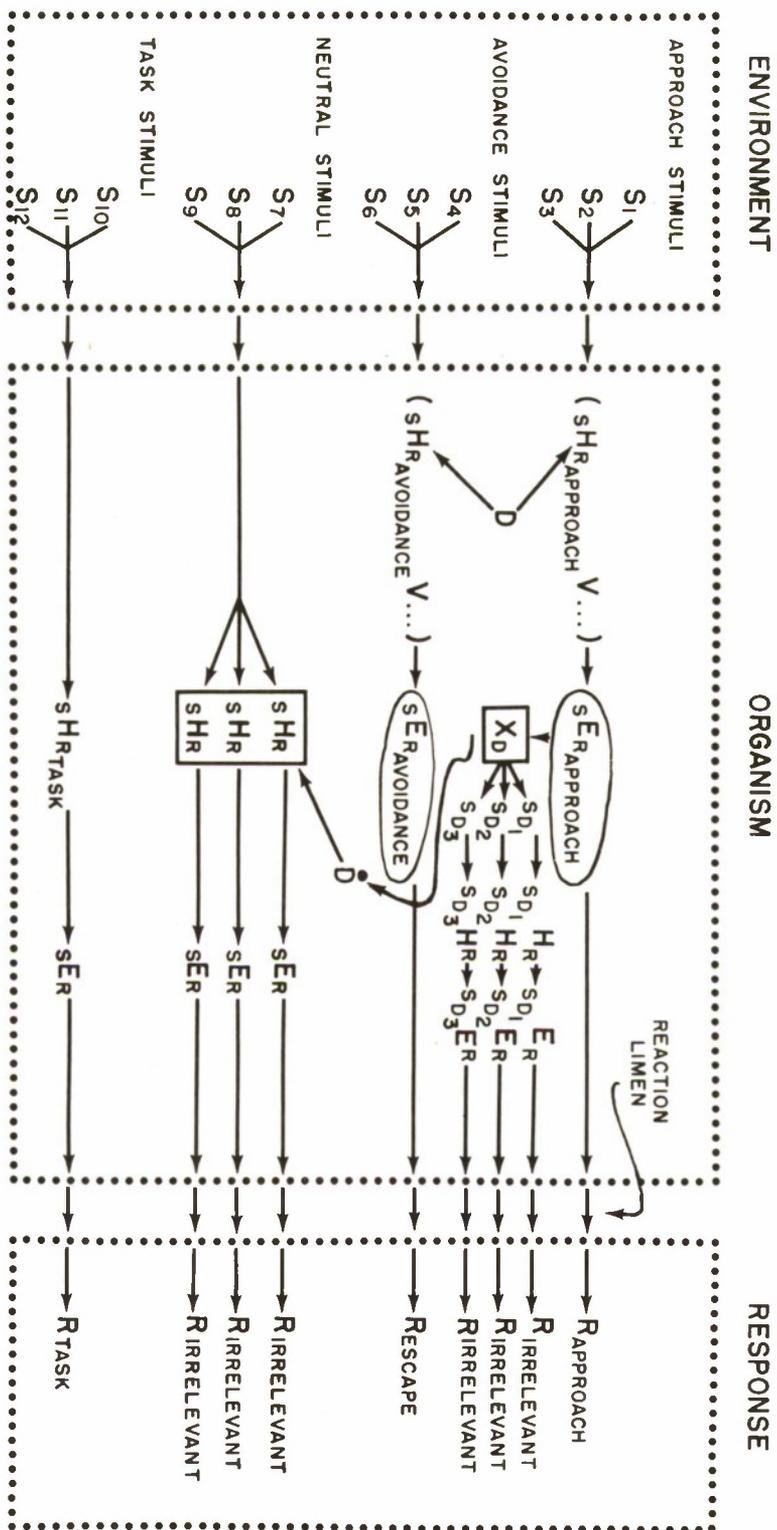
lead to a reduction in the value of X_d , or (2) a decrease in the value of S_R^E avoid. would lead to a reduction in the value of X_d . An indirect decrease in X_d would result from a decrease in the over-all drive level of the organism, i.e., decreasing the over-all drive level would decrease the values of each of the S_R^E 's which would thus produce a reduction in the value of X_d . A similar decrease in X_d could result through the action of reactive inhibition I_R , or changes in the individual S_R^E 's could be brought about through the action of conditioned inhibition, S_R^I . It should be noted that reactive inhibition would be assumed to affect both S_R^E 's independently.

For the most part, past work has been directed at the study of specific task-oriented responses as they may be altered by the "introduction of psychological stress". The aspect of the task-oriented response which has been the major concern of most of these previous investigations has been the summary "output" of that response; e.g., in a pursuit task, the measure has usually been total time on target. The emphasis on the introduction and role of irrelevant responses as a function of X_d results in a reorientation with respect to which of the specific aspects of the behavior in a test situation should be studied; thus, the search should be directed toward:

- (1) isolating specific types of irrelevant responses which would arise with the development of X_d ,
- (2) isolating discrete components of the task-oriented response,
- (3) measuring the specific components of different types of task-oriented responses, and
- (4) delineating functional relationships between environmental changes, on the one hand, and irrelevant and relevant responses on the other.

The schema shown in Figure 1 summarizes the role of X_d within the framework of systematic behavior theory. First of all it will be noted that there are specific external stimuli which presumably have in the past been associated with approach habits; similarly, there are stimuli associated with avoidance habits. Each of these habits is energized by the primary drive state to yield the approach and avoidance reaction tendencies respectively. The simultaneous presence of these two reaction tendencies produces the X_d state. Furthermore, in any given situation there are definite probabilities that either of the two responses may occur, i.e., R - approach or R - avoidance. X_d is seen to have two primary effects: 1. drive stimuli (SD's) are produced and 2., the irrelevant drive (\bar{D}) is produced although actually the \bar{D} and X_d are considered to be identical. Each of the SD's is seen to have associated with it S_{HR} 's which may in turn lead to the production of irrelevant responses. The \bar{D} will activate S_{HR} 's which may have been attached to neutral stimuli in the environment, and the responses associated with these habits will thus have certain probabilities of occurrence. Finally, the stimuli relevant to the task which is occupying the organism will have their S_{HR} 's, S_R^E 's and responses. In effect, we may consider that all of the S_R^E 's in the diagram are in competition with each other and of particular interest is their competition with the task S_R^E 's.

Figure 1: A schematization of the relation of stress to other behavioral variables



It has been the purpose of this diagram and of the paper as a whole to illustrate one possible arrangement into some sort of reasonably orderly relationship the multitude of factors which must be taken account of in the evaluation of the general area described by the approach-avoidance situation, and perhaps, by extension, the area commonly known by the term psychological stress.

BIBLIOGRAPHY

1. Bass, B. M., Hurder, W. P., and Ellis, N. Assessing human performance under stress. Final Report, Contract AF 33(616)-134, Psychology Branch, WADC, February 1955. (Unpublished)
2. Bergmann, G. The logic of psychological concepts. *Philos. Sci.*, 1951, 18, 93-110.
3. Boring, E. G. The physical dimensions of consciousness. New York: Appleton-Century, 1933.
4. Brown, J. S. and Farber, I. E. Emotions conceptualized as intervening variables - with suggestions toward a theory of frustration. *Psychol. Bull.*, 1951, 48, 465-495.
5. Darrow, D. W. and Henry, C. E. Psychophysiology of stress in Human factors in undersea warfare. Committee on undersea warfare, NRC, 1949.
6. Grinker, R. R. and Spiegel, J. P. Men under stress. Philadelphia: Blakiston, 1945.
7. Haggard, E. A. Psychological causes and results of stress. in Human factors in undersea warfare. Committee on undersea warfare, NRC, 1949.
8. Hull, C. L. Essentials of behavior. New Haven, Yale University Press, 1951.
9. Katchmar, L. T. Army Medical R and D Board Project No. DA-49-007-MD-222, University of Maryland Technical Report No. 16. (Unpublished)
10. Lazarus, R. S., Deese, J. and Osler, Sonia F. The effects of psychological stress upon performance. *Psychol. Bull.*, 1952, 49, 293-317.
11. Miller, J. G. The development of experimental stress sensitive tests for predicting performance in military tasks. AGO, TR. PRB 1079, October 1953.
12. Selye, H. Stress. Montreal, Canada: Acta, 1950.
13. Schaffer, H. R. Behavior under stress: a neurophysiological hypothesis. *Psychol. Rev.*, 1954, 61, 323-333.
14. Underwood, B. J. Experimental Psychology. New York: Appleton-Century-Crofts, 1949.