FATIGUE AS A FUNCTION OF SITUATIONAL VARIABLES -- AN EXPERIMENTAL STUDY OF SOME NON-ENERGISTIC FACTORS IN THE PHENOMENON OF TIRING

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THESIS

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By

Robert S. Ramsay

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

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FATIGUE AS A FUNCTION OF SITUATIONAL VARIABLES --AN EXPERIMENTAL STUDY OF SOME NON-ENERGISTIC FACTORS IN THE PHENOMENON OF TIRING

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AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

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A. PROBLEM

Individuals can feel tired and worn out without seriously exerting themselves. In other circumstances they may expend considerable energy and not feel tired. Obviously tiredness may result from muscle-impairing work, but it would appear that it may also occur under conditions of little or no energy expenditure. This study explores the development of fatigue in situations designed to keep the tiredness of muscle impairment at a minimum.

B. APPARATUS, PROCEDURE, AND DATA

Thirty-two subjects were individually employed in the following context. The seated male subject made appropriate verbal responses to simple rectilinear figures which were projected onto a screen ten feet before him.

The stimulus figure changed every three seconds. This fact was recorded kymographically by way of impulses from the projector's sound track. A similar record was kept of the subject's responses by way of an adapted carbon throat-microphone and the same relay system. The latencies thus acquired were hand measured and all of the standard statistics derived from them.

The subjects were divided into eight experimental groups, each of which was distinctively "aligned" to a task which all groups performed in common. This task consisted of responding verbally to simple but meaningful geometric figures as one displaced another on the screen at three-second intervals. The task was designed to command attention, provide opportunity for break-down of integrated effort, and to consume little energy. Each subject was stopped after 400 responses which constituted four times through the endless film loop. He then provided a retrospection on his tiredness at different stages of the task. A mechanical "tiredness reporter" made it possible for him to report tiredness during the test. Observations were also available from the experimenter and an assistant.

Numerous controls were established to underscore and stabilize the effect of three non-energistic independent variables: 1) the intensity of need to do well on the task, 2) apparent distance in time and energy to the proposed goal, and 3) degree of knowledge of "appropriate" mediating behaviors. These variables were dichotomously presented as implied by the 2x2x2 factorial design. The resulting experimental groups represented various shadings of favorable and unfavorable work-alignment.

C. RESULTS

The need factor, whether or not significance was attached to the individual's performance, had no effect on the speed at which the subject worked or on the error tendency of his work. It did, however, significantly affect his reported tiredness, low need producing greater feelings of tiredness. The distance factor, the subject's estimate of the "cost" of the task to himself, slowed up and scattered performance significantly when the distance was remote. It also contributed significantly to felt tiredness. The definition factor, the structuring of mediating pathways, produced significantly slower responses and greater dispersion and increased reported tiredness, when presented unfavorably. Interaction between the independent variables was conspicuously small.

Independent of experimental grouping, there was a highly significant correlation between impoverished performance and reported tiredness. Those who maintained relatively high effectiveness under adverse task orientation often showed compensatory behaviors. Subjective states seemed systematically affected by the work situations.

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I. THE TOPIC OF THE RESEARCH

1. Generalized Statement of Aims

The hypotheses projected and the experimentation reported in the work which is to follow have as their aim the directed exploration of the broad human problem--the onset and growth of the tiredness experience. This exploration will endeavor to show that the tiredness experience can be a function of one's personal orientation to his task rather than the necessary result of the expenditure of significant amounts of energy.

Prior to the formulation of more specific aims, a theoretical and systematic background needs to be presented. Once this has been done the reader will be in a better position to understand the more narrowly defined hypotheses and the manner in which the experimentation brings evidence to bear on them.

2. Theoretical and Systematic Background

In 1947 McGraw-Hill published a source-book titled Fatigue and Impairment in Man. (1) It was written by S. Howard Bartley and Eloise Chute working on a grant from the Dartmouth Eye Institute. Many of the basic suppositions underlying the research to be subsequently presented are contained in this volume.

The book has as its primary purpose the drawing of a utilizable distinction between fatigue and impairment. It is hoped that workers in these fields will thereby be aided in the avoidance of the confusion which is said to result from the failure to make this distinction. In the pursuit of this aim it brings together a wealth of cognate research materials which are intended to facilitate and guide research in this area.

For a clear understanding of what is intended by the terms "fatigue" and "impairment" let us turn to the original work:

> 'Fatigue as an unpleasant experience has entered into the life of everyone. For the one who is tired, the feelings experienced <u>are</u> the fatigue. In spite of this, the experience is taken as merely incidental when attempts are made to analyze and understand what is called "fatigue." The very individual who experiences fatigue and regulates his life with it changes his whole outlook when he steps into the laboratory, supposedly to study fatigue. He forgets what he knows about fatigue from personal experience and attempts to measure human activity solely as a product of a physiochemic machine.' (2)

By "impairment" is intended the notion that exercise temporarily debilitates the muscles thereby impairing their response potential.

> 'Perhaps the commonest notion is that fatigue is closely related to exertion. It is then simply attributed to

> too much exertion or to the lack of rest or sleep. Fatigue is also taken as a warning against supposed physiological damage in the event of further energy expenditure.' (3)

Yet another excerpt from Fatigue and Impairment in Man will help to make clear the distinction:

> 'Although it is known that individuals seldom come near reaching their energistic limits under any conditions, it has not been systematically recognized that the explanation of behavior must therefore lie in other than energistic terms. Apparently it has not been taken into account in theoretical formulations that human activity is both initiated and limited in accordance with the demands the person puts upon himself. Thus in the consideration of fatigue there has been a failure to see that the individual's activity depends upon his organization.' (4)

From the foregoing it may be summarily stated: that the term 'fatigue' is used to denote a conscious experience of tiredness which is likely to have manifest effects upon one's behavior; that impairment, on the other hand, is the temporary using up of a muscle's reactive potential; and finally, that fatigue can and does come to pass within an individual at times when impairment is a palpable impossibility. It is within the framework created by such a distinction that this thesis has been developed. It is in the fact that a great deal of tiredness develops

under conditions inappropriate to produce impairment that this research finds its point of origin.

It is acknowledged by the authors of Fatigue and Impairment in Man that their carefully drawn opposition between fatigue and impairment flies in the face of the ban on arm-chairing:

> . . .The concept of fatigue that we have developed arose from a broad, theoretical view of the organism, which might be termed "over-all" or "holistic." The course of our thinking necessarily led us to formulations that still await experimental corroboration. It is our hope that the systematic presentation we have made will both inspire and direct empirical investigation. (5)

It should be clearly understood by the reader that this dissertation does not represent an effort to defend the manifold nuances unfolded in Fatigue and Impairment in Man. Rather, it is the reporting of a study which was conceived and developed within the basic framework of Bartley's views as expressed in the above-named handbook. So that the reader who has not yet acquainted himself with the content and flavor of Fatigue and Impairment in Man may gain a more direct sense of comprehension, a portion of it is reproduced below. The function of the excerpt is well explained in its first paragraph.

> 'The following items, in stating what fatigue is and is not, are intended as ways of defining the term, and also, by

implication, as ways of stating the errors or shortcomings of the more conventional viewpoints. In many cases, our affirmative assertions imply that the negative is customarily taken for granted, and our negatives imply the existence of the affirmative in prevalent opinion.

1. Fatigue and impairment are not identical. When both exist at once, they can be separated. An individual may be fatigued without being impaired and impaired without being fatigued. There is no need to deduce impairment to account for fatigue. The necessity for distinguishing between fatigue and impairment has never been fully recognized. Various patterns of emphasis of either one or the other appear in the literature, but the two have remained indistinguishably intertwined. The failure to make this distinction has perhaps been primary in precluding a complete systematic treatment of fatigue.

2. Fatigue is not to be measured by measuring impairment. Since the two are not identical, the closest relation they might have is that of a one-to-one correspondence. Such a simple relation, however, does not exist. No fatigue can be deduced or imputed from a measure of impairment. Customary thinking has failed to recognize the discreteness of the two terms.

Frequently, either of two assumptions underlies studies of fatigue: (1) that fatigue is impairment as we defined it, or (2) that the impairment is a sign of fatigue. That fatigue is not impairment has already been shown. It is equally wrong to assume that impairment is a sign of fatigue. Even if it were, the two items would have to have a fixed relation for the sign to be of use, and this is not the case.

3. Unlike impairment, fatigue is always directly experienced--i.e., it is an experience.

4. Fatigue is a part of the individual's stance with reference to activity, whether

the activity is vigorous exertion, the assumption of an attitude toward a proposition, the maintenance of posture, or merely the need for staying awake, etc. Fatigue involves aversion and a feeling of unwillingness and inadequacy for activity. This aversion, when analyzed, can be seen to arise out of personal conflict and to be an expression of frustration.

5. Fatigue is a manifestation of personal continuity. The immediate situation does not contain all the origins of the fatigue of a given moment. The conditions for present fatigue can be traced to previous occasions in which circumstances were more crucial and evoked responses that have led to the specific ways of acting exemplified in the present. Habit formation accounts in part for the character of present reactions, including not only the unpleasant experiential components, but also the systemic bodily reactions.

6. Fatigue is personal. Fatigue pertains to the individual as a whole. Fatigue is consistent with the individual's ideals, goals, etc., and with his evaluation of himself. Conditions for fatigue are unique to the individual. The dynamics of fatigue cannot be adequately described in other than personal terms.

7. Fatigue is an outcome of conflict. The organization of the individual is not so simple as to constitute singleness of desire or tendency. Conflicts are constantly developing, and at any one time many conflicts exist in an individual. Conflict cannot be avoided in active situations, and conflict thwarts action. Many conflicts find resolution in appropriate action, others are very poorly resolved, and still others fail to find resolution at all. Pervasive bodily discomfort is one of the most frequent outcomes. Following its onset the individual becomes increasingly certain of the appropriateness of changing his present behavior. When relief of bodily discomfort is prevented and action is thwarted, fatigue commonly develops.

At the termination of specific activity, fatigue may disappear suddenly or slowly. Whether or not the overt termination of activity represents the actual abandonment of the task determines the outcome. When fatigue has been induced, certain bodily readjustments are required in order that comfort be regained. If, while this transition is in progress, the individual remains concerned with the task, the fatigue remains. On the other hand, to the degree that the individual can forget the task and feel free of obligation to do anything requiring effort, the bodily feelings will not be experienced as inadequacies.

8. Fatigue is not to be confused with boredom. Frequently when fatigue is used synonymously with impairment, the experiential aspect of the individual's response to certain situations is termed "boredom." Introspection reveals that a bored individual attributes his state to environmental events, whereas a fatigued individual lays the blame for his condition on himself. It is felt that merely escaping the situation will alleviate boredom and that it is therefore more transient than fatigue. It might be said that both boredom, and fatigue are stances taken by the individual toward situations confronted. Fatigue, however, is by far the broader term. While boredom may form a part of the fatigue picture, the reverse is not possible.

9. Fatigue is cumulative. Fatigue arises at a level of organization which must be dealt with in terms that reach beyond the immediate situation. Fatigue developed on one occasion is likely to be revived when a similar occasion arises.

10. Fatigue's onset and recovery may be sudden. While impairment is a condition that is more or less gradually reached and recovered from, this is not always the case with fatigue. It is common knowledge that individuals do suddenly feel tired and quite as quickly experience release from fatigue. Fatigue can come and go nearly as rapidly as an individual is able to shift from one frame of mind to a

different one.

11. The concept of fatigue pertains to organization. What the organism does or fails to do can be largely accounted for on the basis of the principles of its organization. Fatigue is a kind of behavior of the organism which is to be understood primarily in terms of organization. One purpose of the analysis of fatigue is to further the understanding of the relations of different organismic functions to each other and to the environment. The factor of organization is particularly critical in the study of fatigue, since this stance always involves internal contradiction.

12. Fatigue does not crucially depend upon energy expenditure. Confusion of fatigue with impairment, and the common practice of comparing men and machines, have contributed to the perpetuation of the energy idea of fatigue. Fatigue, contrary to the usual understanding of it, is not to be considered in terms of energy. Energy of course is involved, but the crucial determinant of fatigue is organization.

13. Fatigue is never specific to a given body member. It, in other words, is never localized, but is general. Bodily sensations, such as feelings of discomfort, can, of course, be localized, but it is only the individual as such that can experience fatigue.

14. Fatigue is not to be defined or analyzed in terms of its supposed origins, nor on the basis of function involved. It is very common for fatigue to be classified as "mental fatigue," "nervous fatigue," "muscular fatigue," "combat fatigue," "operational fatigue," "convoy fatigue," etc. These terms connote the situations under which fatigue is supposed to have developed, or the function or both that are supposedly overworked.

Occasions for the production of fatigue are, of course, endless, but fatigue produced in one situation has an essential similarity with fatigue produced in any other. Fatigue cannot be defined in terms of diversity of external situations in which it occurs.

> Although fatigue may arise in the course of many different kinds of activity, it retains its own unique identity. Fatigue occurring during muscular activity is essentially similar to fatigue occurring in the course of mental activity. Classification in terms of part function of the individual not only denies the unity of the organism, but also throws little if any light on the nature of fatigue.' (6)

What are the implications of such a distinction for experimentation? What demands would have to be met and experimental conditions contrived in order to address a study to a maximal number of pertinent issues?

First it might be opined that the subjects of such an experiment should be asked to do something. This thing to do, the task, should be so manipulable as to assure the essential equation of energy expenditure from subject to subject while permitting the ready control of such experimental variables as emphasize, for example, personal organization and task orientation, and which depend upon energy expenditure not primarily but only incidentally and in a non-crucial manner. A specific example of what is more fully connoted by this is to be found on pages 21-22 in the section titled "Evolving and experimental treatment of the problem."

The topic to be taken up at this immediate point is a Lewinian conception of motivation. It

is a moot issue in the mind of the writer whether the ideational content of Fatigue and Impairment in Man, or the train of thought found in the views to be presented herewith, is primarily responsible for the form which the present experiment has taken.

Lewin, who died in 1947 while serving as professor of psychology in the Massachusetts Institute of Technology, will be recognized by those conversant with the field as a "topologist" who spoke in terms of "life-space" and who cherished a long time ambition which called for the development of a "vector psychology." Lewin was an early Gestalt psychologist with a penchant for the discovery and creation of new ways of thinking and of approaching old and hard-to-handle problems. It will not call for anything like a full introduction to the Lewinian position in order to communicate that aspect of his thinking which is applicable to the problem of fatigue as it is here approached. It should also be noted that the rationale of "motivation" about to be presented comes indirectly by way of Roger G. Barker, a student of Lewinian methods and interests. (7,8)

A motive is a particular need-goal combination. Such an assertion, flatly made and left undeveloped, would remain indeed oracular. Let us examine what

the topologist making such a proposition intends.

The need component of a motive refers to the pressing disposition of an individual to respond selectively and directionally to sensible objects or events in his life-space. Needs may have apparent biological bases and may be thought of crudely as resulting from departures from a biologically defined homeostatic equilibrium. Needs may also be learned, as evidenced by the divergency of the powerful conformity needs which all of us acquire by virtue of our contacts with society. Still other needs are acquired by the individual in the course of his life which are so unique to his own experience as to be very difficult for other people to understand. These last two classes of needs are not easy to explain in terms of the biological mechanisms which mediate them and give them behavior-determining potency. It is speculative but plausible, to assume that the facts of the neurophysiology of learning are their "thing level" correlates.

A goal is any object, event, or set of conditions, which bears such a relationship to an individual's need structure as will elicit some directional response, i.e. some sort of psychological locomotion orientated to the attainment of the goal. It is held that the reaching of the goal reduces the

urgency of the need. Goals are points in psychological time-space toward which one "moves" according to principles laid down by his need constitution.

The acting out of particular need-goal combinations involves the traversing of paths. Put into less picturesque language this means that motives are enacted by means of distinctive bits of behavior. There are numerous different paths which may be followed in the acting out of any motive. To say that only one course of action is appropriate would probably be an unimaginative error in almost any behavioral context.

These three foregoing concepts are necessary to the understanding of the behavior of the motivated individual. Despite all of the many ways in which one picture of motivation differs from another, this remains the crucial common core: an organism possessed of a given need, sets about the task of reaching by way of a certain course of action, a goal which is in some way suited to that need. This is a most basic generalization. It is easy to see how manipulation of needs, the goals, and the pathways might affect the behavior and feelings of the goal-seeking organism.

The reader should now be in a position to understand why this conceptual framework is suited for the manipulation of variables which are more related

to personal organization and task orientation than they are to exertion factors. The precise form which such "non-energistic" factors take is more fully and specifically elaborated on pages 33-34 and again on page 44, at which points the broad picture of the conceptual plan of the experiment is developed.

3. More Specific Statement of Aims

In the light of the foregoing background material it is now possible to more clearly state the aims of this research. The primary objective is the experimental demonstration of the essentially non-energistic nature of fatigue. This will entail the setting up of experimental conditions which will amplify the impact of situational variables while holding as constant as possible the influence of factors rooted in the utilization of energy.

A secondary objective, directed more to matters of theory, is to demonstrate the suitability of Lewinian constructs for this study, and thus, by intimation, for others like it.

Related to this secondary objective is the wish to show that variables capable of achieving marked significance may sometimes require expression in abstract form.

Another second-order objective is the indication of a degree of identification between subjective

and objective fatigue criteria. By this is intended the notion that if fatigue is a conscious experience having behavioral concomitants, one should be able to find a significant relationship between dependent variables expressed in both of these modalities.

4. Antecedent and Contemporaneous Cognate Work

At this point, the dissertation digresses briefly to present to the reader a representation of related research. The course of such a deviation should illustrate why the Bartley-Chute distinction has been made, and should point to why the present research was undertaken.

The lack of unique meaning of the term "fatigue" has long been an object of concern to careful workers and critical thinkers. Muscio's well known objections appeared thirty-four years ago. (9) The book, Fatigue and Impairment in Man, made an issue of retrieving generic univocality for the term.

That was in 1947 and, although busy and astute workers acknowledge the text and make some of its pronouncements their own, its precepts have not yet made a serious dent on experimentation. Researches which call themselves "of fatigue" appear on many fronts and from within many disciplines, rarely making more than an implicit and ambiguous acknowledgment of the distinction between fatigue and impairment.

A British organization, the Ergonomics Research Society, draws fatigue conclusions from the fountainheads of tropical medicine, public health, inanition, one's surrounds, the aging problem, hygiene, muscular potentials, production engineering, poor lighting. Satiation, frustration, and alertness measures also bear fatigue designations. Applied physiologists, human anatomists, experimental psychologists, medical doctors, and practical industrial psychologists all do "fatigue" research, although they are frequently far apart in what they mean. (10)

The foregoing paragraphs suggest that a clear distinction between fatigue and impairment is still a long way from being a functioning reality.

It is not the purpose of this digression to catalogue all of the studies which are conceivably related to its theme. By indirection the number which might bear such relationship would reach into the hundreds. The reader who possesses such an interest will find a monumental effort to pull such cognate materials together in Fatigue and Impairment in Man. Even at that it is a selective source-book from which numerous studies judged by the authors as conceptually empty, non-crucial, or duplications of better works, have been omitted. This book forms an adequate reference up until the year of its

publication, which was 1947.

As far back as Dodge's 1917 investigation of eye-movements the observation was made that pure ergographic reports, the concept of work-decrement, are inadequate and inappropriate to picture fatigue, and that evidence of disorganized effort may be seen creeping into the so-called ergographic records. (11)

A few years later Bills showed by way of his color naming experiments that blocks, presumably representing growing disorganization and inefficiency, seem to characterize repetitive effort calling for coordinated behavior. (12)

In 1937, Baker was at work showing the way that pre-experimental set could differentially affect overt behavior. He demonstrated that suggestions as to the distracting potency of dance music played at a level of 70 decibels would have a significant influence on the work done by the several experimental groups. (13)

Krueger, 1937, went so far as to make a pre-experimental set issue out of the magnitude of the task which the subject anticipated doing. He found that people working toward near goals would work more simple arithmetic problems per minute than those working toward remote goals. (14)

Robert Schwab of the Harvard medical school goes him one step better in constructing a portable ergograph which makes it possible for him to study motivation in the measurement of fatigue. (15)

In his experiment the subject squeezes a rubber bulb until he feels tired and stops. This point of stopping is unique to the individual and the experimenter endeavors to examine three complex variables: 1) individual differences from subject to subject; 2) variation in the same person on different days or under altered circumstances; 3) different incentives or levels of motivation. The reader will note that this experiment is cast along Bartleyan lines. It does not, however, try to avoid exertion as a critical issue nor does it approach fatigue from within a consistent theoretical framework.

Barmack, 1937, the boredom worker, identifies his phenomenon with "inadequate motivation." (16) The reader will note in the pages to come how the present experimenter elaborates the notion of motivation in this connection.

Earlier boredom workers, Wyatt, Fraser, and Stock made similar assertions about improper motivation in 1929. (17)

Cassell and Dallenbach showed that one's "attitude" was capable of affecting simple sensory

reactions. (18)

George Wald, a member of the 1939 Symposium of Visual Fatigue, in summarizing the research brought to the fore in that context said, in part, ". . . a subject's simple statement that he is fatigued is a primary datum, and very much more reliable than any measurement yet suggested in this symposium." (19)

With the exception of Schwab these references have been to work and thought produced prior to 1947. The reader can see that some interest had developed in the direction of the manipulation of situational variables.

Since 1947 the direction of research in fatigue has changed but little if at all. The notion that fatigue is directly and necessarily bound up in energy expenditure is deeply imbedded in our culture. Schwab's research emphasizing individual differences was atypical.

More traditional and in line with common interest is the article by Bartlett which acts as the keynote for the volume containing the 1952 Symposium on Fatigue sponsored by the Ergonomics Research Society at the College of Aeronautics in Cranfield, England. In this article fatigue-impairment distinctions are either esoterically or generally alluded to in such a way as to leave with one the

reductionistic suggestion that there are no real qualitative differences between the two. (20)

Other contributors to the same symposium, Eagles, Halliday, and Redfearn, utilize the distinction.

> . . . As emphasized by Bartley and Chute (1947), the use of the word "fatigue" plunges both author and reader into a semantic morass. It is not our present intention to write a disputation in philosophy, but to report the outcome of certain experiments as simply as possible. We shall therefore . . .

and they go on to explain that their research is a study of the effects of exertion and sleep deprivation on tremor. (21)

In fairly recent times several workers have stressed in a theoretical, structuring way the sorts of ideas advanced in Fatigue and Impairment in Man. There is no need to give them detailed treatment in this dissertation.

Carmichael suggests a re-evaluation of the relationship between work, fatigue, and socially determined motivation. He says, in effect, that all life-space variables need to be included in the full fatigue picture. (22) This is in harmony with the tenets of Fatigue and Impairment in Man. His implicit approach to the matter however is shown by some of his recent researches having in them, for example: six hours continuous reading, three days of tracking with

brief and irregular rest periods, testing reaction and steadiness after fifty sleepless hours, organizational failure with three days sleep deficit. (23) Experiments such as these are scarcely designed to keep impairment a non-crucial issue.

Shands, et al. (1952), whose interest in fatigue is clinically orientated, asserts that ". . . fatigue is a danger signal closely related to anxiety; the behavior indicated by the signal, fatigue, is that of desisting." (24) Those familiar with the content of Fatigue and Impairment in Man will recognize such a sentiment if not almost the terminology.

From the material just presented it is clear that, although most so-called fatigue research is postulated upon notions of exertion, spasmodic attention has been given throughout the years to the way in which the individual is aligned to his task. The present research, to which the attention of the reader will be redirected in a moment, has as its purpose the making of a lucid theoretical issue out of this factor of personal task alignment.

II. BODY OF THE EXPERIMENT

1. Evolving an Experimental Treatment of the Problem

It is clear that if the conditions are to be met which are implied by the intention of the experiment, numerous demands, some of which may be very hard to meet, will be made of the vehicle constructed for the purpose of providing the critical data. This leaves the investigator with a pressing question: What is an optimal task for these purposes? How would it meet the demands implied by its intended use?

First, the context should suggest limited impairment so that the onset of fatigue might appear feasible, i.e. be suggested as a likely outgrowth of the activity. However, the physical demands of the task should be so slight as to keep actual impairment at a minimum.

The task should be of middle range difficulty so that it will remain a psychologically real task. Excesses in the direction of ease or difficulty might cause subjects to become involved in the implicit manipulation of problems other than those which the experiment has set upon them.

It must be conceptually rich and flexible enough to permit ready manipulation.

It must not permit the appreciable presence of factors leading to fatigue distortions such as boredom, satiation, or excessive anxiety. In the subsequent descriptions of the task situation which has been evolved, these and other conditions will be shown in the form of the precautions taken either to insure or avoid them, as the case demands.

The task situation, or the experimental context, is one in which carefully chosen subjects, being processed individually, are asked to make appropriate verbal responses to geometric figures as they appear bradyscopically on a screen which is comfortably situated in the frontal plane. These figures number ten, and they appear one at a time in a "randomized" sequence until a film loop of 100 targets has been run through.

The required performance is one of superficially simple visual-vocal coordination which calls for a "selective reaction". In actuality it is not so simple. The opportunities for disorganized and ineffective performance are high and continually pressing.

2. Instrumentation

Turning to the pictures on pages 24 and 25 one sees in the first instance a male subject seated comfortably, back to the camera, facing a small screen situated at the end of a narrow room. To his left and slightly behind him is a movie projector. It is apparent that this projector is not equipped with conventional reels. The film feeds off of, and then back onto, a single spool. To the subject's throat is attached a carbon microphone of World War II vintage.

All of that which appears in Figure 2 is arranged behind and to the right of the subject. In it an observer is seen keeping a running account of both the general and specific behaviors of the subject. In the foreground is a battery box, the various elements of which provide the power boosts required to activate the styli which are attached to the clearly visible kymograph. In the background, in addition to the free-running device which releases the waxed marking paper, there is a voice-activated relay system. Thus the global picture is one of visual targets being presented on a screen, a subject responding to them, and a reaction latency being kymographically recorded under the watchful supervision of the experimenter and another observer.

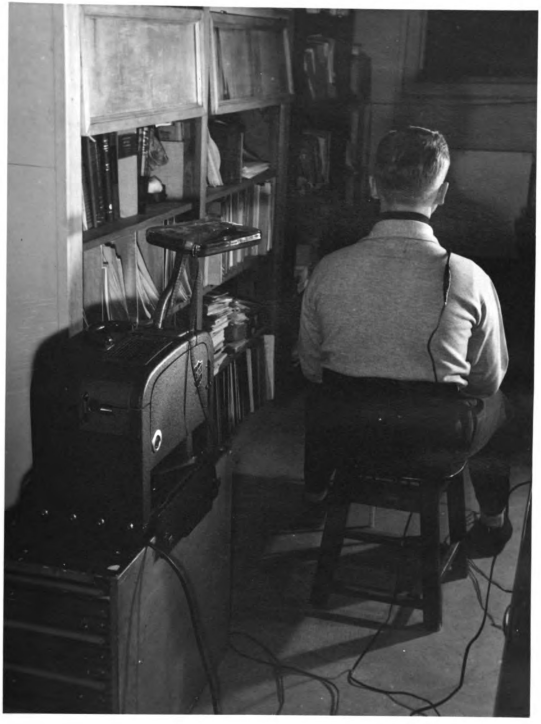

Fig. 1. Posed subject facing screen with projection apparatus and throat microphone in place

Fig. 2. Posed picture showing recording apparatus in foreground, and listener in background

The following is an orderly and detailed rendition of the instrumentation of the experiment. The first part considers the problems involved in the presentation of the stimulus. On page 28 the reader will find a pictorial representation of the visual targets used. Each target was drawn on 8 x 11 white semi-matte paper using black India ink. Each target was designed to subtend approximately equal retinal areas. Each had to lend itself to being aptly designated by a single-syllable abrupt word so as to facilitate the recording of the response. The absence of curvilinear components will also be noticed. Beyond these considerations the selection of targets for photographing was somewhat arbitrary. An effort was made to keep them sufficiently dissimilar to control excessive tendencies toward stimulus generalization.

Having decided upon what the ten stimulus objects should be, they were arranged in a staggered sequence so that each would be presented ten times in the course of one hundred stimulus presentations.

Given the following number-word equivalents 1-tree, 2-box, 3-wedge, 4-hat, 5-flag, 6-book, 7-house, 8-bow, 9-pot, 10-cross, the endless film-loop presented the visual targets in the following sequence which should be read left to right:

1	2	3	4	5	6	7	8	9	10
2	4	6	8	10	1	3	5	7	9
3	6	9	2	5	8	1	4	7	10
4	8	2	6	10	3	7	1	5	9
5	10	6	1	7	2	8	3	9	4
10	9	8	7	6	5	4	3	2	1
9	7	5	3	1	10	8	6	4	2
10	7	4	1	8	5	2	9	6	3
9	5	4	7	3	10	6	2	8	4
1	9	3	8	2	7	1	6	10	5

It will be seen that no symbol precedes one symbol more than any other. This precaution was taken to control opportunities for learning by way of associative reinforcement.

Placing the targets one at a time in a photo easel, forty-eight single-frame exposures were taken of each one in the order previously described. When this film was processed and printed there was a length of film extending through 4800 frames. One end was securely spliced to the other so as to create an endless film loop.

The endless film loop makes possible the repetitive showing of any sequence of film without the necessity of rewinding. It also eliminates the need for stopping and lends itself thereby to

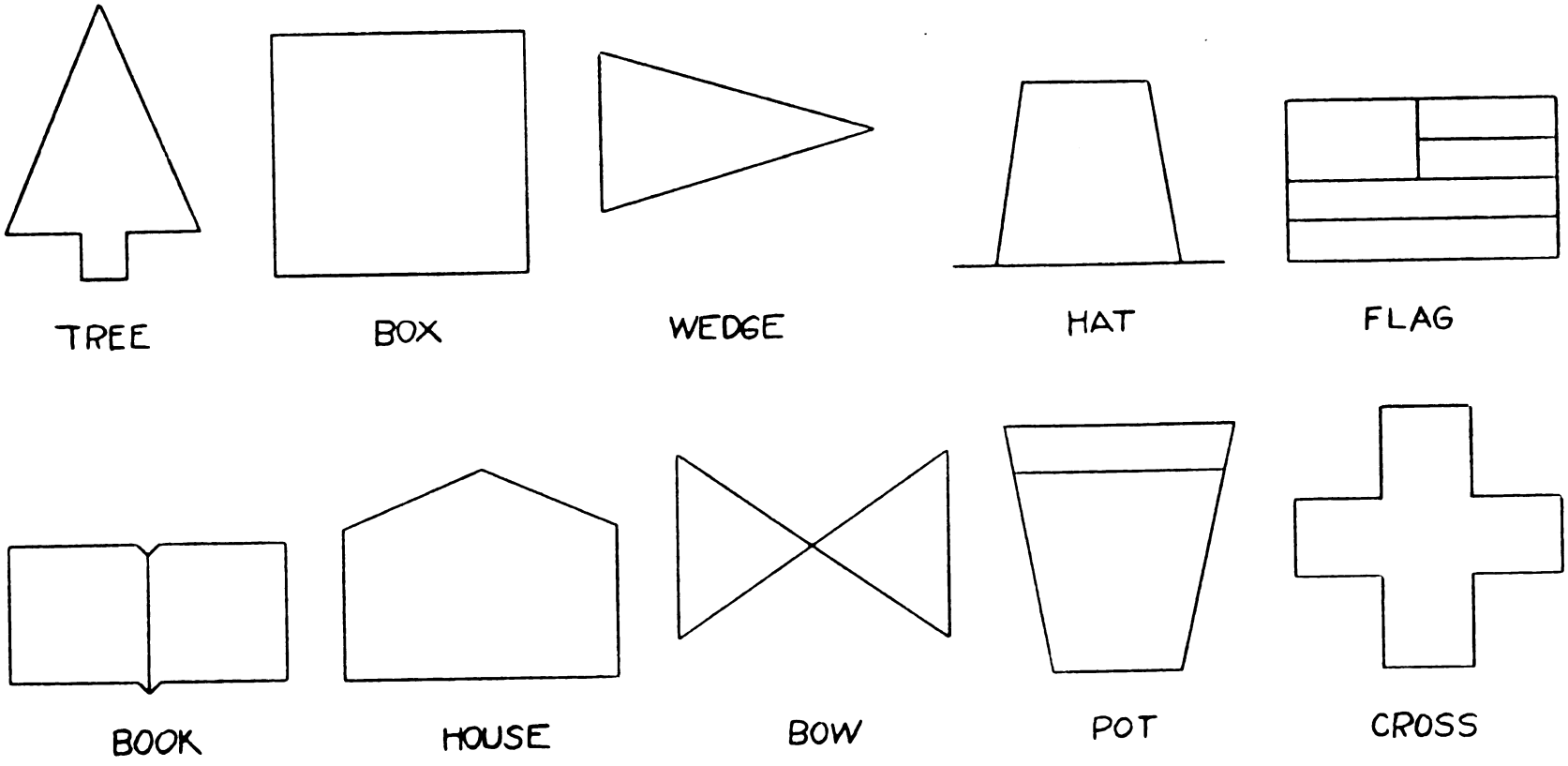

Fig. 3. Visual targets projected onto screen as stimulus objects

experimental situations in which such features are desirable.

The projector was run at silent speed, 16 frames per second, so that a single run through the film loop required five minutes.

So that the time of onset of each new stimulus would be accurately recorded, the sound track of the film was put to use in the following manner. Twenty-six frames before each change of pattern a flattened V-shaped opening was cut longitudinally into the sound track. Over an acoustic system such a device results in the emission of "bloop"-like sounds. The practice is in fact called "blooping" by commercial photographers. Fed into a "voice-key" this electrical impulse serves to indicate the onset of each new stimulus. This impulse was transmitted by way of the stylus to the kymographic paper.

Now that the stimulus has been accounted for, and the fact of its occurrence recorded on paper, let us turn to the making of the response.

Each subject was instructed to make a distinct verbal response to each of the stimuli. The responses required of some of the subjects are found on page 28.

A throat microphone, neatly and comfortably adjusted to the thyroid cartilage, was activated by the reverberation of each verbal response. These

impulses were, in a manner similar to the impulses from the sound track, channeled through the voice-activated relay and finally onto the kymographic paper, thus providing the second element of a reaction latency.

Crystal microphones were tried but were found to be unsatisfactory in that they picked up too many room noises which made for erratic and unreliable latency records. The carbon microphone presented yet another problem since its impedance was so low in comparison to that of the voice-key. This was circumvented by way of the interjection of a small transformer and a single dry cell between the microphone and the voice-key.

Having presented the significant aspects of stimulus and response, the next issue to be considered is a more detailed account of how both were recorded.

Central to the recording of both stimulus and response was the voice-activated relay, or "voice-key." The physical correlates of both stimulus and response were transmitted to the kymographic record by way of it. These impulses were fed in at a common input jack by way of a "mini-mixer". This tiny instrument is clearly visible in the picture on page 25.

One of the input jacks on the mini-mixer was directly connected to the audio-system of the projector. It would be well to note at this point that since the exciter-lamp of the modern Bell and Howell is automatically shut off at silent speed, it required a slight rewiring of the projector before this could be done. The other input jack belonged to the carbon-microphone response system.

The voice relay was of local manufacture having been constructed in recent years by the school of electrical engineering for the purpose of carrying out psychological experiments.

Control of amplification of the input was possible at the mini-mixer and in the voice-key. It was also possible to control the output from the projector. This made it possible to run through the numerous subjects and rarely miss the recording of either a stimulus or a response.

The Phipps and Bird continuous-feed kymograph drew the wax-surfaced paper under the styli at a rate of slightly more than seventeen millimeters per second, which is the approximate equivalent of fifty-one millimeters from stimulus to stimulus.

The onsets of both stimulus and response were recorded by the stylus toward the center of the picture, page 25. The other two styli were connected

to a small black box, a tiredness reporter, which was situated before the subject. By means of this two-key system he was able to report perceived changes in tiredness as the experiment progressed. This will be described in greater detail in sections four and five of Part II.

In addition to the materials thus far described considerable use was found for various paper forms. They were used to establish set, gather subjective data, trace the progress of the subject during the actual experiment, and record necessary quantitative materials. These forms will be introduced and illustrated at appropriate times.

3. Experimental Design

Under this general heading it becomes necessary to distinguish two different ideas, that of conceptual design as contrasted with statistical design.

The conceptual design behind this experiment was cast in the mold of the motivational theory presented a few pages earlier and is attuned to the issues theorized upon in Fatigue and Impairment in Man.

The reader will recall that the behavior of the motivated organism is contingent upon given

needs, goals appropriate to these needs, and pathways which must be traversed in the achievement of the goals. This means that it is possible for a worker who wishes to experimentally manipulate these abstractions to list need variables, mediational variables, and goal variables. The table on page 34 portrays in simplified form, eight potential variables from within the general areas of need, mediation, and goal. Each of these specific variables is capable of making a motivational difference. The reader will note that motivation thus conceived is considerably more of an integrated entity than when thought of as equatable with what is often called drive.

The general idea is that appropriate variations in any of these specific variables will modify the effectiveness of one's goal directed activity and affect not only one's task adequacy but one's perception of his adequacy, as well.

Let us proceed through these variables in the order in which they are listed, indicating which are to be held constant and which are to be cast as experimental variables. In the process, the query will be considered as to why those particular ones selected as variables were selected rather than the others.

TABLE I

DESIGN SHOWING INTEGRATED ORIGIN
OF EIGHT FACTORS ACCOUNTED FOR
IN THE EXPERIMENT

General	Specific	Role	Explanation
NEED	Intensity	var	How strong is one's need to perform?
	Age	cons	How long has this need existed?
MEDIATION	Cognitive	var	How well understood are the paths to the goal?
	Motoric	cons	Is one able to enact the requisite behaviors?
	Extra-subjective	cons	Does anything outside of the person block him?
GOAL	Personal-adaptedness	cons	Is the goal unusually meaningful to the individual?
	Clarity	cons	Can one tell when and if the goal has been reached?
	Distance	var	How far is it in time and energy expenditure to the goal?

The first one, need intensity, is to this theoretical position what drive (D) is to Hull. Although it is quantifiable in terms of "more than" and "less than" it does not lend itself to neat additive formulation. Unlike white rats, the human organism is most driven, short of concentration-camp type varieties of deprivation, by needs arising from social pressures and self-conceptions.

Thus, since need intensity has been selected as one of the experimental variables, the plan is to create in some subjects a considerably higher need to perform the task than in others.

The age of the need may also be important. Old and fixed personality needs might well drive behavior more persistently than needs recently imposed by a shop foreman, or a school teacher. This variable would be most readily discerned as critical to motivation in instances where one man's history, relative to the task, differed uniquely from that of another. Thus the only way out in the present experiment was to introduce all of the subjects to a new neutral and impersonal kind of task in which the need to do well would be minimally conditioned by previous experience. This decision, in as much as it tends to control elements which might otherwise operate randomly in the need context makes of need-age a constant--

even if an imperfect one. The reason for contriving this and other constants lies in the fact that all variation stemming from uncontrolled sources serves to mask and conceal the variance deriving from the experimental variables.

The cognitive mediational variable addresses by its nature the fact that a person may either possess or lack a knowledge of how to enact the procedures leading to the attainment of the goal. The pathways may be very well or very poorly structured, or structured to any degree lying between these two extremes. In the present experiment this, too, is an experimental variable. Some subjects are clearly instructed as to what behaviors are expected of them along the way; others are left in such a position that the pathways are not well defined.

The precise form which all of these variables take in the experiment, which is to say, their operational definition, appears mid-way through Part II, Section 4.

The motoric mediational variable alludes to the notion that it is possible to be obstructed in one's goal-directed activity by inabilities to enact the requisite behaviors. This is a constant for the purposes of our experiment and is acknowledged by the experimenter's refusal to accept subjects having

speech impediments or vision not corrected to 20-20.

Of lesser threat to the integrity of the predominantly visual-vocal task are such factors as age and sex. However, only male subjects between the ages of 17 and 25 were accepted.

Extra-subjective mediational variables are potentially unlimited in number since the concept refers to the possible presence of forces outside of and beyond the subject which might block his progress to the goal. Naturally, this factor is held constant in our experiment. No barrier of any kind is present in the experimental environs which will block the performance of any member or element of the group.

Moving now to goal variables let us consider the adaptedness of specific goals to specific subjects. It seems apparent that what is a proper and meaningful goal for one man need not be for another. It seems unlikely that a task can ever be completely imposed from without, with the certain knowledge that the person assigned it is doing that which the assigner intended. A task that is too simple will induce distractibility which, with its orientation to other peripheral non-specified tasks, will cause the emergence of artifacts in behavioral measures and a corollary fluctuation in subjective feelings.

Making a task too difficult has the same effect, although an overlay of anxiety would be more likely to occur in the latter context if the need to achieve were intense.

Therefore, although it is a laboratory condition which one rarely finds in naturalistic settings, this factor has been made into a constant. A task had to be contrived which was of middle-range difficulty, so easy that any normal person could do it accurately and yet hard enough that mental wandering as a possible adjustive reaction would be very seriously curtailed.

Also, since the task should tap no deep well of personal significance, it had to be prosaic though somewhat interesting at the same time.

The clarity of the goal is the next factor listed. Here is pointed up the possibly existent condition of the individual's not knowing if he has or has not completed the task set for him. The person who has no clear picture of what constitutes reaching the point of task completion is in a conspicuously different situation than one who has this structure. For the purposes of this experiment task-completion was plainly spelled out for all subjects so that it became a constant factor.

The last factor in the motivational complex developed here is concerned with the perceived distance to the goal. How much, in time and/or energy, is it going to cost the organism to achieve task completion? Is the cost too much, or is it well within the reach of the individual? It was assumed in this experiment that these questions are being asked either implicitly or explicitly at all times by goal-orientated people. In the present experimental context this was made into a variable with some subjects being started toward goals that were much more remote than the goals of other subjects.

Thus, the experimental picture was one of three variables played in dual roles, being steadied and accentuated by the relative fixedness of five constants. The factor of need intensity will at times hereafter be simply designated Need or (N); the cognitive factor will be called definition or (d) because the pathways to the goal are defined to different degrees of precision; the goal factor of distance will be called Distance or (D).

The reader is again reminded that the exact operational definitions of these variables are to come in the next section.

The general hypothesis was that the factors of high need, clear definition, and near distance would

legislate to make the worker feel adequate and actually perform more efficiently whether he was explicitly aware of their presence or not. Conversely, it was supposed that operating under low need, or with ambiguous definition of pathways, or toward remote goals, would diminish a person's adequacy, both real and felt, and would legislate to lessen feeling tone and affect behavioral concomitants adversely.

It would likewise appear, on the surface of things, that these factors working together in systematically varied combinations might produce effects jointly which they might not produce independently.

The form which the experimental variables have taken provides the clue to the nature of the primary statistical tool employed. A 2x2x2 factorial design was employed with Need, Distance, and definition as the independent variables. Entered for analysis were such dependent variables as mean reaction times, dispersion indices, subjective ratings, etc.

A more specific statement of the hypothesis would take the form of a prediction that variables N, D, and d, dichotomized as they are, will each produce significant F-ratios when both behavioral and introspective data are analyzed. Section 6 of Part II

makes heavy use of this form of analysis.

4. Carrying out the Experiment

Having surveyed the area to be more differentially explored, and having decided upon the assumptions to be made and procedures to be acted out, as well as likely means of analysis, the problem of actualizing the hypothetical remained.

The data for this research were secured during the summer months of 1954. The problem of selecting a suitable population was no insignificant one. The desirability of visual and vocal competence, and of age and sex control, has already been mentioned. There was also the ajudged need for a communality of social and educational back-grounds, attitudes, and interests. A naive, unjaded body of subjects was deemed desirable.

The first procedure followed was the reviewing of the summer class lists at the office of the registrar. Here a sufficiently large, homogeneous group was found in the form of the constituency of Social Science Basic.

Obtaining clearance to solicit subjects from within the group was done through the departmental head and the particular instructors.

At a regular class session, before the daily lecture was undertaken, the experimenter was

introduced to the class. He spoke to them following this outline:

1. Acknowledge kindness of department and instructor;
2. Explain that some research cannot be done on white rats and that human subjects are essential;
3. Speak of the significance of making a contribution;
4. Talk about number of subjects needed and your willingness to meet them at any time during the day;
5. Specify limiting conditions;
6. Pass out sign-up sheets;
7. Thank class, instructor, and leave.

The appointment sheets were made up to cover a two-week period minus Sundays. Each day was divided into two-hour intervals and the prospective subjects were asked to sign at whatever place would be convenient to them. Thirty-five students in all signed up. Each had been instructed that a two-hour stint might be expected of him and that he should not sign up unless he could afford to devote two hours to the study.

On the next day the subjects started participating in the experiment. The experimentation continued through sixteen days until all subjects had been processed. To guarantee a smooth-running operation the procedure of contacting the subject the day before by telephone, or card, was carried out. No subject was absent nor even seriously late.

When the subject appeared at the experimental room he would be greeted politely with neither excessive friendliness nor reserve. Routinely he would step into the room, look curiously about, and make a comment or two about the experimental set-up which he saw. These comments were politely but non-committally acknowledged and the subject was asked to sit down at once in the chair facing the motion picture screen.

First, he was told that his instructions throughout the experiment were to be presented to him in typewritten form, so that the experimenter could be sure that all subjects 'were getting the same instructions.'

The first task orientation received by the subject consisted of being shown the hand-drawn figures he was later to respond to in projected form on the screen. As the figures were presented the subject was instructed to call them by the names the reader sees associated with them on page 28. The experimenter, holding a manila folder containing the hand-drawn stimulus objects, would expose one after another of them to the subject, saying to him, for example: house, bow, hat, flag, etc. About three seconds were spent viewing each stimulus object. It was of course explained to him that these were the objects to appear later on the screen. A second run

through the stimulus objects at the same tempo required the subject to repeat the names designated by the experimenter during the initial exposure which had been completed only fifteen to thirty seconds earlier. In every instance the subject was able to perfectly reproduce at first try the names proposed by the experimenter.

Half of the subjects employed in the experiment received slightly different introductions to the situation. They too were given two leafings through the portfolio of stimulus objects, but they were told only to make "an appropriate verbal response" to each symbol.

The following is a reproduction of the content of the first manila folder used by the experimenter (not handed to the subject) in establishing the eight separate situational contexts into which the subjects were grouped and within which they worked:

> 'Clear introduction--Subjects are made acquainted with drawn figures. The name of each figure is given. When each can be called promptly, start 5 minute run which is in every respect like the experimental run. The subjects call the symbols their given names.
>
> Ambiguous introduction--Subjects are shown the drawn figures and instructed that these will be the figures later to be seen on the screen. No inclination toward naming them is to be shown by the experimenter. They are told merely to make an appropriate verbal

> response to each symbol. Requests on the part of the subject that the procedure be further structured meet with passive and polite refusal.'

During this initial orientation the folder full of stimulus objects was resting on a small knee-level table which sat directly in front of and slightly between the subject's partially spread knees.

When the familiarization with the targets had been completed the folder was closed and placed on a table along with the other three folders employed in the establishment of the experimental climate for that particular subject.

In anticipation of the five-minute warm-up run a military-type throat microphone was then produced and fastened comfortably about the neck of the subject. On the small table, which had been left where it was, a small black tiredness reporter was placed. The reader will find a picture of this on page 78.

Then, while the film loop was put in place and the various sources of input properly pre-heated and regulated, the subject was reading the contents of another manila folder (the first one he has handled personally) on the outside of which was written simply "technical instructions".

> 'Reporting tiring: The black box next to you is to be used by you to report any noticeable change in your level of tiredness.

If your experience of tiredness increases, you are to press the key to the right.

If you wish to report a lessening of tiredness, you are to press the key to the left.

Pressing both keys simultaneously indicates that a period of time has gone by with no noticeable change in either direction.

There is no time schedule to follow in pressing these keys. You are to press them whenever you feel that you should.

Situate the box comfortably so that you can conveniently press the keys. Are there any questions?

The throat mike: The microphone you are wearing on your throat is particularly sensitive. It should be worn high on the Adam's apple. Contact should be firm but not tight. Speak clearly and distinctly.'

The next element of the sequence was the five minute warm-up run during which time the subject made his first 100 responses.

To designate this preliminary run as "warm-up" is quite proper, but it does not fully connote the significance of this period. Not only did the "warm-up" run permit the firm establishment of response tendencies and take care of the so-called "warm-up effect", but it also gave the subject task perspective. By this is meant that in order for the distance factor, and perhaps to some extent the definition factor, to

have full impact from the beginning of the subsequent experimental run the subject had to know what the task was going to be like.

As soon as the run of 100 was completed the projector was turned off, the audio portion of the projector and the voice key were left on, and the overhead lights turned on.

The experimenter would then address the subject in the following words, "Well, that's what it's like. I'm going to make a few last-minute checks on the apparatus, then I'll give you your instructions and we'll begin. In the meantime, here is an explanation of the background of the research we are doing. I want you to read it."

The subject was handed at this point the following "Explanation and background" if he were in the high need group.

> 'In this research we are studying the effects of repeated visual stimulation on "selective reaction time". A number of visual targets will appear on the screen. They will appear at the rate of one every three seconds. Your task is to respond appropriately by naming each one. Having already made 100 responses during the five minute warm-up period, you are familiar with what the task is like.
>
> The use of these devices and techniques in the measurement of reaction time is still in its developmental or exploratory stage. In the past few years experimenters working with tasks similar to this one

have shown that good performance correlates quite highly with general intelligence, and to a considerable extent with emotional stability. What else it indicates remains to be discovered.

We realize that most of you who have kindly agreed to act as subjects will wish to know how you did on the test. Therefore, you will not be left in the dark with respect to your performance. Several students who are not participating as subjects are analyzing the data as they are accumulated and, before the term is over, a mimeographed sheet will be circulated to all of those who did participate from which you may judge how well you performed.

Any participant wishing to learn more about the experiment and its purpose should feel free to consult the experimenter personally at any time.'

Those subjects who were to carry low need into the experimental run read this "Explanation and background".

'In this research we are studying the effects of repeated visual stimulation on "selective reaction-time". A number of visual targets will appear on the screen. They will appear at the rate of one every three seconds. Your task is to respond appropriately by naming each one. Having already made 100 responses during the five minute warm-up period, you are familiar with what the task is like.

Do not worry about how well you perform individually on this task for that is of no importance at all. After each of the subjects has been run, all of the data will be lumped together and used in that form. We are interested only in the average of the group and not in the performance of any person. For this reason you will not be informed as to the outcome of your performance.'

Each subject was given as much time to read the foregoing as he seemed to require, the typical one requiring one to two minutes.

When the subject made a move to put aside the "Explanation and background" the experimenter extended his hand to receive the folder and said, "And here are the instructions for this experiment."

At this point a third manila folder was handed to the subject. The subject received one of the four different "Experimental Instructions", depending upon the experimental group to which he had been assigned.

Those who were going to undertake the task with the thought in mind that completion was near at hand, and with a clear knowledge of the mediating behaviors required of them, read the following:

> 'The experimental instructions are few, simple, and direct:
>
> > You are to respond appropriately to exactly 500 of these targets as they appear on the screen.
>
> This will require 25 minutes.
>
> An appropriate response consists of calling the targets by the names you learned during your warm-up session.'

The reader will note the contrast between the foregoing "Near-Clear" instructions and the following "Near-Ambiguous":

'The experimental instructions are few and simple, but they are of necessity ambiguous:

> You are to respond appropriately to exactly 500 of these targets as they appear on the screen.

This will require 25 minutes.

It is up to you to determine what is "an appropriate response."'

Those who were to perform under conditions of "Remote-Clear" goal orientation were "set" by these instructions:

'The experimental instructions are few, simple, and direct:

> You are to respond appropriately to exactly 2100 of these targets as they appear on the screen.

This will require 1 hour and 45 minutes.

An appropriate response consists of calling the targets by the names you learned during your warm-up session.'

The last set of instructions reads:

'The experimental instructions are few and simple, but they are of necessity ambiguous:

> You are to respond appropriately to exactly 2100 of these targets as they appear on the screen.

This will require 1 hour and 45 minutes.

It is up to you to determine what is "an appropriate response."'

As the reader can see, this set was intended for those selected to respond to feelings of remoteness

and behavioral indeterminancy.

One suggestion yet remained for those who were to undertake the task under conditions of low need. Each such subject was informed that since too many subjects had signed up he had been selected by purely impersonal devices to be one of a reserve group of four whose performances would be kept and ultimately measured and analyzed--*if* the data provided by the other subjects became somehow unusable.

It should be emphasized at this point and clearly understood by the reader that the time elapsed from the end of the warm-up run to the beginning of the main run was never more than three or four minutes. The various combinations of folders were dispensed to the subjects in a quick, natural, and direct manner, the correct set having been laid out on the table prior to the subjects entry into the room.

To express in conversational language the difference between the task climates of the several groups, let us contrast the extremes in favorability and unfavorability, HNC and LRA.

The subject led into the task by way of High-Near-Clear route was responding, as it were, to the following self-perceived notions. 'This is certainly an easy task, it isn't going to cost me much work, but it *is* important for me as a person to do well.'

The contrasting impact of the Low-Remote-Ambiguous perceptual frame is apparent. 'Here I'll be spending almost two hours doing a task that is unimportant to me as a person and I haven't even got a nice clear picture in mind of how to respond anyway.'

These two were the extremes. Six intermediary combinations of favorable and unfavorable elements were compounded to match corresponding experimental sub-groups in accordance with the design on page 53.

The subjects were run in the following sequence:

HRC, HRA, LNC, LNA, HNC, LRC, HRC, LNA, LRC, LNC, LRA, HRA, HNA, LRA, HNA, LNC, HNA, LRC, LNC, HRC, HNC, LNA, LRA, HRA, LRA, HNA, HRA, HRC, LRC, HNC, LNA, AND HNC.

The main run in which all of the experimental variables were given full play was terminated suddenly when the subject had gone through the film loop four times. Thus a total of 500 response latencies were collected for each subject, 100 for the warm-up run and 400 for the experimental run. The cut-off point of 400 for all subjects was decided upon for several reasons: 1) it would lessen the chance for end-spurt behaviors on the part of those working on 500 response assignments; 2) it was thought long enough to permit opportunities for differential deterioration to set in, if such were going to occur; and 3) it would have

TABLE II

DESCRIPTION OF GROUPS IN RELATION TO EXPERIMENTAL VARIABLES

EXPERIMENTAL VARIABLE	MODE OF PRESENTATION							
NEED INTENSITY	HIGH				LOW			
GOAL DISTANCE	NEAR		REMOTE		NEAR		REMOTE	
PATH DEFINITION	CLEAR	AMBIG.	CLEAR	AMBIG.	CLEAR	AMBIG.	CLEAR	AMBIG.
RESULTING EXPERIMENTAL GROUPS *	HNC	HNA	HRC	HRA	LNC	LNA	LRC	LRA

* THESE LETTER DESIGNATIONS ARE USED THROUGHOUT THE TEXT OF THE DISSERTATION.

the effect of generally equating the energy out-put from subject to subject. If one subject were to become more impaired than another in the doing of this low-energy-demand task, it was assumed that such differences would occur randomly and that they would neutralize one another.

While the subject was making his responses, the experimenter was watching the mechanical apparatus for possible defects in operation and occasionally marking on the waxed paper indications that would be of value in simplifying the eventual measurement of the latencies.

An observer was following the response-by-response progress of the subject on a so-called Listener's Report sheet, an example of which is found on page 55.

At the end of the experimental run the projector was abruptly turned off, the light turned on, and the subject handed a post-experimental report to fill out. A copy of this may be seen on page 56. This form was filled out by the subject immediately in an adjoining room. The experimenter instructed each subject to fill it out carefully and left the room, offering no suggestions and in no way indicating what responses the subject should make. Three or four minutes later the experimenter would return to the

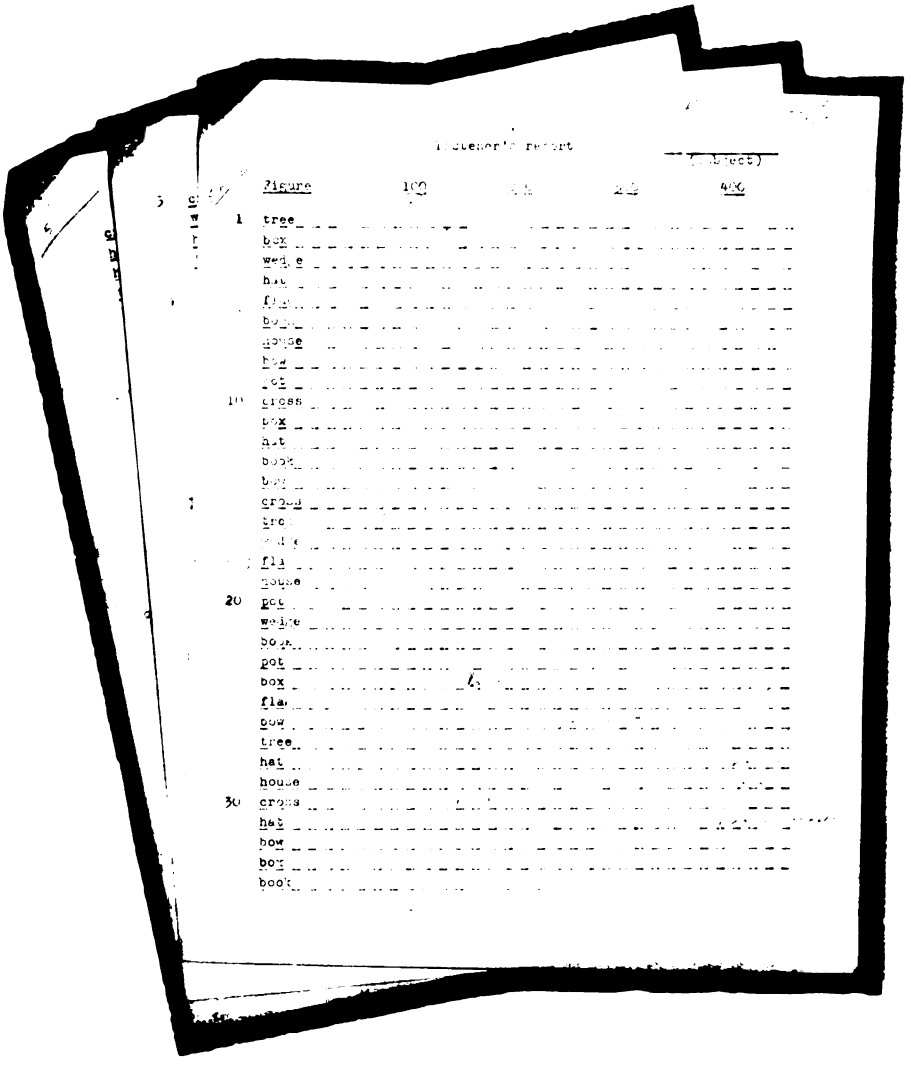

Fig. 4. Example of 'Listener's Report'

Subject's Post-experiment Report

Fatigue, or tiredness, scale:

1	2	3	4	5	6	7	8	9	10	11
alert and energetic		slightly tired		moderately tired		quite tired		very tired and fatigued		

In terms of the above scale, give numerical answers to the following questions:

a) How did you feel at the beginning of the experiment?___

b) How did you feel midway through the experiment?___

c) How did you feel just before you were stopped?___

. . . . . .

If you were to rate this task as to its ability to produce feelings of fatigue or tiredness, where would you place it on the following 11 point scale?___

1	2	3	4	5	6	7	8	9	10	11
not tiring		slightly tiring		moderately tiring		quite tiring		very tiring		

. . . . . .

Which target was hardest for you?_____

Which target was easiest for you?_____

Write a 100-200 word report of how you felt and what you thought about while the experiment was underway. Put it on the reverse side of this sheet.

Fig. 5. Report filled out by each subject immediately following his performance

room and ask the subject to write a completely open-ended introspection on his thoughts and feelings concerning and during the test. Each person utilized as much time and paper as he wished for this assignment.

When it became apparent that the subject wished to write no more on this topic, the experimenter would again re-enter the room, read completely the material that had been written on the sheet and undertake some detailed questioning, for example: Did any of the mechanical apparatus distract you? Did you use the tiredness reporter as you felt you should? Did you feel embarrassment at any point? Did you resort to any escape behavior in order to avoid carrying out the assignment? How would you rate your need to perform on this task?

In addition to these questions, others would be asked, if called for by the context. The purpose of this practice was to fill out a global and representative picture of the feeling experiences of each person.

Findings of a qualitative nature are reported in section 3, Part II.

Even after the subject's report had been completely written and handed in, one thing yet remained to do. The turn of events made it clear for

some of the subjects that all things were not as they had been represented in the pre-run perceptual structuring. For example, those directed toward remote goals were clearly aware of the fact that they had been misled. At no point in the post-experimental interview did any evidence appear that any of the subjects had failed to accept the suggestions put to them. A typical rejoinder to the inquiry as to whether or not they had accepted the suggestions was "Boy, was I faked out !"

In only two instances did subjects fail to take immediately this illuminating experience in good grace and in both of these instances the young men were especially sensitive and eager to please. The reader can clearly see and appreciate the need for a terminal interview. It would be quite impossible to have persons respond meaningfully to suggestions of low need, remoteness, and ambiguity if they had been coached by those who had already acted as subjects. This interview consisted of keeping each subject in the experimental room for a sufficiently long period of time to impart a feeling for and comprehension of the meaning and spirit of the experiment. Only when, in the experimenter's judgment, sufficient empathic contact had been made to guarantee the integrity of the experiment, was the subject allowed to leave.

Each subject was ultimately quizzed as to whether or not he had been coached or filled in on the details of the experiment. Each one denied that he had, although eight acknowledged making efforts to find out about the experiment.

Toward the end of the terminal interval each subject was informed that a party for all participants was to be held at the home of the experimenter four days after the subjects had been run. At this time, in addition to a social evening, a report on the progress of the research was to be made.

Such a party, playfully constructed around a psychological theme, was held and was very well attended. The rapport established by way of these efforts to maintain maximum security still evidence themselves seven months later.

It is the opinion of the experimenter that the enjoining of the trust of a relatively large group of people, an interesting psychological problem in itself, can be realistically and effectively achieved if the sufficient and efficient conditions leading to or facilitating breech of faith are directly addressed. Without such an approach a whole family of prospectively important research is cut off.

5. Measurement of the Obtained Data

Two main forms of quantitative data were obtained from each subject. The subject's self-rating was accepted directly as written, but the measurement of 75 feet of reaction latencies per subject was yet another matter.

To insure an accurate and analyzable measurement of these reaction latencies a plexiglass template (see page 61) was constructed by the experimenter. Its size would permit a quick measurement of eight reaction latencies before the waxed paper was moved through it and another eight measurements made. All of these measurements were made by one person and a recorder whose task it was to enter them into a convenient work-sheet, seen on page 62.

These measurements were made to the nearest millimeter in the judgment of the measurer. Since the waxed paper advanced at a rate of slightly better than 51 millimeters per three seconds, the measurements express temporal units of very nearly 1/17 of a second. These measurements are utilized in their original form and no effort has been made in this dissertation to convert them to time-units, although such would not be hard to do.

Possible sources of error reside in variation of motor speeds of the projector and kymograph.

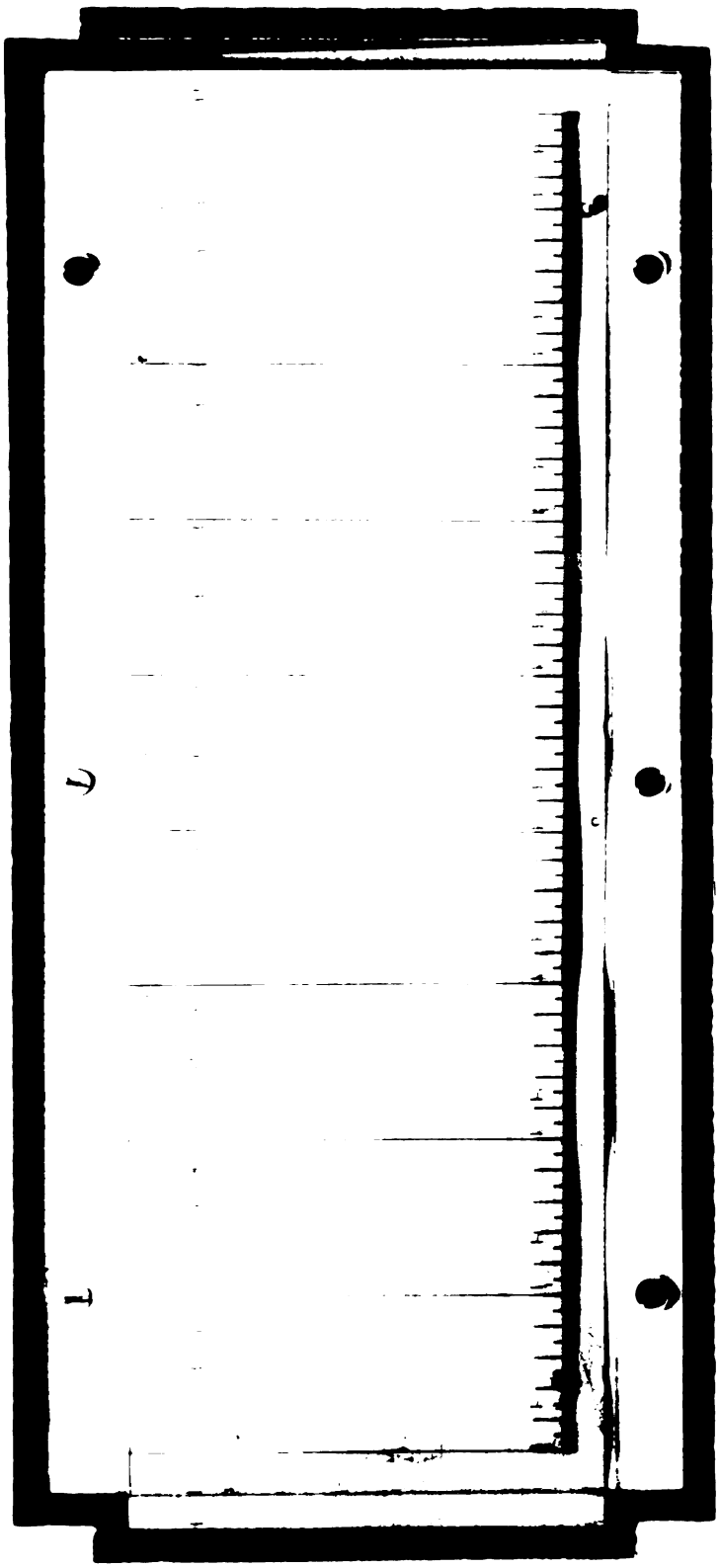

Fig. 6. Plexiglass template used in measuring subject's response latencies

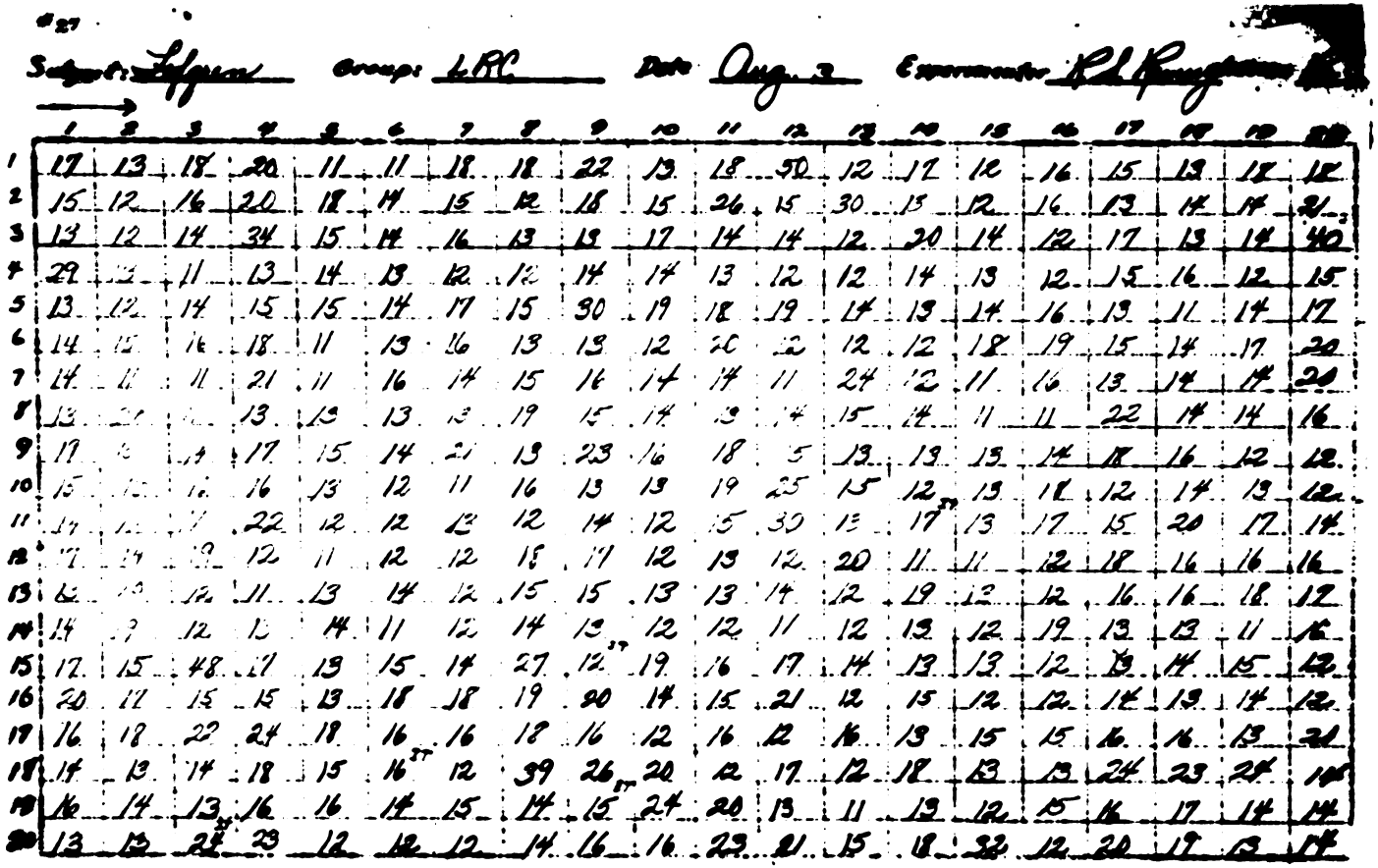

Fig. 7. Work-sheet of recorded response latencies of one subject

Frequent checks were made by stop watch; the variance stemming from this was so negligible as not to warrant analysis.

6. Analysis of Data

First to be discussed will be the two main dependent variables, performance in a reaction-time situation and scaled tiredness judgments.

Lengthy retrospections of the subject's feelings and thoughts while performing the task were gathered after each experimental run. These will be presented toward the end of the section along with the limited findings gotten from the mechanical tiredness reporter.

Beginning with the two mutually independent criteria of fatigue being used, one a retrospective evaluation of feeling, the other a straight forward reaction latency, a question obtrudes itself. What basis exists, other than the overworked appeal to common sense, for assuming that these two criteria are related? Might they not vary completely independently from one another? This is to say, might not those who report less tiredness produce completely unrelated reaction latencies?

The information appearing in Table III, page 64, suggests otherwise. In fact it indicates at well

TABLE III

SOME CORRELATIONS BETWEEN RETROSPECTIVE AND BEHAVIORAL FATIGUE CRITERIA

Subject's performance expressed in	Subject's Estimate of:		
	End of Test Tiredness	Tiringness of Test	Total of All Estimates
Mean reaction latency	.48** (.139)	.54** (.127)	.59** (.118)
SD of reaction latency		.52** (.132)	.58** (.119)
Median reaction latency			.57** (.120)

** $r_{.01(30\ df)} = .449$

beyond conventional fiducial limits that impoverished performance in terms of slowness of response and increased dispersion is predictable from a knowledge of the subject's reported tiredness-feelings. Beyond the raw data of the experiment which are portrayed on pages 66, 67, 68, numerous derived measures were obtained. These are to be found on page 69. It is these data which have then been subjected to the analyses presently to be reported.

The contents of tables VII and VIII on page 70 are intended to facilitate the interpretation of the summarized analyses since they represent a picture of the procedure followed in arriving at each of the tabled findings.

On page 71 the reader will find a summary statement of eleven different analyses. The first six are of purely behavioral records. The remaining five are of data gathered from retrospective self-rating, i.e. the subject's Post-experimental Report. Let us look first at the analyses of the behavioral data.

The first numerical data analyzed were the median response times from the second fifty responses of each subject's warm-up run. The first fifty responses produce a similar median in most instances, but there were some subjects who did not settle down

TABLE IV

FREQUENCY DISTRIBUTION OF THE RESPONSE LATENCIES OF 32 SUBJECTS

GROUP	SUBJ.	RESPONSE LATENCIES EXPRESSED IN MILLIMETERS
		6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
	1	8 34 45 42 52 54 33 17 14 18 8 12 6 9 6 8 3 5 6 4 3 2 3 2 2 1 1 1 1 1
	2	1 6 49 151 84 46 18 18 12 6 1 4 1 1 1
	3	4 8 33 59 53 81 43 26 26 13 8 9 6 5 10 2 4 2 2 1 2 1 1 1
HNC	4	1 10 44 64 85 53 50 25 18 8 5 2 5 3 7 5 3 1 2 1 1 1
	Σ	1 6 50 173 170 190 204 177 171 107 62 52 37 19 28 15 21 11 13 8 9 9 6 5 2 3 3 1 2 2 1 2 1 1
	5	3 20 37 48 63 50 42 23 19 9 13 12 8 10 6 6 3 4 1 4 3 1 1 1 1
	6	1 10 14 51 65 38 28 16 14 9 9 8 4 3 2 1 8 3 3 1 1
	7	3 21 36 65 73 62 33 34 21 11 8 5 8 3 1 3 2 1 2 1 1 1
HNA	8	1 3 17 38 57 56 45 38 22 20 22 13 5 10 9 6 4 7 5 3 2 2 2 2 1 2 1 1 1 2
	Σ	3 22 53 130 146 217 235 159 106 74 61 60 37 24 27 20 17 11 10 12 7 6 3 2 3 4 2 1 1 2 1 3 1
	9	1 1 1 7 7 20 36 41 55 42 32 27 14 14 13 13 12 10 6 3 6 2 7 4 4 3 2 1 3 1 1 2 1 1 1
	10	1 1 10 36 37 44 47 33 25 22 11 14 14 15 10 11 10 3 7 5 5 3 6 1 3 3 1 3 3 1 1 1 1 1
	11	5 33 42 134 71 36 10 6 3 3 1 1 1 1 1 1
HRC	12	8 14 29 48 71 48 29 33 26 23 14 10 7 6 2 2 2 1 5 1 3 1 2 1 3 2 1 1 1 1
	Σ	6 35 121 165 144 135 148 103 106 113 87 70 55 39 34 31 16 17 21 13 13 10 13 9 9 8 7 4 5 7 1 2 2 3 1 1 2 1 1
	13	5 10 33 45 56 43 39 32 36 25 14 12 7 7 5 5 4 2 1 2 6 2 2 1 1 1 1 1
	14	3 21 28 48 54 42 27 33 21 12 17 4 6 6 5 4 6 1 6 3 3 1 2 1 2 2 2 1
	15	2 7 10 25 52 48 36 33 23 25 14 25 20 15 9 17 7 10 3 3 2 5 5 3 4 3 1 1 1 3
HRA	16	7 11 13 31 23 40 28 25 28 18 12 18 11 12 19 8 4 11 13 5 13 7 8 6 6 3 3 4 3 1 1 3 2 1 2 2 1 2 1 3 1 2 1
	Σ	5 10 35 52 75 79 87 112 133 126 119 114 81 63 61 50 41 35 33 26 18 24 23 11 25 13 16 10 9 4 6 7 4 2 3 4 5 1 2 2 1 2 1 3 1 2 1

TABLE V

SUMMARY OF RESPONSES TO QUESTIONS ABOUT TIREDNESS APPEARING ON SUBJECTS' RETROSPECTIVE REPORTS

Subject and group		Response to Question: #1	#2	#3	#4	Total
HNC	1	3	1	1	5	10
	2	3	3	4	3	13
	3	1	3	4	3	11
	4	2	5	3	3	13
HNA	5	2	4	9	5	20
	6	2	2	3	7	14
	7	6	3	6	1	16
	8	1	6	6	6	19
HRC	9	2	2	4	4	12
	10	2	4	5	4	15
	11	2	3	3	3	11
	12	1	2	2	2	7
HRA	13	3	3	6	8	20
	14	2	5	3	5	15
	15	6	7	11	9	33
	16	3	7	10	7.5	27.5
LNC	17	1	3	6	5	15
	18	1	6	6	5	18
	19	4	4	6	6	20
	20	3	3	3	5	14
LNA	21	5	6	5	3	19
	22	2	5	5	8	20
	23	3	4	5	6	18
	24	2	7	7	5	21
LRC	25	5	8	8	6	27
	26	4	5	7	7	23
	27	2	5	5	6	18
	28	1	4	5	8	18
LRA	29	7	8	8	10.5	33.5
	30	1	7	11	11	30
	31	2	7	9	8	26
	32	5	6	6	9	26

TABLE VI

SUMMARY OF BASIC MEASURES DERIVED FROM ANALYSIS OF REACTION LATENCY DATA OF 32 SUBJECTS

Subject and group		Measurement					
		Number	Mean	Mode	Median	Sigma	Skewness
HNC	1	400	16.70	11.3	14.9	5.858	.920
	2	399	11.01	9.3	10.5	1.949	.861
	3	400	15.99	13.1	15.0	4.052	.712
	4	399	14.29	11.6	13.4	3.438	.774
HNA	5	399	15.31	11.6	14.1	4.648	.799
	6	358	15.71	12.1	14.5	4.045	.895
	7	387	16.49	14.3	15.7	3.678	.608
	8	397	17.66	13.0	16.1	5.206	.905
HRC	9	400	20.76	15.6	19.0	5.695	.902
	10	399	18.70	11.2	16.2	6.534	1.379
	11	399	12.34	11.4	12.0	2.216	.440
	12	395	17.52	13.2	16.1	5.063	.857
HRA	13	398	14.83	11.4	13.7	4.903	.703
	14	371	20.57	15.9	19.0	5.226	.897
	15	399	19.44	14.5	17.8	7.664	.649
	16	398	23.93	15.8	21.2	9.322	.872
LNC	17	400	13.18	11.3	12.5	2.856	.662
	18	396	16.45	11.3	14.7	5.200	.999
	19	400	15.37	12.1	14.3	4.446	.746
	20	398	12.56	10.9	12.0	2.672	.626
LNA	21	388	13.01	11.4	12.5	3.463	.454
	22	395	20.67	11.2	17.5	8.956	1.055
	23	400	19.30	14.2	17.6	5.717	.897
	24	400	17.31	13.0	15.9	5.637	.707
LRC	25	398	18.96	12.2	16.7	6.954	.978
	26	391	19.73	14.3	18.1	5.222	1.099
	27	400	15.48	11.7	14.2	4.689	.810
	28	400	15.00	12.5	14.2	3.326	.766
LRA	29	398	20.80	16.7	19.4	6.441	.678
	30	392	22.78	20.6	22.0	4.798	.461
	31	399	17.79	12.4	16.0	5.996	.893
	32	397	20.44	16.1	19.0	6.474	.629

TABLE VII

MEDIAN RESPONSE TIMES OF EIGHT GROUPS OF FOUR SUBJECTS EACH WHO PERFORMED THE SAME PHYSICAL TASK UNDER DIFFERENT INSTRUCTIONAL SETS

HIGH NEED				LOW NEED			
NEAR GOAL		REMOTE GOAL		NEAR GOAL		REMOTE GOAL	
CLEAR PATHS	AMBIG. PATHS	CLEAR PATHS	AMBIG. PATHS	CLEAR PATHS	AMBIG. PATHS	CLEAR PATHS	AMBIG. PATHS
14.9	14.1	19.0	13.7	12.5	12.5	16.7	19.4
10.5	14.5	16.2	19.0	14.7	11.5	18.1	22.0
13.0	15.7	12.0	17.8	14.3	17.6	14.2	16.0
13.4	16.1	16.1	21.2	12.0	15.9	14.2	17.0
Σ 53.8	60.4	63.3	71.7	53.3	63.5	63.2	76.4

TABLE VIII

COMPLETE ANALYSIS OF VARIANCE OF MEDIAN RESPONSE TIMES OF EIGHT GROUPS OF SUBJECTS WHO PERFORMED THE SAME TASK UNDER DIFFERENT INSTRUCTIONAL SETS

SOURCE OF VARIATION	SUM OF SQUARES	df	MEAN SQUARE	F
HIGH AND LOW NEED	1.71125	1	1.71125	.3340
NEAR AND REMOTE DISTANCE	59.86125	1	5836125	11.5944**
CLEAR AND AMBIGUOUS DEFINITION	45.60125	1	45.60125	8.9045**
NEED × DISTANCE	.10125	1	.10125	.0179
NEED × DEFINITION	2.10125	1	2.10125	.4126
DISTANCE × DEFINITION	.78125	1	.78125	.1534
NEED × DISTANCE × DEFINITION	.06125	1	.06125	.0120
WITHIN GROUPS	122.22000	24	5.0125	
TOTAL	231.43750	31		

** $F_{.01(1-24)} = 7.82$

TABLE IV

FREQUENCY DISTRIBUTION OF THE RESPONSE LATENCIES OF 32 SUBJECTS

RESPONSE LATENCIES EXPRESSED IN MILLIMETERS

GROUP	SUBJ.	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
	1				8	34	42	42	52	54	33	17	14	18	8	13	6	9	6	8	3	5	6	4	3	2		3	2		2
	2	1	6	49	151	84	46	18	18	12	6	1	4	1	1	1															
	3				4	8	33	59	53	41	43	26	26	13	8	9	6	5	10	2	4	2	2	1	2					1	
HNC	4			1	10	44	69	85	53	50	25	18	8	5	2	5	3	7	5	3	1	2	1	1					1		
	Σ	1	6	50	173	170	190	204	177	157	107	62	52	37	19	28	15	21	21	13	8	9	9	6	5	2		3	3	1	2
	5				3	20	37	48	63	50	48	23	19	9	13	12	8	10	6	6	3	4	1	4		3	1		1	1	
	6					1	10	44	41	65	58	28	16	14	9	9	8	4	3	2	7	8		3	3	1					
	7						3	21	36	45	73	65	33	34	21	17	8	5	8	3	1	3	2		1					2	
HNA	8					1	3	17	38	51	56	45	38	22	20	22	13	5	10	4	6	4	7	5	3	2	2	2	2	1	2
	Σ				3	22	53	130	146	217	235	159	106	71	61	60	37	29	27	20	17	11	10	12	7	6	3	2	3	4	2
	9					1	1	1	7	7	20	36	41	55	42	32	27	14	14	13	13	12	10	6	3	6	2	7	4	4	3
	10				1	1	10	36	37	44	47	33	26	22	19	14	14	15	10	11	10	3	7	5	5	3	6	1	3	3	1
	11				5	33	42	134	71	36	10	6	3	3		1			1	1	1			1			1				
HRC	12						8	14	29	48	71	48	29	33	26	23	14	10	7	6	2	2	2	1	5	1	3	1	2	1	3
	Σ				6	35	121	165	144	135	148	125	106	113	87	70	55	39	32	31	26	17	21	13	13	10	13	9	4	8	7
	13			5	10	33	45	56	43	39	32	36	25	14	12	7	7	5	5	4	2	1	2	6	2	2		1		1	
	14									3	21	28	48	54	42	27	33	21	12	17	4	6	6	5	4	6	1	6	3	3	1
	15					2	7	10	25	32	48	36	33	23	25	19	25	20	15	9	17	7	10	3	3	2	5	5	3	4	3
HKA	16							7	11	13	31	25	20	28	25	28	18	12	18	11	12	19	8	4	11	13	5	13	7	8	6
	Σ			5	10	35	52	73	79	87	122	133	126	119	144	81	83	61	50	41	35	33	26	18	24	23	11	25	13	16	10

GROUP	SUBJ.	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
	1	1	1				1	1				1																		
	2																													
	3	1					1																							
HNC	4																													
	Σ	2	1				2	1				1																		
	5												1																	
	6			1																										
	7				1		1																							
HNA	8	1	1	1			2																							
	Σ	1	1	2	1		3						1																	
	9	2	1	3		1	1	2	1				1																	
	10		3	3	1	1	1						1									1								
	11																													
HRC	12	2	1	1				1		1																				
	Σ	4	5	7	1	2	2	3	1	1			2									1								
	13			1		1	1																							
	14	2	1	2	2			2	1																					
	15	1			1					3																				
HKA	16	6	3	3	4	3	1	1	3	2	1		2	2	1	2		1				3	1	2					1	
	Σ	9	4	6	7	4	2	3	4	5	1		2	2	1	2		1				3	1	2					1	

TABLE IV -- CONTINUED

GROUP	SUBJ	RESPONSE LATENCIES EXPRESSED IN MILLIMETERS
LMC	11	
	12	
	13	
	10	
	Σ	
LMH	21	
	22	
	23	
	24	
	Σ	
LRC	25	
	26	
	27	
	28	
	Σ	
LLH	29	
	30	
	31	
	32	
	Σ	
	Σ	

TABLE V

SUMMARY OF RESPONSES TO QUESTIONS ABOUT TIREDNESS APPEARING ON SUBJECTS' RETROSPECTIVE REPORTS

Subject and group		Response to Question: #1	#2	#3	#4	Total
HNC	1	3	1	1	5	10
	2	3	3	4	3	13
	3	1	3	4	3	11
	4	2	5	3	3	13
HNA	5	2	4	9	5	20
	6	2	2	3	7	14
	7	6	3	6	1	16
	8	1	6	6	6	19
HRC	9	2	2	4	4	12
	10	2	4	5	4	15
	11	2	3	3	3	11
	12	1	2	2	2	7
HRA	13	3	3	6	8	20
	14	2	5	3	5	15
	15	6	7	11	9	33
	16	3	7	10	7.5	27.5
LNC	17	1	3	6	5	15
	18	1	6	6	5	18
	19	4	4	6	6	20
	20	3	3	3	5	14
LNA	21	5	6	5	3	19
	22	2	5	5	8	20
	23	3	4	5	6	18
	24	2	7	7	5	21
LRC	25	5	8	8	6	27
	26	4	5	7	7	23
	27	2	5	5	6	18
	28	1	4	5	8	18
LRA	29	7	8	8	10.5	33.5
	30	1	7	11	11	30
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	4	2	5	3	3	13
HNA	5	2	4	9	5	20
	6	2	2	3	7	14
	7	6	3	6	1	16
	8	1	6	6	6	19
HRC	9	2	2	4	4	12
	10	2	4	5	4	15
	11	2	3	3	3	11
	12	1	2	2	2	7
HRA	13	3	3	6	8	20
	14	2	5	3	5	15
	15	6	7	11	9	33
	16	3	7	10	7.5	27.5
LNC	17	1	3	6	5	15
	18	1	6	6	5	18
	19	4	4	6	6	20
	20	3	3	3	5	14
LNA	21	5	6	5	3	19
	22	2	5	5	8	20
	23	3	4	5	6	18
	24	2	7	7	5	21
LRC	25	5	8	8	6	27
	26	4	5	7	7	23
	27	2	5	5	6	18
	28	1	4	5	8	18
LRA	29	7	8	8	10.5	33.5
	30	1	7	11	11	30
	31	2	7	9	8	26
	32	5	6	6	9	26

TABLE VI

SUMMARY OF BASIC MEASURES DERIVED FROM ANALYSIS OF REACTION LATENCY DATA OF 32 SUBJECTS

Subject and group		Measurement					
		Number	Mean	Mode	Median	Sigma	Skewness
HNC	1	400	16.70	11.3	14.9	5.858	.920
	2	399	11.01	9.3	10.5	1.949	.861
	3	400	15.99	13.1	15.0	4.052	.712
	4	399	14.29	11.6	13.4	3.438	.774
HNA	5	399	15.31	11.6	14.1	4.648	.799
	6	358	15.71	12.1	14.5	4.045	.895
	7	387	16.49	14.3	15.7	3.678	.608
	8	397	17.66	13.0	16.1	5.206	.905
HRC	9	400	20.76	15.6	19.0	5.695	.902
	10	399	18.70	11.2	16.2	6.534	1.379
	11	399	12.34	11.4	12.0	2.216	.440
	12	395	17.52	13.2	16.1	5.063	.857
HRA	13	398	14.83	11.4	13.7	4.903	.703
	14	371	20.57	15.9	19.0	5.226	.897
	15	399	19.44	14.5	17.8	7.664	.649
	16	398	23.93	15.8	21.2	9.322	.872
LNC	17	400	13.18	11.3	12.5	2.856	.662
	18	396	16.45	11.3	14.7	5.200	.999
	19	400	15.37	12.1	14.3	4.446	.746
	20	398	12.56	10.9	12.0	2.672	.626
LNA	21	388	13.01	11.4	12.5	3.463	.454
	22	395	20.67	11.2	17.5	8.956	1.055
	23	400	19.30	14.2	17.6	5.717	.897
	24	400	17.31	13.0	15.9	5.637	.707
LRC	25	398	18.96	12.2	16.7	6.954	.978
	26	391	19.73	14.3	18.1	5.222	1.099
	27	400	15.48	11.7	14.2	4.689	.810
	28	400	15.00	12.5	14.2	3.326	.766
LRA	29	398	20.80	16.7	19.4	6.441	.678
	30	392	22.78	20.6	22.0	4.798	.461
	31	399	17.79	12.4	16.0	5.996	.893
	32	397	20.44	16.1	19.0	6.474	.629

TABLE XII

MEDIAN RESPONSE TIMES OF EIGHT GROUPS OF FOUR SUBJECTS EACH WHO PERFORMED THE SAME PHYSICAL TASK UNDER DIFFERENT INSTRUCTIONAL SETS

HIGH NEED				LOW NEED			
NEAR GOAL		REMOTE GOAL		NEAR GOAL		REMOTE GOAL	
CLEAR PATHS	AMBIG. PATHS	CLEAR PATHS	AMBIG. PATHS	CLEAR PATHS	AMBIG. PATHS	CLEAR PATHS	AMBIG. PATHS
14.9	14.1	19.0	13.7	12.5	12.5	16.7	19.4
10.5	14.5	16.2	19.0	14.1	17.5	18.1	22.0
12.0	12.7	12.0	17.8	14.5	17.6	14.2	16.0
13.4	16.1	16.1	21.2	12.0	15.9	14.2	17.0
Σ 50.8	61.4	63.3	71.7	53.2	63.5	63.2	76.4

TABLE XIII

COMPLETE ANALYSIS OF VARIANCE OF MEDIAN RESPONSE TIMES OF EIGHT GROUPS OF SUBJECTS WHO PERFORMED THE SAME TASK UNDER DIFFERENT INSTRUCTIONAL SETS

SOURCE OF VARIATION	SUM OF SQUARES	df	MEAN SQUARE	F
HIGH AND LOW NEED	1.71125	1	1.71125	.2360
NEAR AND REMOTE DISTANCE	58.86125	1	58.86125	11.5594**
CLEAR AND AMBIGUOUS DEFINITION	45.60125	1	45.60125	8.9046**
NEED × DISTANCE	.10125	1	.10125	.0179
NEED × DEFINITION	2.10125	1	2.10125	.4126
DISTANCE × DEFINITION	.78125	1	.78125	.1534
NEED × DISTANCE × DEFINITION	.06125	1	.06125	.0120
WITHIN GROUPS	122.22000	24	5.0925	
TOTAL	231.43875	31		

** $F_{.01\,(1-24)} = 7.82$

TABLE IX

F-RATIOS OBTAINED FROM ANALYSIS OF VARIANCE OF OBJECTIVE MEASURES SHOWN IN COLUMNAR HEADINGS

SOURCE OF VARIATION	MEASURE ANALYZED:					
	1 PRE-TEST MEDIANS	2 MEANS	3 MODES	4 MEDIANS	5 SIGMAS	6 SKEW-NESSES
NEED	.137	.237	.466	.336	.137	.311
DISTANCE	.855	7.825**	10.486**	11.558**	4.259*	.080
DEFINITION	8.193**	7.331**	8.937**	8.455**	3.918*	1.213
N × DIST.	.360	.010	.648	.020	.144	.119
N × DEF.	.048	.305	.302	.413	.061	.101
DIST. × DEF.	.093	.016	1.193	.153	.001	1.711
N × DIST. × DEF.	.328	.030	.493	.012	1.319	.373

*FOR SIGNIFICANCES, SEE TABLE BELOW

TABLE X

F-RATIOS OBTAINED FROM ANALYSIS OF VARIANCE OF RETROSPECTIVE MEASURES SHOWN IN COLUMNAR HEADINGS

SOURCE OF VARIATION	TIREDNESS ESTIMATE:				
	I BEGINNING OF TEST	II MIDDLE OF TEST	III END OF TEST	IV OF TEST AS TASK	V TOTAL OF ESTIMATES
NEED	.565	10.316**	3.148	14.478**	16.828**
DISTANCE	.505	4.263*	4.342*	13.623**	13.631**
DEFINITION	2.320	8.895**	10.885**	15.779**	26.528**
N × DIST.	.238	.079	.482	2.247	2.327
N × DEF.	.093	.026	2.442	1.078	2.327
DIST. × DEF.	.238	.105	1.085	6.439*	4.589*
N × DIST. × DEF.	.258	.105	.121	.013	.831

* $F_{.05(1-24)} = 4.26$

** $F_{.01(1-24)} = 7.82$

to representative performance immediately.

The analysis of the pre-test data indicates that the factor of definition alone was playing a significant role. In order to assure poorly defined pathways during the experimental run they (the pathways) were left ambiguous from the first introduction, and this accounts for the large F-ratio in column 1 which signifies a significantly slower rate of responding for those with poorly defined pathways.

This first analysis, as well as all the subsequent ones, was carried out quickly and simply by the use of the "variance analyzer" pictured on page 73.

Columns 2, 3, and 4 give pictures similar to one another. It will be noted that the factor of distance which was introduced after the warm-up run has achieved even greater significance than definition as a deterrent to fast reaction-time.

The need factor shows no significance whatsoever. There is likewise no indication of interaction variance.

Inspection of the distributions of the various subjects indicates apparent skewness* which is the usual state of affairs for reaction-time data. It is not surprising that the analysis of median scores

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* see Table IV.

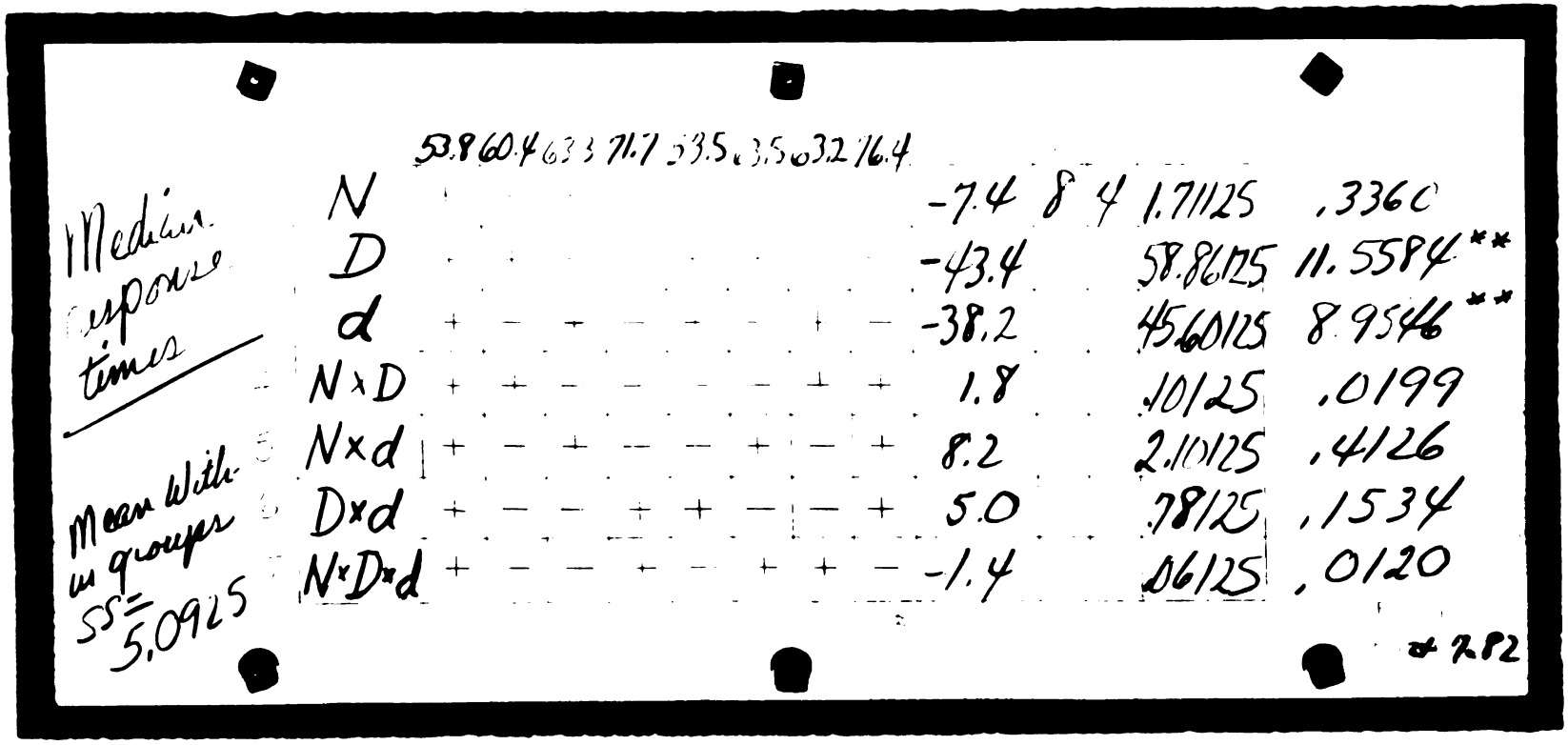

Fig. 8. "Variance analyzer" helpful in determining between groups variance

(column 3) produces the most significant ratios, for they (medians) are ostensibly the best indications of central tendency for skewed data.

In addition to making some subjects vary along an absolute time dimension the experimental variables also had effects upon the tendency of reaction-times to disperse. Here the effect of the variables (column 5) is less marked, definition alone producing a ratio significant at the 5% level. Distance too seemed to increase the tendency toward erratic performance. Need, once again, makes no unique contribution to any distinctive variance pattern. Interaction variances are again negligible. The F-ratios recorded in column 6 tell a different kind of story. Although each of the subjects produced a skewed array of data, none of the experimental variables showed up as having a distinctive effect on skewness, nor were there any significant interaction variances.

Thus it would appear that directing subjects toward a remote goal tended to slow them up appreciably. Remoteness also evinced an apparent but unreliable increase in the error factor.

The reader will remember that even in the preliminary run the traversing of ambiguously defined pathways significantly lengthened reaction-time.

This same impairment of performance carried over into the experimental run and was present both in measures of reaction-time and error tendency.

The effect of the experimental variables upon reported feeling states was similar but different. Checking the subject's post-experimental report (Fig. 5) will give one an indication of the form taken by the data now being analyzed.

Each subject was asked to estimate his tiredness at the beginning, middle, and end of the experiment. He was then asked an impersonal question. "How would you rate the task as to its tiringness?" The answers to question 1 reported in column I indicate, by way of the absence of significant F-ratios, no variance patterns being set-up by the experimental variables singly or jointly. Had any extreme variance shown up it would have served only to emphasize the frailty in asking for subjective data. Indeed it is interesting to note that those working by way of ambiguous paths "remembered" feeling a little tireder at the beginning than did anyone else. The ratio set up by their skewed memories fell far short of significance however.

But now, note column II. The midway ratings were significantly affected by each of the independent variables. The factor of need, whether or not the

subject was permitted to attach any significance to his task, looms up as very significant. Those who worked on tasks unimportant to them reported much more tiredness mid-way through than those who attached importance to their work. This is in marked contrast to the role played by need in conditioning the behavioral data. There was still no significant interaction variance.

Analysis of the end-of-test tiredness ratings produced one disconcerting element. While the effects of distance and definition remained constant, or were enhanced slightly, the effect of the need factor faded, so far as its importance in conditioning remembered-tiredness was concerned. While this is suggestive of inconsistency it might well be that this is the way the organism works.

The fourth question on the subject's report, "If you were to rate this task, as to its ability to produce feelings of fatigue or tiredness, where would you place it on the following 11 point scale?", proved to be the most sensitive. Presumably it permitted the subject to get some distance away from himself as the frame-of-reference. Need, distance, and definition all contributed heavily to the way in which the subject estimated the difficulty of the task. In this instance, distance interacted with

ambiguity to produce a significant increase in reported tiredness. This was the only such interaction variance found in the study.

It was found that by combining all of the tiredness introspections for each subject, and then analyzing the aggregate, the effect of each of the variables was enhanced. The interaction between distance and definition alone was diminished, thereby suggesting that the significant figure occurring in column V exists by virtue of the inclusion of the tiringness estimate in the total estimate.

The most marked distinction manifested by the apposition of the behavioral and retrospective analyses is the sudden significance of the need factor in the second instance. Although low task-significance had no material effect on speed or errors, it seemed to very noticeably affect in an ulterior way the subject's perception of his own tiredness.

On the next page the reader will find a picture of the tiredness reporter. It was a simple two-key device which gave the subject an opportunity to report fluctuations of felt tiredness without interrupting that which he was doing.

The tiredness reporter was not played up as an important element in the instructions out of which the situational climates were constructed. The

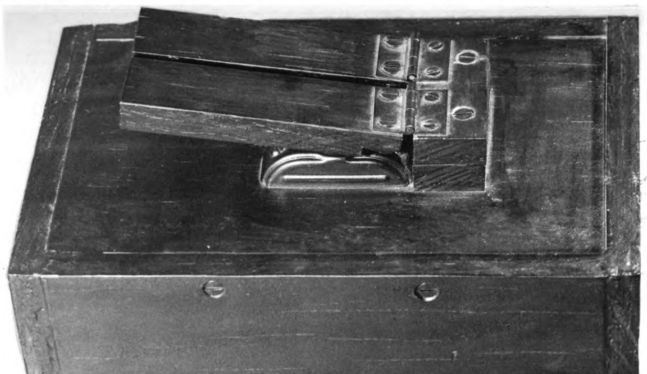

Fig. 9. Two-key tiredness reporter used by subjects to record variations in experienced tiredness

subject was placed under no compulsion to use the reporter and as a result the data obtained were too spotty to admit of careful analysis. The data are reported on page 80. The attendant graphs may tell somewhat of a story but no conclusiveness is claimed for them.

The reader is reminded at this time that the experiment was, at its onset, one which was constructed so that it might possibly elicit interaction effects. Global work-atmospheres were constructed and joint influence of experimental variables was, if anything, anticipated.

It would not be well to go beyond the data of this experiment in generalizing upon the absence of interaction. Further experimentation would be required to crucially test a no-interaction, channelization" hypothesis.

At the base of the customary piece of research is a bed rock of empirical data, evidence which is drawn impersonally and in an unbiased way from a population which is free to vary randomly outside of the limitations imposed by the experimenter, which limitations should be clearly understood and communicated.

This common denominator, conventional, laudable, and necessary, may not lend itself to the

TABLE XI

DESCRIPTIVE SUMMARY OF USE OF TWO-KEY TIREDNESS REPORTER BY 32 SUBJECTS RELATIVE TO INSTRUCTIONAL SETS

Instructional set of subjects	Number of Times Subjects Reported:			
	Increasing Tiredness	Decreasing Tiredness	No Change	T
High need	14	4	10	28
Low need	50	20	29	99
Near goal	32	18	35	85
Remote goal	32	6	4	42
Clear paths	37	13	9	59
Ambiguous paths	27	11	30	68

capturing of the other important data. In other words, analyzing a subject's response latencies and his tiredness ratings will reveal certain kinds of information in an easy to interpret form, but it leaves untouched a wealth of other processes which were transpiring throughout the experiment and which were in and of themselves important and instructive. It is one of the persistent problems of the researcher to bring the subtlty of his machinery closer to the subtlty of that fabric which he studies.

In an effort to do just that, each subject was required to write an introspective essay on his feelings and thought throughout the experiment. In addition, both the experimenter and the observer watched the performance of the subject as closely as possible, noting and writing down his mannerisms and behaviors.

These steps were taken with full knowledge that the information gained thereby would not lend itself to neat, quantitative treatment, but with the hope that it might provide a broader and more complete picture. Observe the data on page 82 in which the number of individuals in each experimental group referring to various mental activities or feeling states in the subject's report are listed according to group and in order of total number of references.

TABLE XII

NUMBER OF SUBJECTS REPORTING VARIOUS CONSCIOUS EXPERIENCES RELATIVE TO EXPERIMENTAL GROUP

Reported thinking or feeling activity	Group								
	HNC	HNA	HRC	HRA	LNC	LNA	LRC	LRA	T
curiosity, hypothesizing	3	3	1	2	2	2	4	4	21
tiredness	3	2	1	3	1	1	3	2	16
worry, anxiety	4	2	1	3	2	2	1	0	15
'time left'	1	2	3	0	1	1	2	3	13
guessing at answers	0	0	1	2	2	0	2	2	9
tenseness	2	1	1	2	1	0	2	0	9
anger, irritation	1	1	0	1	0	1	0	3	7
alertness	1	2	1	1	0	1	0	0	6
confusion	0	2	0	1	0	2	0	0	5
self-insufficiency, embarrassment	0	1	0	1	0	2	0	1	5
resignation	0	0	3	0	0	0	2	0	5
rationalization	0	1	0	2	0	1	0	0	4
boredom, monotony	1	0	0	0	1	0	1	1	4
blocking	0	1	0	0	0	0	0	1	2
discomfort	0	0	0	1	0	0	1	0	2
excitement	0	1	0	0	0	0	0	0	1
exhaustion	0	0	0	1	0	0	0	0	1
yawning	0	0	0	1	0	0	0	0	1
Total	16	19	12	21	10	13	18	17	126

The reliability of such coded material is of course an issue and is no doubt far from what might be desired. The experimenter included in this listing only specific references to the attributes mentioned by the subject and did not read between the lines. Checks of the written material by several other coders produced similar results.

The reader will note that worry and anxiety were reported most often by those working under high need set, that reports of guessing at correct responses were more frequent among those under low need set. That anger and irritation in six out of seven instances were reported by those who had received ambiguous sets. That five out of six of those reporting alertness came from high need groups. Also of note is the fact that reports of felt confusion were limited to those who were ambiguously set; that self-insufficiency and embarrassment were limited to those under ambiguous conditions. Resignation in the face of the task was reported by five members belonging to two of the sub-groups both of which were orientated toward remote goals.

Four individuals employed rationalization for poor performance and all were ambiguously set. Only four of the thirty-two subjects reported boredom or monotony, and three of these came from low-need groups.

Mentions of curiosity, hypothesizing as to the nature of the experiment, and tiredness itself, although these were the most common themes mentioned, did not seem to fit any differentiated pattern.

The reader will note that no contentions are being made as to the meaning or ultimate significance of these data. However, it might well be that they point the way to testable hypotheses. They do seem to suggest that orientational sets are taken and responded to according to expected routes although the instructions are given in a casual manner.

Hypothesizing as to the nature of the experiment, which was the most commonly given report, suggests the feasibility of checking in a more precise way for the presence of "escape behavior". By this the writer intends the notion that the tendency to "escape the field" might be seen to fall into some pattern if this attribute were studied specifically.

The following procedure was set into effect. Each subject's post-experimental report was read by the experimenter at the same sitting. Each was placed into one of three groups according to the following plan: 1) those who described no or virtually no efforts to avoid the task; 2) those who reported some task-avoidant effort; and 3) those whose reports indicated considerable or great concern with behaviors

other than those central to the task.

Using such a coarse three-category system, and averaging the scores according to instructional sets, the following picture was obtained:

TABLE XIII

AVERAGE ESTIMATED MENTAL WANDERING* OF SUBJECTS RECEIVING DIFFERENT INSTRUCTIONAL SETS

Instructional set	Mental wandering as estimated by coder:			
	I	II	III	AVE
H	2.1	2.3	2.1	2.2
L	2.2	2.0	2.2	2.1
N	1.7	1.9	1.8	1.8
R	2.6	2.4	2.4	2.5
C	2.1	2.1+	2.0	2.1
A	2.2	2.1+	2.3	2.2

*Columnar scores of 1=no, 2=some, and 3=much wandering

The question of reliability is pertinent at this point. What liklihood is there that another checker would arrive at conclusions similar to the experimenters if he were to appraise the retrospective reports independently?

To answer this question two other coders, as in the case of the subjective materials reported on page 82, were asked to follow the same three-category procedure in making their own evaluations of the presence or absence of mental wandering.

The tabular material listed above represents an average of the conclusions of the experimenter and two other coders. There was little variation between the judgments of the three coders, as shown in Table XIII.

Whether or not this indicates a relationship between the perceived remoteness of one's goal and the tendency toward mental wandering is a moot issue. The writer would be content to say that such is "suggested".

Not without significance is the peculiarity of the performance of the isolated individual. In the experimenter's opinion a number of such accounts merit acknowledgment although they could not be spoken of as hard empirical findings. Subject number twenty-eight, who was operating under Low, Remote and Clear conditions, performed very efficiently showing a mean reaction time of 15.0 millimeters (15/17 of a second). His standard deviation was very small. However, the tiredness reported by him was out of line with his good performance. The reason for mentioning him at this point lies in the fact that he yawned at least nine times which was more than any of the other subjects. At the end of his experimental run he was so reclined as to be almost horizontal.

Yawning was a significant problem for another subject of Low, Remote and Ambiguous orientation, number thirty. After making the first three hundred responses without yawning, he yawned expansively and prolongedly five times during the last one hundred.

Subject number twenty-seven, Low-Remote-Clear, was an alert and energetic football player whose eagerness to please was apparent from his first entry into the room. His performance as measured in response-latency, means, and dispersions, was held at a fairly high plane. His tiredness self-evaluation was in line with the hypothesis, and, what is of greater note in this section, the eager, cocky attitude had been dissipated after only ten minutes of instructions and simple work.

Perhaps no subject in the experiment experienced the manifest physical difficulties of subject number twenty-five. His orientation to the task had been by route of Low-Remote-Clear. He moved about continually, leaning forward in the chair, sprawling backwards, leaning to one side and then to the other. Noticeably lacking was any posture-maintaining muscle tonus. His was a strange mixture of restlessness and atonic relaxation. Again the performance of this subject was not outstandingly poor but his reported tiredness was high. He even tried closing his eyes

between symbol presentations and early in the run turned his wrist watch around on his arm so he could not see it.

The sixth subject experienced extreme difficulty in his efforts to respond to one symbol and failed to make any response throughout the test. His task orientation had been High, Near, and Ambiguous. The "hat" looked like "something upside down" to him. He reported never really giving up in a quest for a designation, and said that he tried to think of something each time it appeared on the screen. This failure did not appear to distort either his subjective or response-latency data in such a way as to make them atypical.

One other instance would seem to merit mention. Subject number twenty had been assigned to the Low-Near-Clear experimental group. The following is a partial quote from his own report ". . . at several times I reminded myself that now, of all times, I should concentrate on what I was doing. In connection with this, I remembered what my girl has told me 'There is nothing you can't do, if you want to, if you try hard enough, if it is right.'"

Inspection of his data reveals a picture which might have typified that of the High-Near-Clear subjects. Manifest failure to achieve desired need

level because of fixed ego-needs is a constant threat to any experiment such as this one. This topic is pursued at greater length in the last part of this dissertation.

Interesting and possibly valuable behavior descriptions might have been written about each subject used in this experiment. The experiment was not set up along these lines.

Several observations may be made about the accounts just given. They would appear to suggest that successfully fighting off behavioral deterioration did not eliminate felt tiredness and there was some indication that the performance was maintained at some cost; for example, making excessive postural adjustments, yawning, evidencing general restlessness, and displaying other behavioral oddities.

7. Conclusions Based on the Experiment

The dependent variables of primary concern in this experiment took two different forms, retrospective tiredness ratings and response latencies.

The experimental, or independent, variables were three: need, distance, and definition.

The purpose of this section is to indicate conclusions, based upon experimental evidence, about the roles played by the experimental variables as

conditioners of the dependent variables.

The need factor, discussed as to conceptual and operational significance at prior points in the dissertation, played a turn-about role. Whether the subjects were in high- or low-need groups made no difference in how the subjects performed on their reaction time task. It did make a difference however in the subject's rating his own tiredness.

The distance factor played a very determining role on both dependent variables. Those who were directed toward near goals fared better in performance and felt less tired.

The factor of definition was crucial throughout. Not having a clear idea of the specific behaviors to be used in acting out the task had an impoverishing effect upon performance and added notably to the subject's scaled perception of his own tiredness. This is noteworthy in view of the fact that those receiving ambiguous instructions rarely made responses which were more complex than those receiving clear instructions.

Analysis of variance frequently reveals numerous interactions which require explanation. This research was characterized by the lack of interaction variance. Throughout all of the analyses which were run, only one direct and clear-cut F-ratio appeared

which was traceable to interaction. This was the interaction between distance and definition, as it affected the subjects' estimate of the tiringness of the task.

Conclusions of a generalizing nature which go by extrapolation beyond the data are not presented here but are to be found in the last few paragraphs of the dissertation.

III. SUMMARY AND CRITIQUE OF THE EXPERIMENT

In summarizing that which has gone before, it is well to keep in mind that all of the components of the body of information achieved do not carry equal weightings as to certainty and conclusiveness. It would be well then to compartmentalize the summary according to such a principle.

1. That Which is Pointedly Indicated

As a general assertion it can be said that life-space, situational, or "set" factors can be contrived in such a way as will permit their controlled utilization in an experiment addressed to the topic of human tiredness.

It may be stated that these factors, although primarily personal and task orientational and minimally concerned with exertion, can and do make a difference in 1) how tired a person feels and 2) how adequately he performs when the criteria of good performance are 1) time utilized in the single performance and 2) the variance of the performances.

More specifically it may be stated that distance and definition significantly affect feelings and performance, and need affects feelings only.

It also seems quite conclusive that felt tiredness and impoverished performance vary together even in the absence of differentiated experimental variables. This is to say that people who feel tired, work less effectively even though they are not characterized as belonging to one or another experimental group.

One of the significances of this research has been the pointing out of the fact that the already existent relationship between feelings of tiredness and poor performance is in part under the directed control of factors which serve to orientate a person to his task so that one work-situation may increase it while another diminishes it.

2. Less Conclusive Results

In this section the comments will again be limited to the findings deriving from the subject's post-experimental report and from the latency data.

The reader will recall that not one but four different ratings were required of each subject. He was asked to judge his tiredness at the beginning of the experiment, mid-way through it, and just before he finished. He was also asked to specify how tiring he thought the task to be. The findings shown in Table X indicate that, with a single exception, each

subsequent rating was more sensitively affected by the experimental variables than had been the rating just before it; that is, the total tiredness estimate produced F-ratios more significant than the tiringness estimate, the tiringness-estimate produced larger F-ratios than the end-estimate which was larger in turn than the middle estimate, and so on.

That these are results to be accredited as meaningful seems plausible. To say that they conclusively demonstrate a principle of cumulative effect would be yet another thing. They do appear to demonstrate however that a summation of self-ratings on such a personalized matter, as feelings of tiredness produces more reliable conclusions than does any separate evaluation.

Turning to the behavioral data there are several observations which, although based upon findings, could scarcely be called conclusive. One is the insignificance of different need-levels in affecting the latency and dispersion of various subjects' responses. One would hardly know on the basis of this experiment alone if this could be made into a generalization. Perhaps difference in levels of need, otherwise defined, would have had a significant effect. The reality of the need factor as presented in the present experiment seemed to be attested to, however,

by its marked influence on the variance patterns within the subjective data.

Another apparent result lies in the almost complete absence of interaction effects in the analyses of the reaction latencies. Neither need, nor distance, nor definition teamed up in any way to distinctively modify typical performance in either latency or dispersion.

3. Qualitative Conclusions and Suggested Results

Qualitative data by their very nature are more summarily reported in first presentation than are quantitative findings. Therefore to dwell at any length, in summarizing effort, on that which has been already expressed in general and broad terms, would be uncalled for. The qualitative findings were reported in section 6 of Part II.

It might be said in drawing conclusions from them that high-need tended to make people anxious and worrisome, and to report feelings of alertness. Low-need seemed to stimulate guess-work and to be associated with what mentions of monotony were reported. Ambiguity of pathways appeared to precipitate reports of anger and irritation, embarrassment and inadequacy, and rationalization.

Remoteness of goals was associated with the theme of resignation as well as a tendency to resort

to mental wandering and escape behavior.

A research differently organized might have stressed the accumulation of more of these kinds of data. They are obviously filled with latent hypotheses.

Another briefly stated suggested conclusion from the qualitative data is that widely varied behavioral manifestations seemed to attend working under unfavorable task alignment and that such subjects, even if they kept their performance on a relatively effective plane, still reported the expected tiredness and often showed behavior quirks as well, such as yawning or reclining.

4. Critical Evaluation of the Experiment

The text of the dissertation has been largely restricted to the information revealed in the course of the experiment. It is apparent however that all work, no matter how impersonally objective, had to begin with the impressions and hypothesizing of the worker. How does the experimenter view the experiment now that it is done? How might a similar assignment be better laid out and executed? What fringe speculations might be made which, being founded on experience, might assist another in exploring this or related areas?

The plan for this summarizing section consists of retracing the experimental sequence from beginning

to end, interpreting, criticizing, and suggesting on the basis of what has been done. This review will depart from compulsive objectivity wherever such a course of action is called for.

The demands of the theoretical issues to be tested, the contrast between fatigue and impairment, called for the use of a task which would necessitate little physical exertion, yet the feasibility of tiring as a result of the work had to be present.

The task had to provide opportunity for the breakdown of integrated behavior. It had to be impersonalized, i.e. not be adapted to any individual's unique need system. It had to avoid pure and simple repetition such as has characterized the elicitation of satiation and boredom. The task as described in this dissertation fulfilled these requirements quite well.

The utilization of one subject at a time was a function of the experimenter's conceptualization of the mechanics of the task. Conspicuously, it is conceivable that a task might be constructed which could be performed by a number of subjects simultaneously. Receiving the same instructional sets, they could readily compose the membership of an entire experimental group, for example, high-near-clear. In this way a larger N could be achieved, but a competitive

element would also be added to the list of independent variables.

The instrumentation of the experiment is an area which provides many opportunities for recommendation and warning.

The use of visual targets, presented bradyscopically, proved quite successful. The particular targets used were easy to learn and to respond to. The use of motion picture film with stimulus-indicating V's cut into the sound track was likewise very effective. No more than half a dozen times in 12,800 did the apparatus fail to record the presentation of the stimulus.

The use of an endless film loop to permit the repetitive and unbroken presentation of a lengthy sequence proved in and of itself very appropriate, but the proper construction of a film loop is a precise matter which can be the source of problems. The Bell and Howell sixteen millimeter projector is particularly suited to the adaptation of an inexpensive magazine. The size of the free loop, that portion of the film which is not tightly wrapped around the single spool from which and back onto which the film leads, is determined by the make of the machine and should be carefully studied, for while an insufficient loop draws tight and can tear the film, an excessive

loop can dangle uncontrolledly and do damage to the film.

The throat microphone as an agent for initiating the response is much preferable to a crystal microphone, although it requires bolstered impedance before it can be fed into the normal amplification system. In the experiment reported in this dissertation, the carbon microphone performed the task required of it 99.2 times per one hundred responses.

The tiredness reporter proved an inadequate way of getting at subjective tiredness evaluations. The idea, adapted from the Classroom Reporter, used in Pennsylvania State University research, was that the subject would be able to make a discriminating response with a minimum of effort, without driving his attended task from the center of his behavioral field. To make this idea work satisfactorily, in the opinion of the present writer, would require no more than the arrangement of a "forced response" context. In a free-response context, such as was employed in the present research, the frequency of response varied from many per subject to virtually none, thereby giving a partial and inadequate picture.

Nothing in the present research furnishes any direct information as to the fatigue-delivering potency of the five elements of the conceptual design

which were intentionally played down, or turned into constants, for the sake of this experiment.

In the life-situation of a typical fatigue victim the behavior-determining factors fluctuate freely. People pursue goals on the basis of pressing and persistent needs which have been with them so long as to have become integrated parts of their personalities. They may need to achieve in an area in which they are physically unable to measure up to the task. Other people may hold the jobs they want, so that they may be blocked by factors over which they exert no control. They may work from day to day on a job which is so simple and meaningless to them as to fit nowhere in any of their larger schemes. It is not out of the realm of the possible that the goals of their daily behaviors may be so poorly defined that they never experience, occupationally at least, a clear-cut goal achievement.

In this research, its purpose being the demonstration of situationally-perpetrated tiredness, the variation of the above factors might well have thoroughly confounded the results and would have served no meaningful purpose anyway. In a clinically or industrially centered case of fatigue they could well be the variables of greatest importance.

The 2x2x2 factorial design by way of which the central hypotheses were tested was adequate to the task. Upon mathematical counsel, despite the apparent skewnesses of the separate distributions, it was decided that analysis of variance would be a suitable instrument to use.

In critically reviewing the carrying out of the experiment a process of segmentation seems straightforward and clear, hence appropriate.

The selection of a population to be sampled is always important. In this particular experiment the problem was the finding of summer-session courses enrolling a sufficiently large number of students to permit the recruitment of an adequate N even after all of the restrictive conditions governing subject optimity had been met. It is the writer's opinion that although age and sex factors were controlled in the research, failure to control them would have spelled no serious difference.

One thing to be underscored about the recruitment of subjects for this kind of task is the wariness with which one should approach the notion of acquiring subjects by compulsion. The need factor is the source of enough uncertainty without confounding the picture further by the inclusion of subjects with very low needs, or even negativistic attitudes.

It is worthy of note that the large clear-cut F-ratios obtained in this research came from data provided by only thirty-two subjects. A larger N would have doubtless been better had the same controls been exercised throughout; but a failure to consider the issues addressed by the five constants in the conceptual design might easily have meant that a much larger N than thirty-two would have been unable to produce ratios of similar significance. This experiment seems to point up the value of carefully controlling suspected sources of variance even though one has not systematically established the validity of each as a behavior-conditioner.

It is well to have a reserve of subjects for one's best laid plans often go awry. Thirty-five students participated as subjects whereas the data from thirty-two were all that were ultimately used.

One subject was excluded because the film loop broke in his experimental run and the attempted substitution of another print was so inadequately performed that the records became badly garbled.

Two others were excluded because of manifest failure to achieve the low-need set. One of them, with whom the experimenter had accidentally lunched several days before, confided to friends that he had never before "sat that close to a psychiatrist".

The other presented himself frequently to the experimenter over a four or five day period in "counsel-seeking" roles. These young men were so conspicuously energized that to represent their performances as characterizing the effects of low-need, would have been wholly misleading. They were, by way of such reasoning, excluded and their data were never measured nor analyzed.

Central to the methodology of the experiment was the creation of the situations under which each subject worked. The procedure employed worked very well and, even upon pointed interrogation, only one subject admitted that he had momentarily speculated about the sincerity of the work orientation presented to him.

The subject's written Post-experimental Report is an area where more thoughtful work might profitably have been done. Some of the factors which cropped out in the essay portion of the report, e.g. embarrassment and confusion, might profitably have been represented along continua as were the first four questions of the Post-experimental Report. This would have made it possible to give them a more quantified checking.

It was observed in the main portion of the dissertation that, if the post-experimental contacts

had been careless and loose, the experiment might have been robbed of its validity. If even a small part of a not-too-large experimental population had been given reason to think that the experiment was going to be other than as it was being represented to them, it is probable that variables such as those employed in this experiment would have lost their efficacy. In the judgment of the writer this problem was satisfactorily met.

The problems faced in measuring the obtained data were not insurmountable as managed by the procedures followed by the experimenter; however, there are some issues which if pointed up, could improve the performance of any wishing to set up similar research.

At four hundred responses per subject, plus one hundred responses per trial run for each subject, sixteen thousand response latencies had to be measured to the nearest observed millimeter. The frailities of lighting, the tediousness of such close work, the sheer weight of numbers and the oppressive tiredness which can attend such a task, made of the human measuring element probably the largest single source of error in the gathering of the data. In an effort to avoid confusion and inconsistency, the experimenter made all of these measurements himself, never doing more at a single sitting than his sense of adequacy indicated.

Instrumentation by means of which this human measuring element could be eliminated would have improved the research.

It has already been mentioned that skewness, if not too extreme, represents no practical bar to the use of the analysis of variance procedure. Satisfactory and clear-cut findings were obtained in this research from the relatively small N of thirty-two.

The reader should keep in mind that this feature is very possibly traceable to the stablizing influence of the five constants described earlier.

In section 6 of Part II it was observed that submitting the introspective ratings of the tiringness of the task to analysis of variance revealed one significant interaction in which remoteness of goal and ambiguity of pathways interacted to make the task seem more tiring. Conservative statistical practice consists in employing a significant interaction F-ratio as the error term for the ratios attributed to the single variables contained in the interaction. To follow this practice would throw open to doubt the one percent level significance of distance and definition as conditioners of the subject's responses to question four; viz. "If you were to rate this task as to its ability to produce feelings of fatigue or tiredness, where would you place it on the following

eleven point scale?"

5. Concluding Remarks

Recalling the provisions set forth in the first pages of this dissertation, it may be seen in retrospect that the task asked of the subjects in this fatigue experiment was not physically impairing, that the opportunity for behavioral disorganization was present, and that the conceptual design employed was in line with "holistic" or "over-all" notions of the organism and its motivation.

While the writer early asserted that this dissertation did not represent an effort to defend the manifold nuances unfolded in Fatigue and Impairment in Man, it has brought pointed evidence to bear on several of the issues prominently displayed in that book. Some examples follow.

Assuming the validity of operationally defining fatigue as 1) reportable feelings of tiredness, and 2) impoverished performance as indicated by increased reaction time and variance, it is possible to measure fatigue without measuring impairment.

This is not to say that small differences in energy expenditure did not occur from subject to subject in their runs through the five hundred responses, but, since the externally-observable vocal

work done from subject to subject varied so little, it would appear fantastic to attribute the large ensuing introspective and behavioral differences to this source. In any event so little energy was utilized in this task as to fall far short of the thresholds implied by the concept of impairment. This virtual independence of energy expenditure is another of Bartley's contentions.

The hypothesized conflictual nature of fatigue seems to receive some support when one considers manipulation of any of the eight elements of the conceptual design as a way of obstructing or facilitating ready goal achievement.

Little evidence was found which would cause one to identify the concepts of boredom and fatigue. Only four subjects mentioned "boringness" in their reports. Only one subject attributed his tiredness to the "boring" task, whereas most of the subjects spoke in terms of excitement, curiosity, interest, and on-going speculation. If they became tired it was attributed to late hours, excessive work, ROTC, or some other energy-consuming prior activity.

The reader will recall that, according to Bartley, the characteristic of boredom is the attributing of the individual's felt tiredness to the nature of the task being performed.

Bartley shows a great unwillingness to permit fatigue to be defined in terms of the context in which it arose. One of the quotations from Fatigue and Impairment in Man cited early in this dissertation objects to such terminological undergrowth as "mental fatigue, nervous fatigue, combat fatigue, convoy fatigue, etc."

In the opinion of the writer, the present work, i.e. that which is reported herein, can be seen to sharpen up and clarify this principle. It is not so much that a term like "convoy fatigue" is illicit in and of itself so much as the fact that it is unparsimoniously specific. What is needed is an abstract conceptual vehicle, rich enough to describe the essential tiring elements in many different life situations without necessitating the departure of the experimenter from semi-particularized terms. On the basis of such a modus operandi many superficially different cases are seen to have much in common.

The writer suspects that the variables specified in the eight factor conceptual design are capable of performing such a role. The fact that fatigue, defined as it has been in the context of this thesis, has proven manipulable by the systematic variation of need, distance, and definition causes this writer to envision the eventual systematic

working-out of most of the situational variables to which one responds by way of fatigue reactions.

Drawing the significant findings of this research into a few summarizing paragraphs is the goal of that which lies beyond this point.

The experimental picture was one of thirty-two different subjects contributing to a single pool their performances and experiences relative to a task situation common to all. In terms of overt behavior each subject did essentially the same task and no subject was given the opportunity to exert himself materially more than another.

The extent to which the subjects faced different task situations lay in factors which tended to orientate various experimental groups differently to the common task.

The concepts of need, mediation, and goal were ramified so as to bring into focus eight different variables, the variation of any one of which would alter the motivation of the performing individual.

Three of these, the strength of one's need to perform the task, how well the pathways to the goal were understood, and how far it was in time and energy expenditure to the goal, were played in the roles of variables. The others were made into constants to the limits imposed by their own natures and the imagination

of the experimenter.

Subsequent gathering and analyzing of data showed that need intensity significantly affected perceived tiredness but that it had no effect on speed or variance of performance.

Knowledge of pathways produced significant effects on both perceived tiredness and performance. Distance, or the expected cost of the labor to the organism, materially affected both felt-tiredness and performance indices.

There was a noteworthy lack of interaction between the independent variables as conditioners of behavior and felt tiredness.

Qualitative data and conclusions of a less general nature have been reported earlier.

It is as though the conclusions might finally be stated in this manner. An individual's fatigue as measured in terms of feelings and performance can be seen as a function of his orientation to his task, quite independent of the absolute amount of energy utilized in the carrying out of this task.

The concomitant manipulation of three such organizational principles as those used as main sources of variance in this research is only a beginning. These, plus some of the factors played as constants in this experiment, plus others yet unspecified, may

prove capable of spelling out the broad origins of fatigue as a crippling and inhibiting experience and a debilitator of efficient behavior.

FOOTNOTES

[1]Bartley, S. H. and E. Chute. Fatigue and Impairment in Man. 1st ed. New York: McGraw-Hill Company, Inc. 1947, pp. ix + 429.

[2]Ibid., p. 1.

[3]Ibid., p. 1.

[4]Ibid., p. 2.

[5]Ibid., p. vii.

[6]Ibid., pp. 53-56.

[7]Lewin, K. Principles of Topological Psychology. 1st ed. New York: McGraw-Hill Book Company, Inc. 1936, pp. ix + 231.

Lewin, K. Field Theory in Social Science. ed. by D. Cartwright. New York: Harper and Brothers. 1951, pp. xx + 346.

[8]Barker, R. G., J. S. Kounin, and H. F. Wright. Viewpoints on Science and the Psychology of Motivation. Unpublished manual. Copyright 1942 by R. G. Barker. 47 numb. leaves. 18 figures.

[9]Muscio, B. Is a fatigue test possible? Brit. J. Psychol. 12 (1921-22) pp. 31-46.

[10]Floyd, W. F. and Welford, A. T., Editors. Symposium on Fatigue. London: H. K. Lewis and Co. Ltd. 1953, pp. viii + 196.

[11]Dodge, R. The laws of relative fatigue. Psychol. Rev. 24 (1917) pp. 89-113.

[12]Bills, A. G. Blocking: A new principle of mental fatigue. Am. J. Psychol. 43 (1931) pp. 230-245.

Footnotes (con-)

[13]Baker, K. H. Pre-experimental set in distraction experiments. J. Gen. Psychol. 16 (1937) pp. 471-488.

[14]Krueger, W. C. F. The influence of amount limits and time limits upon the rate of work. J. Appl. Psychol. 21 (1937) pp. 113-118.

[15]Floyd and Wolford. op. cit. pp. 143-149.

[16]Barmack, J. E. The effect of benzedrine sulfate (benzyl methyl carbinamine) upon the report of boredom and other factors. J. Psychol. 5 (1938) pp. 125-133.

[17]Wyatt, S., J. A. Fraser, and F. G. L. Stock. The effects of monotony on work. Industrial Fatigue Research Board. Rept. 56 (1929).

[18]Cassel, E. E. and K. M. Dallenbach. The effect of auditory distraction upon the sensory reaction. Am. J. Psychol. 29 (1918) pp. 129-143.

[19]Bartley. op. cit. p. 43.

[20]Floyd and Wolford. op. cit. p. 1.

[21]Ibid., p. 43.

[22]Eckman et. al. Editors. Essays in Psychology. D. Katz Uppsala: Almqvist and Wiksells. 1951, pp. 65-71.

[23]Carmichael, L., J. L. Kennedy, and L. C. Mead. Some recent approaches to the experimental study of fatigue. Science. (1949) pp. 110-445. Abstract.

[24]Shands, H. C. and J. E. Finesinger. A note on the significance of fatigue. Psychosomatic Medicine. 14 (1952) pp. 309-314.

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3. Barmack, J. E. The effect of benzedrine sulfate (benzyl methyl carbinamine) upon the report of boredom and other factors. J. Psychol. 5 (1938) pp. 125-133.

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