THE EFFECT OF TWO DIFFERENT STRESS SITUATIONS ON THE PERFORMANCE AND LEARNING OF A PURSUIT ROTOR TASK

by

Howard Allan Wenger

B.P.E., University of British Columbia, 1967

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PHYSICAL EDUCATION in the School of Physical Education and Recreation

We accept this thesis as conforming to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA
August, 1969
In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the Head of my Department or by his representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of Physical Education

The University of British Columbia
Vancouver 8, Canada

Date August 31, 1969

Please forward thesis receipt to:

Thank you.
ABSTRACT

Thirty volunteer subjects were given thirty trials on the pursuit rotor. Twenty trials were given on one day and ten further trials were given approximately twenty-four hours later. The subjects were randomly assigned to one of three groups: 1) the directed stress group; 2) the non-directed stress group; and 3) the control group. Shock and instructions were used to induce the stress in the two stress groups. The instructions to the directed stress group were assumed to have directed the subjects' attention toward the pursuit rotor task, while the instructions to the non-directed stress group were not designed to give direction to their attention. The results showed that there was no difference in performance due to either stress condition when compared to the control group. However, when tested twenty-four hours later, both stress groups showed significant improvements in learning over the control group. There was no significant difference in learning between the two stress groups.
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. STATEMENT OF THE PROBLEM</td>
<td>1</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>The Problem</td>
<td>6</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>7</td>
</tr>
<tr>
<td>Theoretical Expectations</td>
<td>8</td>
</tr>
<tr>
<td>Limitations of the Study</td>
<td>9</td>
</tr>
<tr>
<td>Delimitations of the Study</td>
<td>9</td>
</tr>
<tr>
<td>References</td>
<td>11</td>
</tr>
<tr>
<td>II. REVIEW OF THE LITERATURE</td>
<td>12</td>
</tr>
<tr>
<td>Some General Theories of Behavior</td>
<td>12</td>
</tr>
<tr>
<td>The Effects of Stress on Verbal Tasks</td>
<td>17</td>
</tr>
<tr>
<td>Non-Directed Stress and the Performance of Motor Tasks</td>
<td>18</td>
</tr>
<tr>
<td>Directed Stress and the Performance of a Motor Task</td>
<td>20</td>
</tr>
<tr>
<td>Transfer of Stress Effects to Post Stress Performance</td>
<td>20</td>
</tr>
<tr>
<td>Directed and Non-Directed Stress and the Learning of a Motor Task</td>
<td>21</td>
</tr>
<tr>
<td>References</td>
<td>22</td>
</tr>
<tr>
<td>III. METHODS AND PROCEDURES</td>
<td>24</td>
</tr>
<tr>
<td>Subjects</td>
<td>24</td>
</tr>
<tr>
<td>Experimental Design</td>
<td>24</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>PAGE</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Apparatus</td>
<td>28</td>
</tr>
<tr>
<td>Procedures</td>
<td>30</td>
</tr>
<tr>
<td>Statistical Analysis</td>
<td>33</td>
</tr>
<tr>
<td>References</td>
<td>35</td>
</tr>
<tr>
<td>IV. RESULTS AND DISCUSSION</td>
<td>36</td>
</tr>
<tr>
<td>Results</td>
<td>36</td>
</tr>
<tr>
<td>Discussion</td>
<td>46</td>
</tr>
<tr>
<td>References</td>
<td>53</td>
</tr>
<tr>
<td>V. SUMMARY AND CONCLUSIONS</td>
<td>54</td>
</tr>
<tr>
<td>Recommendations</td>
<td>55</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>56</td>
</tr>
<tr>
<td>APPENDIX A Statistical Treatments</td>
<td>61</td>
</tr>
<tr>
<td>APPENDIX B Raw Data</td>
<td>62</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Summary of Experimental Design</td>
<td>25</td>
</tr>
<tr>
<td>II. A Comparison of the Group Means and Standard Deviations for the Various Conditions</td>
<td>37</td>
</tr>
<tr>
<td>III. Analysis of Variance for the Initial Scores</td>
<td>38</td>
</tr>
<tr>
<td>IV. Analysis of Variance for the Performance Scores</td>
<td>40</td>
</tr>
<tr>
<td>V. Analysis of Variance for Transfer Scores</td>
<td>42</td>
</tr>
<tr>
<td>VI. Analysis of Variance for Learning Scores One (LS1)</td>
<td>44</td>
</tr>
<tr>
<td>VII. Analysis of Variance for Learning Score Two (LS2)</td>
<td>44</td>
</tr>
<tr>
<td>VIII. t-Tests for Differences Between Groups in Learning Scores</td>
<td>46</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

FIGURE

1. The Apparatus . . . . . . . . . . . . 29

LIST OF GRAPHS

GRAPH

I. Mean Initial Scores For All Three Groups . . 39
II. Mean Performance Scores For All Three Groups 41
III. Mean Final Scores For All Three Groups . . 43
IV. Mean Scores For All Groups Over All The
   Trials . . . . . . . . . . . . . . . . . 45
ACKNOWLEDGEMENT

William Thackery said "Next to excellence is the appreciation of it." The guidance and assistance which I received from my committee members was excellent and I appreciated it very much. I would like to thank Dr. S.R. Brown, Dr. S.S. Lee, Mr. A. Bakogeorge, Mr. N. Korchinsky, and especially Dr. R.G. Marteniuk, my committee chairman, for their many hours of time and effort.

I would also like to thank my classmates who made this my most enjoyable year yet.

A very special thank you to my wife, Janet, whose devotion and inspiration made this possible.
CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

To fully understand the implications of the present problem, an introduction to some of the basic constructs of human behavior and motivation (or drive) is necessary. The following approach was thought to best develop the theoretical framework involved in this thesis.

Hull (1:133), in an attempt to explain behavior, developed a theory based upon the premise that all behavior involves stimulus-response connections. A response is never simply emitted; it is always a response to a stimulus. Hull utilized mathematical equations to describe behavior patterns. He linked the independent variables to the dependent variables via intervening variables such as habit strength (sHr), drive (D), and incentive motivation (K). Within this framework, he stated that the product of habit strength (sHr), drive (D) and incentive motivation was equal to the reaction potential of the individual or, in other words, the product of sHr x D x K was the total tendency of the organism to make a given response to a given stimulus. Thus according to Hullian theory, the response or performance would be facilitated by a high drive (D) if the correct habit
strength was strong. However, if the habit strength was weak and thus there were competing responses, performance would be hindered by a high drive level.

Spence (2:77) modified Hull's theory by clarifying the status of incentive motivation (K). Spence stated that there was a bodily process related to incentive motivation and that incentive motivation served to produce a response which is reinforcing. For Hull (1), K was related to the stimulus-response connection; however, Spence has related K purely to the stimulus. Thus the incentive component (K) in the equation $sHr \times D \times K$ was not the incentive for making a response but rather for getting to certain stimuli. By relating K to the stimulus, Spence clarified the quantitative relationship between habit strength ($sHr$) and reinforcement, stating that habit strength increased whenever a response was made in the presence of a certain stimulus. Thus the habit strength ($sHr$) depends only upon practice, not upon reinforcement. Spence further altered Hullian theory by making incentive motivation (K) an additive element and thus $sE_r = H(D+K)$ and behavior could then still occur in the absence of either drive (D) or incentive motivation (K).

Hullian and Spencian theory in recent years, however, have not been readily accepted as valid explanations of human behavior. One reason was an apparent neglect concerning the role that attention played in
determining behavior. In this respect, Duffy (3:5) developed a two-dimensional hypothesis of behavior, which suggested that there were two basic aspects in which behavior showed variation: direction and intensity. The construct of behavioral direction was derived from the fact that behavior characteristically shows selectivity. An organism may approach or withdraw from a stimulus situation, and this approach or withdrawal was conceived to be basically goal-oriented. By inclusion of this directional factor into a behavioral theory, Duffy has described the role of direction as a determinant of behavior. Her second component of behavior, intensity, was derived from and emphasizes the fact that a living organism is characteristically an energy system. Activity of all types, whether covert or overt, requires the release of energy and hence the concept of intensity, or more correctly activation level, was concerned with the amount of potential energy released. According to Duffy (3:3), such concepts as drives, stress, and motivation are analogous to activation. Some ways in which the activation level has been measured are: (a) tension level in the muscle by grip pressure, point pressure, changes in thickness, or an electromyogram (E.M.G.); (b) Galvanic Skin response (G.S.R.); and (c) an electroencephalogram (E.E.G.).

Activation itself has appeared to affect the speed, the intensity, and the coordination of responses. In
general, the optimal degree of activation has appeared to be a moderate one, and the curve that has expressed the relationship between activation and level of performance has been theorized to be an inverted "U" when the direction of behavior has been controlled (3:8). Duffy (3:193) suggested that "Perhaps certain features of the directional aspect of behavior interact with the arousal aspect in determining the outcomes." For example, a clearly defined goal might be conducive to the organization of responses while conflicting goals could lead to disruption. Ryan (4) stated that the effect of any given degree of activation upon performance has appeared to vary with such factors as the nature of the task to be performed and the ability of different individuals to inhibit and coordinate responses under a high degree of activation.

Eason and Branks (5), while testing Duffy's two-dimensional hypothesis, stated that recent literature has indicated that muscle tension level reflects the amount of effort exerted during the performance of a task and at the same time has indicated activation level. Further, they stated that whether tension level would correlate positively or negatively with performance level on a given task was dependent upon the factor or factors responsible for the change in the activation level. For example, if an increase in activation level was produced by factors extraneous to the task in which performance was being
measured, then the resultant increase in tension may correlate negatively with the performance on that task; but if the increased activation level reflected a greater degree of concentration on the task at hand, then tension level may correlate positively with performance. Eason (10), however, showed that an exception to this might be expected when one was already performing at his maximal skill level and then a decrement in performance might occur.

Klein (6) and Freeman (7) suggested that for every task there might exist optimum tension levels above or below which performance would be impaired and that the level of performance (Klein) in skilled motor tasks was dependent upon the extent to which the performer manifested these optimal levels on any given occasion.

Duffy (3), as mentioned earlier, has stressed that all variations in behavior have two aspects, i.e. behavior varies in both direction and intensity. Thus one could not tell from changes in activation alone whether the performance on a given task has improved or deteriorated, since performance level is also dependent upon the direction of one's behavioral activity at the time.

Most studies dealing with activation and motor skills have been concerned with performance which Singer (8:3) has defined as a temporary change in behavior due to many variables. These studies (4, 9, 10) have shown that
increased activation, within certain limits, improved motor performance. There has been the tendency, though, to study performance as a unidimensional construct, i.e. to only vary the intensity level and to ignore the dimension of direction as postulated in Duffy's theory. Thus it has not been clearly established whether changes in performance were due to changes in activation, to changes in the direction of behavior, or to simultaneous changes in both of these variables.

In contrast to those studies that have investigated the effect that activation has had on performance level, relatively few studies (4, 11) have been concerned with the problem of the effects that activation has had on learning a motor task. The study of learning, unlike that of performance, is concerned with the relatively permanent change in behavior due to past experience (10:3). The influence that certain variables (e.g. fatigue, knowledge of results) have on performance may only be temporary in nature and because of this, to determine the effects that these variables have on learning, time must be interpolated between a performance test and a test for learning.

The Problem

Since Duffy (3:193) has suggested that direction of behavior and the level of activation interact to determine performance level, this study endeavored to determine if the direction of behavior affected performance and learning
under an induced level of activation. For purposes of this study it was assumed that the induced activation level was synonymous with the stress produced by a situation involving application of electric shock (refer to Duffy (3:3)). Thus the problems studied were:

1. To determine the effects that stress, designed to direct the subjects' attention to the demands of the task, had on the motor performance and learning of that task.

2. To determine the effects that stress, designed only to activate the subjects while not necessarily directing their attention to the motor task, had on the motor performance and learning of that task.

Subsidiary Problem. A secondary problem consisted of determining if the effects produced by a stressful situation would affect performance immediately following that situation.

Definition of Terms

Activation. "... the extent of release of potential energy stored in the tissues of the organism, as this is shown in activity or response" (3:17). There was no attempt made to measure activation level in this study but the increased activation was assumed to be analogous to the stress created by shock and instructions.

Performance. "... a temporary change in behavior, fluctuating from time to time because of many potentially
operating variables" (8:3).

**Learning.** "... a relatively permanent change in behavior due to past experience" (8:3). In this study, to differentiate between performance scores (temporary) and learning scores (more permanent), such factors as motivation and fatigue, which can temporarily effect performance, were controlled. The learning scores were the difference between the scores on day two minus the initial scores on day one.

**Stress.** In this study, stress refers to the stress created by the electric shock and instructions.

**Directed stress.** One stress group had their attention directed toward the task through verbal instructions by the experimenter.

**Non-directed stress.** The other stress group's attention was not purposefully directed toward the task.

**Theoretical Expectations**

1. (a) Directed stress will facilitate performance on the motor task because the subject's attention will be directed towards making the correct response.

(b) Non-directed stress will impair the performance on the motor task because the subject's attention will have no direction and hence there will be competition between responses.

2. (a) There is an absence of literature regarding the effect of directed stress on the learning of a
motor task. However, it might be expected that learning will be facilitated due to the emphasis on the correct response.

(b) Ryan (4) and Carron and Morford (11) have indicated that non-directed stress will show no effect on the learning of a motor task.

Limitations of the Study

1. Thirty volunteer undergraduate physical education students were used as subjects.
2. Only right-handed, naive subjects were used.
3. Each subject was tested on two consecutive days but there was no attempt to control the subjects' activities during the intervening interval.
4. The stress level was subjectively controlled by the experimenter through adjustments to the voltage output of the shocking apparatus.
5. Direction was given to the subjects verbally by the experimenter.
6. Stress was operationally defined as the combined effects resulting from the placement of the shock electrodes, the receiving of electric shock, and the instructions from the experimenter.

Delimitations of the Study

1. The only motor skill sampled was the pursuit rotor tracking skill.
2. Although important learning effects may have occurred after the practice sessions provided by this study, the investigation of the permanence of learning was delimited to approximately twenty-four hours.
REFERENCES


CHAPTER II

REVIEW OF THE LITERATURE

The literature has been reviewed under the following six headings: 1) some general theories of behavior; 2) the effects of stress on verbal tasks; 3) the effects of non-directed stress on the performance of a motor task; 4) the effects of directed stress on the performance of a motor task; 5) the transfer of stress effects to post-stress performance; and 6) the effects of directed and non-directed stress on the learning of a motor task.

Some General Theories of Behavior

There are three general theories of behavior related to this study as regards the effects of stress on motor performance and learning: a) the stimulus-response theory of behavior; b) Duffy's (1) two-dimensional theory of behavior; and c) Leuba's (2) theory of optimal stimulation.

The stimulus-response theorists have been concerned with functional relationships between different stimuli and responses. Their attention has been directed toward observable events and they tend to ignore information processing and cognitive functions. Clarke Hull (3), mentioned in Chapter I, originated stimulus-response theory. He considered three kinds of variables: 1) input or stimuli; 2) intervening variables; and 3) outputs or
responses. Thus the intervening variables made the link between the stimulus and the response. He listed three intervening variables, incentive motivation (K), drive (D), and habit strength (sHr). Incentive motivation (K) to Hull was a function of the amount of reward. Drive (D) was a function of deprivation and habit strength (sHr) was a function of the number of reinforced trials. The product of the intervening variables (i.e. sHr x D x K) was hypothesized to equal the reaction potential of the individual or the individual's tendency to respond. Hull also postulated the existence of another motivational construct, inhibitory potential (sIr). This element acted as a deterrent or negative motivation and subtracts from the reaction potential (sEr) to give the net reaction potential (sEr). The inhibitory potential (sIr) was the product of reactive inhibition (Ir) which was analogous to fatigue and conditioned inhibition (sIr). Whatever was associated with the dissipitation of reactive inhibition (Ir) (usually rest) becomes conditioned to its stimulus and a negative habit forms--this was conditioned inhibition. The difference between the reaction potential (sEr) and the inhibitory potential (sIr) equalled the net reaction potential (sEr). Thus in Hull's theory, excitatory and inhibitory factors were balanced against each other in the determination of behavior.

Spence (4) as mentioned in Chapter 1, made three
important changes in Hullian theory. Firstly, he changed habit strength \( (s_{HR}) \) to a function of the number of trials instead of the number of reinforced trials. This change eliminated the dependence of learning on the presence of reward and drive reduction. Secondly, but in conjunction with the first change, he incorporated more fully the motivational construct of incentive \((K)\) into his theory. He associated incentive motivation \((K)\) with the stimulus so that it was not the incentive for making the response but rather it was the incentive for getting to certain stimuli. This clarified the relationship between habit strength \((s_{HR})\) and incentive motivation in that habits could be strengthened with just practice and in the absence of reward. Thirdly, Spence changed \(K\) to an additive rather than a multiplicative element in determining the reaction potential \((s_{ER})\). Whereas Hull's system had \(s_{ER} = s_{HR} \times D \times K\), Spence advocated that \(s_{ER} = H(D+K)\). Thus in Spencerian theory, behavior could still occur in the absence of either drive \((D)\) or incentive motivation \((K)\).

Dollard and Miller (5:179) described motivation within the stimulus-response theory as primary and secondary drives. The primary drives being innate or unlearned while secondary drives were learned ones. The primary drives were powerful stimuli which impelled the organism to respond until the stimulation was reduced. They
activated behavior but did not initially direct the activity; direction was later achieved through learning.

Duffy (1:5) stated that observation of behavior suggested that there were only two basic respects in which behavior showed variation. These were direction and intensity. An organism might approach or withdraw from a stimulus situation, and this approach or withdrawal might take place at any one of many possible degrees of intensity. While there were many objects, persons, and situations, and many aspects of all these which might be approached or withdrawn from, the behavior of the organism could always be described as approach or withdrawal with respect to some condition of the environment. This characteristic of behavior was designated as the direction of behavior. The behavior of the organism might also be described as occurring always with some particular degree of intensity. Approach or withdrawal could occur, for example, at a low degree of intensity, at a high degree of intensity, or at an intermediate degree of intensity. For most purposes, a concept of intensity based upon the measurement of internal processes appeared to be a more useful psychological construct than a concept based on the force of overt responses. Such a concept (i.e. the degree of energy release within the organism), is referred to as the level of activation or the degree of arousal. Duffy's activation level was described as a condition conceived to vary in a
continuum from a low point in deep sleep to a high point in extreme effort or intense excitement. Duffy (1:16) has attempted to incorporate "drives," "tensions," "stress," "motives," "emotions," and "libido" etc. into her dual concept of activation and direction. Because the living organism has been thought of as an energy-system, and because attending and thinking, as well as locomotion and manipulation, can be shown to involve increased release of energy, Duffy has developed her theory of activation as a direct measure of this internal release of energy. Some of the ways in which the activation level has been measured were mentioned in Chapter I. Duffy (1:10) stated that integration or coordination of behavior seem less likely to be maintained when the degree of activation was very low or very high.

Leuba (2:29) stated that the organism has a tendency to acquire those reactions which, when overall stimulation was low, were accompanied by increasing stimulation and when overall stimulation was high, to acquire those which were accompanied by decreasing stimulation. In other words, the organism seeks to maintain an optimal stimulation level. Leuba (2:30) has said if we assumed that changes from either minimal or excessive stimulation toward an optimal level tended to be experienced as more satisfying and pleasant than those involved with changes in the opposite direction, then the concept of optimal stimulation could
be stated in familiar subjective terms. Agreeable reactions could be said to gain priority over less pleasant ones. Leuba (2:32) concluded that "learning may occur best when stimulation is strong enough to provide maximum reinforcement but not strong enough to be disruptive."

The Effects of Stress on Verbal Tasks

In the area of paired-associate verbal learning, it has been shown (6, 7, 8, 9) that high-anxious subjects have performed significantly better than low-anxious subjects in tasks where the habit of making the correct response was stronger than the incorrect responses. It has also been shown (6, 7, 8, 9) that high-anxious subjects were inferior to low-anxious subjects on the performance of tasks where the incorrect habits were the strongest.

Lee (10) did a study to determine the effects of stress on the performance of a verbal paired-associates task by high anxious and low anxious subjects. All subjects learned a list of adjective pairs and then they learned a mixed list (5 unchanged pairs from the first list and 5 new pairs and 5 pairs from the first list with changed partners). Half of each group received shock in the inter-trial interval, while the other half received no shock. It was found that when the dominant habit was correct, a high drive level improved the performance; however, when the dominant habit was incorrect, the high drive level impaired the performance.
Non-Directed Stress and the Performance of Motor Tasks

Within Hull's theory of learning and performance, habit strength (sHr) and drive (D) jointly determined behavior. Thus if drive (stress) level was high and the correct habit strength was strong, performance would be better than if the drive level was high and the correct habit strength was weak.

In a study to substantiate the above, Carron (11) used a stabilometer balancing task and induced stress (through the threat of shock) early in practice when the strength of the correct habit had not been built up and hence incorrect responses were being made. The stress was also induced late in practice in another group when the correct habit should have been strengthened. He found that the stress early condition caused a high anxious group (as measured by the Taylor Manifest Anxiety Scale) to perform inferiorly to a low anxious group. This suggested that competition between correct and incorrect habits when coupled with a high activation level (in the high anxious group), would impair performance. With shock induced stress late in practice, there was a decrement in performance for both high and low anxious groups. This part of the experiment did not substantiate Hullian theory because the correct habit should have been strong enough late in practice and thus, in combination with high stress, should have facilitated performance. However, it is
possible that the amount of practice was insufficient to strengthen the correct habit to the extent that performance would have been improved. This impairment effect could also have been caused by the fact that the activation (stress) was non-directed (by random shocking) and thus tended to create competition between responses, i.e. shock avoidance vs. performance.

Adams (12), in an attempt to verify the phenomena of performance facilitation (or impairment) as a function of the amount of experimentally induced tension, did not show any difference between three different tension groups. The tension was induced through the subject's holding down a required weight with their foot while performing a two-hand matching test. His results could have been due to the physical maintenance of tension level causing a distraction and this could have taken the subject's attention away from the task at hand.

Ryan (13) in an attempt to show the effect of shock induced stress on the performance of a simple motor task and a complex motor task, found that stress impaired performance when there were many competing responses (in the complex task). He failed to show that the stress improved performance when there were few competing responses (in the simple task). The application of shock (stress) was random and hence the directional aspect of behavior was not considered.
Farber and Spence (14) showed that on a stylus maze task, which was considered complex, performance of anxious subjects was significantly poorer than that of non-anxious subjects with the most difficult points of choice providing the greatest difference between the two groups. They stated that the effects of variations in drive level upon performance was a function of specific characteristics of the given task. Anxiety level was hypothesized by Duffy to be analogous with activation level (1:3).

Directed Stress and the Performance of a Motor Task

Eason and Branks (15) adjusted the level of activation by offering different incentives for good performance. A uniform activation level in each incentive condition was measured by an electromyogram (E.M.G.) and only the direction of behavior was changed. This direction was manipulated by directing the attention of the subjects to one of two tasks (one verbal, the other motor) being performed simultaneously. They showed that performance level was dependent upon the direction of attention as well as the level of activation. Because the two tasks were being performed simultaneously, their results could have been explained by the directional aspect solely and do not necessarily involve the activation level.

Transfer of Stress Effects to Post Stress Performance

Henry (16), in a study on motivational transfer,
showed that motivation due to administering electric shock (during the period of a reaction or movement that is less complex than the required reaction) can be transferred from a simple task to a more complicated movement. The speed-up or improvement was shown to be transferable, at least within limits, from one type of reaction or movement to another and from one stimulus mode to another. The reaction time and movement time tasks were discrete in nature.

Fairclough (17), in support of Henry (16), showed that motivated improvement in a task involving one part of the body (hand) can transfer to cause a significant improvement in speed in another part of the body (foot). Fairclough utilized discrete types of tasks involving reaction time and movement time of the hands and feet.

**Directed and Non-Directed Stress and the Learning of a Motor Task**

Both Ryan (13) and Carron and Morford (18) failed to show any learning effect resulting from the use of stress while performing a stabilometer balancing task. Their experiment, however, used non-directed shock (random) and also their learning scores were taken from day one and could have failed to eliminate temporary effects due to fatigue and/or motivation.

There has been an absence of literature on the effects of directed stress on the learning of a motor task.
REFERENCES


Subjects

The subjects were thirty volunteer undergraduate students from the School of Physical Education and Recreation at the University of British Columbia in the 1968-1969 academic year. Twelve female and eighteen male subjects were randomly assigned to one of three groups with the restriction that four females and six males had to appear in each group.

Experimental Design

A summary of the experimental design has been presented in Table I.

A three-factor design was used—trials, subjects, and groups—with repeated measurements on the subjects over trials. The twelve female and eighteen male subjects were randomly placed into either (1) a directed stress group or (2) a non-directed stress group, or (3) a control group.

Each subject within each group was given twenty trials on the pursuit rotor on day one and then ten further trials on day two, approximately twenty-four hours later.

Shock was administered to the two stress groups following certain trials from trial six to trial fifteen on day one.
### TABLE I

**SUMMARY OF EXPERIMENTAL DESIGN**

<table>
<thead>
<tr>
<th>GROUPS</th>
<th>Treatment A</th>
<th>Treatment B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial Scores</td>
<td>Performance Scores</td>
</tr>
<tr>
<td>(D.A.) N=10</td>
<td>-5 trials</td>
<td>-10 trials</td>
</tr>
<tr>
<td>DIRECTED</td>
<td>-no treatment</td>
<td>-have been instructed during interval that shock will be applied if perfor-</td>
</tr>
<tr>
<td>STRESS</td>
<td>-instructions to do best</td>
<td>mance is not at least 5% better than best previous performance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-shock administered immediately after trial</td>
</tr>
<tr>
<td>(N.D.A.) N=10</td>
<td>-5 trials</td>
<td>-10 trials</td>
</tr>
<tr>
<td>NON-DIRECTED</td>
<td>-no treatment</td>
<td>-instructed that shock will be random and unavoidable</td>
</tr>
<tr>
<td>STRESS</td>
<td>-instructions to do best</td>
<td>-instructed to do best</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-shock administered immediately after trial</td>
</tr>
<tr>
<td>(C) N=10</td>
<td>-5 trials</td>
<td>-10 trials</td>
</tr>
<tr>
<td>CONTROL GROUP</td>
<td>-no treatment</td>
<td>-no shock</td>
</tr>
<tr>
<td></td>
<td>-instructions to do best</td>
<td>-instructions to do best</td>
</tr>
</tbody>
</table>

- place electrodes on D.A. & N.D.A. groups
- remove electrodes from D.A. & N.D.A. groups

**Initial Scores** (shock condition)

**Performance Scores**

**Transfer Scores**

**Final Scores**

**KEY** - see page 26.
KEY to TABLE I

Initial Score (I.S.) - average of first five trials on day one

Performance Score (P.S.) - average of trials six to fifteen on day one

Transfer Score (T.S.) - average of trials sixteen to twenty on day one

Final Score One (FS1) - average of first five trials on day two

Final Score Two (FS2) - average of last five trials on day two

Learning Score one (LS1) = FS1 - I.S.; Learning Score two (LS2) = FS2 - I.S.
The average of the first five trials on day one, for all subjects, was used as the initial score indicating each subject's initial ability on the pursuit rotor. Trials six to fifteen on day one were used to determine what effects stress had on motor performance and thus were called performance scores. Trials sixteen to twenty on day one were used as transfer scores to determine if, following stress conditions, there was any transfer of the stress effects to immediate post-stress performance. The ten trials on day two were divided into two parts with the average of the first five scores being the first final score ($FS_1$) and the average of the second five scores being used as the second final score ($FS_2$). Two learning scores ($LS_1$ and $LS_2$) for each group were obtained by subtracting the initial score for each group from both of the final scores.

An effort was made to equate the two experimental groups by yoking subjects in the directed stress group with subjects in the non-directed stress group in relation to the number of shocks received, i.e., if subject A in the directed stress group was shocked four times during the shock period, and he was yoked with subject A in the non-directed stress group, then the latter would receive four random shocks.

Attention served as an independent variable in that instructions were given by the experimenter to the two
experimental groups either serving to direct the subject's attention toward the rotary pursuit task or giving no direction to the subject's attention.

In order that fatigue did not influence the results, the practice schedule was distributed with a work/rest ratio of 20 secs./20 secs.

**Apparatus**

**Pursuit Rotor.** This apparatus was made by Lafayette Instrument Co. (Figure 1) and was an electrical turntable mounted on a wooden frame. There were four speeds for the turntable with sixty R.P.M.'s being the speed used in this experiment. A metal disc was inserted in the turntable near the circumference and this disc had an electrical connection to a timer. A metal tipped stylus was connected to the rotor, and when it was in contact with the metal disc a circuit was closed and the timer recorded the time on target. When the stylus was not in contact with the disc, the circuit was open.

**The Timer.** A Klockounter - Model 120A.–made by Hunter Mfg. Co. was employed. It recorded the time on target to 1/100 of a second.

**Constant Current Shocker.** This apparatus was made by the Lafayette Instrument Co. - Model 5226 - and had a constant current usage of 5 milliamperes. Two electrodes were attached to the index finger of the left hand during trials six to fifteen and the shock was administered by
FIGURE 1

THE APPARATUS
the experimenter through flipping a switch.

**Procedures**

The standardized procedures for all subjects were as follows. Each subject was told to stand in front of the apparatus and to face the pursuit rotor. They were then told that it was a rotary pursuit tracking task and to hold the wooden handle of the stylus in the palm of their right hand. They were then instructed that the object was to track the metal disc by keeping the metal stylus in contact with it for as long as possible during each trial and that the timer would record the amount of time spent on target. They were warned not to press too hard on the stylus because it was attached to the handle by a spring mechanism and tracking could be facilitated when the spring was completely stretched. The starting position for the stylus was \(180^\circ\) from the disc. The turntable was started by the experimenter flipping the starting switch. The subjects were instructed to hold the stylus stationary until the disc came around to it, at which time they were to start tracking. At the end of a trial, the experimenter said stop and the subject put the stylus down beside the rotor, turned the turntable off, and then returned the disc to its starting position by rotating the turntable in a clockwise direction. The subject then relaxed until the 'get ready' signal, and proceeded to repeat the whole procedure. After instructing the subjects
in these procedures, all questions were answered until the subjects completely understood the task.

In the interval between the end of the initial score condition (trial 5) and the start of the experimental shock condition (trial 6), the electrodes were attached to the subjects of the two stress groups and they were given differential instructions as to how the shock would be applied (for these instructions refer to pages 32 and 33). The control group, during this same interval, was occupied in conversation. All three groups were then given ten trials.

Following the experimental condition, the electrodes were removed and all subjects were then given five further trials which constituted the transfer scores. Following the twenty trials on day one, the experimental subjects were told that there would be no shock on the following day.

On day two, all subjects were asked if they remembered the procedure and then were given ten final trials.

Any time spent in rest by the directed stress or the non-directed stress groups for the purpose of instructions and placement or removal of electrodes was also given to the control group. During this time, the experimenter conversed with the control subjects to eliminate any possibility of rehearsal. It was assumed that the experimental groups did not rehearse since their attention was directed toward the instructions given by the experimenter.
regarding the shock situation. The question of rehearsal is difficult to assess in this task. It has been shown (1, 2) that in verbal learning tasks, an uninterrupted interval between presentation and recall results in an improved performance due to rehearsal. However, the use of verbal labels in performing a pursuit rotor task has been neither confirmed nor denied. Adams and Dijkstra (3) and Posner (4) have shown that the phenomena of rehearsal does not exist in kinesthetic motor tasks but the rotary pursuit tracking task is not completely kinesthetic in that visual cues are present.

**Directed Stress Group Instructions.** Each subject was instructed that if he improved five percent over his previous best score, he would be able to avoid the shock. However, if the subject did not improve the five percent over his previous best score, he would be shocked immediately following the trial. This five percent figure was determined from a pilot study conducted prior to this experiment.

**Non-Directed Stress Group Instructions.** Each subject was told that following certain trials they would receive an electric shock. The random order of the shock was obtained from a table of random numbers. The number of random shocks given to each subject in the non-directed stress group depended upon the number of shocks their counterpart in the directed stress group, with whom they
were yolked, had received.

**Shock Conditions Common to Both Experimental Groups.** From a pilot study conducted prior to this experiment, it was also determined that no more than three shocks be given in succession to any subject and that the total number of shocks not exceed four. Any shocks in excess of this number were found to be detrimental to good experimental technique. As it turned out, an average of three shocks were given to each subject in the two experimental conditions of the present study. All subjects were given a sample of the shock before the experimental trials to allow the experimenter a chance to subjectively adjust the intensity. The sample shock did not count in the total number of shocks. The intensity of the shock was adjusted subjectively, within the range of 225 to 275 volts, by the experimenter so that similar responses to the shock were obtained from all subjects in the two stress groups. It was hoped that this subjective adjustment would equate the experimental stress level between the directed and non-directed stress groups. The duration of all the shocks was one second for all subjects. The subjects were prevented from seeing the experimenter operate the shock device by a screen situated between the subjects and the device.

**Statistical Analysis**

An analysis of variance was employed to determine
if there were any differences in the day one and the day
two scores, i.e. 1) the initial scores, 2) the performance
scores, 3) the transfer scores, and 4) the learning scores.

If the overall F for between groups was significant,
appropriate t-tests were used (see Appendix A) to deter­
mine the differences between groups. The standard error
of the difference, in this case, was the square root of
the error mean square for the group effect from the analy­
sis of variance, divided by the appropriate degrees of
freedom.
REFERENCES


CHAPTER IV

RESULTS AND DISCUSSION

Results

Probability Levels. For all statistical analyses the probability level was at the 5% level of significance for a two-tailed test.

Comparison of the Three Groups Over all the Conditions. The mean scores and standard deviations for each of the groups in all the conditions are listed in Table II. There were two learning scores determined with the first one (LS1) being the difference between final score one (FS1) (average of trials one to five on day two) and the initial score. The second learning score (LS2) was the difference between the second final score (FS2) (the average of trials six to ten on day two) and the initial score.

A Comparison of the Initial Abilities of the Groups. In order to determine whether the initial abilities of all groups were the same, an analysis of variance was done on the initial scores. There was no significant difference between groups in the initial score as indicated by the nonsignificant F for groups (Table III). The significant F for trials (Table III) indicated that there was a change over the five trials and Graph I shows that this was an
### TABLE II
A COMPARISON OF THE GROUP MEANS AND STANDARD DEVIATIONS FOR THE VARIOUS CONDITIONS

<table>
<thead>
<tr>
<th></th>
<th>Initial Score IS</th>
<th>Performance Score PS</th>
<th>Transfer Score TS</th>
<th>Final Score One FS1</th>
<th>Final Score Two FS2</th>
<th>Learning Score One LS1</th>
<th>Learning Score Two LS2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>4.22</td>
<td>7.36</td>
<td>8.89</td>
<td>10.93</td>
<td>12.22</td>
<td>6.71</td>
<td>8.00</td>
</tr>
<tr>
<td><strong>DIRECTED STRESS GROUP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>1.84</td>
<td>2.24</td>
<td>2.99</td>
<td>2.13</td>
<td>2.31</td>
<td>1.30</td>
<td>1.46</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>4.44</td>
<td>7.90</td>
<td>9.36</td>
<td>10.79</td>
<td>11.91</td>
<td>6.35</td>
<td>7.48</td>
</tr>
<tr>
<td><strong>NON-DIRECTED STRESS GROUP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>2.08</td>
<td>2.37</td>
<td>2.85</td>
<td>1.78</td>
<td>2.16</td>
<td>1.46</td>
<td>1.62</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>3.91</td>
<td>7.73</td>
<td>8.95</td>
<td>8.63</td>
<td>9.71</td>
<td>4.72</td>
<td>5.79</td>
</tr>
<tr>
<td><strong>CONTROL GROUP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.D.</td>
<td>1.90</td>
<td>2.42</td>
<td>2.39</td>
<td>2.25</td>
<td>2.85</td>
<td>1.72</td>
<td>2.65</td>
</tr>
</tbody>
</table>
improved performance displayed by all groups. The non-significant F for groups by trials (Table III) indicated that all the groups were improving at the same rate.

TABLE III
ANALYSIS OF VARIANCE FOR THE INITIAL SCORES

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>2</td>
<td>3.574</td>
<td>.19</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Subjects (Groups)</td>
<td>27</td>
<td>18.821</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trials</td>
<td>4</td>
<td>37.831</td>
<td>18.08</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Groups x Trials</td>
<td>8</td>
<td>.679</td>
<td>.38</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Subjects (Groups) x Trials</td>
<td>108</td>
<td>1.808</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A Comparison of the Performance Scores of the Groups.

An analysis of variance was then done on trials six to fifteen to determine if there was any difference between the groups on their performance scores that was attributable to the effects of stress. The non-significant F for between groups indicated all groups achieved approximately the same performance levels (Table IV). The significant F for trials (Table IV) showed there was a change in performance over the ten trials for all the groups which is demonstrated in Graph 2 as an improvement by all the groups. The non-significant F for groups by trials indicated the rate of
GRAPH 1

MEAN INITIAL SCORES FOR ALL THREE GROUPS

TIME ON TARGET (SECS)

DIRECTED STRESS
NON DIRECTED STRESS
CONTROL

TRIALS
improvement for all groups was statistically the same (Table IV).

**TABLE IV**

ANALYSIS OF VARIANCE FOR THE PERFORMANCE SCORES

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>2</td>
<td>7.436</td>
<td>.14</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Subjects (Groups)</td>
<td>27</td>
<td>55.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trials</td>
<td>9</td>
<td>9.746</td>
<td>5.30</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Groups by Trials</td>
<td>18</td>
<td>1.007</td>
<td>.55</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Subjects (Groups) x Trials</td>
<td>243</td>
<td>1.838</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A Comparison of the Transfer Scores of the Groups.

An analysis of variance was computed for trials sixteen to twenty to determine if there was any transfer from the stress condition immediately preceding these trials. The non-significant F for groups indicated there was no such transfer (Table V). There was also a non-significant F for trials (Table V) which indicates there was no change in the scores over the five trials and that all groups failed to improve their scores during these five trials. The non-significant F for groups by trials (Table V) shows all groups tended to level off at the same time.
Graph 2

Mean Performance Scores for All Three Groups

Time on Target (Secs)

Directed Stress
Non Directed Stress
Control

Trials
TABLE V

ANALYSIS OF VARIANCE FOR TRANSFER SCORES

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>2</td>
<td>2.594</td>
<td>.07</td>
<td>&gt;.05</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>37.865</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trials</td>
<td>4</td>
<td>1.470</td>
<td>.92</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Groups by Trials</td>
<td>8</td>
<td>2.324</td>
<td>1.45</td>
<td>&gt;.05</td>
</tr>
<tr>
<td></td>
<td>108</td>
<td>1.606</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A Comparison of the Learning Scores of the Groups.
The ten trials on day two (Graph 3) were treated in two
different sections to study the learning effect. Trials
one to five were averaged to give the first final score
(FS1). Trials six to ten were then averaged to give the
second final score (FS2). The difference between each of
these final scores and the initial score was then taken to
give two learning scores (LS1 and LS2). An analysis of
variance was then performed on both learning scores for
the three groups to determine if there was a difference in
the amount learned. Significant F's for between groups
were obtained for both learning scores among the three
groups (Table VI and Table VII). The t-tests (see
Appendix A) calculated between groups showed that differ­
ences between the two experimental groups and the control
GRAPH 3

MEAN FINAL SCORES FOR ALL THREE GROUPS

TIME ON TARGET (SECS.)

13
12
11
10
9
8
7
6
5
4
3
2
1
0

DIRECTED STRESS
NON DIRECTED STRESS
CONTROL

TRIALS (DAY TWO)
group were significant at the 5% level for the first learning score but only the difference between the directed stress group and the control group was statistically significant for the second learning score (see Table VIII). There was no significant difference between the two stress groups for either learning score.

### TABLE VI
ANALYSIS OF VARIANCE FOR LEARNING SCORE ONE (LS1)

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>11.239</td>
<td>4.99</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Within Groups</td>
<td>27</td>
<td>2.253</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE VII
ANALYSIS OF VARIANCE FOR LEARNING SCORE TWO (LS2)

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>13.35</td>
<td>3.44</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Within Groups</td>
<td>27</td>
<td>3.88</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GRAPH 4

SCORES FOR ALL THREE GROUPS OVER ALL THE TRIALS

TIME ON TARGET (SECS.)

TRIALS

24 HOURS INTERPOLATED REST

DIRECTED STRESS
NON DIRECTED STRESS
CONTROL
**TABLE VIII**

**T-TESTS FOR DIFFERENCES BETWEEN GROUPS IN LEARNING SCORES**

<table>
<thead>
<tr>
<th>Learning Score</th>
<th>t-for difference between directed stress and control</th>
<th>t-for difference between non-directed stress and control</th>
<th>t-for difference between directed and non-directed stress</th>
</tr>
</thead>
</table>
| Learning Score One  
LS1 = FS1 - IS | 3.25* | 2.45* | .52 |
| Learning Score Two  
LS2 = FS2 - IS | 2.50* | 1.92 | .58 |

* Significant at the .05 level of confidence

**Discussion**

Since the analysis of variance revealed no significant differences among the initial scores of the three groups, it was assumed that the initial abilities of these groups were approximately the same. For this reason it was further assumed that these initial abilities would not differentially affect any subsequent performance or learning scores.

The results of the analysis on trials six to fifteen showed there were no significant differences, attributable to either type of stress among the groups in the performance scores (Table IV). This lack of difference was shown in spite of the theory and research of Leuba (1), Lewin (2), and Eason and Branks (3). Leuba (1:29) stated
that "the organism tends to acquire those reactions which . . . when overall stimulation is high are accompanied by decreasing stimulation." With the high stress level created and good performance being the method to reduce this stress level for the directed stress group, they should then have sought to improve performance. According to Lewin (2:66), tension reducing actions should have a high positive valence in stressful situations, and hence good performance on the rotor task in the directed stress situation should have been very desirable. Eason and Branks (3) actually showed that when a subject's attention was directed toward a task, and activation level was increased, the subject's performance improved.

The lack of difference in this experiment conceivably would be explained in terms of the type of task performed. Ryan (4) reported that the effect of a given degree of activation upon performance appears to vary with the nature of the task to be performed. Marteniuk (5) on a discrete type of task, and using shock similar to the present study, has shown that directed stress improves the performance over a non-directed stress situation and a control. Because the rotary pursuit task is continuous in nature, perhaps the lack of difference between groups in this experiment was due in part, to the type of task. In a discrete type of task there are usually only a relatively few performance factors to concentrate on and thus direction
could improve the performance. However, in a continuous task there are many factors constantly involved and varying and thus even with direction, subjects cannot attend to all the relevant cues and therefore performance is not improved. Further to this, Carron (6) reasoned that competing responses were present when skill level was low early in practice. According to Hullian theory, the correct habit strength and drive level are multiplied to give the response strength. From this, Carron stated that early in practice when the correct habit (response) is weak, there are many incorrect competing responses and when this situation is combined with a high drive level, performance can be impaired. In the present experiment, it was possible that even though subjects in the directed stress group were directed toward better performance, the task involved so many factors that the correct habit strength was not strong enough and thus incorrect competing responses occurred and performance did not improve.

The results on the transfer scores (Table V) indicate that there was no systematic trend in these scores that could be attributable to the effects of the immediately preceding stress situation. That these scores were not apparently influenced by the effects of the stress conditions may have only reflected the fact that there were no stress effects produced in the stress situation as designed in this study. It was assumed, however, that
there was some type of stress effect produced since the analysis of the results revealed that the two stress groups were superior insofar as learning the pursuit rotor was concerned (Table VIII). The reason why this stress did not improve the performance scores (trials 6-15 on day one, Table IV) or the transfer scores is only speculative in nature and has been discussed elsewhere.

As regards the effects of directed stress and non-directed stress on the learning of the pursuit rotor task, the results showed that both conditions significantly improved the learning of the pursuit rotor task but there was no significant difference between the amount learned by these two experimental groups (Table VIII). Leuba (1:32) stated that "Learning may occur best when stimulation is strong enough to provide maximum reinforcement, but not strong enough to be disruptive." Because learning was significantly greater in the two stress groups as compared to the control group, it seems likely that the stimulation in the stress groups was within Leuba's optimal range.

Since there was no difference between any of the groups on the performance scores (Table V) and there was a difference in the learning scores (Tables VI, VII, VIII), this might suggest that there are different optimal stimulation levels for learning versus performance, at least insofar as the pursuit rotor is concerned.

In terms of Duffy's (9) hypothesis of two-
dimensional behavior, a difference in the amount learned between the directed stress group and the non-directed stress group might have been expected because the directed stress group had the opportunity to utilize the directional aspect of behavior. This, however, was not the case (Table VIII). The lack of difference between the two experimental groups in learning, as well as in performance, could have been due to the fact that there was no difference between the effects produced by the two types of instructions. This would suggest one of two things: a) that stress alone is responsible for increased learning and that instructions which direct the subjects' attention toward the task play little or no part in the learning of the task except for the part they play in increasing the overall stress level; b) the lack of difference between the two experimental groups in performance and learning may also have reflected the failure of the instructions, as they were designed and given by the experimenter, to direct or not direct the subjects' attention. Which of these two conditions actually occurred in this study cannot be determined by the present experimental design. Accordingly, it must also be noted at this time that the stress level in this experiment could have been caused by any one or a combination of three factors: 1) the electric shock; 2) the verbal instructions; or 3) the presence of electrodes. It was probably a combination of all three
factors but there was no attempt to differentiate between them because there was no method available to measure the stress level. When such measurement is possible, the contribution played by the above factors could be determined.

When determining the percentage improvement over the initial score that was due to learning, the ratio of the first learning score (FS1 - IS) to the initial score was calculated and multiplied by 100. In this way it was found that the directed stress group learned 38% more than the control group and the non-directed stress group learned 22.3% more than the control group. These are meaningful and statistically significant increases in learning which can be attributable to the stress. A 15.7% superiority in learning by the directed stress group over the non-directed stress group, although being an appreciable amount, was not significant at the 5% level of significance.

The lack of a significant difference between the non-directed stress group and the control group on the second learning score (LS2) might be construed to show that the significant difference between these two groups on learning score one (LS1) was only a temporary effect and not a permanent learning effect. However, the results show that there was no decrease over the ten trials of the second day scores of the stress groups and that the lack of difference between the second learning scores of the
non-directed stress group and the control group was caused by an increase in the scores of the control group (Graphs 3 and 4 and Tables V and VI). It seems, therefore, that the stress groups reached a ceiling and the control group began to close the gap. These results could be interpreted to mean that stress can bring the learning of a task to a maximum at a more rapid rate than a control condition but the control subjects may continue to improve and thus, over an extended period of time, reach the level of subjects who had previously worked under stress. Thus one characteristic of learning under stress may be that the rate of learning is increased but the amount of learning is unaffected. The investigation of whether this is really so must be left to future research.

The fact that there was no difference in the performance scores on day one (Table IV) but a distinct improvement by the two stress groups after twenty four hours rest (Tables VI, VII) might also suggest that the aversive nature of the shock was an inhibitory factor which was dissipated during the rest period.
REFERENCES


CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to investigate the effects of directed and non-directed stress on the performance and learning of a rotary pursuit tracking task. Eighteen male and twelve female undergraduate physical education students were each randomly assigned to three groups: a directed stress group; a non-directed stress group; and a control group. Stress was initiated by electric shock during trials six to fifteen on day one with the two experimental groups receiving equal numbers of shocks. The directed stress group was instructed that if they did not improve five percent over their previous high score, they would be shocked. The non-directed stress group received random and unavoidable shock. After twenty distributed trials on day one, all subjects were given approximately twenty-four hours rest and then retested (ten trials) to determine their final scores. The initial scores for each group were then subtracted from the final scores to give the learning scores.

The conclusions were as follows:

1. Stress, whether directed or non-directed, failed to facilitate or impair performance on the rotary pursuit tracking task.
2. Stress, both directed and non-directed, resulted in superior learning of the pursuit rotor tracking task.

3. There was no significant difference in learning between the directed stress and non-directed stress groups.

Recommendations

1. When testing Duffy's two dimensional theory of behavior in the context of motor performance and learning, there must be some method for measuring the activation level and adjusting this level so that all subjects are performing at approximately the same level of activation.

2. When the activation level can be measured, it would be desirable to know what constitutes an optimal level.

3. If this study were repeated, a larger N would be desirable.

4. Extend the scope of the experiment to determine the duration of the superiority of the stress groups over the control group in relation to differences in learning.
BIBLIOGRAPHY


1. The required means, standard deviations, and F ratios were calculated at the computing centre, U.B.C. Campus, using the BMD08V program.

2. A t-test was used to test the differences between the means where the appropriate F was significant. The formula for the t was:

\[ t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_p^2}{1/N_1 + 1/N_2}}} \]

where \( \bar{x} \) = the group means

\( S_p^2 \) = pooled estimate of the error variance of the mean square
APPENDIX B
### RAW DATA

MEANS FOR ALL THREE GROUPS FOR THE THIRTY TRIALS

<table>
<thead>
<tr>
<th>Trial</th>
<th>Directed Mean Day 1 Score</th>
<th>Stress Group Mean Day 2 Score</th>
<th>Non-Directed Mean Day 1 Score</th>
<th>Stress Mean Day 2 Score</th>
<th>Control Mean Day 1 Score</th>
<th>Group Mean Day 2 Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.55</td>
<td>9.69</td>
<td>2.52</td>
<td>9.59</td>
<td>2.05</td>
<td>8.35</td>
</tr>
<tr>
<td>2</td>
<td>3.56</td>
<td>10.87</td>
<td>4.46</td>
<td>10.28</td>
<td>3.57</td>
<td>8.46</td>
</tr>
<tr>
<td>3</td>
<td>4.62</td>
<td>11.04</td>
<td>5.06</td>
<td>11.59</td>
<td>4.52</td>
<td>8.62</td>
</tr>
<tr>
<td>4</td>
<td>4.83</td>
<td>11.53</td>
<td>4.87</td>
<td>11.03</td>
<td>4.71</td>
<td>8.19</td>
</tr>
<tr>
<td>5</td>
<td>5.54</td>
<td>11.51</td>
<td>5.28</td>
<td>11.47</td>
<td>4.69</td>
<td>9.51</td>
</tr>
<tr>
<td>6</td>
<td>6.03</td>
<td>11.25</td>
<td>6.68</td>
<td>11.87</td>
<td>6.22</td>
<td>8.71</td>
</tr>
<tr>
<td>7</td>
<td>6.70</td>
<td>11.84</td>
<td>7.10</td>
<td>12.28</td>
<td>7.91</td>
<td>9.49</td>
</tr>
<tr>
<td>8</td>
<td>7.26</td>
<td>12.69</td>
<td>8.15</td>
<td>10.83</td>
<td>7.76</td>
<td>9.59</td>
</tr>
<tr>
<td>9</td>
<td>7.60</td>
<td>12.13</td>
<td>8.09</td>
<td>12.09</td>
<td>7.81</td>
<td>9.41</td>
</tr>
<tr>
<td>10</td>
<td>7.41</td>
<td>13.18</td>
<td>7.34</td>
<td>12.47</td>
<td>7.79</td>
<td>11.35</td>
</tr>
<tr>
<td>11</td>
<td>7.43</td>
<td></td>
<td>8.74</td>
<td></td>
<td>8.03</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>7.24</td>
<td></td>
<td>7.95</td>
<td></td>
<td>7.49</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>8.26</td>
<td></td>
<td>8.08</td>
<td></td>
<td>8.08</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>7.93</td>
<td></td>
<td>8.31</td>
<td></td>
<td>8.50</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>7.77</td>
<td></td>
<td>8.52</td>
<td></td>
<td>7.75</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>9.08</td>
<td></td>
<td>0.74</td>
<td></td>
<td>7.90</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>9.20</td>
<td></td>
<td>9.37</td>
<td></td>
<td>9.34</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>9.12</td>
<td></td>
<td>9.82</td>
<td></td>
<td>9.14</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>8.72</td>
<td></td>
<td>9.25</td>
<td></td>
<td>9.23</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>8.84</td>
<td></td>
<td>8.64</td>
<td></td>
<td>9.15</td>
<td></td>
</tr>
</tbody>
</table>