CONSOLIDATION THEORY AND THE EFFECTS OF

STRESS AND ANXIETY ON MOTOR BEHAVIOR

by

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CHAPTER 1

THE PROBLEM

The effects of anxiety and stress on the human organism
have been topics of concern in research in recent years. There
have been a number of investigations conducted in the area of
anxiety and stress with respect to the effects on behavior, which
have employed a variety of research techniques. Many of the
investigations involved with anxiety have attempted to draw con-
clusions regarding the effects of anxiety on motor behavior.
Specifically, the effects of anxiety and stress have been in-
vestigated in relationship to motor performance and learning
a motor task.

In the area of anxiety and motor performance, drive theory
has been an important theoretical model. The basic idea of
drive theory was developed by Hull in 1943. However, Spence
modified the theory slightly and expressed drive theory as
$R = f(D \times H)$ with (H) being habit strength, (D) being drive
state, and (R) being response strength. "Thus, total effective
drive state results from the summation of all individual need
states exisistant at a given time, irrespective of their source."
(7: 154) Many studies have investigated drive theory, however,
the results have not supplied conclusive evidence in support
of the theory.

To describe the relationship between anxiety and verbal

learning, Walker and Tarte (22) developed the consolidation theory.
The consolidation theory was based on the premise that high
arousal during learning situations will create a more intense
neural activity circuit trace in the brain, thus supplying
stronger permanent memory patterns and facilitating learning
rates. (22: 113) This theory was also investigated by Klien-
smith and Kaplan (5,6) using a verbal learning task. In an ef-
fort to apply the consolidation theory to a motor learning situa-
tion, two studies were conducted, one by Marteniuk and Wenger
in 1970, and the other by Sage and Bennett in 1973. These
studies were similar in design and found evidence to support
the consolidation theory.

Continued investigation into the relationship between
anxiety and motor performance is warranted when the results
may directly affect the teaching and learning of motor skills.
The practitioner in the teaching field is reliant upon learning
theories and models to guide them in the instructional process,
and thus these theories and models should have a logical and
sound research basis.

Since relatively few studies have been conducted in rela-
tionship to the consolidation theory, there seems to be a justi-
fiable need for further investigations in this area.

The Problem Statement

The purpose of this investigation was to study the utili-
zation of consolidation theory in the area of motor behavior.

Hypothesis

In solving this problem one major hypothesis and two

subhypotheses were tested.   These hypotheses are:

Major Hypothesis

As predicted by consolidation theory, subjects stressed during acquisition trials will exhibit superior learning scores after a 24 hour retention interval.

Subhypotheses

As predicted by drive theory, during acquisition, increased stress will inhibit performance on early trials and facilitate performance on late trials.

Ego involved failure instructions will result in higher anxiety state scores for the high stress subjects.

Limitations

The following were considered limitations of this investigation:

1. Only 40 subjects were tested, with 10 subjects assigned to each treatment group.

2. The subjects used in the study did not display extreme differences in trait anxiety scores.

3. There were no controls imposed on the daily routines of the volunteer subjects, which might possibly have influenced the learning and performance results in either a positive or negative direction.

Delimitations

The study was limited to female undergraduate students attending Kansas State University during the spring of 1979.

Definition of Terms

Several terms were used when discussing anxiety and motor

performance which are listed below:

Anxiety

The term "anxiety" describes an emotionally unpleasant condition which could be characterized by feelings of tension, worry, and apprehension caused by arousal of the autonomic nervous system. (18:482)

Consolidation theory

Consolidation theory suggests that high arousal during learning situations will produce a more intense activity trace and thus facilitate learning rates. (22:113)

Drive theory

Drive theory indicates that when drive is increased, the responses with the greatest habit strength will be elicited. (13:196)

Learning

Learning describes a relatively permanent change in performance which is brought about through practice or experience and is observed indirectly through progressive measures of performance. (7:153)

Performance

Performance refers to an observable behavior of relatively short duration which is goal centered and purposeful in nature. (7:153)

State anxiety

State anxiety is defined as the reaction or response pattern that is elicited when an individual perceives a situation as dangerous or threatening, regardless of the presence or absence

of objective danger.   (18:489)

Stress

Stress is defined as any environmental situation which has a variable degree of objective physical or psychological danger.   (18:488)

Trait anxiety

Trait anxiety describes a fairly stable personality characteristic.   It is a predisposition to perceive a range of objectively nondangerous situations as threatening and responds with state anxiety which is disproportionate in magnitude with the degree of objective danger.   (17:275)

CHAPTER 2

REVIEW OF LITERATURE

The review of critically related literature will be pre-
sented in two sections. The first section will include studies
related to drive theory, while the second section will be con-
cerned with investigations regarding consolidation theory.

Drive Theory

Drive theory indicates that higher drive levels will faci-
litate performances in which the response tendency to be learned
is elicited, or in which the correct response is highly dominant
over the incorrect response. However, if the situation involves
multiple response tendencies and the correct response tendencies
are weak, then high drive levels will interfere with performance.
(13:196) This situation might occur in the initial stages of
learning, where the wrong responses have the greatest probability
of occurring. (14:297) However, as habit strength improves,
correct habits become predominant and high drive would produce
superior performance. Thus, according to drive theory, drive
facilitates performance but obstructs learning. (4:119)

An early study conducted by Farber and Spence (1953)
utilized a stylus maze task. In this study, 80 undergraduate
students were given a modified version of the Taylor Manifest
Anxiety Scale. The subjects were divided into anxious and

nonanxious groups according to the scores that were obtained
on the anxiety scale. A criterion of two successive perfect
trials on the task was used and the results indicated that the
anxious subjects scored significantly lower on the task than
did the nonanxious subjects. Thus, the results supported the
drive theory. In replication of this study, Axelrod, Cowen,
and Heilizer (1956) found no significant difference between
anxiety groups, which does not support the drive theory or
coincide with the findings in the Farber and Spence (1953)
study. Thus, McGuigan, Calvin, Richardson (1959) decided to
resolve the differences between these two studies by reproducing
the study once again, only in addition, they included a palmar
perspiration index as a physiological measure of anxiety. The
stylus maze was used as the task but the results indicated
that there was no significant differences to be found between
groups. In 1962, Wiggins, Brokaw, Heckel, and Salzberg con-
ducted an experiment using a stasiometer steadiness apparatus.
The stasiometer was used to measure the motor steadiness of 20
male hospital patients and 10 male college students. Each sub-
ject was given the Heineman Forced Choice Anxiety Scale and were
then asked to perform four trials on the stasiometer. Subjects
were grouped, according to the anxiety scale scores, into high
anxiety groups and low anxiety groups. The low anxiety group
made significantly fewer errors than the high anxiety group.
These findings indicated support for the drive theory. Palermo,
Castaneda, and McCandless (1956) gave 36, ten and eleven year
old children, the Taylor Manifest Anxiety Scale and studied the

relationship between the child's trait anxiety and the child's

performance. The child's performance was measured by the num-

ber of errors made on a learned light sequence task. The high

anxious subjects made a significantly more errors than the low

anxious subjects on the learning task. These findings also

support the drive theory. Spence and Taylor (1951) conducted

an investigation to determine the effects of varying intensity

of an unconditioned stimulus on the amount of conditioning shown

by anxious and nonanxious subjects. Eyelid conditioning was

the terminal effect with light brightness used as a conditioned

stimulus and air puffs as the unconditioned stimulus. The

Taylor Manifest Anxiety Scale was given to a large number of

individuals and the individuals that scored in the upper 20%

and the lower 20% were chosen as subjects. These subjects

were divided into four treatment groups, anxious - strong puff

group, anxious - weak puff group, nonanxious - strong puff

group, and nonanxious - weak puff group. In support of drive

theory, the results indicated superior conditioning in the anxious

subjects. In another study conducted by Taylor and Spence (1952)

subjects chosen by extreme Taylor Manifest Anxiety Scale scores,

were given a T-maze task. It was found that the nonanxious sub-

jects were superior to the anxious subjects in terms of the

number of trials necessary to achieve the success criterion and

in relationship to the number of errors that were committed.

This also lends support for the drive theory under certain learning

situations.

The following studies incorporated a stress situation

within the study design. Stressors that could be used to in-
voke an anxiety producing situation include a variety of el-
ements such as competition, pain, and failure instructions.
In a study conducted by Taylor (1951), a trait anxiety test was
given and two groups of subjects, low anxiety subjects and
high anxiety subjects, were determined according to their
anxiety scores. Both groups were given an eyelid conditioning
sequence while one group received instructions that would in-
crease the anxiety of the situation, the other group received
instructions to decrease the anxiety of the situation. Taylor's
results suggested that there was no significant difference in
performance between the groups with different instructions, how-
ever, it was found that high anxious subjects were higher in
conditioning. This result tended to agree with drive theory.
Consider Carron and Morford's (1968) study, involving stress
situations that were introduced at different stages of lear-
ning; (a) control, (b) early stress, and (c) late stress. In
this study 60 high anxiety subjects and 60 low anxiety sub-
jects were assigned to one of the three conditions. The sub-
jects were given 35 trials per day, for two days, on a stabilo-
meter task. The stress situation consisted of a shock which was
administered either early in learning, late in learning, or not at
all. No significant difference existed between groups in the
amount of learning on the task. These findings were contrary to
drive theory predictions. Martens and Landers (1969) used a co-
incident-timing task to determine what effect anxiety had on

learning and performing a complex motor task, along with the effects of competition and failure as stressors. They took 40 subjects that scored high on the Taylor Manifest Anxiety Scale and 40 subjects that scored low, and randomly assigned them to one of four treatment groups. The four conditions were competition, noncompetition, success, and failure. Each subject was given two practice swings on the timing task, followed by ten trials. At the end of the second and third sets involving the success and failure groups, the experimenter altered the correct knowledge of results with either success results or failure results. In the other group, the competitive group, instructions were given that a monetary reward would be given for the best performance, creating a competitive situation. The noncompetitive group was not given this information. The results gave support for the hypothesis that low anxious subjects performed significantly better than the high anxious subjects during the initial learning of the task. After the task was learned, there were no differences in task performance thus giving no support to the hypothesis that drive facilitates performance in high anxious subjects after the correct habit strength has been established. In another study, Ryan (1962) proposed to determine how groups with higher levels of arousal would compare with groups having lower levels of arousal, measured by galvanic skin conductance, on performing motor task. The study used 40 male volunteer university students as subjects. They were divided into low and high arousal groups according to conductance ratings and were given 12 trials on a motor task.

When the groups were compared according to the final conductance
reading and the total change in conductance, the higher conductance
group had superior performances to the low conductance group
both in late and early learning.

After reviewing the related literature on drive theory,
there are apparent inconsistencies in the findings. No con-
clusive evidence could be accumulated since the studies re-
viewed utilized a variety of testing instruments and tasks to
look at the effects of anxiety on performance.

Consolidation Theory

This theory was based primarily on verbal learning studies
and was developed by Walker and Tarte (1963). The theory ex-
plains the activity of the brain after receiving a pattern se-
quence. When the pattern is received in the brain, a corresponding
closed reverberating neural circuit is produced by firing neu-
rons. If extraneous neural activity created by arousal is pre-
sent, the neural trace will reverberate a greater number of
times. Thus producing a greater perseverative consolidation
of the neural trace and essentially, greater permanent memory.
(5:192) In Walker and Tarte's (1963) study 72 women were used
as subjects. The subjects were assigned to learn a high-arousal
word list, a low-arousal word list, or a heterogeneous word list.
A skin resistance measurement was taken on each subject through-
out the testing session. The subjects were given one learning
trial and then were asked to recall the word lists at 2 minutes
after initial presentation, 45 minutes after initial presentation,

and one week following the initial presentation. The findings

gave support for the consolidation theory, since the subjects

in the low-arousal group showed a decrease in recall with time

and the high-arousal group showed greater ultimate recall.

In two similar verbal studies conducted by Kleinsmith and Kaplan

(1963, 1964), the subjects used were university students. The

1963 study included word-number paired associates of high arousal

and low arousal value. This study also included the use of a

skin resistance measurement as an arousal indicator. The sub-

jects were given one learning trial on the word-number associate

list and then were asked to recall the list at intervals of 2

minutes, 20 minutes, 45 minutes, one day, and one week following

the initial learning trial. This investigation found that the

subjects assigned to learn the high arousal list had greater

recall than the subjects assigned to the low arousal list, as

time progressed. The 1964 study by Kleinsmith and Kaplan was

identical in design to the previous study, however, the task

included nonsense syllables paired with an associate number list.

Skin resistance levels were again recorded as an indicator of

arousal levels. This study also found support for the consol-

idation theory. In an attempt to expand this theory to motor

learning, Marteniuk and Wenger (1970) conducted a study to de-

termine the effects of task-related and task-unrelated shock

on learning a pursuit rotor skill. There were 30 subjects

who were assigned to one of three groups either the related

arousal group, the unrelated arousal group, or the control group. The related arousal group was given shocks according to their actual task performance, whereas, the unrelated arousal group was given shocks randomly disregarding performance levels. The pursuit rotor was the task and each subject was given 20 trials the first day of testing and then returned after 24 hours and performed 10 more trials. For the subjects assigned to the stressed groups, the shock was administered on trials 6-15 on the first day of testing. Learning scores were determined for all subjects and the results indicated that greater learning occurred for the stressed groups than the control group however, there was no significant difference between the related arousal group and the unrelated arousal group. These results indicated support for the consolidation theory when applied to a motor task. In another study using the pursuit rotor as a learning task, Sage and Bennett (1973) investigated the effects of arousal on learning and performance. The subjects, 11 females and 31 males, were randomly assigned to either a related arousal group, an unrelated arousal group, or a control group. The pursuit rotor was set at 60 revolutions per minute and each subject was given 15, 30 second trials, with each subject returning 24 hours later and completing an additional 10 trials. The subjects were also given the Spielberger State - Trait Anxiety Inventory. The trait anxiety form was given to ensure that all groups were equal with regard to anxiety trait levels. The state anxiety form was given at the conclusion of the first day of testing

to determine if the subjects were stressed by the shock that was administered. Electric shock was administered, to those subjects assigned to the arousal groups, on trials 6-15 on day one. The shock schedule for the related arousal group was dependent upon performance, however, the unrelated arousal group had a shock schedule that was randomized regardless of performance. Learning scores were calculated, and the results indicated that both arousal groups performed better than the control group. Also, it was found that the related arousal group learned significantly more than the control group which supports the consolidation theory and agrees with the findings of Marteniuk and Wenger.

Thus, the verbal studies and the motor learning studies reviewed, have found support for the consolidation theory.

Summary

In conclusion, the review of critically related literature indicates that there are several inconsistancies with regard to the studies investigating drive theory, and the conclusions that are implied from these studies. Thus, the interpretation of the relationship between anxiety and motor learning and performance is questionable. It is also evident that the consolidation theory and its relationship to motor behavior is an area justifiably requiring further investigation, since it seems to be a theory that can supply an appliable model in learning situations.

In view of these findings and in an effort to continue to apply and expand these theories, a study involving the compounding effects of stress and anxiety on the consolidation of a memory trace seems to be the next logical investigation. Also, the effects of failure instructions and anxiety on the performance and learning of a motor task would provide further information about the complex relationships between these variables.

CHAPTER 3

PROCEDURES

This investigation was conducted in the spring, 1979,
at Kansas State University. This chapter includes information
regarding the subjects that were used in the study, the equip-
ment used, the testing procedures, and the treatment of the
data.

Subjects

The volunteer subjects used in this study were 40 female
undergraduate students chosen from a sample of 65 individuals
who were enrolled in general physical education activity classes
at Kansas State University during the spring of 1979. The sub-
jects had a mean age of 19.89 years, with a standard deviation
of 1.22 years. There were 37 subjects who preferred the right
hand and 3 subjects who preferred the left hand.

Equipment

The novel motor task was performed on a Lafayette Photoe-
lectric Pursuit Rotor, with a circular tracking template, and
had a standard setting of 60 revolutions per minute for each
subject. A Lafayette Data Cube electric chronoscope was also
used to record the amount of time on target to the nearest one
hundredth of a second.

Before the testing procedures began, each subject was asked
to read and sign an informed consent form and also complete the
Spielberger Trait Anxiety Inventory form (19). After completing
the trait anxiety form, the experimenter scored the form to
determine if the subject was in the high anxiety category or
the low anxiety category. This was determined by comparing the
subjects scores with the mean score that was reported by Spiel-
berger (19:8). The mean that was reported for female under-
graduate students was 38.25, thus subjects scoring 39 or above
were placed in the high trait anxiety group. Sixty-five indi-
viduals were given the trait form and 40 subjects were chosen
to participate in the experiment based on their scores. Each
subject was then randomly assigned to either the high stress
group or the low stress group.

The subjects were scheduled for specific testing times,
during which an explanation of the task and testing trials were
given to the subject. The testing included 15 trials, with
each trial consisting of a 30 second tracking period and a 30
second rest interval. The subject was instructed when to begin
and end each trial. At the end of each trial, the experimenter
recorded the time on target, within one hundredth of a second.
After the third trial had been completed these failure instruc-
tions were given to the subjects who had been assigned to the
stress group, "I don't think you are doing the best you can,
so I want you to try a little harder." Again, after trial number
nine, these failure instructions were given to the stressed

subjects, "I have been watching your performance and you're not doing very well, your scores are falling well below average, please concentrate on the task and try harder." The subjects assigned to the low stress group received no instructions during the fifteen trials.

After the fifteenth trial, the subjects were asked to fill out the Spielberger State Anxiety Inventory form (19). Each subject then returned to the testing area 24 hours later and was given 10 additional trials on the pursuit roter. No failure instructions were given to either group during the trials on the second testing session. After the tenth trial was completed, the subjects were thanked and asked not to discuss the testing with anyone. At the termination of the investigation, the subjects were informed of the purpose of the study along with an explanation of the procedures and any other clarification that was necessary.

Treatment of the Data

In analyzing the data, the trials were divided into acquisition trials, which were trials 1 through 15, and into retention trials, which were designated as trials 16 through 25.

A 2(stress) by 2(anxiety) by 15(trials) variance analysis with repeated measures on the trials factor was used to analyze the acquisition data. The dependent variable in this analysis was time on target.

A 2(stress) by 2(anxiety) variance analysis was used to analyze the learning data. The dependent variable in this analysis was the time on target difference scores between the

average of trials 1 to 3 (acquisition trials) and trials 16 to 20 and 21 to 25 of the retention trials (relearning trials).

A 2(stress by 2(anxiety) variance analysis was also used to analyze the state anxiety and the trait anxiety test scores.

In all analyses, an alpha level of .05 was adopted.

CHAPTER 4

ANALYSIS OF THE DATA

The statistical analysis of the data will be divided into
three specific areas. These areas are: a) analysis of the ac-
quisition data; b) analysis of the learning data; and, c) ana-
lysis of the stress and anxiety test scores. The .05 level of
significance was used in all analyses. The data analysis will
be followed by a discussion of the results.

Acquisition Data

The acquisition data were analyzed using a 2(stress)
by 2(anxiety) by 15(trials) variance analysis with repeated
measures on the trials factor. The dependent variable was the
amount of time the subject was on the target. As can be observed
in the analysis of variance table for the acquisition data (Ta-
ble 1), the significant main effect was that of trials, $F(14,504)=$
56.66, $p < .001$. All of the other main effects and interactions
were insignificant.

Table 1

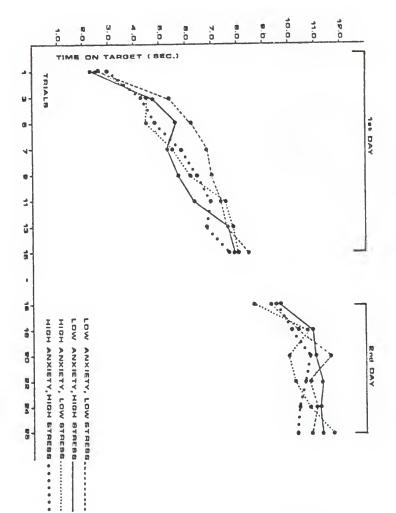Analysis of Variance Table for
Acquisition Data

Source	Sum of Squares	Df	Mean Square	F	Tail Prob.
Anx.	26.31	1	26.31	0.29	0.592
Stress	34.75	1	34.75	0.39	0.538
Anx x Str	17.61	1	17.61	0.20	0.661
Sub/Gr	3241.01	36	90.03		
Trials	1290.64	14	92.19	56.66*	0.000*
Tr x Anx	31.50	14	2.25	1.38	0.157
Tr x Str	18.46	14	1.32	0.81	0.658
Tr x Anx x Str	23.88	14	1.71	1.05	0.403
Tr x Sub/Gr	820.07	504	1.63		
Total	5504.23	599			

* Significant at the .05 level

Illustrated in Figure 1 are the performance curves for the four
treatment conditions. The performance curves are displayed for
both the acquisition data and the retention trials. The
curves are expressed by showing every other trial performance
for the ease of interpretation.

FIGURE 1

PERFORMANCE CURVES FOR TREATMENT GROUPS

Learning Data

Learning scores were calculated by finding a difference
score between trials 1-3 (acquisition data) and trials 16-20
of the relearning trials; and between trials 1-3 and trials
21-25 of the relearning trials. These two scores (learning
score 1 and learning score 2) represented the amount of learning
by each subjects under each treatment condition. From close
observation of the acquisition data analysis displayed in
Table 1 and Figure 1, it is apparent that the four treatment
conditions did not differ in initial performance across trials
one through three. However, to assure that this was the case,
a 2(stress) by 2(anxiety) analysis of variance was conducted
with the average of trials 1-3 for each treatment condition
used as the dependent variable. The results of this analysis
again confirmed the absence of significant difference between
initial time on target scores of the four treatment groups.
The details of this analysis (analysis of variance table and
means and standard deviations) can be found in Table 8 and
Table 9 located in the appendix.

Learning Score 1

A 2(stress) by 2(anxiety) variance analysis was used for
this analysis. The results of this analysis (see Table 2) re-
vealed no reliable differences between the treatment condi-
tions in terms of learning.

Table 2

Analysis of Variance Table for
Learning Score 1

Source	Sum Squares	Df	Mean Square	F	Tail Prob.
Anx	4.17	1	4.17	0.62	0.435
Str	0.32	1	0.32	0.05	0.829
Anx x Str	0.87	1	0.87	0.13	0.720
Sub/Gr	240.21	36	6.67		
Total	245.57	39			

Learning Score 2

A 2(stress) by 2(anxiety) variance analysis was also
used to analyze the second group of learning scores. The
results of this analysis (see Table 3) also revealed no
reliable differences between the independent variables of
stress and anxiety.

Table 3

Analysis of Variance Table for
Learning Score 2

Source	Sum of Squares	Df	Mean Square	F	Tail Prob.
Anx	2.61	1	2.61	0.51	0.480
Str	0.12	1	0.12	0.02	0.881

Table 3
(Cont.)

Source	Sum of Squares	Df	Mean Square	F	Tail Prob.
Anx x Str	0.96	1	0.96	0.19	0.668
Sub/Gr	183.90	36	5.11		
Total	187.58	39			

The means and standard deviations for the analysis of learning scores 1 and 2 are displayed in Table 4. From Table 4, it is interesting to note that the variability in performance (difference scores) is much larger for the low stress subjects than for the high stress subjects (across learning scores).

Table 4

Means and Standard Deviations for
Learning Scores 1 and 2

Treatment Groups	Mean		Standard Dev.	
	Score 1	Score 2	Score 1	Score 2
Low anxiety, low stress	6.96	7.32	3.11	2.23
Low anxiety, high stress	6.84	7.52	1.72	1.79
High anxiety, low stress	6.02	7.12	3.64	3.40
High anxiety, high stress	6.49	6.70	0.90	0.82

Spielberger State Anxiety Scores

To verify that the subjects that were in the stress con-
ditions were in fact "stressed" by the failure instructions,
a 2(stress) by 2(anxiety) analysis of variance was conducted
on the Spielberger State Anxiety scores (dependent variable).
The results of this analysis revealed a significant main
effect for stress, $F(1,36)=13.63$, $p < .001$. However, the
effect for anxiety and the interaction between stress and
anxiety were insignificant. The analysis of variance results
for this analysis are displayed in Table 5. The means and

Table 5

Analysis of Variance Table for
State Anxiety Scores

Source	Sum of Squares	Df	Mean Square	F	Tail Prob.
Anx	99.22	1	99.22	1.39	0.246
Str	970.22	1	970.22	13.63*	0.001*
Anx x Str	0.02	1	0.02	0.00	0.985
Sub/Gr	2563.49	36	71.21		
Total	3632.97	39			

* significant at the .05 level

standard deviations for the state anxiety scores are dis-
played in Table 6. From Table 6, it is interesting to note

that the highest level of state anxiety was exhibited by the
high stressed-high anxiety subjects, with the lowest amount
exhibited by the low stressed-low anxiety group of subjects,
however these differences were not reliable.

Table 6

Means and Standard Deviations for
State Anxiety Scores

Treatment Group	Means	Standard Deviations
Low anxiety, low stress	36.50	8.07
Low anxiety, high stress	46.39	6.99
High anxiety, low stress	39.70	6.67
High anxiety, high stress	49.50	11.24

Spielberger Trait Anxiety Scores

In an attempt to verify that the subjects differing in
trait anxiety were equally distributed into the high and low
stress conditions by random assignment, a 2(stress) by 2(anxi-
ety) analysis of variance was conducted on the trait anxiety
scores (dependent variable). As can be observed in Table 7
(analysis of variance table), the analysis failed to support
this assumption. Specifically, a reliable difference between
stress groups was noted, $F(1,36)=4.71$, $p < .04$ As expected,
however, a significant difference between anxiety groups was
noted, $F(1,36)=109.6$, $p < .001$.

Table 7

Analysis of Variance Table for
Trait Anxiety Scores

Source	Sum of Squares	Df	Mean Square	F	Tail Prob.
Anx	1232.09	1	1232.09	109.63*	0.000*
Str	52.89	1	52.89	4.71*	0.037*
Anx x Str	0.00	1	0.00	0.00	1.000
Sub/Gr	404.59	36	11.24		
Total	1689.59	39			

The means and standard deviations for the trait anxiety ana-
lysis are displayed in Table 10 found in the appendix.

Discussion

The findings of this study indicated that there was no
significant difference found with regard to the effects of
stress on performance between groups, which does not lend
support for drive theory or the research hypothesis dealing
with drive theory. Several studies investigating drive theory
have indicated similar findings. (1,2,8,10) Drive theory would
predict that during acquisition, increased stress would in-
hibit performance on the early trials and facilitate perfor-
mance on late trials. However, there was a significant dif-
ference found on the trials factor which indicated that all
groups were improving significantly on performance as the trials
continued. The fact that no evidence was found to support drive

theory may relate to the small sample size and the small variance among trait anxiety scores between the high and low groups. In most studies that have investigated drive theory, the sample sizes were fairly large and the subjects were chosen on the basis of their extreme trait anxiety scores. Both of these limitations could have been operating in this study and could have contributed to the nonsupportive conclusions.

The findings also indicated no significant differences between groups on the two learning scores which does not support the consolidation theory. The consolidation theory indicates that the high arousal during the learning stage will create a more intense neural activity trace and thus facilitate permanent memory storage. Thus, consolidation theory would predict that the subjects who were stressed during the acquisition trials would exhibit greater learning scores after a retention interval. The verbal learning studies by Walker and Tarte (1963) and Kleinsmith and Kaplan (1963,1964) found evidence to support the consolidation theory, with subjects learning under high arousal exhibiting greater permanent memory recall. Also, studies done by Marteniuk and Wenger (1970) and Sage and Bennett (1973) resulted in findings that supported the consolidation theory applied to motor behavior.

In addition, the results suggested that the failure instructions were stressful to the subjects, and significant differences were found between the stressed and nonstressed subjects in their reported state anxiety scores. However, the

randomized assignment of subjects to the experimental groups
did not result in completely balancing the groups in relation-
ship to their anxiety scores. The analysis of variance indi-
cated that the subjects assigned to the high stress condition
were slightly higher on the trait anxiety scores and since the
Spielberger trait anxiety and state anxiety tests are corre-
lated (.11 to .53), this would indicate that these subjects
were already biased toward higher state anxiety scores. Thus,
even though the results indicated that subjects were stressed;
some question must be raised with regard to the fact that the
bias toward higher trait scores in the stressed groups may
have inflated their state anxiety scores.

The failure of this study to find support for the consoli-
dation theory may be related to two basic factors. The first
factor to be considered, is that the subjects in the study
may not have been genuinely stressed by the failure instructions,
in which case the mechanisms of the consolidation theory would
not be functioning. The foundation of the theory rests on the
arousal stimuli and its production of a more intense activity
trace. The second factor is that the stress applied to the
subject may be specifically related to the learning task in-
volved. In the previous studies by Kleinsmith and Kaplan (1963,
1964) and Walker and Tarte (1963) a verbal stress was used in
conjunction with a verbal learning task. Furthermore, Mar-
teniuk and Wenger (1970) and Sage and Bennett (1973) used a
physical stress (shock) and a motor learning task (pursuit
rotor) in their study design. Perhaps there is a very specific

relationship between the type of stress and the learning task that is employed. The results of this study were not in agreement with studies that were conducted by Sage and Bennett (1973) and Marteniuk and Wenger (1970).

CHAPTER 5

SUMMARY AND CONCLUSIONS

The final chapter includes a summary section, a findings
section, and a section for conclusions and recommendations.

Summary

The purpose of this research study was to investigate the
utilization of consolidation theory in motor behavior.

A review of related literature demonstrated the need for
further investigation into the relationship between the ef-
fects of anxiety on a motor learning task.

The volunteer subjects for the study included 40 female
undergraduate students attending Kansas State University. Each
subject was given the Spielberger Trait Anxiety Inventory and
15 trials on a pursuit rotor. Failure instructions were given
to the subjects who were randomly assigned to the high stress
condition. Following the 15 task trials, the subjects were
asked to fill out a questionnaire which was the Spielberger
State Anxiety Inventory and was used to determine the indivi-
dual's state anxiety. Each subject was also assigned to either
the high trait anxiety group or the low trait anxiety group
depending upon the individual's trait anxiety score. After
a 24 hour retention interval, the subjects were given an ad-
ditional 10 trials on the motor task.

The data analysis was conducted using an analysis of variance. A 2(stress) by 2(anxiety) by 15(trials) variance analysis with repeated measures on the trials factor was used in analyzing the acquisition data. The learning data was analyzed using a 2(stress) by 2(anxiety) variance analysis with dependent variables being the calculated learning scores. An analysis of variance was also used for the trait anxiety and state anxiety scores.

Findings

Acquisition data

An F value of 56.66 for the trials factor was significant at the .05 level.

There were no significant differences found between the stress and anxiety groups on the acquisition trials.

Learning data

The analysis of variance indicated that there were no significant differences found between experimental groups with regard to performance on trials 1-3.

When analyzing the learning scores 1 and 2, there were no significant differences found between the stress and anxiety groups.

State anxiety scores

In looking at the state anxiety scores, the main effect for anxiety and the interaction between stress and anxiety were insignificant.

Trait anxiety scores

On the trait anxiety scores, a significant difference between anxiety groups was noted.

The trait anxiety scores also indicated a reliable dif-
ference between the stress groups which had a significant F
of 4.71.

Conclusions

Within the limitations of this investigation, the following
conclusions appeared to be justified based on the statistical
results reviewed in Chapter 4.

1. There was no significant evidence found in support
   of the drive theory.

2. Consolidation theory was not supported by the re-
   sults indicated in this investigation.

3. The failure instructions given to the subjects were
   stressful, however, the random assignment of the sub-
   jects to the stress condition may have biased the
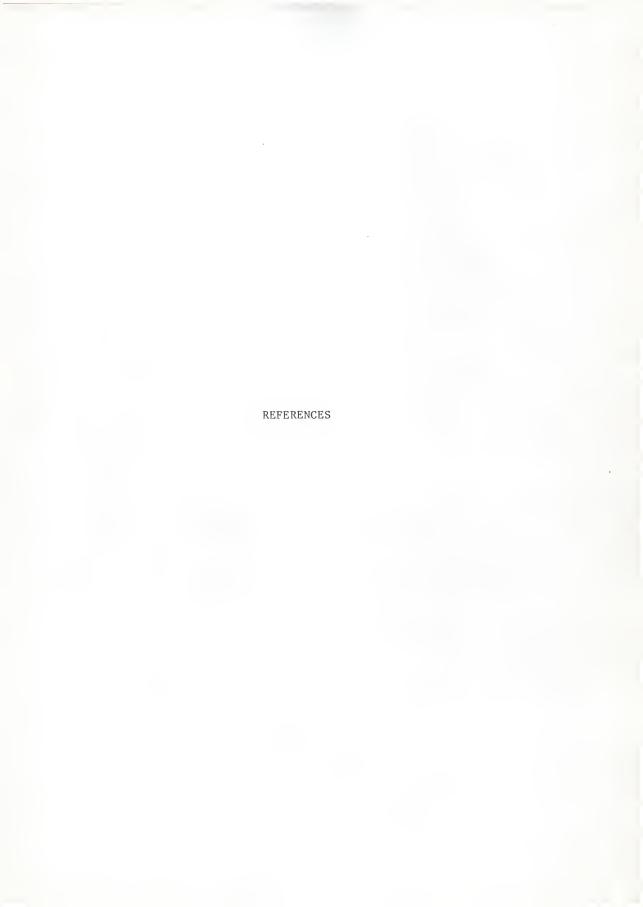   state anxiety test scores.

Recommendations

After completing this study, my recommendations for con-
ducting a similar investigation in this area would include the
following:

1. Increase the subject sample size.

2. Use subjects who display extreme trait anxiety
   scores.

3. Employ the use of a skin resistance measurement as
   an indicator of stress rather than using a paper and
   pencil test.

My recommendations for a teacher involved in instructing
motor activities, based on the conclusions of this study,

would be to avoid the use of failure instructions in learning situations until further investigations have been completed in this area.

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APPENDIX

Table 8

Analysis of Variance Table
for Trials 1-3

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Probability
Anxiety	0.00121	1	0.00121	0.00	0.987
Stress	0.36862	1	0.36862	0.08	0.775
Anxiety x Stress Interaction	0.21317	1	0.21317	0.05	0.828
Subjects/Groups	160.70288	36	4.46397		
Total	161.28588	39			

Table 9

Means and Standard Deviations for
Acquisition Trials 1-3 (Time on Target)

Treatment Groups	Mean	Standard Deviation
Low anxiety, low stress	3.81599	1.23555
Low anxiety, high stress	3.76999	1.34949
High anxiety, low stress	3.97300	2.22021
High anxiety, high stress	3.63500	3.09497

Table 10

Means and Standard Deviations for
Trait Anxiety Scores

Treatment Groups	Mean	Standard Deviation
Low anxiety, low stress	30.39	3.40
Low anxiety, high stress	32.70	2.79
High anxiety, low stress	41.50	3.06
High anxiety, high stress	43.79	4.02

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by

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CONSOLIDATION THEORY AND THE EFFECTS OF STRESS
AND ANXIETY ON MOTOR BEHAVIOR

The purpose of the investigation was to study the utilization of consolidation theory in the area of motor behavior. There were 40 female subjects used in the investigation who performed a pursuit rotor task. These subjects were categorized into high and low trait anxiety groups according to scores they obtained on the Spielberger Trait Anxiety Inventory. The subjects were also assigned to either a high stress group or a low stress group, in which the high stress group received failure instructions during the acquisition trials on the task. The task was performed on two consecutive days, with 15, 30 second trials performed on the first day (acquisition trials) followed by a 24 hour retention period, and then performance on an additional 10 trials. At the completion of the first 15 trials on the pursuit rotor, the subjects were given the Spielberger State Anxiety Inventory to determine the effects of the failure instructions.

Acquisition scores and learning scores were determined for the subjects and an analysis of variance for repeated measures was conducted on the data. The acquisition scores were recorded as the time the subject was on the target and the data indicated a significant main effect (.05 level) on the trials factor while all other interactions and main effects were insignificant. The learning scores were also calculated using time on target data and was analyzed by a 2(stress)

by 2(anxiety) variance analysis. The results showed there were no reliable differences between treatment conditions.

The state anxiety scores and the trait anxiety scores that were recorded for each subject, were analyzed using an analysis of variance. The data on the state anxiety scores revealed a significant main effect for stress but no interaction between stress and anxiety. The trait scores indicated a reliable difference between stress groups and an unexpected significant difference between anxiety groups.

The results of the study indicated that the effects of various anxiety and stress levels in subjects produced no significant differences with regard to their performance levels and learning achievements on a motor task. Thus, the consolidation theory was not supported by these findings.