THE RELATIONSHIP BETWEEN INTELLIGENCE AND ANXIETY-PRODUCED MOTOR SKILL PERFORMANCE VARIATION

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ABSTRACT

ABRAHAM, Lawrence D.: The Relationship between Intelligence and Anxiety-Produced Motor Skill Performance Variation

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Purpose: The purpose of this study was to investigate the relationship between intelligence and anxiety-produced variations in motor skill performance.

Method of Research: Thirty-six boys were randomly selected from the sixth grade at North Potomac Middle School in Hagerstown, Maryland. Otis-Lennon Mental Ability Test scores were used to divide the sample into three groups: high intelligence, middle intelligence, low intelligence. A simple target test, throwing a tennis ball at a bottle, was used to establish a motor skill performance level for each subject. Anxiety was then produced by the introduction of a small, passive audience and verbal cues by the experimenter. The difference between performances with and without anxiety was used as the test data. Analysis of variance was utilized to determine statistical significance at the .05 level.

Conclusions:

(1) Anxiety produced by the presence of an audience and periodic verbal cues by the experimenter caused a significant change in motor skill performance of sixth grade boys.
(2) Subjects of varying intelligence levels showed no significant difference in motor skill performance variations caused by anxiety.
(3) Subjects of varying intelligence levels showed no significant differences in magnitude of motor skill performance variations caused by anxiety, regardless of the direction of change in performance caused by anxiety.

Approved for the Major Department

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L. A.

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Chapter 1

INTRODUCTION

Athletics in modern culture is a combination of mental and physical endeavor. Today's athlete must use every available means to be able to match his competitors; there are so many participants engaging in every activity that no single performer can achieve victory easily. Many hours of practice and study are necessary to insure a chance of being able to compete on equal terms. In such a situation every factor influencing performance must be considered to determine its possible effects and causes.

One of the most important aspects of athletic performance is psychological. Ogilvie and Tutko claim that anxiety is a basis for psychological effects on performance.

> The hyper-anxious athlete presents a unique problem in that his contribution to your team is endangered by too much drive and dedication. The athlete who seems to burn himself out psychologically prior to actual competition is actually his own enemy. He differs quite significantly from most other problem athletes we have discussed with you in that motivating him is not a problem; rather, the problem will always be to aid him in setting a pace that will prove most beneficial in terms of his future performances. (24:65)

There are several converging theories which constitute this study. The basic theory is the effect of anxiety on motor skill performance. In this theory anxiety is considered a component of drive. Also involved is the

concept of neural pathways formed to produce cognitive and motor processes. The possible influences of anxiety on these neural pathways can be derived from observation of performance. The effect observed may be linked to intelligence, insofar as that construct is also tied to the organization of the brain. Evidence of such a connection is necessary for the mechanism to be fully understood.

These theories form a solid foundation from which athletic coaches can work. Coaching methodology is basically a set of ways to obtain maximal performances from all the individuals of the team. A coach must consider each athlete as an individual and allow him to perform in the environment most conducive to success. If there is a difference in the performance of athletes whose intelligence differs, coaches should be aware of this fact. Much of coaching technique involves manipulating the drive of the athlete to obtain the desired performance. Coaches can and do add extra pressure or try to ease the anxiety for the competitor. Since coaches are prohibited from helping to hit, throw, lift, or run, they must content themselves during actual competition with attacking the psychological factor. Thus, a coach should be able to apply the effects of anxiety on performance to athletes of varying levels of intelligence.

Observation reveals that the influence of anxiety on motor performance varies among individuals. The Yerkes-Dodson Law is cited as the rule of behavior governing the

influence of anxiety on performance. This law, according to Marx and Tombaugh (22), states that the more complex the task the lower the optimal drive level for maximum performance; the simpler the task the higher the optimum drive level. Anxiety as a component of drive implies that the sum of anxiety can influence motor skill performance. Thus, individuals with a high level of anxiety need little further initiative or incentive to achieve well. Conversely, individuals with low anxiety can handle difficult tasks more easily, but need additional drive as the task complexity decreases.

Several methods have been used by experimenters to produce anxiety. Cox (5) related an effective method to be the presence of an audience during performance. Many variables can be found according to the nature of the audience and the performers; but the increase in anxiety is always present.

SIGNIFICANCE OF THE STUDY

Many coaches use specific theories to justify their particular methodology of coaching. These theories often have little statistical basis and are founded upon personal prejudices. The value of scientific exploration into these areas has been justified whenever it has been tried. Training methods, eating regulations, and conditioning programs have been subject to physiological analysis with positive

results. The psychological realm of sport, however, has been more resistant to investigation.

The comparison in this study of intelligence and performance variations was prompted by the possible implications it might have for coaching athletics. Lott and Lott (17) found manifest anxiety to be negatively correlated with intelligence. Manifest anxiety is the individual's normal operating level of anxiety to which external influences add more anxiety. If the effect of the environment be constant among subjects of varying intelligence, then "high intelligence" can be substituted for "low anxious" in the Yerkes-Dodson Law. This switch reveals that intelligent subjects should perform complex skills better under pressure of anxiety-producing conditions than less intelligent subjects. Such a claim is not only worth investigation, it is of great importance to many engaged in competitive athletics.

Many coaches have access to the intelligence scores of their athletes. The possiblity that intelligence tests measure a cortical factor which is related to anxiety and performance is another area worthy of investigation. Should there be such a relationship, coaches would have an additional tool for use in making important decisions involving pressure situations and problem athletes.

STATEMENT OF THE PROBLEM

The purpose of this study was to investigate the relationship between intelligence and anxiety-producing

variations in motor skill performance. More specifically, the following questions were investigated:

1. Does anxiety produced by the presence of an audience and periodic verbal cues by the investigator effect performance?

2. Is there a relationship between intelligence and variations in motor skill performance caused by anxiety?

Statement of the Hypotheses

In order to investigate the above questions, the following hypotheses were tested:

1. There is no significant difference in change of motor skill performance when anxiety is produced by the presence of an audience and periodic verbal cues by the investigator.

2. There is no significant difference in the motor skill performance variations effected by anxiety of students with high, middle, and low intelligence test scores.

Limitations

The following were considered limitations of the study:

1. The subjects in this study were sixth-grade boys at North Potomac Middle School in Hagerstown, Maryland.

2. Anxiety was induced in each case by the same means--introduction of an audience and periodic verbal cues by the investigator. However the subjects may have experienced different levels of anxiety from the same stimuli.

3. The sample size was limited to twelve boys in each of the three groups.

DEFINITION OF TERMS

The following definitions were used for discussion and interpretation in this study:

Anxiety. Anxiety is an emotional response to a situation, producing an inner tension which is similar to drive.

Audience. An audience is four or five peers observing performance in the tournament situation.

Drive. A drive is a motivation toward a certain type of behavior.

Intelligence. Intelligence is that faculty measured by the Otis-Lennon Mental Ability Test. Subjects rated high scored over 115, subjects rated low scored below 100, and subjects rated middle scored between 100 and 115.

Motor skill. Motor skill is muscular movement required to execute a particular act. In this study, the act is throwing a tennis ball at a target on the floor, fifteen feet from the subject.

Motor skill performance. Motor skill performance is a temporary occurrence used as an indicator or measure of motor ability.

Normal score. Normal score is the mean number of target hits of each subject during his last thirty practice throws.

Tournament score. Tournament score is the number of target hits in the final, "championship" round.

Verbal cues. Verbal cues are encouraging statements offered to each subject during competition. (See Appendix D).

Chapter 2

REVIEW OF RELATED LITERATURE

The review of literature related to this study is handled in three parts. The first section deals with relevant aspects of motor performance, including physiology of motor ability, variation in performance, and implications for intelligence. The second section covers the relationship between anxiety and performance, including the Yerkes-Dodson Law, audiences and anxiety, and competition and anxiety. The third section deals with the relationship between intelligence and anxiety.

The hypotheses of this study contain two important concepts, one a documented phenomenon and the other an experimental observation. The first of these concepts is that anxiety affects motor performance. This fact has been the topic for a large amount of research on the part of psychologists and physical educators. The second concept is the relationship between the effect of anxiety on motor performance and intelligence. No study was found which approached the two concepts this way. The only relationships found in the literature were between anxiety and intelligence, or intelligence and performance. The concept that cognitive ability is linked to the variations in motor performance caused by anxiety appears to be unique.

MOTOR PERFORMANCE

The first step toward understanding the phenomenon of anxiety and motor performance is linked to the physiological nature of motor activity. Only by understanding the normal processes involved in performing a motor skill can aberrations be scientifically examined.

Physiology of Motor Performance

Gardner and Osburn (10) related that conscious and coordinated motor action begins in the cerebral cortex. Any of a multitude of sensory stimuli may produce the impulse to action. When the need to activate certain muscles becomes apparent, the cortical neuron is stimulated. The neurons descend through the central nervous system, forming the corticospinal tract or pyramidal system. At the lower level of the medulla, the majority of the neurons cross over the midline, providing the phenomenon of one side of the brain controlling the opposite side of the body. At segmental levels axons turn outward through the spinal cord to activate spinal (lower motor) neurons.

Each nerve ending is connected with a few striated muscle fibers (a motor unit). The motor unit operates on an all or none policy--when the nerve fires, the muscle fibers contract completely. Variations in firing patterns of related muscle groups, antagonistic muscles, and the frequency of impulses controls the observed behavior. Thus the variations in performance which can be observed are due in

large part to the mechanisms of the brain which sort out sensory information and control motor activity.

Reflex action must be ignored in this study, since according to Gardner and Osburn (10) it completely bypasses the brain. Sensory input is converted to motor impulse by an 'association neuron' in the spinal cord at the level of entry. These reflexes are not learned but inherited, and they are entirely without connection to influencing conditions of activity in the brain, with the possible exception of fatigue.

Variations in Performance

At all times a homeostatic level of sporadic nerve firings is present in the nervous system. These impulses, combined with postural reflexes, provide the basic level which is interrupted by concerted action on the part of cortical cells. Under situations of stress or anxiety this homeostasis is disturbed. Selye described this condition:

> Just what happens to us when we are alerted? Being keyed up is a very real sensation which must have a physiochemical basis. It has not yet been fully analyzed, but we know that at times of tension our adrenals produce an excess, both of adrenalines and of corticoids. We also know that taking either adrenalines or corticoids can reproduce a very similar sensation of being keyed up and excitable. For example, a person who is given large doses of cortisone in order to treat some allergic or rheumatoid condition often finds it difficult to sleep. He may even become abnormally euphoric, that is, carried away by an unreasonable sense of well being and buoyancy, which is not unlike that caused by being slightly drunk (35:264).

Increased receptivity and extra impulses constitute interference for the normal movements and provide an

unfamiliar environment in which the brain must operate. It will undoubtedly meet unexpected resistance in other areas. Wilson (43) reported increased muscle tension as a result of increased anxiety. Inhibition of anxiety resulted in muscle relaxation. The unpredictable resistance encountered will result in unpredictable performance; perhaps it will be jerky and unsure, perhaps merely weaker, or perhaps even stronger than expected. Thus motor activity under stress is less consistent, assuming the brain initiates the same impulses down the cortical neurons.

Implications for Intelligence

The exact physiological causes of the change in homeostasis in the brain are as yet undetermined. A possible basis is that the chemical composition at the synapse changes to allow more frequent firing with the normal charge buildup. Another possibility is that cognitive interference in the form of more input maintains a greater amount of cortical activity. Since one of the characteristics of intelligence is the ability of the cerebral cortex to assimilate input, channeling of anxiety-produced cortical activity may be associated with intelligence. According to Ragsdale,

> psychologists have commonly assumed that there is a parallel between the mental and the physical. Theoretically we should be able to find a fairly high correlation between physical and mental traits (28:71).

Ismail, Kane, and Kirkendall (13) conducted a study of intellectual and non-intellectual variables on ninety-four British primary school children. Three general motor items,

two kinesthetic items, seven coordination items based on hopping activities, six balance items, two personality items, and nine intelligence and achievement items were compared by factor analysis. The conclusions indicated that:

> due to the presence of positive significant relationships between four of the motor coordination items and intellectual items, as shown in the correlation matrix, it could be postulated that the motor coordination items involved are either confounded with intelligence or that there is a common neurophysiological process which takes place in performing intellectual as well as motor coordination items. Such a neurophysiological process may be such that it enhances facilitation in performing both intellectual and motor coordination items in high achievers, while it inhibits such facilitation in low achievers. Or the presence of such positive relationships may be due to the similarity of the perceptual process in both the intellectual and motor coordination tasks (13:10).

ANXIETY AND PERFORMANCE

In a study of the effects of anxiety, Lucas concluded that:

> There has been an increasing awareness among psychologists that anxiety possesses definite motivational properties. These properties appear to exist regardless of the criterion of anxiety used. Evidence that anxiety operates as a drive comes from clinical observations as well as from the results of recent experiments (18:59).

The complex ways anxiety affects performance are alluded to in a study of stress and anxiety by Marks (19). Learning performance was concluded to be affected in unknown ways by drive and anxiety. While investigating further, Taylor and Chapman concluded that:

> . . . increases in drive should yield superior performance in experimental situations which arouse a single S-R tendency, but tend to impair performance in situations which evoke several competing response tendencies (40:671).

This agrees with Raymond (29) and Farber and Spence (7) who found that varied drive levels affect performance according to the nature of the task to be performed. Also important, according to Zajonc and Nieuwenhuyse (45), is the amount of practice involved or habit strength developed.

The Yerkes-Dodson Law

The findings of all of the above studies confirm the Yerkes-Dodson Law, which states that complex tasks require lower drive for optimal performance than simple tasks. However many other investigations in the realm of performance have been aimed more specifically at the entire Yerkes-Dodson Law and have proven it conclusively. A few of these are by Montague (23), Spence, Farber, and McFann (36), Spence, Taylor, and Ketchel (37), and Taylor (39). Explanations of the function of high or low normal anxiety with relation to the Yerkes-Dodson Law can be found in the reports of Cratty (6) and Carron (4). That the performance curve is an inverted U-shaped curve as predicted has been also established by Sharma (34) and Marteniuk (20).

Basic to the understanding of anxiety as a form of arousal is the work presented by Ryan (30). He equates arousal with the intensity of motivation.

> The definition of arousal level has usually been in terms of certain physiological measures such as galvanic skin conductance (GSC), pulse rate, respiration, electromyographic (EMG) or electroencephalogram (EEG) recordings (30:279).

Ryan also stated that these measures had been used to establish the validity of performance studies.

Several studies involving the Yerkes-Dodson Law have been particularly applicable to the present investigation. A brief review of this recent research will prove helpful in understanding procedure.

At the University of Washington, Sarason (32) investigated the use of several anxiety scales. After several statistical comparisons the bulk of his findings suggested that high-anxious subjects were affected more detrimentally by motivating conditions or failure reports than were subjects lower in the anxiety score distribution. High-anxious subjects were found to be more self-conscious, particularly when a threat was perceived. Thus the immediate reaction to intense stimulation (anxiety production) was a personalized, self-oriented interfering response. Sarason concluded his report by agreeing with the Yerkes-Dodson Law that as task complexity increased, the disadvantage of high to low-anxious subjects increased.

At Florida State University, Bluhm (3) approached the topic from another viewpoint. Bluhm used an incentive-related Discomfort-Relief Quotient (DRQ) anxiety in a test of discrimination reaction time, varying task difficulty. The result of this study found that higher anxious (DRQ) subjects did not respond faster to the simpler tasks, and the low-anxious subjects did not respond faster in the complex tasks. This disagrees with the Yerkes-Dodson Law, if

reaction time can be compared to task performance (a debatable position). However Bluhm also noted that the possible effects of the item difficulty itself on the anxiety level were not considered.

Audiences and Anxiety

At the University of Illinois, Martens (21) attempted an important type of experiment on motor skill performance. Forty eight subjects were chosen from the top eleven percent and an equal number from the bottom eleven percent of 519 male undergraduates who took the Manifest Anxiety scale. The subjects were taught to perform a coincident timing task scored in milliseconds of deviation. Half of the group was placed in the presence of a passive audience consisting of the peers and the skill was performed. Martens found that once learning occurred, high-anxious subjects performed significantly better than low-anxious subjects for both the alone and audience treatments.

The concept of an audience raising the anxiety level of an individual is very important to many who deal with complex motor skills.

> Palmar sweat print results provided evidence in support of the assumption that the presence of others is a source of arousal. Results clearly indicated that significant increases occurred in the PSI when learning and performing a complex motor task in the presence of passive spectators (21:387).

One factor which was lacking in Martens's experiment was a variation in task complexity. Still it provides valuable insight into the effect of an audience on anxiety level.

The same basic concept was attacked by Cox (5) at the University of Melbourne. Several refinements which were added were the restriction of subjects to fourth grade boys, the composition of the audience (either fathers, male peers, or male teachers), and a verbal analysis on the part of the subjects as to the nature of their experiences. All subjects who were subjected to the intervention of some persons reported that they were affected by this intervention, and that they subsequently tried harder at the task. Cox found that the subjects rated as low-anxious reported an increase in effort that was positively associated with response increments. The high-anxious subjects showed a more complex relationship between effort and performance. Negative relationships were found with audiences of fathers and male teachers, while no relationship was found with an audience of peers.

The assumption that audiences produce anxiety in performers has also been shown by numerous studies in the field. Perhaps one of the earliest was by Gates (11) in 1923. Pessim (27), Travis (41), and Singer (35) also agree that performing before an audience increases anxiety. The size and composition seems to matter very little. In general, as Ganzer found,

> Audience presence is assumed to promote the same effects as are obtained by increasing generalized D states, that is, multiplicatively strengthening dominant response tendencies (9:197).

Several other studies have been performed in the area of audience effects on performance. Bergum and Lehr (2) investigated the effects of authoritarianism on performance. Two groups of twenty subjects each were compared to determine the effect of authoritarian monitoring conditions on vigilance performance. Both groups worked at a light monitoring task for 135 minutes without rest. One group worked alone, and the other group was observed by an officer according to a random visitation schedule. This constituted a particular type of audience which produced intense anxiety, more than a passive audience would have. "The results indicated a highly significant facilitation of detection performance resulting from observation by the officers (2:75)."

Also related to audience effects are studies of social facilitation. These experiments, done mostly with non-human animals, have been very conclusive. Lasagna and McCann (16) found that mice became very agitated in a crowded environment presumably increasing all types of arousal. A study by Zajonc (44) concluded that the presence of an audience increases arousal level.

Competition and Anxiety

A frequent cause of arousal in the world of sports is competition. Two studies were found which documented this mechanism. Ryan and Lakie (31) conducted an extensive study and found, among other things, that competition did indeed contribute to anxiety. In a study of sixth grade students'

performance of seven fitness tests, Strong (38) reported that competition proved to be a strong motivator. The similarity of this study to the present research made the conclusion more important and applicable.

INTELLIGENCE AND ANXIETY

The relationship between intelligence and anxiety has been explored by several psychologists. Since both of these concepts have many unexplored and undefined areas, any further research pertaining to them may aid in explaining some of their characteristics. Intelligence is often approached by many different pathways. Creativity and I.Q. tests are two avenues commonly used. Anxiety has several components measurable separately or combined. Test anxiety and manifest anxiety are examples. Test anxiety is produced by a specific testing situation. Manifest anxiety is a basic level which is considered characteristic of an individual. Other types of anxiety may be added by the environment to produce the sum of anxiety present at any given time.

While investigating manifest anxiety, learning task performance, and other variables, Lott and Lott (17) found manifest anxiety to be negatively correlated with intelligence. Negative relationships have also been found between anxiety and creativity (a common factor in intelligence measurement) by Kobayashi (15). These facts suggest that highly intelligent subjects are commonly low-anxious, while less intelligent subjects are high-anxious.

This conclusion was supported by Hughes (12) in a general study of sixth grade pupils. Hughes also discovered that high intelligence was related positively to high achievement and performance. In a study of the effect of practice on performance, Johnson (14) reported a positive correlation between intelligence and achievement. Contrary to Johnson's conclusions, Perrin (26) found high intelligence to be less involved in solutions of maze puzzles. This psycho-motor skill involved patience, which seemed to come more readily to the less intelligent subjects.

SUMMARY

Evidence has been reviewed which supports the Yerkes-Dodson Law as a fundamental scientific principle. Performance is the result of complex motor and cortical actions which combine in various ways. Both the input and the general neural pathways involved have been examined. The Yerkes-Dodson Law is based on the relationship between the input and the output or performance. Actual motor skill performance is influenced by the amount and type of input (specific stimulus and general arousal), and by the neural processes in the cerebral cortex, which are in turn influenced by habit strength and task complexity.

Intelligence has been introduced as a measure of neural organization, perhaps indicative of some general abilities. The purpose of this study was to determine the

nature of a relationship between intelligence and the variations in performance caused by anxiety.

Numerous experiments revealing the effect of an audience have been cited, thus justifying the use of an audience to produce anxiety in performers. Competition has likewise been reported as an anxiety-producing factor in motor performance.

The few links between intelligence and anxiety which have been reported point to an inverse relationship between the two variables. This situation leads to certain hypotheses. Should these hypotheses be verified, their importance to athletic coaches would be immense. Current literature is unable to provide the necessary facts to support or refute such beliefs. Thus it is important to continue to search for the nature of the relationship between intelligence and anxiety-produced motor skill performance variations.

Chapter 3

RESEARCH PROCEDURES

This chapter describes the nature of the population and sample, selection of the subjects, instrumentation, testing procedure, and statistical methods for analyzing the data. The purpose of this study was to investigate the relationship between intelligence and anxiety-produced variations in motor skill performance. Test results were statistically analyzed to determine the relationship between performance variation and also performance variations and intelligence.

NATURE OF THE POPULATION AND SAMPLE

This study was conducted at North Potomac Middle School in Hagerstown, Maryland. North Potomac Middle School is one of three public middle schools serving the city of Hagerstown. The students at this school come from a wide variety of backgrounds, ranging from inner-city slums to expensive suburban areas.

Subjects were chosen in a random manner with the aid of a school guidance counselor. The population from which the sample was chosen consisted of the 130 males in the 271 member sixth grade class. The subjects chosen came from six different sections of the sixth grade.

Thirty-six male students comprised the sample. The subjects were selected on the basis of intelligence test scores on file in the school guidance office. Scores were divided into one of three groups--high, middle, or low. High scores were over 115, middle scores fell between 115 and 100, and low scores were below 100. These divisions were consistent with score values associated with one standard deviation above and below the median for the entire sixth grade class (see Appendix A). Subjects were chosen at random until twelve scores fell in any one group, at which time subsequent scores in that range were rejected. After all thirty-six scores were selected, the names and sections of the subjects were determined. On the days of testing, two subjects in the high and low groups were absent, causing those groups to consist of only ten members each.

INSTRUMENTATION

The selection of subjects was based on current scores in school files on the Otis-Lennon Mental Ability Test. The test had been administered the previous year and represented the most recent I.Q. scores of the subjects. The test manual included several important aspects to be remembered when using scores.

> The assessment of general mental ability, or scholastic aptitude, with tests such as the Otis-Lennon rests upon the basic assumptions that (1) all pupils have had substantially equal opportunity to learn the types of things included in the test and (2) all pupils are equally motivated to do their best on the test (25:4).

The manual went on to describe the content of the test as . . .

> . . . 80 items arranged in spiral omnibus form. A single total score summarizes performance on this particular test. Various types of verbal and non-verbal items sample a wide variety of mental processes. Emphasis is placed upon the measurement of abstract reasoning ability (25:5).

Six levels of the test have been constructed; Primary I, Primary II, Elementary I, Elementary II, Intermediate, and Advanced. "Selection of items for the tests at the various levels was based upon the results obtained in three separate research studies involving more than 20,000 pupils (25:6)." The level administered for the population in this study was Elementary II.

> It should be clearly understood that the Otis-Lennon tests do not measure the innate mental capacity of the pupil. There is, indeed, no test of mental ability which can support such a claim (25:4).

Therefore one should realize that . . .

> . . . the single total score obtained at a given level summarizes the pupil's performance on a wide variety of test materials selected for their contribution to the assessment of this general ability factor (25:4).

The Otis-Lennon Mental Ability Test yields a score similar to other intelligence tests.

"The Otis-Lennon Deviation I.Q. (DIQ) is, in effect, a normalized standard score with a mean of 100 and a standard deviation of 16 points (25:15)." Further examination reveals the standard error of measurement to be about 5 DIQ points for pupils above age nine.

Three standard methods of determining reliability have been applied to the Otis-Lennon Mental Ability Test, according to the Manual for Administration (25). This booklet states split-half reliability with .95 correlation, Kuder-Richardson reliability with .95 correlation, and alternate forms reliability with .92 correlation. Since the test is fairly new, complete validity studies are currently being collected and will be published in a Technical Handbook to accompany future editions of the test.

Testing Procedure

In order to provide the experimenter with a reasonably small number of subjects at one time, subjects were divided into six subgroups of six students each. All of the students in each subgroup were scheduled for a regular physical education class at the same time. The cooperation of the physical education instructor was obtained to facilitate conducting the experiment.

When the class arrived in the gym, the six subjects were instructed by the teacher to report to the experimenter for special duty. The boys were introduced to the experimenter and received an established explanation (see Appendix B). They were told to try to knock over a target, using a tennis ball, with an overhand throw.

Physical arrangement. The testing was conducted on the gymnasium floor. Two parallel lines fifteen feet apart were marked on the gym floor. One line had three marks

spaced equally along its length. A plastic milk bottle eight inches high and two and one half inches in diameter at the base, was placed on each of the three marks. The subjects who were throwing stood behind the line, each facing his target fifteen feet away. A large box of tennis balls was placed near the throwers. The partners of the throwers stood well behind the targets, to retrieve balls and reset the bottles. A large box was supplied to store the retrieved balls.

Testing. The group of six subjects was divided into three pairs. One member of each pair would throw at the target while his partner acted as ball retriever and bottle resetter. Three subjects threw ten balls each at their targets. Then the throwers exchanged places with their partners, who proceded to throw ten balls. This procedure was repeated until each subject had taken five trials or fifty throws.

Scoring. The experimenter sat in the bleachers on the side of the gym and kept a record of each throw by each subject. Throws were marked as hits or misses. The first two trials or twenty throws were regarded as warm-up throws and the scores were disregarded. The last three trials or thirty throws were used to determine the normal score for the individual subject. The normal score was found by taking the mean of the three scores in the last three trials. That is, the normal score equalled the number of hits in the last thirty throws divided by three (see Appendix E).

Several studies in the field of motor performance have recommended this practice of using an average score. Whitley and Smith (42) found larger correlations using average scores rather than best scores on strength and skill tests. Baumgartner and Jackson (1) also decided that more than one trial should be used to establish a score for an individual. In this study, each trial consisted of ten throws, and three trials were used to determine an individual's score.

Competition

After the five practice trials, the situation was altered. Each of the groups was informed that a contest would be held to determine a champion of the group (see Appendix C). The subjects then took one more trial of ten throws, while the rest of the group watched. The experimenter reminded each subject of the competition before each throw (see Appendix D). The number of hits for each subject was recorded as his tournament score.

In deciding to allow only one trial of ten throws in the pressure or anxiety situation, it was important to keep in mind reports from other experiments. An effort was made to intensify the anxiety to a peak by combining the effects of an audience with constant reminders of the competition. No measure of anxiety was necessary since the stimuli were identical for each of the subjects. The data desired was only the effect of the anxiety as measured through performance

variations, not the level of anxiety reached in each individual. While identical stimuli may not induce the same amounts of anxiety in different individuals, this characteristic of an individual may be part of the phenomenon this study is researching. To eliminate it by correcting for anxiety level variations would be to ignore the outline of this study.

The effect of anxiety is shown most accurately in the first trials after its initiation. If measurement consisted of averaging the results of several trials, evidence points to a diminishing effect due to practice under the stressful conditions. Therefore it was decided to allow only one trial in the competition situation.

STATISTICAL PROCEDURE

The experimental data in this study were collected to compare variations in motor skill performance caused by anxiety with intelligence. The first step in treatment of the data was to determine if the variations measured were significant, that is, if the anxiety actually caused variations in performance. The second step was comparison, between three levels of intelligence, of the variations. This would determine the nature of any relationship between anxiety-produced performance variations and intelligence of a qualitative nature. The third step was to compare the absolute values of the variations in motor skill performance

for the three levels of intelligence, thus discovering any relationship of a quantitative nature.

In each of these tests, analysis of variance was used to determine statistical significance. In each case the .05 level of significance was used to determine if a significant difference existed between the groups.

For each of the three tests, one-way classification analysis of variance, as explained by Ferguson (8), was employed. According to Ferguson, total variance can be divided into two additive parts: between groups and within groups. Thus the following steps are involved:

1. Partition the total sum of squares into two components, a within-groups and a between-groups sum of squares, using the appropriate computation formulas.

2. Divide these sums of squares by the associated number of degrees of freedom to obtain S_w^2 and S_b^2, the within- and between-groups variance estimates.

3. Calculate the F ratio S_b^2/S_w^2 and refer this to the table of F.

4. If the probability of obtaining the observed F value is small, say, less than .05 or .01, under the null hypothesis, reject that hypothesis. (8:215)

Chapter 4

ANALYSIS OF THE DATA

This chapter contains a discussion of the statistical analysis of the data to support or refute the hypotheses. It contains the following sections: significance of difference between normal scores and tournament scores, significance of difference between high, middle, and low intelligence groups for mean variation in motor skill performance due to anxiety, and significance of difference between high, middle, and low intelligence groups for mean absolute value of variation in motor performance due to anxiety.

The purpose of this study was to investigate the relationship between intelligence and anxiety-produced variations in motor skill performance. The measure of intelligence was determined by the Otis-Lennon Mental Ability Test scores recorded in school files. The variation in motor skill performance was determined by first measuring a normal score and a tournament score for each individual subject. The variation was then found by subtracting the normal score from the tournament score, yielding a positive value if anxiety produced an increase in raw score (see Appendix F).

SIGNIFICANCE OF DIFFERENCE BETWEEN NORMAL SCORES AND TOURNAMENT SCORES

The first step in analyzing the data collected in this study was to test the first hypothesis. This hypothesis stated there is no significant difference in change of motor skill performance when anxiety is produced by the presence of an audience and periodic verbal cues by the investigator. In order to accurately judge the significance of the difference between normal and tournament scores, an analysis of variance was performed on the mean values of both scores. A complication existed in the presence of positive and negative increments in performance. If the data were treated as collected, positive and negative increments would cancel each other out, yielding typically no significant difference. This is better understood if the Yerkes-Dodson Law is recalled. Anxiety would predictably improve some individuals' performance while limiting that of others. To eliminate this cancelling effect, the absolute value of change was considered, regardless of its direction. This value was considered as the amount of change caused by anxiety. With this correction, the analysis of variance was performed.

The F ratio of 23.7419 was significant at the .01 level of significance. Of the thirty-two scores in the sample, only five failed to show any change, and only nine failed to change more than .33 (see Appendix H).

Table 1

Analysis of Variance between Mean Normal Score and Mean Tournament Score, using Absolute Value of the Differences

Source	df	ss	Ms	F	p
between groups	1	31.6266	31.6266	23.7419	p .01
within groups	62	82.5954	1.3321		
Total	63	114.2220			

significant at the .05 and .01 level

SIGNIFICANCE OF DIFFERENCE BETWEEN HIGH, MIDDLE, AND LOW INTELLIGENCE GROUPS FOR MEAN VARIATION IN MOTOR SKILL PERFORMANCE DUE TO ANXIETY

A second hypothesis of this study was that there exists no significant difference in the motor skill performance variations effected by anxiety of students with high, middle, and low intelligence test scores. Variations were determined by subtracting the normal score from the tournament score. The mean variation for the high intelligence group was 0.467. The mean variation for the middle intelligence group was -.056. The mean variation for the low intelligence group was 0.867. An analysis of variance was performed on these data.

The F-ratio of 0.696 was not significant at the .05 or the .01 level of significance. Of the thirty-two scores in the sample, sixteen were changed in a positive direction, five remained the same, and eleven changed in a negative

direction. The largest positive change was 4.00 and the largest negative change was -3.33 (see Appendix H).

Table 2

Analysis of Variance between High, Middle, and Low Intelligence Groups for Mean Variations in Motor Skill Performance due to Anxiety

Source	df	ss	Ms	F	p
between groups	2	4.4	2.2	0.696	N.S.
within groups	29	91.738	3.163		
Total	31	96.138			

not significant at the .05 or .01 level

SIGNIFICANCE OF DIFFERENCE BETWEEN HIGH, MIDDLE, AND LOW INTELLIGENCE GROUPS FOR MEAN ABSOLUTE VALUE OF VARIATION IN MOTOR SKILL PERFORMANCE DUE TO ANXIETY

When the above data had been collected, there arose the possibility of an additional and valuable test. The test for a significant difference in variations caused by anxiety among groups of varying intelligence had yielded no significant difference. Yet it was possible for a significant difference to be present. That test had determined that there was no predictable direction in which performance would vary when anxiety increased for a given level of intelligence. However with the available data it was also possible to determine whether the amount of variation, or magnitude of change, differed from group to group. Since the anxiety-

producing stimuli remained constant, the absolute values of the subjects' variations were the magnitude of change values.

To test for a relationship, an analysis of variance was performed on the mean absolute value of variation for the high, middle, and low intelligence groups.

Table 3

Analysis of Variance between High, Middle, and Low Intelligence Groups for Mean Absolute Value of Variation in Motor Skill Performance due to Anxiety

Source	df	ss	Ms	F	p
between groups	2	0.5515	0.2757	0.2126	N.S.
within groups	29	37.6045	1.2967		
Total	31	38.1560			

not significant at the .05 or .01 level

The F-ratio of 0.2126 was not significant at the .05 or the .01 level of significance. The mean change for the high intelligence group was 1.600. The mean change for the middle intelligence group was 1.306. The mean change for the low intelligence group was 1.332.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter contains a summary of the study, conclusions drawn from the statistical data, and recommendations for additional studies.

SUMMARY

The purpose of this study was to investigate the relationship between intelligence and anxiety-produced variations in motor skill performance. It was hypothesized that knowledge of such a relationship would prove valuable to coaches, physical educators, and others interested in motor skill performance. Implications for organization of practices, coaching technique, testing conditions, and personnel utilization added to the importance of the study.

In order to test the hypotheses of this study, thirty-six sixth grade boys from the North Potomac Middle School in Hagerstown, Maryland were selected as subjects. Each of the subjects was asked to throw a tennis ball at a plastic bottle fifteen feet away. Five trials consisting of ten throws each were used to establish a normal score for each subject. The experimenter then changed the conditions by adding a small, passive audience and introducing competition. Ten more throws were taken by each subject to establish a tournament

score. These two scores, together with the subjects' Otis-Lennon Mental Ability Test scores, were used to test the hypotheses (see Appendix F).

Analysis of variance of the tournament scores and normal scores was used to test the first hypothesis. A significant difference was found at the .01 level. Only five subjects failed to change, and only nine subjects failed to change more than .33. Thus performance under anxiety-producing conditions was different from performance under normal conditions.

In order to test the second hypothesis, an analysis of variance was performed on the mean variation in performance for the high, middle, and low intelligence groups. Subjects were divided into three groups according to Otis-Lennon Mental Ability Test scores. The high group scored over 115, the middle group scored between 115 and 100, and the low group scored below 100. Although the mean variation for the low group was twice that of the high group, there was no significant difference between any two groups at the .05 level of significance.

A third possibility to be tested arose after the data had been collected. An analysis of variance was performed on the absolute values of the mean variations in performance for the high, middle, and low intelligence groups to determine if the magnitude of change differed significantly between groups. The results were not significant at the .05 level

CONCLUSIONS

Within the limitations of this study, the following conclusions appear justified:

1. Anxiety produced by the presence of an audience and periodic verbal cues by the experimenter caused a significant change in motor skill performance of sixth grade boys.

2. Subjects of varying intelligence levels showed no significant difference in motor skill performance variations caused by anxiety.

3. Subjects of varying intelligence levels showed no significant differences in magnitude of motor skill performance variations caused by anxiety, regardless of the direction of change in performance caused by anxiety.

RECOMMENDATIONS

Based on the findings of the present study, the following recommendations for additional studies are made:

1. A replication of this study should be conducted using a larger sample of subjects in each group.

2. Replications of this study should be conducted using other age levels for the sample.

3. A similar study using another type of performance measurement should be conducted.

4. A similar study using other means of inducing and measuring anxiety should be conducted.

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APPENDICES

APPENDIX A

OTIS-LENNON MENTAL ABILITY TEST SCORES

Test Scores	Total Population*	Sample
135-139	4	1
130-134	4	0
125-129	16	1
120-124	33	5
115-119	34	5
110-114	34	0
105-109	46	5
100-104	37	7
95-99	26	3
90-94	20	5
85-89	8	3
80-84	7	1
75-79	1	0
70-74	1	0
Total	271	36
Median	108	105

*sixth grade class at North Potomac Middle School

APPENDIX B

INTRODUCTION OF EXPERIMENT

I am conducting an experiment to see if throwing a ball at a target is a good test for physical education students. You all know how gym teachers give you tests to see how good you are; push-ups, sit-ups, running, and other activities. The important thing is for a test to measure your ability accurately. I am trying to see if there are other tests for gym students. So I want to see if the scores you get are consistent. It doesn't matter how many times you hit the target, but that you do your best each time you try. You will get five trials of ten throws each trial to knock down these bottles. I will pair you up so you take turns with your partner, one throwing and the other catching and setting the bottle back up. You are to throw overhand, but don't throw too hard because you might get tired too soon. The throwers stand behind this line, and the catchers stand behind the bottles. To count as a hit, the ball must knock the bottle over before bouncing or touching the floor.

APPENDIX C

EXPLANATION OF COMPETITION

Now everyone has thrown at the bottles fifty times. You are so good that I'd like to have a contest to see who in this group is the best thrower. To be fair, each of you will get ten more tries. You will throw one at a time, and I will count the number of hits. Take your time and don't miss, because you may need ten hits to win. Remember that this is a contest to find out who is the best thrower. All of you who are not throwing will sit and watch while the thrower is at his mark. His partner will catch the balls and set up the bottle as before.

APPENDIX D

LIST OF CUES

One remark was inserted by the experimenter before each throw.

1. Every throw counts--you only get ten tries.
2. You can't afford any misses.
3. You can hit more than these guys.
4. You can do better.
5. Show these guys how to do it.
6. Take careful aim.
7. Every hit helps.
8. Take your time.
9. You need every one.
10. This is your last throw, make it good.

APPENDIX E

TEST RESULTS

Subject	IQ	Trials 1	2	3	4	5	Competition
1	123	1	1	2	0	0	4
2	119	2	2	1	2	2	0
3	139			ABSENT			
4	121	0	1	2	2	3	4
5	116	0	4	3	0	0	1
6	118			ABSENT			
7	117	3	5	4	2	3	1
8	115	0	1	2	1	0	3
9	122	5	0	2	2	4	4
10	121	2	1	2	1	2	3
11	122	1	2	3	2	4	1
12	126	4	1	0	1	0	1
13	100	2	0	1	0	0	2
14	104	1	1	3	0	0	0
15	105	1	3	2	2	2	2
16	105	1	2	2	4	3	2
17	103	1	2	0	4	2	2
18	103	2	2	1	2	2	0
19	106	1	1	2	1	2	2
20	101	1	0	0	2	1	0
21	109	1	0	0	1	2	5
22	108	1	2	2	2	2	2
23	101	2	2	0	3	1	3
24	104	6	1	6	5	5	2
25	92	1	3	0	3	2	4
26	96	2	2	0	1	0	3
27	94	4	1	2	1	1	0
28	93	0	3	2	1	2	1
29	92	1	3	2	3	0	2
30	99	2	1	1	1	1	3
31	91	2	2	0	3	1	1
32	96			ABSENT			
33	85	0	0	0	0	0	0
34	85	1	0	1	0	1	1
35	88			ABSENT			
36	95	2	0	3	3	2	6

APPENDIX F

TEST RESULTS COMPILED

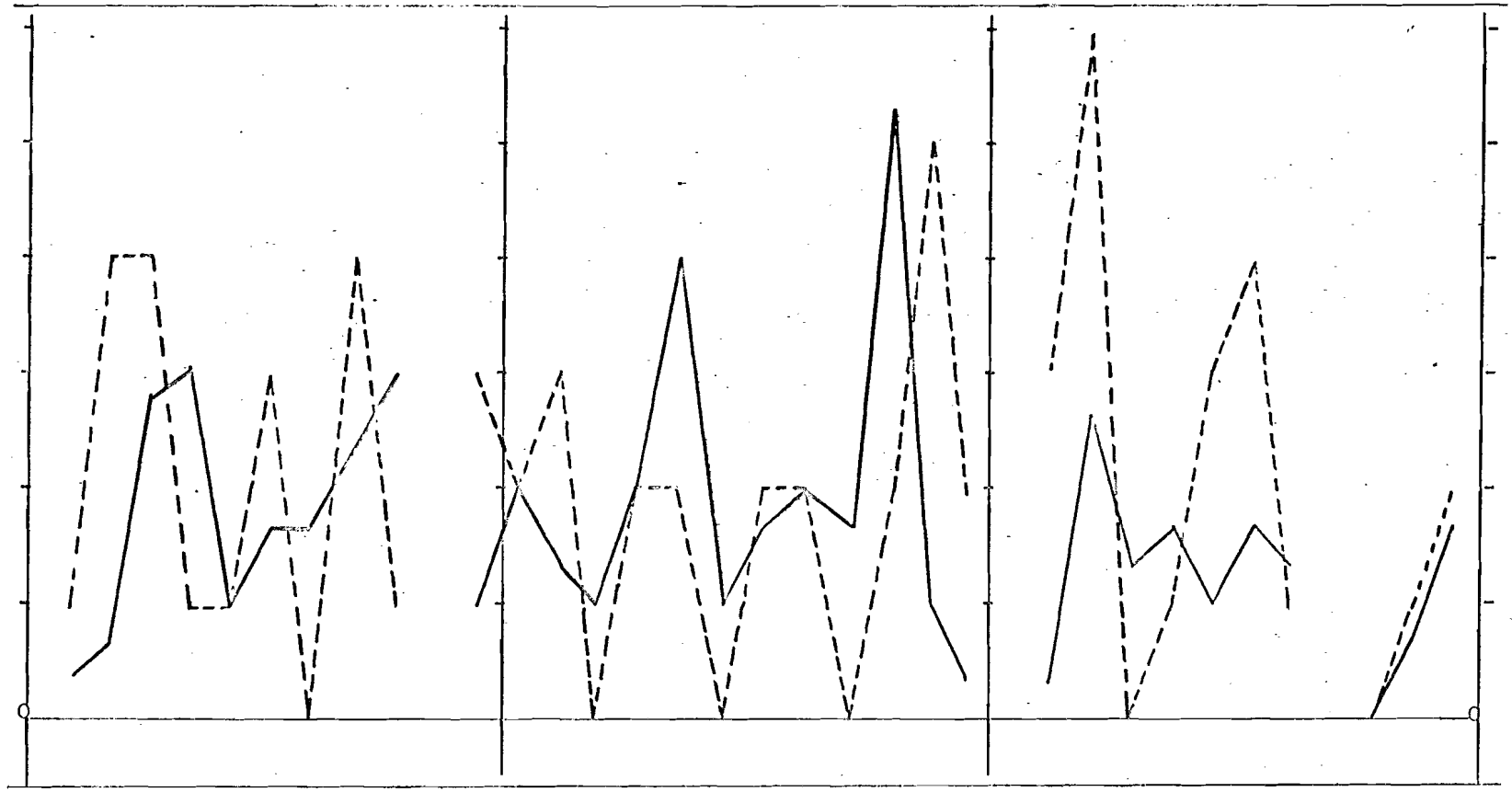
Subject	IQ	Normal Score	Tournament Score	Variation
1	123	0.67	4.00	+3.33
2	119	1.67	0.00	-1.67
3	139	ABSENT		
4	121	2.33	4.00	+1.67
5	116	1.00	1.00	0.00
6	118	ABSENT		
7	117	3.00	1.00	-2.00
8	115	1.00	3.00	+2.00
9	122	2.67	4.00	+1.33
10	121	1.67	3.00	+1.33
11	122	3.00	1.00	-2.00
12	126	0.33	1.00	+0.67
13	100	0.33	2.00	+1.67
14	104	1.00	0.00	-1.00
15	105	2.00	2.00	0.00
16	105	3.00	2.00	-1.00
17	103	2.00	2.00	0.00
18	103	1.67	0.00	-1.67
19	106	1.67	2.00	+0.33
20	101	1.00	0.00	-1.00
21	109	1.00	5.00	+4.00
22	108	2.00	2.00	0.00
23	101	1.33	3.00	+1.67
24	104	5.33	2.00	-3.33
25	92	1.67	4.00	+2.33
26	96	0.33	3.00	+2.67
27	94	1.33	0.00	-1.33
28	93	1.67	1.00	-0.67
29	82	1.67	2.00	+0.33
30	93	1.00	3.00	+2.00
31	92	1.33	1.00	-0.33
32	90	ABSENT		
33	85	0.00	0.00	0.00
34	86	0.67	1.00	+0.33
35	88	ABSENT		
36	95	2.67	6.00	+3.33

APPENDIX G

TEST SCORES COMPILED

SUBJECTS ARRANGED ACCORDING TO IQ

3 12 1 9 11 5 10 2 4 7 6 8 22 23 20 15 16 14 19 17 18 24 21 13 32 26 36 27 28 30 25 31 35 33 34 29



tournament score - - - - - - - - normal score ————————

APPENDIX H

MOTOR SKILL PERFORMANCE VARIATIONS

SUBJECTS ARRANGED ACCORDING TO IQ

3 12 1 9 11 5 10 2 4 7 6 8 22 23 20 15 16 14 19 17 18 24 21 13 32 26 36 27 28 30 25 31 35 33 34 29