Chapter III

PROCEDURE

In this chapter the procedure adopted for the selection of subjects, selection of variables, reliability of data, collection of data, experimental variables and the statistical techniques for analysing the data have been described.

Selection of Subjects

Two fitness groups (n = 30 each) were selected as subjects for the purpose of this study. For selecting these fitness groups AAHPER Youth Fitness Test\(^1\) was administered to all the male students of classes 9, 10 and 11 of the Kendriya Vidyalaya No.1, Gwalior. Before the actual recording of the performances of all the students on the AAHPER Test, reliability of the performances was established by using test-retest method. For this purpose the performances of 10 randomly selected students were taken twice on this test under similar conditions.

and the reliability coefficients obtained by correlating the test-retest scores for all the items of AAHPER test have been presented in Table 1.

**TABLE 1**

**RELIABILITY COEFFICIENTS OF TEST-RETEST SCORES ON AAHPER TEST ITEMS**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Items of AAHPER Test</th>
<th>Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pull-up</td>
<td>0.83*</td>
</tr>
<tr>
<td>2</td>
<td>Bent Knee Sit-up</td>
<td>0.85*</td>
</tr>
<tr>
<td>3</td>
<td>Standing Broad Jump</td>
<td>0.90*</td>
</tr>
<tr>
<td>4</td>
<td>Shuttle Run</td>
<td>0.87*</td>
</tr>
<tr>
<td>5</td>
<td>50 Yards Dash</td>
<td>0.88*</td>
</tr>
<tr>
<td>6</td>
<td>600 Yards Run/Walk</td>
<td>0.30*</td>
</tr>
</tbody>
</table>

*N = 10

*Significant at .01 level.

As the reliability coefficients were very high the performances of students on AAHPER Test were recorded and these were considered highly reliable.

According to their performances on the said test all the 140 students who completed the test were ranked in order from high to low from which top and bottom
20 percent were selected as subjects for high fitness group and low fitness group respectively. Further to provide for dropouts due to unforeseen circumstances like sickness, injury etc. two more subjects were included in each group from the ranked performances according to high and low fitness scores. Therefore, each group had 30 subjects.

The selection of only top 20 percent and bottom 20 percent was made to provide for greater variation and wider gap in the fitness levels \( t = 24.76 \) against \( t_{.01} \) df 58 = 2.67, so that real differences in high and low fitness groups before and after the inducement of the physical and the mental fatigues separately, on the psychophysiological variables could be observed without overlappings, if any. This had a further support of the work done by Heale and Wearing who also selected only top and bottom 20 percent of their population while studying the physical and physiological differences between most fit and the least fit.

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Administration of AAHPER Youth Fitness Test

As the selection of subjects for this study was based on the performances of male students of classes 9, 10 and 11 of Kendriya Vidyalaya No.1, Gwalior, the test was administered to all the students in the following manner:

The cooperation of physical education teachers of Kendriya Vidyalaya No.1, Gwalior and the selected Master of Physical Education classes students' of Lakshmibai National College of Physical Education, Gwalior was sought to conduct this test according to the prescribed procedures and to give adequate training to the students prior to the test to elicit true performances to grade their levels of capacity.

For administering the test a 200 yards track was marked in the football field of Kendriya Vidyalaya No.1 and the other stations to conduct other items, were set-up in the school grounds. On the day of the test, the students of all the three classes were exhorted to put in their best performances. The test was administered strictly in accordance with the prescribed procedures.

All items of the test were administered in the
evenings between 3.00 p.m. and 5.00 p.m. on all days till the completion of the test. The test items administered were as described below:

**Pull-up**

Each subject performed as many pull-ups as he could possibly do, in the manner described below, from a horizontal bar of appropriate height so that the feet of the tallest boy did not touch the floor when performing the test.

In taking this test, the subject hung from the bar by his hands with forward hand grip and chined himself as many times as he could. In executing the movement, he was asked to pull himself up until his chin was even with his hands, and then lower himself until his arms were straight. The subject was not permitted to kick, jerk or use a kip motion.

The number of completed pull-ups was recorded as the score on this test.

**Bent Knee Sit-up**

Each subject did as many sit-ups as he could do, in one minute, in the manner described below:

The subject assumed a supine lying position,
knees bent at an angle of less than 90 degrees, and hands clasped behind neck. The feet were held down by a partner. To perform sit-ups, the subject brought his head and elbows upward in a curl-up motion, touching elbows forward to the knees. In returning to the supine position it was ensured that the elbows touched the floor each time.

The number of completed sit-ups in one minute was recorded as the score for this test.

Standing Broad Jump

A take off line was drawn near one edge of a jumping pit. The subject was asked to take his position with toes just behind the take off line, and feet slightly apart. Taking off from both the feet simultaneously, he jumped to cover the maximum possible horizontal distance, landing on both feet. While jumping, he was asked to crouch slightly and swing the arms to aid the jump. Three trials were given and the best of the three jumps was recorded as the standing broad jump performance.

The horizontal distance between the take off line and the nearest break made in landing was measured and recorded to the nearest centimeter as the score on this test item.
Shuttle Run

Two parallel lines were marked on the ground, ten yards apart. For this test item the starting and the finishing lines were the same. Two wooden blocks were placed behind the restraining line. Each subject positioned himself behind the starting line and on the preparatory command ready "go" he ran to the opposite end line, picked up a block, ran back to the starting line, placed the block behind it, ran back and picked up the second block and carried it across the starting line.

The timing was clocked from the starting to the carrying of the second wooden block across the starting line to the nearest one-tenth of a second. Two trials were allowed and the better timing, was recorded as the score on this test item.

50 Yard Dash

Two parallel lines were marked on the ground at 50 yards distance from each other. One of these served as the starting line and the other the finish line.

Four subjects selected at random were started at a time with a clapper and two time keepers for each subject recorded the time taken to cover the distance of 50 yards.
The slower timing of the two watches, corrected to the nearest one-tenth of a second was recorded as the score for each subject in this test item.

**600 Yard Run Walk**

This test item was conducted in 200 yards track marked for this purpose in the school football field.

Four subjects selected at random were started off with a clapper with the instruction to finish the distance of 600 yards preferably by running throughout and when it was not possible, resort to walking but complete the total distance. Two time keepers at the finish line took the timing of each subject.

The slower timing of the two watches was the score recorded in minutes and seconds for this test item for each subject.

To get the total performance of a subject on the AAMPER Test the performances on all the test items were converted into standard scores and the average of all the six items constituted the composite score for each subject on this test. The test scores obtained were used for the purpose of ranking. The top 20 percent subjects and the bottom 20 percent subjects
were selected for the study, as high and low fitness
groups respectively.

Selection of Variables

Proficiency in any sport requires the ideal
combination and interaction of numerous abilities
developed to an ideal degree. However, performance
measures of these abilities vary from activity to
activity.

Edwin Fleishman, Director of American Institutes
for Research, completed numerous research investigations
on the nature of human abilities and their relationship
to task proficiency. He identified the dimensions
underlying human performance in two categories: the
physical proficiency (fitness) area and the psychomotor
(pycho-physiological) area. The factors of strength,
power, stamina, flexibility, coordination and balance
constituted the physical proficiency whereas reaction
time, speed of movement (response time), arm-hand
steadiness, visual perception, manual dexterity and
rate control were the abilities considered under
psychophysiological area.4

4Singer, Myths and Truths of Sport Psychology,
p.43.
To study the psychophysiological performance variations as a result of induced physical and mental fatigues in high and low fitness groups the psychophysiological variables of reaction time, speed of movement, hand steadiness and depth perception were selected out of the variables mentioned earlier as they represent the performance of an individual in terms of quickness of reactivity, muscle-twitch speed, motor stability and coordination, and visual efficiency and judgement respectively. The selection of these variables was also based on the feasibility criteria; the nature of subjects and the facilities available to conduct the tests, and their high relevancy to the present study.

Reliability of Data

The reliability of data was ensured by establishing the instrument reliability, tester competency and reliability of tests, and the subject reliability.

Instrument Reliability

The stop watches used for measuring performance of students in 50 and 600 yards runs and to record the time score of subjects for hand steadiness were all calibrated, Swiss made and supplied by Krishna Watch Co., Bombay, whereas the steel tape used to measure the
performance of students in standing broad jump, and the metric scale used for measuring speed of movement of subjects were of standard quality and which were also calibrated.

Reaction time was measured by using electronic reaction time apparatus which was manufactured and supplied by Anand Agencies, Pune. This instrument had the transistorised chronoscope showing time upto four decimal places, and hence, it was accepted accurate enough for the purpose of this study.

The Steadiness Tester was supplied by the National Psychological Corporation, Agra which was considered quite reliable for measuring hand steadiness.

Depth perception was measured by using Depth Perception Box manufactured by Biological Concern, Calcutta, a leading firm in the manufacture and supply of the instruments and equipments used in psychological and physiological research. It was, therefore, accepted as reliable for the present study.

Electrical Ergometer used in this study to induce physical fatigue was manufactured and supplied by Venky Engineering, Madras, the accuracy of which was guaranteed. It also had the direct arrangement to
change and control the load.

Instrapulse Digi Max 5000 employed in this study to record the pulse rate of subjects while they were pedalling the ergometer was manufactured by the Hindustan Scientific Instrument Company, New Delhi. This was an electronic instrument which recorded pulse rate along with blood pressure directly, and its accuracy was ensured by the manufacturers.

Thus all the instruments used for various measurements were considered reliable and precise enough for purposes of this study.

Tester Competency and Reliability of Tests

The tester competency was evaluated together with reliability of the tests. To determine the reliability of tests, the performances of 10 subjects (five each from high and low fitness groups) selected at random were recorded twice, on the psychophysiological variables of reaction time, speed of movement, hand steadiness and depth perception under identical conditions by the scholar. A Pearson's Product Moment Correlation was computed between the two measures of each variable and these reliability coefficients are shown in Table 2.
**TABLE 2**

**RELIABILITY COEFFICIENTS OF TEST-RETEST SCORES**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Tests</th>
<th>Coefficients of Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reaction Time Test</td>
<td>.95*</td>
</tr>
<tr>
<td>2</td>
<td>Nelson Speed of Movement Test</td>
<td>.78*</td>
</tr>
<tr>
<td>3</td>
<td>Hand Steadiness Test</td>
<td>.92*</td>
</tr>
<tr>
<td>4</td>
<td>Depth Perception Test</td>
<td>.97*</td>
</tr>
</tbody>
</table>

*Significant at .01 level.

From the test-retest coefficients of correlation (Table 2) it was obvious that the tester reliability was significantly high, establishing the competency of the scholar to administer the tests.

The correlation coefficients also indicated the reliability of the tests selected, as very high correlations were obtained, when the tests were repeated.

**Subject Reliability**

The above test-retest method also established that subject reliability was significant at .01 level of confidence, as the same subjects were used under
similar conditions by the same tester and no motivational techniques were used on both occasions or training given to them between test and retest.

**Pilot Study**

A pilot study was conducted on ten subjects (five from each fitness group) selected at random for fixing the duration of the mental fatigue test to follow the uniformity in terms of time so that each subject could be put through the same demands of mental work, and also to simplify the procedure, as the actual procedure required the subject to multiply continuously the numbers given in the columns and put a horizontal line at the end of every two minutes intervals when a signal was given, between the columns he was multiplying and below the last multiplied value written by him till that time. After finishing the test the mistakes committed in each two minutes interval were noted and the interval in which more mistakes were committed decided the time for setting in of mental fatigue. This pilot study on the ten subjects revealed that nine out of ten subjects committed more mistakes between 18th and 20th minute from the start of the test. Therefore, the total duration of this test for all the subjects was fixed at 20 minutes for the purpose of this study.
Collection of Data

The necessary data on the selected psychophysiological variables was collected by administering the test of these variables, before and after inducing physical fatigue and mental fatigue on separate days in the Research Laboratory of the Lakshmibai National College of Physical Education, Gwalior. Three scores for each variable selected were obtained i.e. performances on a particular variable without fatigue, after physical fatigue and after mental fatigue on that variable. After inducing a particular fatigue the data on a single variable was collected only on that day and to avoid the fatigue effects being carried over at least a day's gap was provided to all the subjects.

Reaction Time Data

The reaction time was measured by the Test of Reaction Time on Anand$^5$ Electronic Reaction Time Apparatus (Fig.1). This test was preferred to other tests available as the instrument measures reaction time directly and accurately. The other available

Fig. 1. Measurement of Reaction Time
test for measuring reaction time, the Nelson Reaction Time Test\textsuperscript{6} was not used as it involved a long procedure of administration and was not considered accurate enough, because the time could not be read directly.

The procedure of reaction time test was explained and demonstrated to all the subjects before it was administered. No motivational technique was used but the subjects were asked to do their best.

For measurement of reaction time the apparatus was set according to prescribed procedure. The detachable screen was fixed in the desired holes which divided the reaction time apparatus into two sides the subject's side and the tester's side. The subject sat in a chair on subject's side and the tester stood on the tester's side. The tester rang a bell, which was a signal for the subject to press the right or left key as selected by tester with selector switch. Then the tester pressed one of the short keys giving the required stimulus (light). The short key was a double key which gave the stimulus and also started the chronoscope.

As soon as the subject received the light stimulus, he lifted his finger from the right or left key which stopped the chronoscope and the reaction time to the light stimulus was read and recorded from the chronoscope. Three trials were provided to each subject and the average of the three readings was the reaction time score.

**Speed of Movement Data**

Nelson Speed of Movement Test\(^7\) was used to measure speed of movement. Some other tests referred to the electrical circuit procedure for measuring speed of movement but the details of these were not available and hence could not be considered. Nelson's test was meant to measure the combined reaction and speed of movement of the hands and arms and was found suitable for both sexes and all ages. The equipment needed was a metric scale, table and chair, and a chalk piece.

Before conducting the speed of movement test, all the details of the test were clearly explained to the subjects and each subject was given five practice trials.

\(^7\)Ibid., p.220.
at the beginning to familiarise him with the procedure of the test.

The subject was seated in a chair, facing the table, with his hands resting over the edge of the table. The palms were kept facing each other with the inside border of the little fingers resting along two lines which were marked on the edge of the table 12 inches apart. The research scholar held the scale near the top so that it hung midway between the subject's palms with the "base line" of the scale positioned evenly with the upper edges of the subject's index fingers and subject looked on the concentration zone (Fig.2). After a preparatory command "ready" the meter scale was dropped and the subject stopped it as quickly as possible with an inward horizontal movement of arms (Fig.3).

Only three trials were given to each subject (as the twenty trials according to prescribed procedure were not considered favourable to study the fatigue effects immediately after the inducement of fatigue) and the distance the scale fell through the hands before it was stopped everytime was recorded. The average of the three trials was taken as the distance score. This distance score was then converted to time score by applying the following formula:
Fig. 2. Measurement of Speed of Movement: Ready Phase

Fig. 3. Measurement of Speed of Movement: Completion Phase
Time = \sqrt{\frac{2 \times \text{Distance the scale falls}}{\text{Acceleration due to gravity}}}

Hand Steadiness Data

The hand steadiness was measured by the Test of Hand Steadiness on the Steadiness Tester, supplied by the National Psychological Corporation, Agra. This apparatus had nine holes of different diameters arranged in sequence from big hole to small hole, four in the top row and five in the bottom row and a light indicator (Fig. 4). There was an electrical circuit key which was attached to the light indicator as well as to the different holes which when inserted in a hole and touched any side of the hole put the light indicator on and this was a signal for the error score to be recorded which was written under a particular hole as all the holes had been assigned certain error score.

Prior to the hand steadiness data collection each subject was given five trials at the beginning to facilitate orientation into the procedure of this test.

For measurement of hand steadiness the subject sat in a chair and held the key in the hand he preferred. The hand holding the key was not allowed to touch any part of the hand steadiness apparatus. When the subject was ready, on the command "start" he inserted the key
Fig. 4. Measurement of Hand Steadiness
one by one in all the holes as fast as he could because the time was also clocked to complete all the holes. The stopwatch being started on the command "start" and stopped after the key was inserted in the last hole. The test desired the subject to insert the key in the sequence in which they were given from bigger hole to smaller hole. Whenever the light indicator was put on, the error score of that hole in which the key was inserted at that time was noted and the total error score was recorded in this manner.

Three trials were given to each subject and the average of the three total error scores and the three time scores were recorded as the error score and time score for each subject. This error score and time score were then converted to standard scores (Z-scores) and the average of these two constituted the hand steadiness score for each subject.

In this test greater error score and more time taken to complete all the holes meant lack of steadiness and vice versa, and the standard scores were assigned accordingly, in a reverse manner less time for more points.

Depth Perception Data

The depth perception was measured by using Depth
Perception Box, supplied by the Biological Concern, Calcutta. This box contained three steel rods of similar diameters which could be seen through the slit against an illuminated white background. Two of the rods (outers) were fixed rods whereas the middle rod (inner) could be moved towards or away from the observation slit. A metric scale on the top of the box indicated the distance of the movable rod from the fixed rods on either side as desired. The centre point of the metric scale which was directly above the line joining the fixed rods was marked zero, and the scale read from zero to fifty centimetres on either side of zero. An iron plate of similar width as that of the box but projected upwards prevented the subject to see the metric scale.

Before collecting the data on depth perception all the subjects were explained the test clearly and the necessary amount of practice trials were given to all till they became familiar with the procedure of the test.

The subject sat on a stool of adjustable height in such a position that the observation slit of the box was in level with his eyes and at such a distance from where he could see the steel rods only against the illuminated white background and no other part inside
the box. The research scholar stood on one side of the box (Fig. 5) and moved the middle rod towards inner side of the box (slit side) and then slowly towards fixed rods (inner to middle) and asked the subject to indicate when he (subject) felt that the middle rod had come in line with the fixed rods. The research scholar noted the actual distance from the zero mark. Similarly outer to middle (from illuminated white background side to middle) the rod was moved and reading noted.

Three trials each from inner to middle and from outer to middle were given to each subject and the least distance for both sides out of the three trials was taken as the depth perception score. This score was further rounded off to the nearest centimetre as per the prescribed procedure.

The inner to middle score and the outer to middle score were then correlated to reduce the depth perception score to single instead of two scores but based on a very high correlation \( r = .91 \).

Depth perception was selected as it had greater relevancy with the games field since in both the person has to make judgement in relation to three dimensions.
Fig.5. Measurement of Depth Perception
Experimental Variables

Physical fatigue and mental fatigue were the two experimental variables, the effects of which were studied on the psycho-physiological variables of reaction time, speed of movement, hand steadiness and depth perception. The effects of these two types of fatigues on the said psychophysiological variables of high and low fitness groups were also compared.

Physical Fatigue

Physical fatigue was induced by cycle ergometer test (continuous loading method) in which the subject was asked to pedal the cycle ergometer continuously (load was fixed by trial) till his pulse rate reached between 150 and 170 bpm the criterion fixed to judge the inducement of physical fatigue and the pulse rate was noted by Intrapulse - an instrument which measures pulse rate along with blood pressure (Fig.6). As soon as the subject's pulse rate reached to the judgement criterion value of 150 to 170 bpm, he was tested on the psycho-physiological variables of reaction time, speed of

8Mathew and Fox, Physiological Basis of Physical Education and Athletics, p.505.
Fig. 6. Physical Fatigue Inducement
movement, hand steadiness and depth perception separately.

Mental Fatigue Test

In case of the mental work, it is not the difficulty of the task in the usual sense which determines the severity of the fatigue decrement, but rather its sameness, continuity and uninterestingness.  

So the mental fatigue was induced by using a standard test of mental fatigue supplied by the National Psychological Corporation, Agra, as its procedure was in conformity with the said para.

This test had ten vertical columns of 36 numbers each, the numbers varying from 1 to 9. In between all the columns adequate space had been provided to proceed with the test in the following manner:

The subject was asked to multiply the corresponding numbers of columns one and two and write their multiple value in the space provided between these columns and proceed in the descending order starting

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9 *Encyclopaedia Britannica*, p.112.

from first number. At the completion of the multiplication of columns one and two he was to multiply columns two and three and so on. The total time duration was fixed at 20 minutes (arrived at by the pilot study) and the subjects were asked to do the multiplications as fast as they could without taking any rest in between.

Statistical Techniques for Analysis of Data

To determine the significance of differences between the two experimental groups (high and low fitness) under different fatigue conditions (non-fatigue, physical fatigue and mental fatigue) two way analysis of variance was computed for each variable.

To test the significance of differences between the paired means, other than the pair with the greatest difference, the Scheffe's S Test of Post Hoc significance was used.

For testing the hypothesis, the level of significance was set at .05 level of confidence.