Comparison Of Departmental Performances Of Motor Skills

Susan Court
Carroll College

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COMPARISON OF DEPARTMENTAL PERFORMANCES
OF MOTOR SKILLS

Submitted in Partial Fulfillment of the Requirements for
Graduation with Honors to the Department of Physical
Education at Carroll College, Helena, Montana

Susan Jean Court
March 30, 1979
This thesis for honors recognition has been approved for the Department of Physical Education.

Mrs. DeeAnna Stalnaker, Director

Mr. Thomas J. Kelly, Reader

Dr. James J. Manion, Reader

March 30, 1979
To Mom and Dad, for all their help
in making my goals become a realization.
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ACKNOWLEDGEMENTS

I would like to take this opportunity to thank my thesis director, Mrs. DeeAnna Stalnaker, Instructor in Physical Education, for all her help and enthusiasm. I would also like to thank the people who read my thesis, Mr. Thomas Kelly, Associate Professor of Physical Education and Dr. James Manion, Professor of Biology. Also, the interest and cooperation of Mrs. Mary Lou Abbott, Assistant Professor of Dental Hygiene, was most valuable in my experimentation. It is of utmost importance to thank the 30 Carroll College students who gave up their precious time and cooperated fully to participate in the experimentation. Without the ten students from each area of athletics, biology and dental hygiene, I would not have been able to undertake and complete this thesis.
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CHAPTER I
INTRODUCTION

Control Groups

30 students performed in four motor skill tests: 1) Spatial Relations, 2) O'Connor Tweezers Dexterity, 3) Bilateral Transfer and 4) Movement Time. For the purpose of experimentation I chose ten students from each area of athletics, biology and dental hygiene. The ten athletes' names were given to me by their coaches on the basis of quickness in their sport. All athletes were participating in basketball, with five athletes from the women's basketball team and the other five from the men's basketball team. The ten biology students were more of a random choice. After getting a list of senior students who would voluntarily perform each test, I then chose the ten persons from the list based mainly upon my knowledge of each one's physical activities. The biology students were all males. The dental hygiene students were all female and seniors. There were only 11 seniors in dental hygiene so I tested each one. The bilateral transfer test eliminated one of the girls, so I disregarded her test results in the other tests to bring the number of dental hygiene students to 10.
Statement of the Problem

The problem of this study was to determine the motor skill abilities of three different Carroll College departments: athletics, biology and dental hygiene. The abilities will be measured in the areas of 1) Spatial Relations, 2) O'Connor Tweezer Dexterity, 3) Bilateral Transfer and 4) Movement Time.

Purpose of the Study

The purpose of this study was to determine by experimentation whether or not there were performance differences of motor skills between the athletes, biology students and dental hygiene students. Ten students each from athletics, biology and dental hygiene were tested in each of four tests: 1) Spatial Relations, 2) O'Connor Tweezer Dexterity, 3) Bilateral Transfer and 4) Movement Time.

Hypothesis

The basic hypotheses of the study are as follows:

$H_0$ - There is no comparable difference between the students in athletics, biology and dental hygiene in the performance of motor skill abilities.

$H_A$ - There is a difference between the students in athletics, biology and dental hygiene in the performance of motor skill abilities.
Definition of Terms

Following are some of the mathematical terms which are used in the report of results:

\[ n = \text{number of students in group (10)} \]

\[ \bar{y} = \text{mean of a group} = \frac{\sum y_i}{n} \]

\[ \sum y^2 = \text{sum of squares} \]

\[ (\sum y)^2 = \text{sum squared} \]

\[ \text{S.D.} = \text{standard deviation of one group} \]

\[ s = \text{pooled standard deviation of two groups} \]

\[ t = \frac{(\bar{x} - \bar{y})}{s \sqrt{\frac{1}{n_x} + \frac{1}{n_y}}} \]
CHAPTER II
SPATIAL RELATIONS

Testing Information and Observations

There has been some agreement in previous research that spatial ability is a reflection of two major capacities: first, spatial relations and orientation includes "perceiving spatial patterns, recognising objects when seen from different angles, and perceiving arrangements of elements within a visual stimulus pattern"; second, spatial visualization involves the ability to mentally rotate, turn or invert one or more parts of a configuration. Our comprehension of imaginary movement in three-dimensional space comes from the latter ability. A 1969 study found "high spatial ability subjects to be superior to low spatial ability subjects in solving syllogisms, time-rate of travel, and logical deduction problems in treatments where no instructions were given." When instructions on how to use diagrams, symbolic maps or other devices were given, there were no differences between the groups. It is the first capacity, that of spatial relations, which I am concerned with in this paper.

The spatial relations test utilizes a Minnesota spatial relations board. This board consisted of 52 cut-outs being laid out in front of the board. Each cut-out had an identical pattern on the board into which it would fit neatly. The fifty-two pieces consisted of seventeen different patterns (circles, squares, triangles, E's, etc.). Each
pattern existed in three different sizes, with the exception of circles which had four different sizes. Each group of three patterns was on the board in a specific area; in other words, the different sizes of any one pattern were not mingled throughout the board. Some of the patterns were very closely related in size, so I had marked black dots on the back side of each piece to signify that this side should be placed down on the board. Even though the students had this aid, they would still try to force a piece into an opening on the board in which it wouldn't fit. The athletes especially tried to force the pieces when they would not fit. As I scrambled up the pieces in front of the board I would allow the subjects to study the open positions on the board. Very few of them realized that each group of three patterns or shapes was in a certain area of the board. I started the timing when the person would pick up the first cut-out off the table. Only one cut-out at a time could be picked up. When the last cut-out was placed into its proper position I would stop the clock, making sure that all cut-outs were in place. My observations revealed that the biology students were very precise and methodical in their placing of the cut-outs into the board, whereas the athletes were working in a hurried state with not too many errors. The majority of biology students also demanded silence as a prerequisite to performing the test. The dental hygiene students were comparable to the athletes.
Results

In computing all the results for this test I converted the timings from minutes into seconds to make for easier computations and compilings. The results for the spatial relations test are recorded in Table I. The athletes had a slow time of 265 seconds and a reading of 152 seconds for the fastest time. The slow time came from a male athlete and the fast time from a female. The mean for athletes was 202.4 seconds. For the biology students, 284 seconds was the slowest and 151 seconds the fastest time. The biology students tended to either be at the slow end or the fast end of the scale, which was reflected in their large standard deviation measure of 46.1 seconds. Their mean was 226.4 seconds. The dental hygiene students had a slow time of 275 seconds and a fast time of 152 seconds. They also tended to either be at one end or the other of the two extremes, as was evidenced in the fact that half of them were within the first standard deviation of 41.4 seconds and the other five were in the second deviation. The mean for dental hygiene students was 202.2 seconds, faster than that of the athletes and biology students.

After finding out what my s value would be, for the purpose of comparing two departments with each other, it was then possible to compute the t value which would make it possible either to reject the \( H_0 \) and accept the \( H_A \), or not to reject the \( H_0 \). After using a confidence level of 90% and a degrees of freedom of sixteen \((n_x + n_y - 2)\), I found that my critical value would be 1.734. Since all of the t values for each pair of comparisons between the departments was less than the critical value, I can not reject the \( H_0 \) that each department is the same.
TABLE I

Spatial Relations Test Results

<table>
<thead>
<tr>
<th>Group</th>
<th>Group Mean</th>
<th>Group S.D.</th>
<th>t(1-2)</th>
<th>t(2-3)</th>
<th>t(1-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athletes</td>
<td>202.4</td>
<td>37.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>226.4</td>
<td>46.1</td>
<td>1.26</td>
<td>1.20</td>
<td>.01</td>
</tr>
<tr>
<td>Dental Hygiene</td>
<td>202.2</td>
<td>41.4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Group 1 is the athletes
Group 2 is the biology students
Group 3 is the dental hygiene students

Summary

In summary I would like to say that in my observations of these students there were many different traits utilized in putting the cut-outs into the board. The quick student contrasted to the student who was studious and methodical, and also differed in states of being humorous versus that of seriousness. Although the group means show a difference in times, the difference calculated by comparing two departments with each other (the t value) was less than the critical value. Therefore, the $H_o$ cannot be rejected and the $H_A$ can't be accepted saying, in effect, that I can't reject the hypothesis that there will not be a difference between the groups.
The O'Connor tweezer dexterity test consists of 100 pins which are one inch in length. These pins fit into 100 holes which are arranged in ten rows of ten holes each spaced 1/2 inch apart. The holes are about 1/16 inch in diameter. There is a shallow tray into which all the pins are placed which makes them easier to pick up with the tweezers. Each subject was given a trial run in which they were allowed to put ten pins into the top 10 holes running horizontally. This was the only practice they would get before the test. The person being tested had to place the first ten pins in the furthest row from his hand and complete it vertically first and then move on to the next nearest row of holes. This method was to prevent the hand of the person from touching those pins already placed in holes and possibly bumping them out of the holes.

The test presumably measures the speed with which someone using tweezers is able to pick up pins and place them in small holes on a board or metal plate. As soon as the tweezers picked up the first pin I would start the stop watch. When the last pin was safely in place the timing would stop. A high score indicates "manual aptitude for work involving precision and steadiness in the use of small hand tools," such as a surgeon's forceps or a watch repairman's tweezers.
Early norms found previously on the performance of factory employees and applicants indicated that "men scored higher and that women scored distinctly lower" in the tweezer dexterity test. But in a measure of finger dexterity by Hines and O'Connor it was found that "women perform the test better than men." The present norms for tweezer dexterity show that women perform just slightly better than men. In all subjects observed, I noticed that with about fifty pins having been placed in the holes, there would be comments to the effect that "this is enough!" The athletes seemed to get more frustrated when the pins wouldn't fall in place than either of the other two groups. But overall the three groups compared reasonably the same.

Results

Again, for this test I converted the timings from minutes into seconds. The results of the O'Connor tweezer dexterity test are recorded in Table II. The athletes had a range from 292 seconds for a low up to 445 seconds for a high (slow) timing. The fastest time was from a female and the slowest came from a male athlete. The mean for the athletes was 334.4 seconds. The standard deviation for this group came out to be 43.6 seconds. Nine out of ten athletes were recorded with times within the first deviation. The biology students had a fast time of 254 seconds and the slow time was that of 391 seconds. The mean was 323 seconds and the standard deviation came out to be 41.2 seconds. The biology students experimented with the tweezer hold and tension, which presumably aided them in their timings. The dental hygiene students had a fast time of 276 seconds and a slow time of 423 seconds. Their mean was 323.7 seconds and the standard deviation was 44.0 seconds. Again, after computing the s value for two
departments, I was able to find the t value for the use of comparing two departments with each other. In this test also I used the critical value of 1.734 (page 6), and found that all t values (departmental comparisons) were considerably less than the critical value. Therefore, the \( H_0 \) cannot be rejected, which states that each department is the same.

### TABLE II

O'Connor Tweezer Dexterity Test Results

<table>
<thead>
<tr>
<th></th>
<th>Group Mean</th>
<th>Group S.D.</th>
<th>t(1-2)</th>
<th>t(2-3)</th>
<th>t(1-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athletes</td>
<td>334.4</td>
<td>43.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>323.0</td>
<td>41.2</td>
<td>.60</td>
<td>.03</td>
<td>.51</td>
</tr>
<tr>
<td>Dental Hygiene</td>
<td>323.7</td>
<td>49.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Group 1 is the athletes
Group 2 is the biology students
Group 3 is the dental hygiene students

**Summary**

In summary I would like to say that in my observations of these students there were many of them who wanted to quit putting pins into the holes at about the 50th pin, or halfway mark. As you can see by the t values there was not much difference between any of the groups. The greatest difference was between the athletes and biology students, with the least difference coming from the biology students and dental hygienists. In this test, as with the spatial relations test, I cannot reject the \( H_0 \), based on the t values being considerably less than the critical value of 1.734. Therefore, I cannot accept the \( H_A \).
Bilateral transfer or cross education was first described back in 1900 by E.W. Scripture as the "peculiar phenomenon of transference of the effects of practice from one side to the other." Bilateral transfer experimentation has been used to "investigate fundamental methods by which motor control is achieved, the genetic development of muscular coordination, adaptation in learning, bilateral transfer or 'cross education', the effect of different intervals of practice upon the rate of improvement, interference, learning curves, and so on."

In this test vision is displaced by looking into a mirror and tracing a six-sided star, thus giving a reversal effect to the physical movement of tracing the star. Looking into the mirror to trace the star "requires movement which is not in agreement with your established habits."

This test determines what effect unilateral practice will have on the performance of the relatively unpracticed opposite, or contralateral, limb. Each subject traced the star seven times; the first and last trials were with the non-preferred hand. Trials numbered 2-6 were with the preferred hand. "Training given to one muscle group will carry over to the symmetrical muscle group on the opposite side of the body." This is seen by tracing the star five
times with the preferred hand and then tracing it again with the non-preferred hand. The improvement between trials 1 and 7 is remarkable. The person was seated so that he could not see the star under a shield; therefore, he had to look in the mirror to trace the star. Preliminary trials with direct view of the star were omitted. All errors were counted in the first and seventh trials to be used in the formula for computing the score. I had the person first find the end of the arrow in the star and would start the stop watch when the first motion was made. The timing would stop when the person was back to the arrow where he had started.

In my observation of the students I couldn't help but feel sorry for some of them. With some times over 5 minutes and the errors counting up close to 100, there were many frustrated looks on their faces. The athletes were the group that got the most frustrated and actually had to make modified screams to let off some of their tension. The dental hygiene group for the most part didn't become too frustrated; however, there was one girl in the group who could not do the test, so I had to drop her name from all experimentation in my studies. This was the first test in which the biology students did not remain silent for the entire seven trials and would remark on the difficulty of the test and also the improvement they were experiencing.

Results

The number I used for my determination of performances was computed using two formulas. The first formula is what was called the Score. Again for ease of computation I converted minutes into seconds. \[ \text{Score} = \frac{100}{\text{Seconds} + \text{Errors}} \] The second formula is the Percent Improvement (P.I.) which equals \[ \frac{\text{Trial 7 Score}}{\text{Trial 1 Score}} \]. It is the
P.I. score with which I am concerned. The following results are in Table III. The athletes had the greatest P.I. mean with 2.04. Two individuals both had a P.I. score of 3.62. The largest range of time between the first and last trials was one of four minutes and eighteen seconds. The number of errors on this person dropped by 28. This improvement in both time and errors for one person was unequalled throughout the experiment. The standard deviation for athletes was .961. The biology students had a P.I. mean of 1.80. The largest range between trials by the biology students was three minutes, forty-two seconds and an error decrease of 26. The biology group standard deviation was .548. The dental hygiene had a P.I. mean of 1.74, which was the least of all three groups. This could mean that dental hygienists had less room for improvement because of their professional work with looking in mirrors and seeing objects in reverse. The largest time range in dental hygiene students was one minute, twenty-three seconds. The greatest decrease in errors was that of 16. Interesting to note was the fact that eight out of 10 dental hygiene students failed to decrease the number of errors by more than 2, with some of these even increasing the number of errors. The standard deviation measure of the dental hygienists was .330.
TABLE III
Bilateral Transfer Test Results

<table>
<thead>
<tr>
<th></th>
<th>Group Means</th>
<th>Group S.D.</th>
<th>t(1-2)</th>
<th>t(2-3)</th>
<th>t(1-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athletes</td>
<td>2.04</td>
<td>.961</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Biology</td>
<td>1.60</td>
<td>.543</td>
<td>.68</td>
<td>.30</td>
<td>.94</td>
</tr>
<tr>
<td>Dental Hygiene</td>
<td>1.74</td>
<td>.330</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Group 1 is the athletes
Group 2 is the biology students
Group 3 is the dental hygiene students

**Summary**

As can be seen by the table, the greatest difference between groups was that of the athletes and the dental hygiene students. The athletes had the greatest percent improvement, while the dental hygiene group had the least percent improvement. The percent improvement is figured by comparing the scored from the seventh trial to the first trial. As was shown by T. W. Cook in 1932, bilateral transfer does occur to ”the symmetrical muscle group on the opposite side of the body.” Although the t values are again smaller than the critical value of 1.734, I cannot reject the H₀ which states that there is no difference between the groups; at the same time I may not accept the hypothesis either.
CHAPTER V
MOVEMENT TIME

Testing Information and Observations

The fourth and final test was a measure of movement time. Movement time is "that amount of time from the first overt sign of movement to the completion of the task." Speed of movement varies with the part of the body involved as well as the direction of the movement. Practice, strength, age, sex, joint mobility and tissue consistence are thought to have some effect on movement time. To measure movement time, a time button is depressed by the person being tested. A light barrier is directly above the time button at a distance of 11 inches. When the depressed time button is released, the person moves his hand as quickly as possible through this light barrier, thus stopping the time at the instant his hand passes through the light. There is no reaction to the stimulus involved; therefore, the student can let go of the button voluntarily. This measurement is one of very small values, often in hundredths of a second. The students each operated the time button for 10 trials and I then averaged their individual times for compiling the group time and mean. There was a sense of competition with each student to get a lower time than the previous one. This feeling of competition was especially keen among the biology students who were just about ready to tear the apparatus apart when it wouldn't lower their time. The biology
students were also the most experimental with the position in which they moved their arm or hand. The athletes and dental hygiene students just accepted the explanation of the test and performed it without experimenting on positioning. I did not allow for any practice, but told them to move as fast as they could from the time button that was depressed through the light barrier.

Results

The test results for movement time can be found in Table IV. The athletes had a movement mean of 0.067 of a second, the fastest time was 0.053 and the slowest for any individual in the athlete group was 0.073. The quickest time came from a male athlete and the slowest came from a female. This tends to be in agreement with previous investigations which state that movement time has a "slight sex difference in favor of the males." Checking this statement further, I found that the mean for female athletes was 0.075 and for male athletes was 0.059 of a second. The standard deviation for the athletes was 0.014. The biology students did very well with a group mean of 0.056 of a second. The fastest time was 0.048 and the slowest was 0.062. The standard deviation for the biology students was 0.008, which is indicative of their similar times. The dental hygiene students had a movement time mean of 0.108 of a second, with the fastest being 0.066 of a second and the slowest being 0.150 of a second. The standard deviation for this group was 0.039. Because of such a small measurement for time, the difference between any two groups is much more significant as is evidenced in the t values. The athlete-biology groups had a t value of 2.14, which is greater than the critical value of 1.734; thus there is a difference in the two groups as far as
their movement time is concerned. This is particularly noticed in the biology-dental hygiene comparison where the t value is 5.50 - the largest difference of any two groups being compared. The t value for the athlete-dental hygiene groups was 4.14. Since the t values were all larger than 1.734 (the critical value), I can reject the $H_0$, which stated that there is no difference among groups, and for the first time accept the $H_A$, which states that there is a difference between groups in measurement of movement time.

**TABLE IV**

Movement Time Test Results

<table>
<thead>
<tr>
<th>Group</th>
<th>Group Mean</th>
<th>Group S.D.</th>
<th>t(1-2)</th>
<th>t(2-3)</th>
<th>t(1-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athletes</td>
<td>.067</td>
<td>.014</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>.056</td>
<td>.008</td>
<td>2.44</td>
<td>5.50</td>
<td>4.14</td>
</tr>
<tr>
<td>Dental Hygiene</td>
<td>.103</td>
<td>.039</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Group 1 is the athletes  
Group 2 is the biology students  
Group 3 is the dental hygiene students

**Summary**

As can be seen by the times in the table, there is a difference between each group. Also it is apparent that previous statements of movement time being slightly faster in males than females is also true in my research. The dental hygiene students and half of the athletes were females; whereas the biology and the other half of the athletes were males. Male athletes were on an average faster than female athletes. This was the first experiment where the t values were greater than the
critical value determined earlier of 1.73. Therefore, I can reject
the $H_0$ and accept the $H_A$ which states that there is a difference
between groups in the measurement of movement time. Although the
group means may be very similar in time measurement, the difference
between groups is significant considering the very small distance of
eleven inches that was travelled in recording a time measurement.
CHAPTER VI

SUMMARY

The purpose of my research was to determine by experimentation, whether or not there were performance differences of four specific motor skills between the athletes, biology students and dental hygiene students. By utilizing four major tests: Spatial Relations, O'Connor Tweezer Dexterity, Bilateral Transfer and Movement Time, the group performances could be compared against one another to check for significant differences between each group. In the first three tests I found that I could not reject the hypothesis which states that there is no difference between the students in athletics, biology and dental hygiene in the performance of motor skill abilities. By using a confidence level of 90% and degrees of freedom which equalled 18, the critical value thus became 1.734. On the first three tests all t values were well below this critical value. In the movement time test the t values were larger than the critical value and I could therefore accept the hypothesis that there is a difference between the students in these three departments in the performance of movement time. To make some of the testing more valid I would suggest that a tight screening program be enacted so that you would not get an overlap of athletic biology students or athletic dental hygienists. In the future, groups would have to be so completely free from any link with the other two, that a study like this probably would not be
feasible using the small number of Carroll students that are available. As a suggestion for further study it would probably be more valid if the comparison of motor skill abilities was only between athletes and non-athletes or between males and females. Non-athletes would be those who never engage in physical activities and would be easier to find than non-athletic biology and dental hygiene students.
REFERENCES


2 Ibid.

3 O'Connor Tweezer Dexterity Test Instructions, (Lafayette Instrument Company), Lafayette, Indiana

4 Ibid.


8 Ibid.


10 Ibid.


