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A Comparison of Two Types of Turns Used in the Breaststroke and Butterfly

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A COMPARISON OF TWO TYPES OF TURNS USED IN THE BREASTSTROKE AND BUTTERFLY

by

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A COMPARISON OF TWO TYPES OF TURNS USED IN THE BREASTSTROKE AND BUTTERFLY

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Faculty Advisor: Professor Robert Clayton

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The conclusions were that no significant difference existed between the time of the touch-turn and the grab-turn when used with the butterfly stroke and the breaststroke.

This thesis submitted by Larry W. Swanson in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

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Department Physical Education

Degree Master of Science

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Date Aug 26, 1970

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ABSTRACT

This study compared the speed of the touch-turn to the grab-turn using the competitive butterfly and breaststrokes. The subjects were twenty five male high school swimmers, all of whom had at least three years of competitive experience. All subjects received instruction on each turn during 16 weeks of a competitive season and practiced each turn dozens of times. Each subject was tested on the speed of each turn. The tests were given on two consecutive days to establish reliability. The Pearson Product Moment correlation was used to determine the relationship of the initial test to the retest. An analysis of variance was used to ascertain if any significant difference existed between the two types of turns.

The conclusions were that no significant difference existed between the time of the touch-turn and the grab-turn when used with the butterfly stroke and the breaststroke.

CHAPTER I

INTRODUCTION

Since its beginning, competitive swimming has been under detailed research to try to help swimmers lower their existing times. Stroke analysis and physiological studies have helped to lower times to a point previously thought unattainable.

One of the most important areas of competitive swimming is the turns. It is here that many races are won or lost. If performed properly, racing turns can cut tenths of seconds off times. When the number of turns in a race is considered, these tenths of seconds can add up to full seconds.

Studies have been done comparing the crawl stroke flip-turn to the crawl stroke grab-turn, an experimental crawl flip-turn to a modified crawl-flip turn, and an experimental backstroke flip-turn to the standard method of backstroke flip-turn. There was a need to carry this type of study into other areas of competitive swimming.

Statement of the Problem

This study was undertaken to determine if any difference existed between two types of turns used in the competitive breaststroke and butterfly.

Need for the Study

The National Collegiate Athletic Association, final authority for interscholastic and intercollegiate swimming in the United States, states that:

> When touching at the turn or finishing a race, the touch shall be made with both hands simultaneously on the same level, and with the shoulders in the horizontal plane. Once a legal touch is made, the contestant may turn in any manner desired, but the prescribed form must be attained before the feet leave the wall on the push off.[1]

This ruling pertains both to the breaststroke and the butterfly turn. The way that the rule is stated gives both the swimmer and the coach a great deal of freedom to experiment. The fact that many pools have no overflow trough to grab when turning might account for two schools of thought concerning the touch and the grab turn. Many coaches teach their swimmers to grab the trough or end of the pool at the beginning of the butterfly or breaststroke turn so as to aid the swimmer in the turning motion and position for the push off. Others tell their swimmers to just touch the wall with the palms of their hands, and then push their body around with one hand. The momentum of the body will aid in the positioning for the push off on this type of turn. It would be beneficial to know which, if either, of these turns is faster.

Definition of Terms

The following terms were used in this study:

A touch-turn refers to a turn that was performed with the hands touching, but not grasping, the wall or trough of the pool, and pushing away with one hand while turning into position for the push off.

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[1]National Collegiate Athletic Association, National Collegiate Athletic Association Swimming Guide (Phoenix, Arizona: College Athletics Publishing Service, 1968), p. 11.

A grab-turn refers to a turn that was performed with the hands grasping the trough or edges of the pool and pulling the body in close to the wall. Then, one hand is released as the body turns and the other acts as a brace in the turning action.

The turn itself was defined for this study as beginning when the swimmer's hands touch the wall and ending when his feet leave the wall on the push off.

The glide starts with the feet breaking contact with the wall on the push off and ends when the hands reach a point five yards from the turning wall.

Delimitations

1. The study was delimited to 25 male high school swimmers, age 15-17 inclusive. All the subjects were experienced swimmers having a minimum of three seasons of competitive experience and a maximum of five seasons.

2. The turns studied are those used with the competitive breaststroke and butterfly stroke.

3. The types of turns were delimited to the grab-turn and the touch-turn.

Limitations

1. There was no way of controlling the subject's attitude on the days of or during the time trials.

2. There was no way of controlling the diet of the swimmers or the amount of sleep obtained just prior to or during the days of testing.

Review of Related Literature

While the number of studies related to competitive swimming is large, little research appears in the literature on racing turns. The following studies and articles were first noted in Swimming and Diving: A Bibliography.[1] This recent book lists all aquatic references published up through 1967.

Jamerson[2] and Ryan[3] have published articles on swimming turns, but the information from these articles lent little to this study, since they either were not concerning with racing turns, or did not mention the butterfly or breaststroke.

Jacobson[4] states that the breaststroke turn begins when the swimmer's hands touch the wall. At this point the swimmer drops the shoulder on the side in which he wants to turn. No mention is made of grabbing the wall or trough. However, Jacobson does say that no attempt should be made to pull the body out of the water.

Jacobs[5] indicates that the tuck maneuver begins with the completion of the approach and upon contact with the wall by the swimmer's hands. Again no mention is made of grabbing the trough.

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[1]Council for National Cooperation in Aquatics, Swimming and Diving: A Bibliography (New York: Association Press, 1968).

[2]Dick Jamerson, "Relay Starts and Racing Turns," JOHPER, XXI (February, 1956), 42.

[3]J. E. Ryan, "Teach Them How to Turn," Athletic Journal, XXIV (January, 1954), 22.

[4]T. S. Jacobson, "Coaching the Breaststroke Turn," Athletic Journal, XLIV (April, 1963), 66.

[5]Marshall L. Jacobs, "Turns for the Butterfly and Breaststrokes," Athletic Journal, XLI (November, 1960), 40.

Armbruster, Allen and Billingsly[1] state that a swimmer must drive, not coast into the wall, since his momentum is needed to bring the body up to the wall. The hands should be placed flat on the wall with the fingers projecting slightly above the surface of the water. After touching, the elbows bend until the head almost touches the wall. It was stated that the mechanics of the breaststroke and the butterfly are the same.

Counsilman[2] agrees that the swimmer should just touch the wall. He says that the swimmer should not pull into the wall but should let his elbows bend so that his momentum will carry him close to the wall. No mention is made of grabbing the trough, although he does say that one of the most common errors in the breaststroke and butterfly is pulling in too close to the wall.

Torney[3] also feels that the swimmer should just touch the wall and let his momentum bring him in close to the wall rather than grabbing the trough or wall and pulling.

Gambril,[4] however, disagrees with the above points when he says that in the breaststroke and butterfly turns the swimmer should grab the trough with both hands and pull himself strongly towards the wall. He does make note that this is impossible in a pool with a flat wall and in such cases a touch turn should be used.

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[1]David A. Armbruster, Robert H. Allen, and Hobart Sherwood Billingsly, Swimming and Diving (5th ed.; St. Louis: The C. V. Mosby Company, 1968), p. 156.

[2]James E. Counsilman, The Science of Swimming (Englewood Cliffs, N. J.: Prentice-Hall, 1968), p. 151.

[3]John Torney, Jr., and Robert Clayton, "Coaching the Swimming and Diving Team," (unpublished manuscript, University of North Dakota, 1969), p. 17.

[4]Donald L. Gambril, Swimming (Pacific Palisades, California: Goodyear Publishing Company, 1969), p. 47.

The aforementioned thoughts were those of experienced coaches, some of whom have gained international fame. However, there appears to be no direct research on the butterfly and breaststroke turns, although turns for other strokes have been studied. For example, King and Irwin[1] did a time and motion study of backstroke racing turns. In this study 100 subjects were used, half of them being 18 years or older. All subjects were members of either high school or college swimming teams. The two methods studied were: (1) the somersault turn followed by a two arm glide, and (2) a somersault turn followed by a one arm glide. Each swimmer was timed five times by one individual using two stopwatches. This was done so that two measurements could be made, one of the turn alone and one of the turn and glide. The time of the turn was then subtracted from the time of the turn and glide, thus giving the time for the glide. The results of this study showed that in each group there was a significant difference between the times for the two turns, with the one arm glide proving to be superior in each instance.

The same type of study using a different stroke was later performed by Scharf and King.[2] The two methods of front crawl turns were: (1) the modified flip turn with a two arm glide, and (2) an experimental flip turn followed by a one arm glide. The subjects were divided into two groups, one consisting of 23 college swimmers and the other consisting of 24 high school swimmers. One split-hand stopwatch was

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[1]William H. King, Jr., and Leslie W. Irwin, "A Time and Motion Study of Competitive Backstroke Swimming Turns," Research Quarterly, XXVII (October, 1957), 257-268.

[2]Raphael J. Scharf and William King, Jr., "Time and Motion Analysis of Competitive Freestyle Swimming Turns," Research Quarterly, XXXV (March, 1964), pp. 37-44.

used to record the time for the turn and, also, for the time of the turn and glide. The time of the turn was then subtracted from the time of the turn and glide, this being recorded as the time for the glide. Each swimmer performed each turn five times. The results showed that the experimental turn followed by the one arm glide was significantly faster than the modified turn in each group.

Fox[1] also studied two types of turns used in the crawl stroke. His study dealt not only with the speed of the turns, but also with the oxygen expenditure of the swimmer. The study was delimited to six male swimmers, all of whom competed on the same college team. The two types of turns studied were a one-handed grab-turn and a forward somersault turn. Each swimmer performed the turn only once. The results showed that the forward somersault was significantly faster than the one-handed grab-turn, while the grab-turn was found to require less oxygen than the somersault turn.

Summary of Related Literature

As was noted earlier, little research appears in the literature on butterfly and breaststroke racing turns. King and Irwin and Scharf and King have each studied the speed of other swimming turns. However, none of the coaches whose publications are cited appear to make use of the results of these studies.

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[1]Edward Lyle Fox, "An Analysis of Speed and Energy Expenditure of Two Swimming Turns" (unpbulished Master's thesis, The Ohio State University, 1961), p. 14.

CHAPTER II

METHODOLOGY

A preliminary study showed that it was feasible to use a modification of King and Irwin and Scharf and King's study on the breaststroke and butterfly. This preliminary study was of great help in setting the design for the final study.

Procedure for Initial Study

Selection of Subjects

The participants in the initial study were a non-probability sample of six male students from the University of North Dakota Varsity Swimming Team. Each had competed a minimum of four years previous to the study and had gained experience in performing the grab and touch-turn with both the breaststroke and butterfly. Their ages ranged from 17 to 22 years.

Procedure

The test that was employed was a modification of one developed by King and Irwin[1] and later used by Scharf and King.[2] The procedure used required three split-hand stopwatches. The timers were instructed

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[1]King and Irwin, "A Time and Motion Study of Competitive Backstroke Swimming Turns," pp. 257-268.

[2]Scharf and King, "Time and Motion Analysis of Competitive Freestyle Swimming Turns," pp. 37-44.

to start the watches when the swimmer's hands touched the wall. The split-hand was stopped when the swimmer's feet broke contact with the wall on the push off. The sweep hand was stopped when the swimmer's hands reached an imaginary line under an aluminum pole that was placed over the water five yards from the turning wall.

The objectivity of the test was controlled by the use of three timers that had received the same instructions as to how the watch should be held, when and how it was to be started, and when and how each hand should be stopped. The same timers were used for all the trials. The time pieces were adjusted and validated against a Bulova Accutron timing device just prior to the initial trial. The test was given to the same individual twice, the first session being on a Thursday evening and the second session on the following Tuesday afternoon. After the swimmers had received instructions on what was to be done, they were allowed 10 minutes for practice. The subjects were requested not to practice between the initial test and the re-test.

To control any possible training effects the trials might have had on the swimmers, the treatments were assigned at random by the use of a list of random numbers. Each stroke and turn were assigned to odd and even numbers. The first number in a pair of random numbers was assigned to the stroke and the second number was assigned to the turn. An odd first number mean that the butterfly stroke was to be done, while an even number meant that the breast-stroke was to be done. An odd second number in the pair meant that the grab turn was to be done, while an even second number signified

the touch turn. (Example: if the number 51 appeared on the random numbers table, the swimmer would perform the butterfly grab turn.) Each swimmer performed each turn three times. There was a rest interval of approximately four minutes while the other swimmers performed their trials. While the swimmers were being timed, the timers placed themselves in the same spot for each trial and each had an unobstructed view of the turn and finish.

After each swimmer had completed each turn, the timers orally reported the times to the experimenter. The times were recorded in seconds, tenths, and hundredths, as recommended by the NCAA in recording times for swimming meets. If two watches agreed this was recorded as the official time. If none of the watches agreed, the middle time was used.

Design

The test was one of a single group design. This offered the most precise method of pursuing the problem since there could be no intergroup error. In this test each individual acted as his own control. This design was also beneficial since it allowed for a test-retest.

Analysis of Data

The Pearson Product Moment correlation procedure was used to determine the relationship of the initial test to the retest. If a correlation of .50 or higher was calculated, the data were then treated with an analysis of variance. The null hypothesis of no difference was established at the .05 level. If an F ratio higher than the table value of 4.13 was calculated, the null hypothesis was rejected.

Summary of Results

The reliability correlations ranged from -.20 to .69. The analysis of variance yielded F-ratios below that needed for significance at the .05 level. Appendices A and B show the completed data for these measures.

Procedure for Final Study

Selection of Subjects

The participants in this study were a non-probability sample of twenty-five male students at Davenport Central High School, Davenport, Iowa. Each had at least three seasons of competitive swimming experience and no more than five seasons. All were sophomores, juniors, or seniors. Their ages ranged from 15 to 17 years inclusive. Each had trained one and one-half hours per day, five days a week for sixteen weeks before testing.

Procedure

All the subjects went through the same pre-season general instructional program. Each had received instruction on five different occasions on the grab-turn and the touch-turn. The instructional procedure was as follows:

1. Explanation by the coach
2. Demonstration by the coach
3. Supervised general swim practice sessions of fifteen minutes, three times per week for sixteen weeks. Both the touch-turn and the grab-turn were used dozens of times by the end of the sixteen week period.

The subjects were tested at the end of the competitive season. The test for this study was a further modification of the test developed by King and Irwin.[1] Instead of breaking the turn down into three separate areas and timing each segment, the total time for the turn was used. There were two reasons for this modification. First, the initial test, though not highly reliable, gave indication that no difference existed between the turn, the glide, or the total time of either the touch-turn or the grab-turn when used with either stroke. Second, the rules limit how the turns can be done, therefore it is of no consequence where the difference, if any, exists. Thus the total time was that which elapsed from the time a swimmer's hands touched the walls at the beginning of the turn, until his finger tips passed under an aluminum pole placed fifteen feet from the turning wall after the push off. As in the initial study, three timers were again instructed and tested by the author. Single hand stopwatches were used. The three watches had been synchronized and adjusted by a jeweler so that the watches were all within .2 seconds of each other and of the Bulova Accutron timing device at the end of a four minute test period.

The testing was done on two consecutive days, beginning at four P.M. on each day. The water temperature on both days was 76°F., the air temperature was 79°F. on Thursday and 80°F. on Friday. The water level was kept even with the overflow trough during all testing. The lighting was uniform throughout both testing sessions.

The order of the swimmers performing the turns was randomized by use of a drawing each day. The type of stroke and the type of turn

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[1]King and Irwin, "A Time and Motion Study of Competitive Backstroke Swimming Turns," pp. 257-268.

were again randomized by use of a list of random numbers. The first number was assigned to the breaststroke and an odd first number was assigned to the butterfly stroke. An even second number meant that the touch-turn was to be done, while an odd second number signified the grab-turn. Each swimmer performed twelve turns per testing session with approximately a twelve minute interval between each turn.

Design

As before, the single group design was used so that no intergroup error could result. Each individual acted as his own control. A test, retest was given.

CHAPTER III

ANALYSIS OF DATA OF FINAL STUDY

Introduction

The Pearson Product Moment correlation procedure was used to determine the relationship of the initial test to the retest. Because all cases showed a correlation greater than .50, all the data were then treated with a one-way analysis of variance. This analysis was used to determine if any significant difference existed between the times for the touch-turn and the grab-turn. The null hypothesis of no difference was established at the .05 level. If an F-ratio higher than the table value of 4.04 were calculated, the null hypothesis was rejected.

The computational procedures for the Pearson Product Moment correlation and the analysis of variance were completed at the Computer Center of the University of North Dakota. The data were supplied to an IBM 360/30 computer. The Pearson Product Moment correlation was computed by the standard form, Pearson Product Moment, Means, Standard Deviation, and Correlation Coefficient. The analysis of variance was calculated by the form, one-way analysis of variance.

Results

Table 1 shows the correlations for the breaststroke and butterfly touch-turn and grab-turn test-retest. The complete data are found in Appendix D. The breaststroke touch-turn and grab-turn both have a correlation of .94. The butterfly grab-turn showed a correlation of .98 and the touch-turn a correlation of .97.

TABLE 1

CORRELATIONS OF BREASTSTROKE AND BUTTERFLY TOUCH TURN AND GRAB TURN

Comparisons	Correlations
Breaststroke	
Grab-turn Test-Retest	.94
Touch-turn Test-Retest	.94
Butterfly	
Grab-turn Test-Retest	.98
Touch-turn Test-Retest	.97

Table 2 deals with the analysis of variance for the breaststoke and butterfly turns. For an F-ratio to be significant it had to be in excess of the table value of 4.04. This did not happen in any of the cases and thus the null hypothesis of no difference was retained. The completed data are found in Appendix C.

TABLE 2

F-RATIOS FOR BREASTSTROKE AND BUTTERFLY GRAB TURNS AND TOUCH TURNS

Comparison	
Breaststroke Initial Test	1.152*
Breaststroke Retest	.367*
Butterfly Initial Test	1.401*
Butterfly Retest	2.475*

*Not significant

CHAPTER IV

DISCUSSION

While reviewing the literature for this study, it was found that much work had been done on competitive swimming. Most of these studies, however, were of a physiological nature. It was surprising and disappointing that only three studies could be found on turns, and that none of these were related to the butterfly or breaststroke.

Although coaches disagree on the "best" method for performing these turns, there is no research to defend their opinions. It is possible that this disagreement stems from the fact that all pools do not have the same type of overflow system. The different types of overflow systems, such as the overflow trough, deck level, rimflow, and blank wall, all make different demands upon the swimmer as he performs these turns. The overflow trough gives the swimmer an edge to grab firmly and pull himself into the wall. The deck level pool offers only the ninety degree angle of the wall and the deck. A rimflow pool has a small lip on the edge that may be grabbed, but not firmly. The blank wall pool has no overflow troughs at the ends of the pool, but there are troughs on the sides. In this type of pool and in the deck level pool the grab turn would be impossible to do. Therefore, a coach that teaches in a pool with overflow troughs might feel that the grab turn is the "best" method, while the coach that teaches in a deck level pool might have the opposite opinion.

The fact that a difference of opinion exists and so little research has been done might lead one to believe that most coaches are not researchers or that they do not want to challenge the ideas of more famous coaches. For instance, King and Irwin,[1] and later Scharf and King,[2] showed that a turn with a one-handed push off was superior to a turn with a two-handed push off in both the backstroke and the crawl stroke. These studies were done in 1957 and in 1964, respectively, and still few coaches prescribe these turns for their swimmers. This might stem from the fact that the more successful coaches do not teach these turns. For example, neither Counsilman, Gambril nor Armbruster advocate or even mention such a turn in their publications. Evidently King and Irwin and Scharf and King did not convince these coaches that their results were valid, or else they are ignorant of these studies. It also might be added here that since these studies, the rules governing these turns have been modified. It is possible that faster turns than these have been developed; however, no research is available to substantiate this.

The test used in this study was similar to the one developed by King, except three timers were used instead of one, and the turn was timed as one motion rather than broken into three parts. Timing the turn as one entity seemed more reasonable, because in competition the turn is one continuous motion.

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[1]King and Irwin, "A Time and Motion Study of Competitive Backstroke Swimming Turns," pp. 257-268.

[2]Scharf and King, "Time and Motion Analysis of Competitive Freestyle Swimming Turns," pp. 37-44.

In the aforementioned studies by King, there was no check for reliability. This is one of the reasons why a preliminary study was done. If a test is not reliable, it may not be used with accuracy. Thus in the present study a check was done so that the results have a greater meaning. The reliability of the data from the preliminary study were not high enough to be used with any degree of confidence. It is apparent, however, that since the final results yielded reliability coefficients of .94 or greater, the modifications were beneficial.

The results of this study give no support to the idea that either turn is superior to the other. Even though this might be true, it is unfortunate that the publications by Counsilman, Gambril and Armbruster were based on opinions rather than experimental evidence. Inasmuch as swimmers must perform in various types of pools, coaches should teach both types of turns so that the most appropriate one is used.

CHAPTER V

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

The problem in this study was to compare two types of turns used in breaststroke and butterfly races. It was found that very little research had been done on racing turns and what was done did not relate to the breaststroke or the butterfly.

For this study 25 male competitive swimmers from Davenport Central High School, Davenport, Iowa, acted as subjects. The same test was given twice to determine the reliability of the results.

All data were supplied to an IBM 360/30 computer at the University of North Dakota Computer Center. All correlations between the test and the retest were .94 or higher and neither turn proved to be significantly faster than the other in either stroke. For the results to be significant, an F-ratio of at least 4.04 was needed. Since the test F-ratios were less than the table value the null hypothesis of no difference was retained.

Conclusion

Within the limitations, delimitations and assumptions of this study, the following conclusion has been reached:

1. No significant difference exists between the elapsed time of the touch turn and the grab turn when used with the butterfly stroke or breaststroke.

Recommendations

1. It is recommended that studies on the crawl stroke and backstroke turns be updated since the rules governing them have been modified.
2. It is further recommended that coaches teach both types of breaststroke and butterfly turns to their swimmers since all pool edges are not alike.

APPENDIX A

TABLE 3

ANALYSIS OF VARIANCE FOR THE BREASTSTROKE TOUCH TURN AND GRAB TURN (INITIAL TEST)

Treatment	Sum*	N	Mean*	Standard Deviation	Variance
Touch Turn	25.99	18	1.444	.146	.021
Grab Turn	26.799	18	1.489	.123	.015

*Time in seconds

TABLE 4

BREASTSTROKE TOUCH TURN AND GRAB TURN (INITIAL TEST)

Source of Variance	Sum of Squares	DF	Mean Square	F-Ratio
Raw Sum of Squares	78.079	36		
SS Due to Mean	77.439	1		
Treatments	.017	1	.017	.970*
Within Groups	.622	34	.018	
Total	.639	35		

*Not significant

TABLE 5

ANALYSIS OF VARIANCE FOR THE BREASTSTROKE TOUCH TURN AND GRAB TURN (RETEST)

Treatment	Sum*	N	Mean*	Standard Deviation	Variance
Touch Turn	25.899	18	1.439	.109	.012
Grab Turn	25.999	18	1.444	.150	.023

*Time in seconds

TABLE 6

BREASTSTROKE TOUCH TURN AND GRAB TURN (RETEST)

Source of Variance	Sum of Squares	DF	Mean Square	F-Ratio
Raw Sum of Squares	75.409	36		
SS Due to Mean	74.822	1		
Treatments	.000	1	.000	.015*
Within Groups	.587	34	.017	
Total	.587	35		

*Not Significant

APPENDIX B

TABLE 7

CORRELATIONS (PRELIMINARY TEST) BETWEEN INITIAL TEST AND RETEST FOR THE BREASTSTROKE TOUCH TURN

Comparison	Mean*	Variance	Standard Deviation	Correlation
Turn - Initial Test	1.444	.021	.146	.58
Turn - Retest	1.439	.012	.109	
Glide - Initial Test	1.000	.019	.137	.29
Glide - Retest	.972	.014	.118	
Turn and Glide Initial Test	2.444	.010	.098	.25
Turn and Glide Retest	2.411	.014	.118	

*Time in seconds

TABLE 8

CORRELATIONS (PRELIMINARY TEST) BETWEEN INITIAL TEST AND RETEST FOR THE BREASTSTROKE GRAB TURN

Comparison	Mean*	Variance	Standard Deviation	Correlation
Turn - Initial Test	1.489	.015	.123	.69
Turn - Retest	1.444	.023	.150	
Glide - Initial Test	.906	.026	.163	.52
Glide - Retest	.972	.017	.132	
Turn and Glide Initial Test	2.395	.009	.094	.16
Turn and Glide Retest	2.417	.012	.110	

*Time in seconds

TABLE 9

CORRELATIONS (PRELIMINARY TEST) BETWEEN INITIAL TEST AND RETEST FOR THE BUTTERFLY TOUCH TURN

Comparison	Mean*	Variance	Standard Deviation	Correlation
Turn - Initial Test	1.544	.065	.255	.39
Turn - Retest	1.567	.064	.252	
Glide - Initial Test	.961	.015	.124	.03
Glide - Retest	.917	.027	.165	
Turn and Glide Initial Test	2.505	.057	.239	.13
Turn and Glide Retest	2.484	.058	.241	

*Time in seconds

TABLE 10

CORRELATIONS (PRELIMINARY TEST) BETWEEN INITIAL TEST AND RETEST FOR THE BUTTERFLY GRAB TURN

Comparison	Mean*	Variance	Standard Deviation	Correlation
Turn - Initial Test	1.483	.027	.165	-.20
Turn - Retest	1.761	2.033	1.426	
Glide - Initial Test	.956	.021	.146	.06
Glide - Retest	.917	.023	.150	
Turn and Glide Initial Test	2.439	.024	.154	.09
Turn and Glide Retest	2.678	.037	.192	

*Time in seconds

APPENDIX C

TABLE 11

ANALYSIS OF VARIANCE FOR THE BREASTSTROKE TOUCH TURN AND GRAB TURN (INITIAL TEST)

Treatment	Sum*	N	Mean	Standard Deviation	Variance
Touch Turn	199.40	25	7.975	.704	.496
Grab Turn	194.40	25	7.775	.607	.368

*Time in seconds

TABLE 12

BREASTSTROKE TOUCH TURN AND GRAB TURN (INITIAL TEST)

Source of Variance	Sum of Squares	DF	Mean Square	F-Ratio
Raw Sum of Squares	3122.840	50		
SS Due to Mean	3101.568	1		
Treatments	.498	1	.498	1.152*
Within Groups	20.772	48	.432	
Total	21.271	49		

*Not significant

TABLE 13

ANALYSIS OF VARIANCE FOR THE BREASTSTROKE TOUCH TURN AND GRAB TURN (RETEST)

Treatment	Sum*	N	Mean	Standard Deviation	Variance
Touch Turn	197.300	25	7.891	.720	.519
Grab Turn	194.400	25	7.775	.626	.392

*Time in seconds

TABLE 14

BREASTSTROKE TOUCH TURN AND GRAB TURN (RETEST)

Source of Variance	Sum of Squares	DF	Mean Square	F-Ratio
Raw Sum of Squares	3090.630	50		
SS Due to Mean	3068.577	1		
Treatments	.167	1	.167	.367*
Within Groups	21.885	48	.455	
Total	22.052	49		

*Not significant

TABLE 15

ANALYSIS OF VARIANCE FOR THE BUTTERFLY TOUCH TURN AND GRAB TURN (INITIAL TEST)

Treatment	Sum*	N	Mean	Standard Deviation	Variance
Touch Turn	195.500	25	7.819	.729	.531
Grab Turn	189.800	25	7.591	.628	.394

*Time in seconds

TABLE 16

BUTTERFLY TOUCH TURN AND GRAB TURN (INITIAL TEST)

Source of Variance	Sum of Squares	DF	Mean Square	F-Ratio
Raw Sum of Squares	2992.010	50		
SS Due to Mean	2969.121	1		
Treatments	.649	1	.649	1.401*
Within Groups	22.239	48	.463	
Total	22.888	49		

*Not significant

TABLE 17

ANALYSIS OF VARIANCE FOR THE BUTTERFLY TOUCH TURN AND GRAB TURN (RETEST)

Treatment	Sum*	N	Mean	Standard Deviation	Variance
Touch Turn	195.100	25	7.803	.723	.523
Grab Turn	187.760	25	7.503	.620	.384

*Time in seconds

TABLE 18

BUTTERFLY TOUCH TURN AND GRAB TURN (RETEST)

Source of Variance	Sum of Squares	DF	Mean Square	F-Ratio
Raw Sum of Squares	2952.110	50		
SS Due to Mean	2929.185	1		
Treatments	1.124	1	1.124	2.475*
Within Groups	21.800	48	.454	
Total	22.924	49		

*Not significant

APPENDIX D

TABLE 19

CORRELATIONS (FINAL TEST) BETWEEN THE TEST-RETEST SCORES OF THE BREASTSTROKE AND BUTTERFLY TOUCH TURNS AND GRAB TURNS

Comparison	Mean*	Variance	Standard Deviation	Correlation
Breaststroke Grab Turn				
Initial Test	7.775	.368	.607	.94
Retest	7.775	.392	.626	
Breaststroke Touch Turn				
Initial Test	7.975	.496	.704	.94
Retest	7.892	.519	.720	
Butterfly Grab Turn				
Initial Test	7.591	.394	.628	.98
Retest	7.503	.384	.620	
Butterfly Touch Turn				
Initial Test	7.819	.531	.729	.97
Retest	7.803	.523	.723	

*Time in seconds

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