A COMPARISON OF THREE BREASTSTROKE TURNS AND THEIR EFFECTS ON SWIMMING FIFTY YARDS

DISSERTATION

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF EDUCATION

By

Robert F. Courtway, B. S. E., M. Ed.
Denton, Texas

May, 1973

Courtway, Robert F., A Comparison of Three Breaststroke Turns and Their Effects on Swimming Fifty Yards. Doctor of Education (College Teaching), May, 1973, 89 pp., 18 tables, bibliography, 83 titles.

The problem with which this study was concerned was that of comparing three methods of executing the competitive breaststroke turn and their effects on swimming fifty yards. The turns utilized were the AAU, NCAA, and somersault. A related purpose was that of analyzing the time a breaststroke competitor was to be submerged on the glide following the turn.

One hundred four male, senior swimmers from teams in the Arkansas AAU were rated on five components of the breaststroke. Twenty-nine advanced and thirty novice breaststrokers were selected from this group to participate in this study. The subjects were timed for a distance of fifty yards using, in order, the AAU, NCAA, and somersault turns.

Oral instructions, a demonstration, and a fifteen-minute practice period preceded each testing period. Following the testing period of each turn, oral instructions and a demonstration were given of the next turn to be timed. A minimum of seven days elapsed between each testing session. The subjects

were instructed to practice the required turn for a maximum of fifteen minutes each day prior to their being tested. Testing consisted of one trial per subject on each turn.

Two watches were utilized in the timing procedure. One recorded the total time for the fifty-yard distance. The second watch, a split-timer, was used to measure the turn and glide times. The turn represented the actual time the swimmer was in contact with the turning surface. The glide time consisted of the time the swimmer was submerged after his feet left the turning surface.

An analysis of variance was utilized in testing the hypotheses. When significant differences were found to exist, Scheffe's method was used to determine where they specifically existed. The .05 level of significance was required to reject the null hypotheses. A chi-square test of independence was utilized in analyzing the gliding time following the AAU and NCAA turns by the advanced breaststrokers.

The primary findings were as follows: (1) there was no significant difference in the total time required to swim the fifty yards by either the advanced or novice breaststrokers when the AAU, NCAA, and somersault turns were used; (2) the gliding time following the execution of the somersault turn was significantly less than the gliding time following the AAU and NCAA turns for both groups; (3) the execution of the somersault turn by both groups was significantly slower than the execution of the AAU and NCAA turns; (4) a significant relationship existed between the gliding time and the total time for fifty yards when the NCAA turn was executed by advanced breaststrokers. However, no significant relationship existed when the AAU turn was substituted for the NCAA turn.

It was concluded that (1) either the AAU or NCAA turn could be taught by coaches of swimming without affecting the swimmer's total time for fifty yards; (2) the somersault turn should not be executed until the rules are modified and the hand touch is eliminated; and, (3) a specific optimum gliding time cannot be established.

The study was conducted for the fifty-yard distance to eliminate the conditioning factor. A similar study should be conducted to compare the three turns and their effect on swimming the 100- and 200-yard breaststroke events.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES--Continued

CHAPTER I

INTRODUCTION

The time required to swim a prescribed distance using one of the four competitive strokes determines the level of performance of a swimmer. This time is influenced by many factors, and coaches of swimming have attempted through the years to determine these factors and to what extent they influence a competitive swimmer's performance.

Faulkner[1] suggests that if a specific item, which might be a limiting factor in a competitor's performance, is isolated, it could be most beneficial to both the competitor and the coach of swimming. The turn is one such skill that can be isolated and studied.

The breaststroke is the slowest of all the competitive strokes, and has been modified more than the other strokes.[2]

---

[1]John A. Faulkner, _What Research Tells the Coach About Swimming_ (Washington, D. C., 1967), p. 32.

[2]David A. Armbruster, Robert H. Allen, and Hobert S. Billingsley, _Swimming and Diving_, 4th edition (St. Louis, 1963), p. 153.

Over the years considerable research and writing has occurred concerning the technique of the stroke. There is little research related to the turn as used in competitive swimming, particularly as it is used in swimming the breaststroke.

Virtually all competitive swimming is conducted in closed courses, requiring the swimmer to execute a turn when two or more lengths are being swum. Therefore, the execution of the turn is a skill which must be performed effectively in order for the swimmer to achieve his best time over any distance for which the breaststroke is used.

Two types of turns are presently used in breaststroke competition: one required by the Amateur Athletic Union of the United States (AAU); and one allowed by the National Collegiate Athletic Association (NCAA). A third type, the somersault turn, can be legally executed, but is not presently used in competition.

Statement of the Problem

The problem with which this investigation was concerned was that of comparing three methods of performing the breaststroke turn in competitive swimming and their effects on the time required to swim fifty yards.

Purposes of the Study

The purposes of this study were as follows:

1. To determine the total time of advanced swimmers performing the breaststroke for a distance of fifty yards

a. when using the AAU turn.

b. when using the NCAA turn.

c. when using the somersault turn.

2. To determine the total time of novice swimmers performing the breaststroke for a distance of fifty yards

a. when using the AAU turn.

b. when using the NCAA turn.

c. when using the somersault turn.

3. To determine the length of time an advanced swimmer, performing the breaststroke for fifty yards, is submerged after his feet leave the turning surface until his head breaks the surface of the water

a. when using the AAU turn.

b. when using the NCAA turn.

c. when using the somersault turn.

4. To determine the length of time a novice swimmer, performing the breaststroke for fifty yards, is submerged after his feet leave the turning surface until his head breaks the surface of the water

a. when using the AAU turn.

b. when using the NCAA turn.

c. when using the somersault turn.

5. To analyze the optimum time a breaststroke competitor is to be submerged after his feet leave the turning surface until his head breaks the surface of the water.

Hypotheses

The following hypotheses were tested:

1. Of the advanced swimmers performing the breaststroke for a distance of fifty yards

a. there will be no significant difference in the total time when using the AAU turn as compared with the NCAA turn.

b. there will be no significant difference in the total time when using the AAU turn as compared with the somersault turn.

c. there will be no significant difference in the total time when using the NCAA turn as compared with the somersault turn.

2. Of the novice swimmers performing the breaststroke for a distance of fifty yards

a. there will be no significant difference in the total time when using the AAU turn as compared with the NCAA turn.

b. there will be no significant difference in the total time when using the AAU turn as compared with the somersault turn.

c. there will be no significant difference in the total time when using the NCAA turn as compared with the somersault turn.

3. Concerning the time an advanced swimmer, performing the breaststroke for fifty yards, is submerged after his feet leave the turning surface until his head breaks the surface of the water

a. there will be no significant difference when using the AAU turn as compared with the NCAA turn.

b. there will be no significant difference when using the AAU turn as compared with the somersault turn.

c. there will be no significant difference when using the NCAA turn as compared with the somersault turn.

4. Concerning the time a novice swimmer, performing the breaststroke for fifty yards, is submerged after his feet leave the turning surface until his head breaks the surface of the water

a. there will be no significant difference when using the AAU turn as compared with the NCAA turn.

b. there will be no significant difference when using the AAU turn as compared with the somersault turn.

c. there will be no significant difference when using the NCAA turn as compared with the somersault turn.

Background and Significance

Through the years all the competitive swimming strokes have undergone some change but none have been modified more than the breaststroke.[3] In order to form a comprehensive picture of these changes and to more thoroughly understand the significance of the study, one must examine a portion of the historical background of the breaststroke.

The historical background concerning swimming is very fragmentary prior to the sixteenth century even though there are references recorded in literary works. Oppenheim,[4] the author of one of the more recent histories of sports swimming, states that Japan became the first country to initiate a

---

[3]Ibid.

[4]Francois Oppenheim, The History of Swimming (North Hollywood, California, 1970), p. 3.

national sports organization for swimming when in 1603 an Imperial edict was issued encouraging school swimming competition. However, it was in England that competitive swimming is considered to have had its modern birth, when about 1837 in London, the first races were held by the National Swimming Association. The breaststroke was the first stroke used in these races and Colwin[5] refers to it as the "ancestor" of all the swimming strokes. The stroke received considerable attention as the result of Captain Matthew Webb's use of it to swim the English Channel in 1875. With the advent of competitive swimming there began a search for greater speed and more efficient movements.

Since improvement of speed is the ultimate goal of every competitive swimmer, the breaststroke as used in the early races in England began to evolve into what eventually became the crawl stroke, progressing by stages through the sidestroke, the overarm sidestroke, and the trudgen stroke.

The first breaststroke competition in the Olympic Games occurred in St. Louis in 1904. This also marked the first time that competitive swimming at the games was held in a

---

[5]Cecil Colwin, Cecil Colwin on Swimming (London, 1969), p. 75.

still body of water, having been held previously in the Bay of Zea at the 1896 Athens Games and in the Seine River at the Paris Games in 1900.

Much of the problem concerning the breaststroke has been the limitations placed on the stroke by the rigid rules. These rules have allowed very little deviation from the prescribed method for starting, turning, finishing a race, and swimming the stroke. Kiphuth[6] states that around 1900 interest in the stroke began to wane, and the great interest in the speed of the other strokes brought about changes in breaststroke technique which would produce greater speed.

One of the first of two important changes in the breaststroke was the introduction of the butterfly armstroke, used for the first time in 1926 by the German Erich Rademacher. The butterfly armstroke was referred to by Counsilman as "the greatest innovation in the breaststroke."[7] This change came about because the rules governing breaststroke competition at that time did not force a swimmer to recover his arms under the surface of the water following a stroke. It proved to be

---

[6]Robert J. H. Kiphuth, Swimming (New York, 1942), p. 76.

[7]James E. Counsilman, The Science of Swimming (Englewood Cliffs, New Jersey, 1968), p. 113.

a more efficient method of using the arms, thereby contributing to greater speed in competitive races. Because both arms recovered over the surface of the water at the same time, the stroke became known as the butterfly breaststroke.

The other important change that increased the speed and efficiency of the stroke was swimming underwater. According to Talbot,[8] this was a skill that the Japanese swimmers were particularly adept at performing, since they had competed in ritualistic underwater acrobatics from the Middle Ages.

In 1953 the International Amateur Swimming Federation, officially the "Fédération Internationale de Natation Amateur," (FINA) separated the butterfly and the breaststroke. This organization, founded in London in 1908, had three primary aims, according to Oppenheim,[9] which were to (1) establish rules for international swimming competition; (2) maintain and verify world swimming records; and, (3) organize the swimming competition of the Olympic Games.

The two strokes became separate events for the first time in the 1956 Olympic Games at Melbourne, Australia. It

---

[8]Don Talbot, Swimming to Win for All Ages (London, 1967), p. 93.

[9]Oppenheim, op. cit., p. 7.

was during these games that the underwater style of swimming the breaststroke emerged as the fastest method while abiding by the rules. Masura Furukawa of Japan used this method in winning the 200-meter breaststroke at the Melbourne Games.

Following the 1956 Olympic Games the stroke was changed again by FINA. It became a surface stroke requiring that the head must break the surface of the water at all times except following the start and after each turn. One pull of the arms and one kick of the legs were allowed underwater following the start and after each turn.

Colwin[10] states that after many revolutions the original European swimming stroke was revived, and concludes that coaches and competitors will always find ways and means to swim the breaststroke faster while adhering to the rules.

One way to increase the speed of the stroke over a given distance is to improve the turn. Kiphuth[11] believes that since the breaststroke swimmer doesn't have the advantage of anticipating the turn (as freestyle and backstroke swimmers do), it is even more necessary that he become adept at turning.

---

[10]Colwin, _op. cit._, p. 77.

[11]Kiphuth, _op. cit._, p. 85.

Still[12] states that turning has been a neglected part of the competitive swimmer's training program, but coaches are becoming more conscious of the importance of this essential skill.

Clark[13] emphasized that the execution of a turn is just one facet of the competitive swimmer's program that must not be ignored during a workout and which must be performed in an "all out" manner. The swimmer must assume a great share of the responsibility for executing the turns within the rules while in training, since the coach is unable to observe all the turns performed during any one training session. One can immediately see that turning is a habit and must not be performed carelessly or illegally in practice, or it will likely be performed in the same manner while in a competitive race.[14]

Because the mechanics of executing the breaststroke turn are controlled to a great degree by the rules being followed,

---

[12] Athole Still, Competitive Swimming (New York, 1971), p. 97.

[13] Steve Clark, Competitive Swimming As I See It (North Hollywood, California, 1967), p. 160.

[14] John H. Higgins, Alfred R. Barr, Ben F. Graddy, and Jack Martin, Swimming and Diving (Annapolis, Maryland, 1965), p. 151.

it is essential that these rules be understood and observed. The two sets of rules presently followed in competition are those of the AAU and the NCAA. They are stated in order that the differences may be discerned.

Article II of the AAU Competitive Swimming Rules reads as follows:

A. Breaststroke:

1. START--The forward start shall be used. Swimming under the surface of the water is prohibited except for one arm stroke and one leg kick after start and turn. The surface of the water is defined as that of the pool in a calm state. A wave passing over the head does not constitute a disqualification provided that part of the swimmer's head is above the calm surface.

2. STROKE--The starting position of the breaststroke shall be with the arms together and extended forward and with legs together and extended backward. The instant the hands leave the extended position a new stroke shall have been started. Both hands must be pushed forward together from the breast on or under the surface of the water and brought backward simultaneously and symmetrically with lateral extension. The body must be kept perfectly on the breast and both shoulders in the horizontal plane from the beginning of the first armstroke after the start and after each turn. On the breaststroke, from the moment when a swimmer, after the start or turn, begins the second stroke, one part of the head shall always break the surface of the water. NOTE: Either complete or incomplete movement of the arms or

legs from the starting position shall be considered as one complete stroke or kick.

3. KICK--The feet shall be drawn up simultaneously and symmetrically, the knees bent and open. The movement shall be continued with a rounded and outward sweep of the feet, bringing the legs together. Up and down movements of the legs in the vertical plane and using the top of the instep in the propulsive part of the kick are prohibited. Breaking water surface with the feet shall not merit disqualification unless caused by movement of the legs in a vertical plane.

4. TURNS AND FINISH--When touching the end of the pool or course at the turns or on finishing a race, the touch shall be made with both hands simultaneously on the same level while the body is on the breast. The shoulders shall be in a horizontal position in line with the surface of the water. A legal touch may be made above or below the surface of the water.[15]

The NCAA rules pertaining to the breaststroke (Rule 2, Section 2) reads as follows:

a. The breaststroke must be swum on the surface. Following the take-off and each turn, one arm-pull and one leg-kick may be taken underwater, but some portion of the swimmer's head must break the surface of the water before another stroke is started. Except for this provision, and in Rules governing the turn and finish (see 2f), some portion of the swimmer's head must be higher than the normal, flat surface of the water at all times.

---

[15]Amateur Athletic Union Aquatics Handbook (Indianapolis, Indiana, 1972), Swimming Rules, pp. 102-103.

b. Both hands must be pushed forward simultaneously on or under the surface of the water and brought backward simultaneously.

c. The body must be kept perfectly on the breast, with both shoulders in the horizontal plane.

d. The feet shall be drawn up with the knees and apart. The movement shall be continued with a rounded outward sweep of the feet bringing the legs together. Up and down movements of the legs in the vertical plane are prohibited. All movements of the legs and feet must be simultaneous, and in the same horizontal plane. A swimmer may not introduce a sidestroke movement or use the top of the instep of one or both feet in the propulsive part of the breaststroke kick.

e. When touching at each turn the touch shall be made with both hands simultaneously. It is permissible on a turn to drop a shoulder after the final arm pull and prior to the touch. Once each legal touch has been made, the swimmer may turn in any manner desired, but the prescribed form must be attained before the feet leave the wall in the push-off. On the finish the touch must be made with both hands simultaneously.

f. It is permissible after the final arm pull prior to a turn or finish for the head to be lowered below the water level of the pool. This would apply equally in the breaststroke leg of the medley relay and the breaststroke in the individual medley.[16]

---

[16]NCAA Swimming Guide (Phoenix, Arizona, 1972), Swimming and Diving Rules, pp. 15-16.

Gambril[17] expresses the belief that breaststroke swimmers will go to a modification of the tumble (somersault) turn in the future if the rules are adapted in some manner. Beginning with the 1970-71 swimming season, the NCAA allowed the dropping of a shoulder after the final arm pull and prior to the touch on the turn. Rule change 2f above became effective with the 1972-73 season. With these two significant changes, the execution of the somersault turn in swimming the breaststroke is now more feasible.

Definition of Terms

Certain terms which are used in this study are defined as follows:

Closed course refers to the confined area requiring a swimmer to execute a turn in order to swim continuously. For this study it will be a pool twenty-five yards in length.

Glide refers to the swimmer's action during the period of time he is submerged after his feet leave the turning surface and until his head breaks the surface of the water. It

---

[17]Donald L. Gambril, Swimming (Pacific Palisades, California, 1969), p. 49.

will include the one arm pull and the one kick of the legs allowed by the rules.

Senior swimmer refers to the classification of AAU swimmers twelve years of age or older.

Turn refers to the change of direction at the end of the pool, beginning when the hands touch the turning surface, and ending when the feet leave the same surface.

AAU breaststroke turn refers to the turn requiring the touch to be made with both hands simultaneously on the same level. The shoulders must be in a horizontal position in line with the surface of the water.

NCAA breaststroke turn refers to the turn requiring the touch to be made with both hands simultaneously, but not requiring the shoulders to be in a horizontal position in line with the surface of the water.

Somersault turn refers to the turn, performed after touching the turning surface by the hands simultaneously, where a somersault is followed by a one-half twist.

Limitations of the Study

This study was limited to male senior swimmers from selected teams in the Arkansas Association of the AAU who were in competition during the 1972-73 indoor season.

Basic Assumptions

It was assumed that the subjects would diligently follow the directions of the study and would cooperate and perform to the best of their ability on the criterion measures.

Procedures for Collecting the Data

Permission was granted by the swimming coaches of the Little Rock, Arkansas, Racquet Club, the Little Rock Boys Club, the Little Rock William Thrasher Boys Club, Miller's Swim Gym of Little Rock, Hendrix College and the Hendrix College Aqua-kids of Conway, Arkansas, and the Russellville, Arkansas, Swim Team for their male senior swimmers to participate in the study during the 1972-73 indoor season. All of the teams are members of the Arkansas Association of the AAU.

A breaststroke rating scale was developed to rate each swimmer on his body position, timing, breathing, use of arms, and use of his legs. This scale was submitted to a panel of three qualified college swimming coaches for their approval as adequately describing the five components to be rated.

Upon approval of the instrument by the panel of coaches, two additional qualified college swimming coaches visited each of the teams and rated the swimmers.

After the swimmers were rated they were categorized as novice, average, or advanced breaststroke swimmers. All swimmers scoring 17.5 points or above on the total of twenty-five points were classified as advanced swimmers, and those scoring 12.5 points or below were classified as novices. Swimmers scoring between 12.5 and 17.5 were classified as average and were not used in the study.

Prior to the testing of the two groups, the two persons who operated the stop watches during the study timed a series of sprints on swimmers not involved in the study to test the reliability of their timing.

On the original testing date the swimmers were given oral instructions and a demonstration of the AAU turn, and allowed a fifteen-minute practice period. Following this practice period the subjects were timed for the fifty-yard swim using the AAU turn. After the test was administered the subjects were given oral instructions and a demonstration of the NCAA turn. After a minimum practice period of seven days the subjects were timed on the fifty-yard swim using the NCAA turn.

Following the testing of the fifty-yard swim using the NCAA turn, the subjects were given oral instructions and a demonstration of the somersault turn. After a minimum practice period of seven days, they were tested on the fifty-yard swim using the somersault turn. Oral instructions, a demonstration, and a practice period preceded the administration of each test.

Treatment of the Data

An analysis of variance was utilized to test the four stated hypotheses. The tenability of each hypothesis was tested at the .05 level of significance. When significant differences were found to exist, Scheffe's method was used to determine where the significant differences existed.

A chi-square test of independence was used to analyze the optimum time a breaststroke competitor was to be submerged after his feet left the turning surface until his head broke the surface of the water.

CHAPTER II

REVIEW OF RELATED LITERATURE

Research related to competitive swimming was very limited prior to 1930, and according to Spangler, it was "concerned chiefly with the requirements of a swimming teacher; the psychology of the instructor; the psychology and hygenic effects of swimming; and the mechanics and kinesiology of the activity."[1] He concludes that most of that which was gathered is empirical in nature.

Studies associated with swimming continue to increase, however, due to the increasing popularity of the activity. Van Atta compiled a bibliography of the literature written in the English language concerning swimming and located twenty-seven books that had been written from 1955 to 1960. In addition, there were forty-five articles, ten master's theses, and four doctoral dissertations completed between the years

---

[1]James Richard Spangler, "A Compilation and Analysis of Research in Competitive Swimming and Diving in the U. S., 1930-1963," unpublished master's thesis, Graduate College, University of Illinois, Urbana, Illinois, 1964, p. 6.

1946-1960 which pertained to the technique of the four competitive strokes (crawl, backstroke, breaststroke, and butterfly), the sidestroke, the elementary backstroke, and the underwater breaststroke.[2] The most comprehensive bibliography was completed in 1968 and resulted from the efforts of many organizations which conduct and promote aquatic activities of any nature.[3] It contains most of the material in the aquatics field written or filmed prior to 1966.

The research specifically related to the breaststroke has been very restricted, and a report by the Education and Research Committee of the College Swimming Coaches Association is indicative of the lack of research on the stroke. The report states that only one study was completed, underway, or proposed pertaining to the breaststroke for the year 1971-72 in the ninety-four colleges and universities responding to the survey.[4]

---

[2]William D. Van Atta, "Abstract," Swimming Technique, V (July, 1968), 63.

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

[4]John B. Skehan, Chairman, "Report: Current Status of Research and Publication of the Membership of the College Swimming Coaches Association," (March, 1972).

Much of the research and literature associated with the breaststroke concerns the technique of the kick. Magel, using twenty-six highly trained college swimmers, measured the propelling force exerted by each of the four competitive strokes while being performed in tethered swimming. He found that breaststroke swimmers exerted the greatest force during three minute swims, although it is the slowest of the four strokes. He concluded that the legs contribute a much larger part to the total propulsive force in the breaststroke as compared to the other strokes. In the backstroke and crawl the major portion of the force is provided by the armstroke, while in the butterfly he maintains that the arms and legs provide approximately the same amount of propelling force.[5]

Over isolated the kick and studied the two most frequently used methods, the frog kick and the whip kick. Using one fifteen-year-old subject, she concluded that the frog kick was more efficient at slow speeds.[6] The subject had nine years

---

[5]John R. Magel, "Propelling Force Measured During Tethered Swimming in the Four Competitive Swimming Styles," _Research Quarterly_, XXXXI (March, 1970), 68.

[6]Mary Ellen Over, "A Comparison of the Force and Resistance of the Frog Kick and Whip Kick Used in Swimming the Orthodox Breast Stroke," unpublished master's thesis, Department of Physical Education, Long Beach State College, Long Beach, California, 1964, p. 53.

experience as a competitive swimmer but was not familiar with the whip kick prior to the study. Over recommended further research on the stroke because of its complex nature.[7] Ford, using college women enrolled in beginning swimming classes as subjects, studied two methods for teaching the whip kick in the breaststroke. She found that using the back and front methods resulted in about equal effectiveness in terms of the final achievement.[8]

Cake also compared the wedge and whip kicks as they are utilized in the conventional breaststroke. His subjects were separated into three groups: one consisting of eleven swimmers who were experienced and skilled with both types of kicks; and the two remaining groups were inexperienced swimmers from college classes. Each of these classes was taught a different type of kick.[9] He concluded that the "semicircular arc

---

[7] Ibid., p. 54.

[8] Carol Ford, "A Comparison of the Relative Effectiveness Between Two Methods of Teaching the Whip Kick to College Women in Beginning Swimming Classes," unpublished master's thesis, Department of Physical Education, Women's College of the University of North Carolina, Greensboro, North Carolina, 1958, p. 40.

[9] Frances Cake, "The Relative Effectiveness of Two Types of Frog Kick in Swimming the Breast Stroke," Research Quarterly, XIII (May, 1942), 201.

whipping" action is superior to the wedge kick in force, speed, and economy of movement, and that from the evidence of the study it cannot be considered more difficult to learn.[10] Counsilman substantiated Cake's study and expressed two additional advantages the whip kick possesses over the wedge kick; namely, it is capable of a faster tempo and it does not create as much resistance as the wedge kick in the recovery phase.[11]

Counsilman is considered one of the outstanding authorities on the breaststroke, and as a result of his studies, particularly with his outstanding Indiana swimmer, Chet Jastremski, revolutionized the stroke by placing more emphasis on the arm stroke. With virtually no glide, the stroke has developed into a much faster stroke.[12]

Costil describes the underwater stroke following the turn in detail and concludes that it is more efficient and can produce greater acceleration than the surface stroke provided it is correctly executed.[13] He emphasizes that all aspects

---

[10] Ibid., p. 204.

[11] James E. Counsilman, The Science of Swimming (Englewood Cliffs, New Jersey), p. 117.

[12] Ibid., p. 114.

[13] David L. Costill, "Analysis of the Breaststroke," Athletic Journal, IIIL (October, 1966), 50.

of technique are important to the swimmer desiring to reach his peak performance and these can only be achieved by means of empirically supported training programs.[14]

Success in swimming, according to Chivers, can be attributed to four basic components, namely, technique (stroke mechanics), mental attitude, structural aptitude, and organic condition.[15] He expresses the view that few swimmers take the time to calculate what causes them to go through the water.[16] Spangler cites the following factors as being important in obtaining a winning performance:

> A. super nutrition; B. increase of the will to win; C. increase of mental skill through racing experience; D. increased economy of effort through better direction of positive movements coupled with super relaxation of the for-the-time-being non-participating muscle during the performance of the negative movements; and, E. increase of technical skills in the execution of the associated non-stroking gymnastics, i.e., the starting lap, surface glide, race turn, etc.[17]

---

[14] *Ibid.*, p. 51.

[15] Kenneth C. Chivers, "What Makes for Success in Swimming," *Journal of Physical Education*, LXVIII (November, 1970), 37.

[16] *Ibid.*, p. 43.

[17] Spangler, *op. cit.*, p. 17.

McDonald and Stearns contributed further information by analyzing the breaststroke and butterfly to determine the support given to the whole stroke by the arms and legs individually. Studying college swimmers who were competent in the two strokes, they administered three tests over a distance of sixty feet at maximum speed using the arms alone, the legs alone, and the complete stroke. The subjects numbered nineteen for the breaststroke and twenty-one for the butterfly, and several were tested only once due to unusual circumstances.[18] They found that the arms contributed 53.5 per cent to the complete breaststroke with the legs accounting for 46.5 per cent, and concluded, from a comparison of the literature and their own research, that too much emphasis has been placed upon the breaststroke kick.[19] Their recommendation is that the arms should be accentuated more in the training and instructional programs. The study did not include any data regarding the turn as used in the two strokes.

---

[18]Frederic W. McDonald, Jr., and William J. Stearns, "A Mathematical Analysis of Swimming the Breaststroke and Dolphin Butterfly Strokes," unpublished master's thesis, Graduate School, Springfield College, Springfield, Massachusetts, July, 1969, p. 3.

[19]*Ibid*., p. 35. [20]*Ibid*., p. 37.

Pitt observes that while securing maximum power from the breaststroke "whip" kick is important, a degree of quickness in the "turn over" seems to be a significant factor.[21] He suggests that this turn-over can be achieved by not drawing the legs up as far, nor extending the feet out as wide, as previously practiced by breaststrokers.[22]

One of the more detailed studies was conducted by Clayton, and was concerned with a comparison of three methods of instruction upon learning the breaststroke and crawl. After screening male college students, he selected a group of beginning swimmers to be taught the breaststroke and to be administered a power test at the conclusion of the term. There were nineteen subjects taught by means of a land-drill method, twenty used an implicit-rehersal method, and seventeen were taught by the more traditional water-practice method.[23] He concluded that

---

[21]Don Pitt, "Some Observations on the Breaststroke Kick," Swimming Technique, V (July, 1968), 59.

[22]*Ibid.*, p. 61.

[23]Robert D. Clayton, "The Efficacy of the Land-Drill, Implicit-Rehersal, and Water-Practice Methods of Teaching the Breast Stroke and Crawl Stroke to College Men," unpublished doctoral dissertation, School of Health, Physical Education, and Recreation, University of Oregon, Eugene, Oregon, June, 1963, pp. 44-70.

their performance on the swimming achievement tests was not vitally affected by the method of instruction and suggests that these same methods should be taught to swimmers other than those classified as beginners.[24]

The technique of breathing during the breaststroke has also been a much analyzed component, but it is widely accepted as being the most effective when performed late in terms of the arm pull. Among some of the more prominent coaches advocating the late breathing technique are Colwin,[25] Counsilman,[26] Carlile,[27] and Silvia.[28] Still believes that late breathing is practiced by a majority of the world's leading men and women breaststrokers and encourages all breaststroke swimmers to adopt the method in preference to the method of breathing as the arms begin the pull.[29]

---

[24] Ibid., p. 117.

[25] Cecil Colwin, Cecil Colwin on Swimming (London, 1969), p. 82.

[26] Counsilman, op. cit., p. 126.

[27] Forbes Carlile, Forbes Carlile on Swimming (London, 1966), p. 185.

[28] Charles E. Silvia, Manual and Lesson Plans for Basic Swimming, Water Stunts, Life Saving, Springboard Diving, Skin and Scuba Diving, and Methods of Teaching (Springfield, Massachusetts, 1970), p. 85.

[29] Athole Still, Competitive Swimming (New York, 1971), p. 46.

While there has been considerable study conducted related to stroke technique, the research is fragmentary concerning the turn in competitive swimming, although authorities in swimming clearly agree that this technique is essential in the development of a competitive swimmer if he is to be successful. Schlegal believes the skill of turning is an aquired art and can only be mastered through long hours of work.[30] Jacobson emphasizes that losing breaststroke swimmers can become winners when they have mastered the turn.[31] Jacobs expresses the same opinion.[32]

King,[33] believing the turn to be one of the most important skills a competitor can acquire, proceeded to undertake a study of the backstroke turn to determine whether the turn followed by a one-arm glide is faster than the turn followed by the

---

[30]Charles H. Schlegal, "Turns for the Better," _Scholastic Coach_, XXX (May, 1961), 36.

[31]Thomas J. Jacobson, "Coaching the Breaststroke Turn," _Athletic Journal_, XXXXIII (April, 1963), 76.

[32]Marshall L. Jacobs, "Turns for the Butterfly and Breaststroke," Athletic Journal, XXXXI (November, 1960), 55.

[33]William H. King, Jr., "A Time and Motion Study of Competitive Backstroke Swimming Turns," unpublished doctoral dissertation, School of Education, Boston University, Boston, Massachusetts, 1956, pp. 35-43.

two-arm glide. Two groups of competitive swimmers, fifty in each group, were selected as subjects. One group was composed of college and adult swimmers and the second group consisted of secondary school swimmers. Following the administration of the test for the turn followed by the two-arm glide, the subjects were taught the turn followed by the one-arm glide. The time lapse between the two tests varied from a minimum of ten days up to several months. It is apparent that the conditioning of the subjects would be a factor in the results. He concluded that the one-arm glide following the turn is the faster, more efficient turn, and suggests that some experimentation should occur in the breaststroke, using a push-off following the turn in which the arms are at the side of the body.[34] This would result in an armless glide.

Michaels[35] also studied the backstroke turn using the controversial roll turn. His primary objective was to find new ways of taking tenths and hundredths of seconds off swimming performances. Testing one swimmer over a five day period, he concluded that the roll turn, when performed legally, is

---

[34]Ibid., p. 82.

[35]Richard A. Michaels, "The Roll Backstroke Turn," Swimming Technique, V (October, 1968), 70-72.

significantly faster. The subject executed fifty turns of each type being studied, the roll turn and the conventional backstroke turn. He further expressed the belief that by 1978 all the leading backstroke competitors will be using the roll turn and the conventional turn will be outdated.

King and Scharf[36] studied two types of freestyle turns, to compare a one-arm glide to the two-arm glide following the execution of the turn, and used procedures similar to that employed by King[37] in his study of the backstroke turn. One major difference was the practice period of four weeks allowed each subject prior to the administration of each test. They concluded that the turn followed by the one-arm glide was the faster method of turning.[38] Fox, Bartels, and Bowers[39] studied further the turn as used in the freestyle, comparing the open and closed turns. Using six male competitive swimmers (ages

---

[36]William H. King and Raphael J. Scharf, "Time and Motion Analysis of Competitive Freestyle Swimming Turns," Research Quarterly, XXXV (March, 1964), 39, 43-44.

[37]King, op. cit., pp. 35-45.

[38]King and Scharf, op. cit., p. 43.

[39]Edward L. Fox, Robert L. Bartels, and Richard W. Bowers, "Comparison of Speed and Energy Expenditure for Two Swimming Turns," Research Quarterly, XXXIV (October, 1963), 322-326.

fifteen to thirty-two) as subjects, they timed each type of turn on two occasions over a distance of seventy feet. This distance represents two widths of the pool and is not a distance at which competition is customarily conducted. They found no significant difference in the energy cost of the turns but perceived the closed turn to be favored over the open turn.[40] Freestyle turns were also studied by Pomfret. Comparing the tumble turn with the throw-away turn, he concluded that age and experience were factors in the successful execution of the turn.[41]

Still cites the use of a somersault turn in the breaststroke, but because of the risk of disqualification it has never been accepted.[42] Counsilman has also experimented with the somersault turn in the breaststroke, and believes that

---

[40] Ibid., p. 326.

[41] Jack Bradshaw Pomfret, "An Experiment to Determine the Relative Effectiveness on Improved Swimming Time When Using the Freestyle Tumble Turn in Comparison to the Freestyle Throw-Away Turn," unpublished master's thesis, University of Washington, Seattle, Washington, 1962, cited in Spangler, op. cit., p. 209.

[42] Still, op. cit., p. 112.

the swimmer's need for a breath of air at the turn prevents the efficient execution of the somersault.[43]

A review of the literature reveals the vital role the turn plays in a competitive swimmer's performance. However, this review also disclosed the lack of research related to the competitive turn in general, and the breaststroke turn specifically. It is hoped that this study will aid the coach of swimming in his quest for knowledge concerning the breaststroke turn, thereby resulting in improved performances by his swimmers.

---

[43]Telephone conversation with James Counsilman, Coach of Swimming, Indiana University, Bloomington, Indiana, December 13, 1972.

CHAPTER III

PROCEDURES

The purpose of this study was to compare three types of breaststroke turns and their effects on swimming fifty yards. To carry out this purpose, the procedures which follow were instigated during the 1972-73 indoor swimming season.

Permission was granted by the coaches of seven swimming teams for the male senior swimmers to participate in the study. The teams selected were the Little Rock Boys Club, the William Thrasher Boys Club of Little Rock, the Little Rock Racquet Club, Miller's Swim Gym of Little Rock, Hendrix College and the Hendrix College Aquakids of Conway, and the Russellville Swim Team. All of the teams are members in good standing with the Arkansas Association of the Amateur Athletic Union.

The subjects, 104 in number, were rated on the five components of the breaststroke which are commonly considered to be the basic parts of the stroke. These components are the body position, the timing of the stroke, the technique of breathing, and the proper use of the arms and legs.

Counsilman[1] and Clotworthy[2] are two of the many prominent coaches who agree on the importance of each of these component parts.

A rating scale was developed and used to separate the subjects into the two groups which were to be studied. Prior to its use in rating the subjects, the scale was submitted to a panel of three qualified college swimming coaches for validation as being adequate in describing the five components on which the subjects were rated. The swimming coaches of Southern Methodist University, Texas Agricultural and Mechanical University, and Kansas State College at Pittsburg cooperated in the study by serving as the panel. If two of the three coaches had felt that any one item did not adequately describe the component it was to be revised and resubmitted. Each of the items was approved by the panel for inclusion in the study. A copy of the cover letter and instrument submitted for the panel's approval may be found in Appendix A. Appendix B contains the instrument used for rating each subject.

---

[1]James E. Counsilman, The Science of Swimming (Englewood Cliffs, New Jersey, 1968), pp. 115-132.

[2]Robert Clotworthy, "Thoughts on Breaststroke Swimming," unpublished notes, Princeton University, Princeton, New Jersey, 1965.

In using the scale to rate the subjects, each of the five components was evaluated by a rater and marked on a five-point scale. The scale was graduated from poor to excellent with intermediate values of fair, average, and good. Each of these was equated with point values. Half points were scored when the rater indicated his evaluation by marking between the values on the scale. The five components were then totaled to attain the subject's score.

The subjects were rated by the swimming coach at State College of Arkansas and by the investigator. The scores were averaged to arrive at the final rating for each swimmer. All subjects scoring 17.5 points and above were classified as advanced breaststroke swimmers, and those scoring 12.5 points and below were classified as novices. Subjects scoring between 12.5 and 17.5 were classified as average breaststrokers and were not included among those to be tested. Six of the 104 subjects were not classified since they performed a dolphin or scissors kick, both of which are illegal under the rules of the AAU and the NCAA. The averaged rating for each subject is recorded in Appendix C.

In advance of the testing of the two groups, the two individuals who operated the stop watches during the study reviewed the timing procedures recommended by the Southern Pacific Association of the AAU.[3] Following this review the timers timed a series of sprints to check the reliability of their timings. For this reliability check twenty-eight swimmers were timed during competition at the Little Rock Racquet Club's Annual Thanksgiving Meet. A coefficient of correlation of .999 was calculated and indicates a near perfect correlation between the individual times obtained by the two timers.

The watches used in the study were a Junghans three-dial timer and an Aristo split-timer with a ten-second sweep hand. The Junghans time piece was used to record the total time for the fifty yard distance and the Aristo split-timer was used in taking the turn and glide times. Both watches were checked by a watchmaker prior to all timing operations and found to be highly accurate. The verification of the accuracy of the watches is reported in Appendix D.

Prior to the administration of the first test, the subjects were given instructions to be followed throughout the study. They were asked to: (1) perform to the best of their

---

[3]Southern Pacific Association, A.A.U., "Recommended Procedures for Timing Competitive Swimming," January 25, 1968.

ability on each task; (2) wear the same suit, preferably a tank suit, at each testing period; (3) use the same type of start at each testing period, preferably the one normally used in competition; and, (4) practice the turn a maximum of fifteen minutes each day.

The first test consisted of the subjects swimming the breaststroke for fifty yards using the AAU turn. This was preceded by oral instructions, a demonstration of the turn, and a fifteen-minute practice period. Since the subjects were members of teams competing under AAU rules, all were familiar with the AAU turn.

Following the test using the AAU turn, the subjects were given oral instructions and a demonstration of the NCAA turn. They were instructed to practice the turn for a maximum period of fifteen minutes daily. After a minimum period of seven days the subjects were tested on the fifty-yard breaststroke using the NCAA turn. This was preceded by oral instructions, a demonstration of the turn, and a fifteen-minute practice period.

Following the test using the NCAA turn, the subjects were given oral instructions and a demonstration of the somersault turn. They were instructed to practice the turn for a maximum period of fifteen minutes daily. All the subjects were able to perform the somersault turn while swimming free-style; therefore, the mechanics were not totally unfamiliar to them. After a minimum period of seven days the subjects were tested on the fifty-yard swim using the somersault turn.

All testing consisted of only one trial per subject on each turn. This procedure was followed since this is the condition under which actual competition is conducted and it was assumed that each subject would perform to the best of his ability on the one attempt. The number of trials to be used has been a subject of discussion among leaders in physical education. After studying six combinations of trials on six different skills, McCraw and Tolbert concluded that "it is doubtful whether a single trial or combinations of two trials should be used except perhaps for the fifty-yard dash, where the best of two scores and even one trial scores yielded high coefficients of reliability."[4] A swim of fifty yards was used in this study for the purpose of testing the subjects.

All testing occurred within indoor pools twenty-five yards in length. In the six-lane pools used, the subjects were timed

---

[4]L. W. McCraw and J. W. Tolbert, "A Comparison of the Reliabilities of Methods of Scoring Tests of Physical Ability," Research Quarterly, XXIII (March, 1952), 80.

in either lane two or lane five. One eight-lane pool was used and the subjects were timed in lane seven.

The times recorded were the total time for the fifty-yard breaststroke, the time the subject was in actual contact with the turning surface, and the glide time. The glide time was obtained by subtracting the time the subject was in actual contact with the surface from the total time on the Aristo watch. This difference represented the time the subject was submerged from the instant his feet left the turning surface until his head broke the surface of the water.

The starting procedure for the testing of each subject was performed in accordance with AAU rules and each start throughout the study was judged to be legal. A twenty-two caliber pistol was used to initiate the start by each subject.

One timer, using the Junghans three-dial time piece, started the watch on the starter's signal and stopped the watch when the swimmer touched the wall at the finish of the fifty-yard swim. The second timer stood directly over the lane in which the swimmer was performing in order to secure an accurate time of the turn. Two aspects of the turn were measured and recorded. The second timer started the Aristo split-timer the instant contact was made by the hands with the turning surface and stopped the split-second hand of the watch the instant the feet left the turning surface in the push-off. He stopped the watch the instant the head broke the surface of the water. The turn time was recorded by the reading of the split-second hand of the watch. This time was subtracted from the total time on the watch to obtain the glide time.

In order to treat the data an analysis of variance was used to determine significant differences. Scheffe's method was used to locate specifically where these differences, if any, existed. Scheffe's method is a rigorous method for making multiple comparisons and is not seriously affected by violations of the assumptions of normality. The tenability of each hypothesis was tested at the .05 level of significance. A chi-square test of independence was used to analyze the optimum time a breaststroke competitor was to be submerged after his feet left the turning surface until his head broke the surface of the water. The computations were calculated at the North Texas State University Computer Center, Denton, Texas.

CHAPTER IV

ANALYSIS OF THE DATA

The problem with which this investigation was concerned was that of comparing three methods of performing the breaststroke turn in competitive swimming and their effects on the time required to swim fifty yards. The findings are presented in the order in which the hypotheses were stated in Chapter I. A concomitant purpose was to determine the optimum time a breaststroke competitor is to be submerged after his feet leave the turning surface until his head breaks the surface of the water.

The method utilized in testing the hypotheses was the analysis of variance for repeated measures. When significant differences were found to exist, Scheffe's method of making all possible comparisons of means was used to determine between which groups the significant differences existed. This method is considered more rigorous than other methods of calculating multiple comparisons with respect to committing a Type I error. A Type I error results when a true hypothesis is rejected. The .05 level of significance was required to reject all stated hypotheses.

Chi square was used to analyze the optimum time a breaststroke competitor is to be submerged after his feet leave the turning surface until his head breaks the surface of the water.

The first hypothesis was stated as follows:

Of the advanced swimmers performing the breaststroke for a distance of fifty yards,

a. there will be no significant difference in the total time when using the AAU turn as compared with the NCAA turn;

b. there will be no significant difference in the total time when using the AAU turn as compared with the somersault turn;

c. there will be no significant difference in the total time when using the NCAA turn as compared with the somersault turn.

The mean times and standard deviations for advanced breaststrokers swimming fifty yards are presented in Table I. The findings are presented for each of the three turns studied.

An examination of the means reveals that swimming the fifty yard breaststroke using the somersault turn was, on the

TABLE I

MEAN AND STANDARD DEVIATIONS RECORDED BY ADVANCED BREASTSTROKE SWIMMERS FOR FIFTY YARDS
N=29

Turn Used	Mean	Standard Deviation
AAU	37.05 secs.	3.93 secs.
NCAA	36.98 secs.	3.68 secs.
SS	37.15 secs.	3.37 secs.

average, slightly slower than when the AAU or NCAA turns were used. The time required by the advanced breaststrokers to swim the fifty yards using the NCAA turn was, on the average, slightly faster (.07 seconds) than when the AAU turn was used.

The calculation of the analysis of variance for repeated measures for the twenty-nine advanced breaststrokers are reported in Table II.

As revealed in Table II, the analysis of variance of the group means resulted in an $\underline{F}$ ratio of 0.23084. At the .05 level of significance it would require a ratio of 4.016 in order to reject the hypothesis. Therefore, the hypothesis was accepted.

In order to more thoroughly understand the study, an examination of the time required to perform each type of

TABLE II

ANALYSIS OF VARIANCE FOR REPEATED MEASURES FOR ADVANCED BREASTSTROKERS SWIMMING FIFTY YARDS USING THE AAU, NCAA, AND SOMERSAULT TURNS
N=29

Source	df	Sum of Squares	Mean Square	F	P
Between subjects	28	1076.81264			
Within subjects	58	53.14000			
A (treatments)	2	0.43471	0.21736	0.23084	0.79454
Residual	56	52.70529	0.94117		
Total	86	1129.95264			

turn while swimming fifty yards is necessary. The mean and standard deviation for each turn used by advanced breaststrokers is reported in Table III.

TABLE III

MEAN AND STANDARD DEVIATIONS FOR TURN TIMES OF ADVANCED BREASTSTROKE SWIMMERS
N=29

Turn Used	Mean	Standard Deviation
AAU	1.47 secs.	0.18 secs.
NCAA	1.42 secs.	0.23 secs.
SS	1.68 secs.	0.34 secs.

The actual mean time for performing the NCAA turn, 1.42 seconds, was faster than either the AAU or somersault turns; although, as indicated in Table II, there was no significant difference in the total time required to swim the fifty yards. It may be observed from Table III that the mean time for performing the somersault turn was slower than either the AAU or NCAA turns.

The analysis of variance for the time required to perform each of the turns for the fifty yard distance for advanced breaststroke swimmers is reported in Table IV.

TABLE IV

ANALYSIS OF VARIANCE FOR REPEATED MEASURES FOR THE TURN TIME OF ADVANCED BREASTSTROKERS USING THE AAU, NCAA, AND SOMERSAULT TURNS
N=29

Source	df	Sum of Squares	Mean Square	F	P
Between subjects	28	2.80437			
Within subjects	58	3.98000			
A (treatments)	2	1.06575	0.53287	10.23965	0.00016
Residual	56	2.91425	0.05204		
Total	58	6.78437			

As revealed in Table IV, an analysis of variance of the group means resulted in a probability of .00016 and an F ratio of 10.23965. This is significant at the .05 level. Scheffe's method was used to determine where the significant differences existed.

The results of the comparison of the treatment means using Scheffe's method are reported in Table V.

TABLE V

SCHEFFE "F" VALUES FOR THE COMPARISON OF TREATMENT MEANS OF THE TURN TIMES OF ADVANCED BREASTSTROKERS
N=29

Turn	AAU	NCAA	SS
AAU	0.0	0.3247	5.9636
NCAA		0.0	9.0712
SS			0.0

As indicated in Table V, there was no significant difference between the time required to perform the AAU turn as compared with the NCAA turn. However, there was a significant difference between the somersault turn and the AAU and NCAA turns. A ratio of 4.016 (.05 level) was needed to indicate a significant difference. It may be observed that 5.9636 and 9.0712 exceed the required ratio.

The second hypothesis was stated as follows:

Of the novice swimmers performing the breaststroke for a distance of fifty yards,

a. there will be no significant difference in the total time when using the AAU turn as compared with the NCAA turn;

b. there will be no significant difference in the total time when using the AAU turn as compared with somersault turn;

c. there will be no significant difference in the total time when using the NCAA turn as compared with the somersault turn.

The mean times and standard deviations for novice breaststrokers swimming fifty yards are presented in Table VI.

TABLE VI

MEAN AND STANDARD DEVIATIONS RECORDED BY NOVICE BREASTSTROKE SWIMMERS FOR FIFTY YARDS
N=30

Turn Used	Mean	Standard Deviation
AAU	43.08 secs.	6.66 secs.
NCAA	42.91 secs.	5.27 secs.
SS	43.63 secs.	6.89 secs.

The mean total time for the fifty-yard swim using the NCAA turn, as reported in Table VI, was 42.91. This is slightly faster than the mean total time when using the AAU turn. It is evident that the mean total time for the fifty yards when using the somersault turn was slower than when either the AAU or NCAA turns were used.

The results of the analysis of variance for the time required to swim the fifty yards by the thirty novice breaststrokers are reported in Table VII.

TABLE VII

ANALYSIS OF VARIANCE FOR REPEATED MEASURES FOR NOVICE BREASTSTROKERS SWIMMING FIFTY YARDS USING THE AAU, NCAA, AND SOMERSAULT TURNS
N=30

Source	df	Sum of Squares	Mean Square	F	P
Between subjects	29	3695.95789			
Within subjects	60	118.10667			
A (treatments)	2	8.58289	4.29144	2.27260	0.11215
Residual	58	109.52378	1.88834		
Total	89	3814.06456			

An examination of Table VII reveals an F ratio of 2.27260. A ratio of 4.008 was required to reject the hypothesis; therefore, the hypothesis was accepted as true. Since the difference was not significant, no further comparisons were made between the means.

Although there was no significant difference between the means of the total time required to swim the fifty yards using the three turns, an examination of the turn times is essential. The mean and standard deviation for each turn are presented in Table VIII.

TABLE VIII

MEAN AND STANDARD DEVIATIONS FOR TURN TIMES OF NOVICE BREASTSTROKE SWIMMERS
N=30

Turn Used	Mean	Standard Deviation
AAU	1.59 secs.	0.22 secs.
NCAA	1.51 secs.	0.21 secs.
SS	1.92 secs.	0.58 secs.

It may be observed that the mean time required to perform the NCAA turn (1.51 seconds) is slightly faster than the mean time required to execute the AAU turn (1.59 seconds). The mean time for the somersault turn is 0.41 seconds slower than the mean time required for the NCAA turn and 0.33 seconds slower than the mean time required to execute the AAU turn.

The analysis of variance for the time required to execute each turn for fifty yards by the novice breaststrokers is reported in Table IX.

TABLE IX

ANALYSIS OF VARIANCE FOR REPEATED MEASURES FOR THE TURN TIME OF NOVICE BREASTSTROKERS USING THE AAU, NCAA, AND SOMERSAULT TURNS
N=30

Source	df	Sum of Squares	Mean Square	F	P
Between subjects	29	5.93600			
Within subjects	60	9.60000			
A (treatments)	2	2.85067	1.42533	12.24852	0.00004
Residual	58	6.74933	0.11637		
Total	89	15.53600			

A ratio of 4.008 was required to indicate significant differences in the mean times for the three turns. The *F* ratio of 12.24852, reported in Table IX, indicated that significant differences existed.

In order to locate where the significant differences existed, Scheffe's method was used to compare the means of the turn times executed by the novice breaststrokers. The results are reported in Table X.

TABLE X

SCHEFFE "F" VALUES FOR THE COMPARISON OF TREATMENT MEANS OF THE TURN TIMES OF NOVICE BREASTSTROKERS
N=30

Turn	AAU	NCAA	SS
AAU	0.0	0.4841	6.8776
NCAA		0.0	11.0111
SS			0.0

A ratio of 6.8776 is statistically significant when comparing the means of the somersault and AAU turns. The ratio of 11.0111 is also significant (at the .05 level) when comparing the somersault and NCAA turns. It may be observed from Table VIII and Table X that the somersault turn was significantly slower to execute than the AAU and NCAA turns.

The third hypothesis was stated as follows:

Concerning the time an advanced swimmer, performing the breaststroke for fifty yards, is submerged after his feet leave the turning surface until his head breaks the surface of the water,

a. there will be no significant difference when using the AAU turn as compared with the NCAA turn;

b. there will be no significant difference when using the AAU turn as compared with the somersault turn;

c. there will be no significant difference when using the NCAA turn as compared with the somersault turn.

The gliding time mean and standard deviation for each turn for advanced breaststroke swimmers executing a single turn while swimming fifty yards are reported in Table XI.

TABLE XI

MEAN AND STANDARD DEVIATIONS FOR GLIDE TIMES OF ADVANCED BREASTSTROKE SWIMMERS
N=29

Turn Used	Mean	Standard Deviation
AAU	3.05 secs.	0.51 secs.
NCAA	2.99 secs.	0.55 secs.
SS	2.72 secs.	0.60 secs.

It may be observed in Table XI that the mean gliding time when executing the somersault turn (2.72 seconds) was slightly less than when using the NCAA turn (2.99 seconds) and the AAU turn (3.05 seconds).

The analysis of variance for the gliding times recorded by the advanced breaststroke swimmers while swimming fifty yards is reported in Table XII.

TABLE XII

ANALYSIS OF VARIANCE FOR REPEATED MEASURES FOR THE GLIDING TIME OF ADVANCED BREASTSTROKERS USING THE AAU, NCAA, AND SOMERSAULT TURNS
N=29

Source	df	Sum of Squares	Mean Square	F	P
Between subjects	28	19.66184			
Within subjects	58	7.86667			
A (treatments)	2	1.74437	0.87218	7.97777	0.00089
Residual	56	6.12230	0.10933		
Total	86	27.52851			

The analysis of variance of the group means resulted in an *F* ratio of 7.97777. At the .05 level of significance a ratio of 4.016 or below was required to accept the hypothesis. Therefore, the hypothesis was rejected and further calculations were needed to determine where the differences existed.

Scheffe's method was used to determine where the significant differences existed and the results are reported in Table XIII.

An *F* ratio of 6.9674 existed when comparing the glide following the somersault turn to the glide following the AAU turn. This is a significant difference since a ratio of

TABLE XIII

SCHEFFE "F" VALUES FOR THE COMPARISON OF TREATMENT MEANS OF THE GLIDE TIMES OF ADVANCED BREASTSTROKERS
N=29

Turn	AAU	NCAA	SS
AAU	0.0	0.2019	6.9674
NCAA		0.0	4.7974
SS			0.0

4.016 was required to yield significance at the .05 level. The ratio of 4.7974 is also significant when comparing the glide following the somersault turn to the glide following the NCAA turn.

The fourth hypothesis was stated as follows:

Concerning the time a novice swimmer, performing the breaststroke for fifty yards, is submerged after his feet leave the turning surface until his head breaks the surface of the water,

a. there will be no significant difference when using the AAU turn as compared with the NCAA turn;

b. there will be no significant difference when using the AAU turn as compared with the somersault turn;

c. there will be no significant difference when using the NCAA turn as compared with the somersault turn.

The gliding time mean and standard deviation for each turn are presented in Table XIV. They are reported for novice breaststroke swimmers executing a single turn while swimming fifty yards.

TABLE XIV

MEAN AND STANDARD DEVIATIONS FOR GLIDE TIMES OF NOVICE BREASTSTROKE SWIMMERS
N=30

Turn Used	Mean	Standard Deviation
AAU	2.62 secs.	1.03 secs.
NCAA	2.29 secs.	0.98 secs.
SS	2.09 secs.	1.00 secs

It may be observed in Table XIV that the mean gliding time when executing the somersault turn (2.09 seconds) was less than the mean gliding time when executing the AAU turn (2.62 seconds) and the NCAA turn (2.29 seconds).

The analysis of variance for the gliding times recorded by the novice breaststroke swimmers is reported in Table XV.

The analysis of variance resulted in an F ratio of 6.25860. At the .05 level of significance a ratio of 4.008 or below was required to accept the hypothesis. Therefore,

TABLE XV

ANALYSIS OF VARIANCE FOR REPEATED MEASURES FOR THE GLIDING TIME OF NOVICE BREASTSTROKERS USING THE AAU, NCAA, AND SOMERSAULT TURNS
N=30

Source	df	Sum of Squares	Mean Square	F	P
Between subjects	29	67.63656			
Within subjects	60	24.76667			
A (treatments)	2	4.39622	2.19811	6.25860	0.00346
Residual	58	20.37044	0.35121		
Total	89	92.40322			

the hypothesis was rejected and further calculations were needed to determine where the differences existed.

Scheffe's method was used to determine where the significant differences existed and the results are reported in Table XVI.

TABLE XVI

SCHEFFE "F" VALUES FOR THE COMPARISON OF TREATMENT MEANS OF THE GLIDE TIMES OF NOVICE BREASTSTROKERS
N=30

Turn	AAU	NCAA	SS
AAU	0.0	2.3255	6.1503
NCAA		0.0	0.9121
SS			0.0

An *F* ratio of 6.1503 existed when comparing the glide following the somersault turn to the glide following the AAU turn. This is significantly different since a ratio of 4.008 was required to yield significance at the .05 level.

Chi square was used in analyzing the time a breaststroke competitor was submerged after his feet left the turning surface until his head broke the surface of the water. A test of independence was calculated for the total time required to swim fifty yards by advanced breaststrokers and the glide time following the execution of the AAU and NCAA turns. The glide following the somersault turn was not compared with the total time of the advanced breaststrokers since the turn was found to be significantly slower than the AAU and NCAA turns.

The mean total time for the fifty yard breaststroke, 36.9759 seconds, and the mean gliding time using the NCAA turn, 2.9931 seconds, were rounded to the nearest hundredth of a second and used as division points in establishing the cells in the chi-square distribution. The observed and expected frequencies are reported in Table XVII.

The calculation produced a chi-square value of 9.10268 which was greater than the 3.84 required for significance at the .05 level. This indicated a significant relationship

TABLE XVII

OBSERVED AND EXPECTED FREQUENCIES FOR COMPARING TOTAL TIME AND GLIDE TIME OF ADVANCED BREASTSTROKERS USING THE NCAA TURN
N=29

	Glide Time Above 2.99 Secs.		Glide Time Below 2.99 Secs.	
	Of	Ef	Of	Ef
Total Time Above 36.98 Secs.	4	7	8	7
Total Time Below 36.98 Secs.	15	8	2	7

between the gliding time and the total time required to swim fifty yards when the NCAA turn was used. It is reported in Table XVII that a faster time, below 36.98 seconds, was achieved when a longer glide time, above 2.99 seconds, was executed.

The observed and expected frequencies for comparing the total time by advanced breaststrokers for the fifty yards and the glide time following the AAU turn are reported in Table XVIII.

The calculation produced a chi-square value of 0.70982 which was less than the 3.84 required for significance at the .05 level. This indicated that no significant relationship existed between the gliding time and the total time required to swim fifty yards when the AAU turn was used.

TABLE XVIII

OBSERVED AND EXPECTED FREQUENCIES FOR COMPARING TOTAL TIME AND GLIDE TIME OF ADVANCED BREASTSTROKERS USING THE AAU TURN
N=29

	Glide Time Above 3.05 Secs.		Glide Time Below 3.05 Secs.	
	Of	Ef	Of	Ef
Total Time Above 37.05 Secs.	7	7	5	7
Total Time Below 37.05 Secs.	8	8	9	7

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The problem with which this study was concerned was that of comparing three methods of executing the breaststroke turn and their effects on swimming fifty yards. The related problem was that of analyzing the optimum time a breaststroke competitor was to be submerged on the glide after his feet left the turning surface.

One hundred and four subjects were originally rated and categorized as advanced, average, or novice breaststroke swimmers. The twenty-nine advanced breaststrokers and the thirty novice breaststrokers were selected as the participating groups. All subjects were male, senior AAU swimmers from teams in the Arkansas Association of the AAU.

The subjects were given oral instructions, a demonstration, and a fifteen-minute practice period for the AAU turn prior to being timed on the fifty-yard breaststroke using the AAU turn. Following this timing procedure they were given oral instructions and a demonstration of the NCAA turn. They were instructed to practice the turn each day for fifteen minutes. After a minimum of seven days the subjects were timed on the fifty-yard breaststroke using the NCAA turn. This timing was preceded by oral instructions, a demonstration, and a fifteen-minute practice period.

Following the test using the NCAA turn, the subjects were given oral instructions and a demonstration of the somersault turn. They were instructed to practice the turn for fifteen minutes each day. After a minimum of seven days the subjects were timed on the fifty-yard breaststroke using the somersault turn.

All testing consisted of one trial per subject on each turn. Two watches were used in the timing procedure. One was utilized to record the total time for the fifty-yard distance. The second watch, a split-timer, was used in measuring the turn and glide times. The turn time represented the actual time the swimmer was in contact with the turning surface. The glide time expressed the time the swimmer was submerged after his feet left the turning surface until his head broke the surface of the water.

The method utilized in testing the hypotheses was the analysis of variance for repeated measures. When significant differences were found to exist, Scheffe's method was used to determine between which groups the significant differences specifically existed. The .05 level of significance was required to reject the null hypotheses.

A chi-square test of independence was utilized in analyzing the time a breaststroke competitor was submerged after his feet left the turning surface until his head broke the surface of the water.

Findings

A summary of the findings with respect to the hypotheses is as follows:

1. It was hypothesized that there would be no significant difference in the total time required to swim the fifty yards by advanced breaststroke swimmers when the AAU, NCAA, and somersault turns were used. The findings indicated there was no significant difference. Therefore, the hypothesis was accepted.

2. It was hypothesized that there would be no significant difference in the total time required to swim the fifty yards by novice breaststroke swimmers when the AAU, NCAA,

and somersault turns were used. The findings indicated there was no significant difference. Therefore, the hypothesis was accepted.

3. It was hypothesized that there would be no significant difference in the gliding time following the execution of the AAU, NCAA, and somersault turns by advanced breaststrokers swimming fifty yards. The findings indicated that significant differences existed and the hypothesis was rejected. The gliding time following the somersault turn was significantly less than the gliding time following the AAU and NCAA turns.

4. It was hypothesized that there would be no significant difference in the gliding time following the execution of the AAU, NCAA, and somersault turns by novice breaststrokers swimming fifty yards. The findings indicated that significant differences existed and the hypothesis was rejected. The gliding time following the somersault turn was significantly less than the gliding time following the AAU and NCAA turns.

Additional findings include the following:

1. The execution of the somersault turn by advanced and novice breaststroke swimmers was significantly slower than the execution of the AAU and NCAA turns.

2. The actual mean time for executing the NCAA turn by advanced and novice breaststroke swimmers was faster than the actual mean time for executing the AAU and somersault turns.

3. A significant relationship existed between the gliding time and the total time for fifty yards when the NCAA turn was executed by advanced breaststroke swimmers.

4. No significant relationship existed between the gliding time and the total time for fifty yards when the AAU turn was executed by advanced breaststroke swimmers.

Conclusions

Based on the findings of this study the following conclusions are presented:

1. Coaches of swimming should analyze the turns of their breaststroke competitors and suggest the most effective type of turn, within the limitations of the rules, the swimmer should utilize.

2. The somersault turn should not be utilized until the rules are modified and the required hand touch is eliminated.

3. Either the AAU or NCAA turn could be taught by coaches of swimming without affecting the swimmer's total time for fifty yards. The deciding factor in selecting which turn to teach would be the rules which the swimmer must follow in competition.

4. A competitive breaststroker swims at a faster pace prior to or following the execution of the somersault turn. This is indicated since there was no significant difference in the total time for the fifty yards by advanced or novice breaststrokers; however, the somersault turn was significantly slower to execute.

5. A specific gliding time cannot be established. Several factors influence the gliding time, and until the mechanics of the turn to be utilized in competition are mastered, it may be generally stated that a longer gliding time will contribute to a faster total time.

Recommendations

The findings and conclusions of this study suggest the following recommendations:

1. A similar study should be conducted comparing the three methods of executing the breaststroke turn and the height of the subjects. It was observed that the taller subjects encountered greater difficulty in executing the somersault turn.

2. A similar study should be conducted to compare the AAU, NCAA, and somersault turns and their effects on swimming the 100- and 200-yard breaststroke events.

3. A similar study should be conducted on the effect of executing the somersault turn without the required hand touch upon the time required to swim the 50-, 100-, and 200-yard breaststroke events.

APPENDIX A

APPENDIX A

November 17, 1972

Mr. George McMillion
Coach of Swimming
Southern Methodist University
Dallas, Texas 75222

Dear Coach McMillion:

In preparation for conducting a study of three breaststroke turns and their effect on swimming fifty yards, it is necessary for me to rate the ability of the subjects in swimming the breaststroke. To do this effectively, the enclosed scale has been developed to rate swimmers on five parts of the stroke.

To justify the use of this scale, I am asking several coaches of swimming to give their opinion of the five items by indicating if they agree or disagree with the stated descriptions.

I would appreciate it very much if you would take a few minutes to read each item and then circle the "A" if you agree with the description. If you should disagree, then please circle the "D" located in the margin. Please sign at the bottom of the page and return to me at your earliest convenience.

Your help in this matter is greatly appreciated.

Sincerely,

Robert Courtway

Breaststroke Rating Scale

Name ______________________________ Team ____________________

Instructions

Please rate the swimmer on each of the five items listed below by checking (v) on the scale indicating your evaluation of that component of the breaststroke.

1. Body position -- Horizontal. In a streamlined prone position. The head is positioned so that the water is about at eyebrow level. The arms are extended in front of the head. A D

Poor ' Fair ' Average ' Good ' Excellent ' Points _____

2. Timing -- The arms start pulling. The legs begin as the arms are passing through the last part of the pull. The legs are kicked as the arms recover. A D

Poor ' Fair ' Average ' Good ' Excellent ' Points _____

3. Breathing -- The swimmer should breathe every stroke. Inhalation should occur at the highest point, near the end of the arm pull. Exhalation begins at the extension of the arms. A D

Poor ' Fair ' Average ' Good ' Excellent ' Points _____

4. Arms -- The catch is made six to eight inches under the water. It is a short pull with bent arms going out, down, and back. The hands don't go past the elbows or the shoulders. The arms are stretched to the front. A D

Poor ' Fair ' Average ' Good ' Excellent ' Points _____

5. Legs -- Lift the heels toward the buttocks causing knee flexion. The heels are in and the toes pointed out. The feet are below the surface of the water. The force is backward and not a wide sweep. A D

Poor ' Fair ' Average ' Good ' Excellent ' Points _____

TOTAL POINTS _____

Final Classification

Advanced __________ Average __________ Novice __________

Coach ____________________________ School ____________________

APPENDIX B

APPENDIX B

Breaststroke Rating Scale

Name ______________________ Team ______________

Instructions

Please rate the swimmer on each of the five items listed below by checking (v) on the scale indicating your evaluation of that component of the breaststroke.

1. Body position -- Horizontal. In a streamlined prone position. The head is positioned so that the water is about at eyebrow level. The arms are extended in front of the head.

Poor	Fair	Average	Good	Excellent	Points ____

2. Timing -- The arms start pulling. The legs begin as the arms are passing through the last part of the pull. The legs are kicked as the arms recover.

Poor	Fair	Average	Good	Excellent	Points ____

3. Breathing -- The swimmer should breathe every stroke. Inhalation should occur at the highest point, near the end of the arm pull. Exhalation begins at the extension of the arms.

Poor	Fair	Average	Good	Excellent	Points ____

4. Arms -- The catch is made six to eight inches under the water. It is a short pull with bent arms going out, down, and back. The hands don't go past the elbows or the shoulders. The arms are stretched to the front.

Poor	Fair	Average	Good	Excellent	Points ____

5. Legs -- Lift the heels toward the buttocks causing knee flexion. The heels are in and the toes pointed out. The feet are below the surface of the water. The force is backward and not a wide sweep.

Poor	Fair	Average	Good	Excellent	Points ____

TOTAL POINTS ____

Final Classification

Advanced ________ Average ________ Novice ________

APPENDIX C

APPENDIX C

AVERAGED SCORES OF ALL SUBJECTS

Advanced Breaststrokers

	Subject	Team	Score
1.	David Leggett	LRRC	22.25
2.	Charles Letzig	HC	22.00
3.	Kip Davis	LRRC	21.00
4.	Jim Wright	LRRC	21.00
5.	David Love	LRRC	20.75
6.	Brad Leggett	LRRC	20.25
7.	Ricky Witherspoon	LRRC	20.25
8.	Scott Bowen	LRRC	20.25
9.	Ricky Ensminger	MSG	20.25
10.	John Bumpers	HC	20.25
11.	David Kolk*	LRBC	20.25
12.	Harvey Humphries	MSG	20.00
13.	Jim Bryan	LRBC	20.00
14.	Tom Little	HC	20.00
15.	David White	HC	20.00
16.	Gene Smith	MSG	19.75
17.	Oliver Gatchell	HC	19.75
18.	Chuck Miller	MSG	19.50
19.	John Kane	HC	19.50
20.	Harry Gooding	HC	19.25
21.	Martin Davis	HC	19.25
22.	Trip Strauss	LRRC	19.00
23.	Randy Thomason	MSG	18.75
24.	Richard Turner	LRBC	18.75
25.	Curtis Thomas*	LRBC	18.75
26.	Jim Abraham*	LRRC	18.75
27.	George Brenner	MSG	18.50
28.	David Adams*	LRBC	18.50
29.	Greg Lane	LRRC	18.50

	Subject	Team	Score
30.	Wayne Haydon	MSG	18.50
31.	Doug Phillips	LRRC	18.00
32.	Dub Snider*	LRRC	17.50
33.	Pat Riley	LRRC	17.50
34.	Nick Tolivar	LRBC	17.50

Average Breaststrokers

35.	Jeff Davis	LRRC	17.00
36.	Freely Goodard	RST	16.75
37.	Ben Bevill	LRBC	16.50
38.	Gary Duke	HA	16.50
39.	Bill Baber	LRRC	16.00
40.	Cliff Henry	HA	16.00
41.	Allan Yanko	MSG	15.50
42.	John Weare	MSG	15.50
43.	Martin Dillaha	MSG	15.50
44.	Chris Krodell	MSG	15.25
45.	Howard Duff	LRBC	15.25
46.	Tom Siebenmorgen	HC	15.25
47.	Steve Dell	HA	15.00
48.	Joe Cox	HC	14.75
49.	David Gatchell	LRRC	14.50
50.	Jeff Ledbetter	LRRC	14.50
51.	Jim Flack	LRRC	14.25
52.	Hale Murphy	LRRC	14.00
53.	David Cunningham	RST	14.00
54.	David Laros	MSG	14.00
55.	Jeff Courtway	HA	14.00
56.	Bobby Courtway	HA	14.00
57.	John Pope	LRRC	13.75
58.	Jim Wiedower	HC	13.75
59.	Scott Murphy	LRRC	13.50
60.	Paul Cook	LRRC	13.25
61.	Mike Quattlebaum	HA	13.25
62.	David Perryman	MSG	13.25
63.	Mark Wingfield	HA	13.00

Novice Breaststrokers

	Subject	Team	Score
64.	Mike Miller	HC	12.50
65.	Sam Turner	LRBC	12.50
66.	Jon Rynning	LRBC	12.25
67.	Greg Grace	RST	12.00
68.	John Presley*	RST	12.00
69.	Tom Carpenter	HC	12.00
70.	Chris Ellis	WTBC	11.50
71.	Morris Hughes	HC	11.25
72.	Doug Brewer	RST	11.00
73.	Mark Moore	LRRC	11.00
74.	Scott Ramoly*	MSG	11.00
75.	John Courtway	HA	11.00
76.	David Anthes	HA	11.00
77.	Dick Wiedower	HC	10.75
78.	Bruce Carson*	RST	10.50
79.	Dick Simpson*	RST	10.50
80.	David Arnold	LRBC	10.25
81.	Nick Meriwether	HA	10.25
82.	Bill White	HC	10.25
83.	David Meriwether	HA	10.25
84.	Tony Perryman	MSG	10.25
85.	Joe Bumpers	HA	9.75
86.	Kevin Purifoy	LRBC	9.75
87.	Scott Sanders	LRRC	9.50
88.	Garrett Grace	RST	9.00
89.	Randy Gore	RST	9.00
90.	George Cheatham	HC	9.00
91.	Stan Nieburg	LRRC	8.75
92.	Darryl Warren	HC	8.25
93.	Jerry Mayfield	LRBC	8.00
94.	Doug Hastings	HA	7.50
95.	Lenny Fort	HA	7.25
96.	John Siebenmorgen	HA	7.00
97.	David Wiedower	HA	7.00
98.	Richard Kersh*	HA	6.50

Eliminated Due to Illegal Kick

	Subject	Team
99.	Mark Quattlebaum	HA
100.	Jim Henderson	HA
101.	David Lamerson	HA
102.	Dub Snider	RST
103.	Mark Snider	RST
104.	Grady Reed	RST

*Insufficient test data

Team Abbreviations

HA . . . . Hendrix Aquakids
HC . . . . Hendrix College
LRBC . . . . Little Rock Boys Club
LRRC . . . . . . Little Rock Racquet Club
MSG . . . . Miller's Swim Gym
RST . . . . Russellville Swim Team
WTBC . . . . William Trasher Boys Club

APPENDIX D

APPENDIX D

HAGER'S JEWELERS

910 Front Street
Conway, Ark.

To whom it may concern:

On November 25, 1972, I personally checked two timers -

1 - German made JUNGHANS

1 - Swiss made ARISTO

They were both checked to an accurate time source over a 15 minute period and found to be accurate to 1/100 of a second over this period.

I consider them to be extremely accurate timing devices.

Frank Hamling

Frank Hamling
Watchmaker

APPENDIX E

APPENDIX E

COMPARATIVE TIME MEASUREMENTS FOR ADVANCED BREASTSTROKE SWIMMERS

Name	Team	Date Tested	Type Turn	Total Time	Turn Time	Glide Time
David Leggett	LRRC	12-19-72	AAU	33.0	1.5	3.1
		12-26-72	NCAA	33.7	1.5	3.2
		1- 2-73	SS	33.6	1.6	2.6
Charles Letzig	HC	11-26-72	AAU	33.0	1.4	2.6
		12- 3-72	NCAA	33.4	.9	3.0
		12-10-72	SS	33.2	1.3	2.7
Kip Davis	LRRC	12-19-72	AAU	40.6	1.5	3.3
		1-13-73	NCAA	38.8	1.6	2.7
		1-20-73	SS	38.6	1.3	2.5
Jim Wright	LRRC	12-19-72	AAU	39.4	1.5	3.3
		12-26-72	NCAA	39.5	1.3	2.6
		1-13-73	SS	42.7	1.5	2.5
David Love	LRRC	12-19-72	AAU	37.5	1.5	3.3
		12-26-72	NCAA	38.0	1.5	2.3
		1-13-73	SS	37.3	1.5	2.6
Brad Leggett	LRRC	12-19-72	AAU	34.4	1.4	2.0
		12-26-72	NCAA	35.5	2.0	2.1
		1- 2-73	SS	35.7	2.2	2.2
Ricky Witherspoon	LRRC	12-19-72	AAU	34.7	1.4	2.9
		12-26-72	NCAA	35.5	1.4	3.4
		1- 2-73	SS	34.4	1.6	3.1
Scott Bowen	LRRC	12-19-72	AAU	34.0	1.6	3.6
		12-26-72	NCAA	34.6	1.3	4.5
		1- 2-73	SS	34.9	2.6	3.6
John Bumpers	HC	12-20-72	AAU	35.2	1.5	4.2
		12-27-72	NCAA	34.5	1.3	3.6
		1- 3-73	SS	32.8	1.1	3.3

Name	Team	Date Tested	Type Turn	Total Time	Turn Time	Glide Time
Harvey		12-26-72	AAU	41.8	1.6	3.0
Humphries	MSG	1- 2-73	NCAA	42.3	1.5	2.9
		1-13-73	SS	39.8	1.4	2.7
Jim		12- 4-72	AAU	31.8	1.2	3.6
Bryan	LRBC	12-18-72	NCAA	31.0	1.3	3.4
		1- 2-73	SS	33.7	1.9	2.7
Tom		12- 3-72	AAU	34.7	1.1	2.6
Little	HC	1- 8-73	NCAA	34.7	1.1	2.6
		1-15-73	SS	36.7	2.0	2.9
David		11-26-72	AAU	33.8	1.5	3.3
White	HC	12- 3-72	NCAA	33.1	1.4	3.3
		12-10-72	SS	33.9	1.6	3.4
Gene		12-26-72	AAU	42.3	1.3	2.6
Smith	MSG	1- 2-73	NCAA	42.5	1.4	1.9
		1-13-73	SS	41.0	1.6	1.0
Oliver		12-26-72	AAU	33.8	1.3	3.5
Gatchell	HC	1- 2-73	NCAA	34.1	1.3	3.0
		1- 9-73	SS	34.6	1.3	3.1
Chuck		12-26-72	AAU	36.2	1.4	3.4
Miller	MSG	1- 2-73	NCAA	36.3	1.5	3.2
		1-13-73	SS	35.9	1.6	3.5
John		11-26-72	AAU	32.2	1.2	2.8
Kane	HC	12- 3-72	NCAA	33.0	1.2	3.1
		12-10-72	SS	33.5	1.5	3.2
Harry		11-26-72	AAU	35.9	1.5	2.4
Gooding	HC	12- 3-72	NCAA	36.2	1.4	3.2
		12-10-72	SS	37.5	1.6	3.2
Martin		11-26-72	AAU	35.6	1.7	2.6
Davis	HC	12- 3-72	NCAA	33.7	1.2	3.0
		12-10-72	SS	34.7	1.6	3.0
Trip		12-19-72	AAU	37.7	1.5	4.0
Strauss	LRRC	12-26-72	NCAA	38.9	1.7	3.4
		1- 2-73	SS	37.2	2.1	2.8
Randy		12-26-72	AAU	43.1	1.8	3.1
Thomason	MSG	1-13-73	NCAA	40.4	1.6	3.2
		1-20-73	SS	42.1	2.0	2.8

Name	Team	Date Tested	Type Turn	Total Time	Turn Time	Glide Time
Richard		12- 4-72	AAU	33.0	1.3	2.9
Turner	LRBC	12-18-72	NCAA	33.7	1.2	3.0
		1- 2-73	SS	35.0	1.4	2.8
George		12-26-72	AAU	42.3	1.8	2.1
Brenner	MSG	1- 2-73	NCAA	43.1	1.9	2.0
		1-13-73	SS	40.2	1.6	1.1
Greg		12-19-72	AAU	36.7	1.7	2.9
Lane	LRRC	12-26-72	NCAA	36.7	1.5	3.0
		1- 2-73	SS	38.6	1.4	2.2
Wayne		12-26-72	AAU	43.8	1.8	3.2
Haydon	MSG	1-13-73	NCAA	40.2	1.7	3.2
		1-20-73	SS	41.2	2.0	2.9
Doug		1- 9-73	AAU	38.7	1.3	2.5
Phillips	LRRC	1-20-73	NCAA	38.9	1.2	2.2
		1-27-73	SS	38.2	1.6	2.0
Pat		12-19-72	AAU	32.8	1.3	3.2
Riley	LRRC	12-26-72	NCAA	33.1	1.4	3.6
		1- 2-73	SS	33.4	2.2	3.2
Nick		12- 4-72	AAU	43.9	1.5	3.0
Tolivar	LRBC	12-18-72	NCAA	44.0	1.6	3.3
		1- 2-73	SS	43.9	2.1	2.8

APPENDIX F

APPENDIX F

COMPARATIVE TIME MEASUREMENTS FOR NOVICE BREASTSTROKE SWIMMERS

Name	Team	Date Tested	Type Turn	Total Time	Turn Time	Glide Time
Mike		12-10-72	AAU	38.3	1.3	3.3
Miller	HC	1- 8-73	NCAA	37.6	1.3	2.2
		1-15-73	SS	37.5	1.8	3.0
Sam		12-26-72	AAU	35.1	1.4	3.7
Turner	LRBC	1- 2-73	NCAA	34.2	1.5	3.6
		1- 9-73	SS	35.3	1.1	3.4
Jon		12- 4-72	AAU	38.5	1.7	6.2
Rynning	LRBC	12-18-72	NCAA	37.4	1.4	4.5
		1-13-73	SS	37.5	1.4	4.0
Greg		12-15-72	AAU	45.0	1.2	3.4
Grace	RST	12-22-72	NCAA	45.9	1.3	2.4
		12-29-72	SS	48.7	2.0	2.5
Tom		12-10-72	AAU	39.2	1.4	.9
Carpenter	HC	1- 8-73	NCAA	40.8	1.2	3.1
		1-15-73	SS	40.4	1.8	1.8
Chris		12-20-72	AAU	39.4	1.8	3.0
Ellis	WTBC	12-28-72	NCAA	40.5	1.8	1.4
		1- 4-73	SS	41.7	1.7	1.4
Morris		11-26-72	AAU	37.6	1.5	2.9
Hughes	HC	12- 3-72	NCAA	38.0	1.5	3.1
		12-10-72	SS	39.8	1.9	2.3
Doug		12-15-72	AAU	44.0	1.6	2.5
Brewer	RST	12-22-72	NCAA	43.6	1.5	.8
		12-29-72	SS	43.1	2.2	.9
Mark		12-19-72	AAU	42.4	1.7	2.5
Moore	LRRC	12-27-72	NCAA	42.3	1.7	2.0
		1-13-73	SS	44.3	2.3	1.6

Name	Team	Date Tested	Type Turn	Total Time	Turn Time	Glide Time
John Courtway	HA	11-26-72	AAU	43.9	1.8	1.9
		12- 3-72	NCAA	44.0	1.6	3.4
		12-10-72	SS	43.2	1.4	2.1
David Anthes	HA	11-26-72	AAU	37.0	1.4	3.0
		12- 3-72	NCAA	36.1	1.4	3.4
		12-10-72	SS	36.6	1.4	3.9
Dick Wiedower	HC	11-26-72	AAU	36.1	1.3	2.4
		12- 3-72	NCAA	34.8	1.2	2.5
		12-10-72	SS	35.2	1.6	1.9
David Arnold	LRBC	12- 4-72	AAU	35.2	1.3	3.1
		12-18-72	NCAA	35.9	1.5	2.6
		1- 2-73	SS	36.0	1.6	2.7
Nick Meriwether	HA	12-20-72	AAU	43.7	1.6	1.3
		12-27-72	NCAA	45.4	1.7	.6
		1- 3-73	SS	45.5	2.5	.7
Bill White	HC	11-26-72	AAU	37.5	1.6	2.8
		12-10-72	NCAA	37.8	1.5	3.1
		1- 8-73	SS	38.9	2.2	4.0
David Meriwether	HA	12-20-72	AAU	43.5	1.8	2.9
		12-27-72	NCAA	46.3	1.8	1.8
		1-15-73	SS	43.7	1.7	2.0
Tony Perryman	MSG	12-26-72	AAU	39.3	1.7	3.1
		1- 2-73	NCAA	42.3	1.9	2.8
		1-13-73	SS	38.6	1.6	3.0
Joe Bumpers	HA	12-20-72	AAU	50.0	1.7	1.3
		12-27-72	NCAA	49.5	1.5	.9
		1- 3-73	SS	52.8	1.9	.7
Kevin Purifoy	LRBC	12- 4-72	AAU	44.6	1.5	3.1
		12-18-72	NCAA	44.9	1.3	1.0
		1- 2-73	SS	45.8	1.9	.7
Scott Sanders	LRRC	12-19-72	AAU	37.2	1.3	3.1
		12-27-72	NCAA	36.8	1.3	2.7
		1- 3-73	SS	38.1	1.5	2.7

Name	Team	Date Tested	Type Turn	Total Time	Turn Time	Glide Time
Garrett Grace	RST	12-15-72	AAU	50.3	1.9	1.9
		12-22-72	NCAA	50.4	1.6	2.3
		12-29-72	SS	50.3	2.2	2.8
Randy Gore	RST	12-15-72	AAU	56.5	1.7	2.7
		12-22-72	NCAA	54.0	1.6	.9
		12-29-72	SS	55.7	1.8	.8
George Cheatham	HC	12-10-72	AAU	39.5	1.4	3.0
		1- 8-73	NCAA	38.8	1.3	2.6
		1-15-73	SS	40.5	1.7	2.6
Stan Nieburg	LRBC	12- 4-72	AAU	49.2	1.8	1.5
		1- 2-73	NCAA	50.4	1.9	1.8
		1-13-73	SS	48.1	2.2	2.2
Darryl Warren	HC	11-26-72	AAU	40.0	1.5	2.4
		12- 3-72	NCAA	40.2	1.6	2.4
		12-10-72	SS	41.1	1.8	1.6
Jerry Mayfield	LRBC	12- 4-72	AAU	42.4	2.1	3.6
		12-18-72	NCAA	41.2	1.8	3.2
		1- 2-73	SS	40.8	2.1	2.5
Doug Hastings	HA	12-20-72	AAU	63.2	1.7	1.3
		12-27-72	NCAA	62.1	1.2	.8
		1- 3-73	SS	62.4	2.5	1.0
Lenny Fort	HA	12-20-72	AAU	41.3	1.4	2.9
		12-27-72	NCAA	41.6	1.2	3.2
		1-12-73	SS	39.5	1.3	1.5
John Siebenmorgen	HA	12-20-72	AAU	50.0	1.8	1.8
		12-27-72	NCAA	46.5	1.4	1.9
		1- 3-73	SS	56.3	4.4	1.1
David Wiedower	HA	11-26-72	AAU	52.5	1.9	1.2
		12- 3-72	NCAA	48.0	1.7	1.8
		12-10-72	SS	51.6	2.1	1.2

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

Amateur Athletic Union Aquatics Handbook, Indianapolis, Indiana, AAU House, 1972.

Armbruster, David A., Robert H. Allen, and Hobert Sherwood Billingsley, Swimming and Diving, 4th ed., St. Louis, The C. V. Mosby Co., 1963.

Barnes, Gerald, Swimming and Diving, New York, Charles Scribner's Sons, 1925.

Carlile, Forbes, Forbes Carlile on Swimming, London, Pelham Books Ltd., 1963.

Clark, Steve, Competitive Swimming As I See It, North Hollywood, California, Swimming World, 1967.

Colwin, Cecil, Cecil Colwin on Swimming, London, Pelham Books Ltd., 1969.

Counsilman, James E., The Science of Swimming, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1968.

Cureton, Thomas K., How to Teach Swimming and Diving, Vol. I, New York, Association Press, 1934.

Edwards, Allen L., Experimental Design in Psychological Research, 3rd ed., New York, Holt, Rinehart, and Winston, Inc., 1968.

Elkington, Helen and Tony Holmyard, Better Swimming for Boys and Girls, London, Kaye and Ward Limited, 1969.

Faulkner, John A., What Research Tells the Coach About Swimming, Washington, D. C., American Association for Health, Physical Education, and Recreation, 1967.

Ferguson, George A., Statistical Analysis in Psychology and Education, 3rd ed., New York, McGraw-Hill Book Company, 1971.

Ferinden, William, Teaching Swimming, 2nd ed., Linden, New Jersey, Remediation Associates, Inc., 1971.

Francis, William, Swimming, New York, M. S. Mill Co., Inc., 1938.

Gabrielsen, M. Alexander, Betty Spears, and B. W. Gabrielsen, Aquatics Handbook, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1960.

Gambril, Donald L., Swimming, Pacific Palisades, California, Goodyear Publishing Co., 1969.

Harris, Marjorie M., Basic Swimming Analyzed, Boston, Allyn and Bacon, Inc., 1969.

Haskins, Mary Jane, Evaluation in Physical Education, Dubuque, Iowa, Wm. C. Brown Co., 1971.

Higgins, John H., Alfred R. Barr, Ben F. Graddy, and Jack Martin, Swimming and Diving, Annapolis, Maryland, United States Naval Institute, 1965.

Kiphuth, Robert J. H., Swimming, New York, The Ronald Press Company, 1942.

Levy, Sheldon G., Inferential Statistics in the Behavioral Sciences, New York, Holt, Rinehart, and Winston, Inc., 1968.

McNemar, Quinn, Psychological Statistics, 3rd ed., New York, John Wiley and Sons, Inc., 1966.

Mann, Matt II, Swimming Fundamentals, New York, Prentice-Hall, Inc., 1940.

The Official NCAA Swimming Guide, Phoenix, Arizona, College Athletics Publishing Service, 1973.

Oppenheim, Francois, The History of Swimming, North Hollywood, California, Swimming World, 1970.

Rajki, Bela, The Technique of Competitive Swimming, Budapest, University Printing House, 1956.

Silva, Charles S., Manual and Lesson Plans for Basic Swimming, Life Saving, Water Stunts, Springboard Diving, Skin and Scuba Diving and Methods of Teaching, Springfield, Massachusetts, privately published by the author, 1970.

Smith, Ann Avery, Swimming and Plain Diving, New York, Charles Scribner's Sons, 1930.

Still, Athole, Competitive Swimming, New York, St. Martin's Press, 1971.

Swimming and Diving, Official Coaching Book of the English Schools' Swimming Association, London, Wm. Heinemann Ltd., 1963.

Swimming and Water Safety, 1st ed., Washington, D. C., American National Red Cross, 1968.

Swimming As Taught By Experts, edited by Bill (W. J.) Juba, New York, Arco Publishing Co., Inc., 1961.

Swimming in Japan, Tokyo, International Young Women and Children's Society, 1935.

Talbot, Don, Swimming to Win for All Ages, London, Pelham Books Ltd., 1967.

Torney, John A., Jr., Swimming, New York, McGraw-Hill Book Co., Inc., 1950.

____________________ and Robert D. Clayton, Aquatic Instruction, Coaching, and Management, Minneapolis, Minnesota, Burgess Publishing Company, 1970.

Weber, Jerome C. and David R. Lamb, Statistics and Research in Physical Education, St. Louis, The C. V. Mosby Co., 1970.

Articles

Altman, Richard, "Exercises and Drills for a Swimming Team," *Swimming Pool Age*, XXX (December, 1956), 22, 48-49.

Benson, John, "The McKenzie Breaststroke," *Swimming Technique*, VI (July, 1969), 39-43.

Berger, Bonnie G. and Robert E. Stadulis, "Effects of Method of Presentation and Extent of Angular Displacement Upon Accuracy in Horizontal Arm-positioning," *Research Quarterly*, XXXIX (October, 1968), 449-455.

Cake, Frances, "The Relative Effectiveness of Two Types of Frog Kick Used in Swimming the Breast Stroke," *Research Quarterly*, XIII (May, 1942), 201-204.

Chivers, Kenneth C., "What Makes for Success in Swimming," *Journal of Physical Education*, VXVII (November, 1970), 37, 43.

Costill, David L., "Analysis of the Breaststroke," *Athletic Journal*, XXXXVII (October, 1966), 18, 21-22, 50-51.

Cureton, Thomas K., Jr., "What Makes a Champion," *Training Competitive Swimmers*, 1949.

________________________, "Review of a Decade of Research in Aquatics at Springfield College, 1929-1939," *Research Quarterly*, XI (May, 1940), 68-79.

Dawson, Buck, "A Study of Breaststroke Training," *Swimming World-Junior Swimmer*, V (May, 1964), 6-7.

De Vries, Herbert A., "Effects of Various Warm-up Procedures on 100-Yard Times of Competitive Swimmers," *Research Quarterly*, XXX (March, 1959), 11-20.

East, David J., "Stroke Frequency, Length and Performance," *Swimming Technique*, VIII (October, 1971), 68-73.

Fox, Edward L., Robert L. Bartels, and Richard W. Bowers, "Comparison of Speed and Energy Expenditure for Two Swimming Turns," Research Quarterly, XXXIV (October, 1963), 322-326.

Jacobs, Marshall L., "Turns for the Butterfly and Breaststroke," Athletic Journal, XXXXI (November, 1960), 40-41, 53-55.

Jacobson, Thomas J., "Coaching the Breaststroke Turn," Athletic Journal, XXXXIII (April, 1963), 66-67, 76.

Jamerson, Dick, "Relay Starts and Racing Turns," Journal of Health, Physical Education, and Recreation, XXVII (February, 1956), 42.

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

Kinnear, A. D., "Breaststroke Today," Swimming Technique, IV (January, 1968), 111-112.

Kinsey, Dan, "Optimum Distribution of Effort in the 200-Yard Breaststroke," Athletic Journal, XXVI (January, 1946), 39-40.

Lindberg, Russell, "Racing Turns," Athletic Journal, XIX (February, 1939), 40-43.

McCraw, L. W. and J. W. Tolbert, "A Comparison of the Reliability of Methods of Scoring Tests of Physical Activity," Research Quarterly, XXIII (March, 1952), 73-81.

Magel, John R., "Propelling Force Measured During Tethered Swimming in the Four Competitive Swimming Styles," Research Quarterly, XXXXI (March, 1970), 68-74.

Maglischo, Cheryl W. and Ernest Maglischo, "Comparison of Three Starts Used in Competitive Swimming," Swimming Technique, VI (October, 1969), 69-71.

Michaels, Richard A., "The Roll Backstroke Turn," Swimming Technique, V (October, 1968), 70-72.

Pitt, Don, "Some Observations on the Breaststroke Kick," Swimming Technique, V (July, 1968), 58-59, 61.

Rajki, Bela, "One Year Training Plan for Competitive Swimmers," Swimming Pool Age, XXXII (February, 1958), 74-78.

Ryan, Jack, "Teach Them How to Turn," Athletic Journal, XXXIV (January, 1954), 22, 44, 46.

Scharf, Raphael and William H. King, "Time and Motion Analysis of Competitive Freestyle Swimming Turns," Research Quarterly, XXXV (March, 1964), 37-44.

Schiltz, Jack H., "Five Steps to a Successful Freestyle Flip-Turn," Athletic Journal, DII (January, 1972), 62-90.

Schlegal, Charles H., "Turns for the Better," Scholastic Coach, XXX (May, 1961), 36, 38-39.

Singer, Robert N. and Robert E. Neeves, "Effect of Food Consumption on 200-Yard Freestyle Swim Performances," Research Quarterly, XXXIX (May, 1968), 355.

Stallman, Robert K., "Teaching Progressions for the Backstroke Turn," Swimming Technique, IX (January, 1973), 121-122.

__________, "Teaching Progressions for the Front Crawl Flip Turn," Swimming Technique, IX (January, 1973), 119-120, 122.

Swegan, Donald B. and Hugh L. Thompson, "Experimental Research in Swimming," Scholastic Coach, XXVIII (April, 1959), 22, 24, 26.

Van Atta, William D., "Abstract," Swimming Technique, V (July, 1968), 63.

Wetmore, Reagh C., "Experimental Data Applied to the Crawl and Breaststroke," Athletic Journal, XXXIII (November, 1952), 30, 41-42.

Wilson, Colin T., "Coordination Tests in Swimming," Research Quarterly, V (December, 1934), 81-88.

Reports

Council for National Cooperation in Aquatics, Swimming and Diving: A Bibliography, New York, Association Press, 1968.

John B. Skehan and Committee, Report: Current Status of Research and Publication of the Membership of the College Swimming Coaches Association, March, 1972, St. Bonaventure, New York, 1972.

Unpublished Materials

Clayton, Robert D., "The Efficacy of the Land-Drill, Implicit-Rehersal, and Water-Practice Methods of Teaching the Breast Stroke and Crawl Stroke to College Men," unpublished doctoral dissertation, School of Health, Physical Education, and Recreation, University of Oregon, Eugene, Oregon, June, 1963.

Clotworthy, Robert, "Thoughts on Breaststroke Swimming," unpublished notes, Princeton University, Princeton, New Jersey, 1965.

Ford, Carol, "A Comparison of the Relative Effectiveness Between Two Methods of Teaching the Whip Kick to College Women in Beginning Swimming Classes," unpublished master's thesis, Department of Physical Education, Women's College of the University of North Carolina, Greensboro, North Carolina, 1958.

King, William H., Jr., "A Time and Motion Study of Competitive Backstroke Swimming Turns," unpublished doctoral dissertation, School of Education, Boston University, Boston, Massachusetts, 1956.

McDonald, Frederic W., Jr. and William J. Stearns, "A Mathematical Analysis of Swimming the Breaststroke and Dolphin Butterfly Strokes," unpublished master's thesis, Graduate School, Springfield College, Springfield, Massachusetts, July, 1969.

Over, Mary Ellen, "A Comparison of the Force and Resistance of the Grog Kick and Whip Kick Used in Swimming the Orthodox Breast Stroke," unpublished master's thesis, Department of Physical Education, Long Beach State College, Long Beach, California, 1964.

Spangler, James Richard, "A Compilation and Analysis of Research in Competitive Swimming and Diving in the U. S., 1930-1963," unpublished master's thesis, Graduate College, University of Illinois, Urbana, Illinois, 1964.