Coaching Applications

How speed makes a difference - A case study of 100-meter races

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Abstract

Swimming faster has always been of interest to coaches. How we perceive time and swimming speed is vital to how we train, interpret the results of training, plan for completion and evaluate performance. Modern technology has broadened our perspective on how to interpret performance. The data was collected online (www.swim.ee) and statistical tests were used to analyze the results. In all 100 meter events at the European short course and long course championships, The swimmers were swimming slower as a group from 15 to 95 meters, regardless of stroke, course and sex. The differences that occur in swimming speed during 100 m races are larger than the difference that can have an impact on placing at the end of the race. We hypothesize; that the difference in swimming speed between fixed points occurs continuously because of the density of water creates a high resistance that the swimmer has to over-come, thus leading to a reduction in swimming speed between individual stroke-cycles. Interpreting the difference in time at the finish of the race, or differences in split-times during the race increases the the magnitude of improvements that has to be made in order to improve performance. By looking at swimming speed instead of time differences, a reduction of the magnitude in the improvement-gap becomes manageable. This has implications for both training an d competition, because it changes the perception of how performance can be improved from physiological, biomechanical and psychological perspectives.

Introduction

"It´s performance that counts" was the saying on Phillips 66 Long Beach Swim Club T-shirts when Coach Don Gambril was in charge of the program that produced seven world record holder and eight Olympic Champions in the late 60´s and early 70´s. The epithet holds still true today. But with the help of research in the sport of swimming, the understanding of what makes performance counts has expanded the interest in the sport of swimming over the years. Performance is a conglomerate of; applying psychological skills and strategies, tactical distribution of physiological resources over time, understanding and utilizing biomechanical principles and hydrodynamic forces and finally maximizing utilization of energy resources, muscular strength, power and flexibility in a given situation.

Part of the improvements in performances can be attributed to technological developments, and also to psychological training, improved physiological training methods and a better understanding of the application of biomechanical principles. But racing strategy and evaluation of performance in 100 meter races has basically been maintained. Research has confirmed that an all-out effort maximizes the utilization of available energy resources. Split times, stroke frequencies and stroke-cycles per length are used for evaluation and the racing strategy is more or less an all-out effort.

The perception of the winning performance is often that a swimmer who wins the race is either the fastest on the first 50 meters of the race or the second 50 meters. Training strategy is influenced by the perception of winning performance i.e. the assumption that swimming speed can be improved in the end of a race, resulting in a come from behind swim to win, is common among coaches at all levels.

With the use of technological developments, it has become evident, that swimmers within a race vary their speed, both in relation to managing the factors influencing performance and factors associated with their position in the race at a given time. This paper takes an objective look, with the help of statistical tests, at how swimming speed varies within the race for a group of swimmers in the final of 100 meter events both long course (LC) and short course (SC) meters at the European Championships.

Methods

Data relating to swimming speed (SS) at different reference points during 100 meter races at the European Championships, 2010 both SC and LC was collected from internet (www.swim.ee) and transformed for statistical analysis and comparisons. The data has a high reliability, since it used video analysis and fixed measuring points at 5 meters' interval. The camera was connected to the timing-system, creating a picture of distance and time at these points. From this picture swimming speed was calculated.

Discussion

Swimming speed changes throughout the race. It changes during the actual swimming phase, not only when the swimmer reacts to the starting gun or pushes off from the wall. As shown in table 1, the difference in swimming speed is so great that we can say, that there is an actual difference in swimming speed at different fixed points during the race. This actual difference is larger than the calculated difference that can impact the placing in a race, as proposed by different researchers.

The out-of-water start allows the swimmer to gain the highest swimming speed at 15m. Solid material allows for a better transfer of power as opposed to the fluids. The movement of the swimmer through water is affected by the density of water. Water is 784 more dense than air, this creates a large resistance for the swimmer to overcome. This increased resistance, in conjunction with decreased metabolic effectiveness impedes the possibility to increase speed during 100 meter races.

The overall observed reduction in swimming speed for the first 50 meters for men is between 1,114 m/s (100 m butterfly LC) and 0,740 m/s (100 m backstroke SC). The corresponding values for women are 0,936 m/s (100 m butterfly SC) and 0,592 (100 m backstroke SC). For the second 50 meters, the decrease in swimming speed are smaller in comparison to the first 50 meters. Regardless of sex the the smallest decrease is in the women´s 100 m breaststroke LC, 0,153 m/s and the largest is in the men´s 100 m backstroke LC, 0,403 m/s (see table 2).

Comparing, the greatest differences that occur in reduction of swimming speed between the two 50 meter portions regardless of stroke and sex, is for the men´s 100 butterfly LC (82,8% versus 17,2%). The smallest difference is for the men´s 100 m backstroke LC (69% versus 31%). The differences are larger in butterfly and breaststroke for both men and women, and smaller in backstroke stroke and freestyle.

Our way of evaluating performance in a race does not take these changes in speed into account. Differences in speed variation within portions of the race are much greater than difference in average swimming speed at the end of the race when comparing the 1st and 8th place finishers (see table 2). When converting swim time to speed for all events, the difference is between 0,024 m/s (men´s 100 free LC) to 0,125 m/s (men´s 100 m backstroke SC). That is to say for example that the winner travels 2,4 cm longer per second in the men´s 100 m freestyle LC than the eight place finisher. To travel 2,4 cm further every second of a race that last around 47-48 seconds is a different way of framing the problem, requiring a different solution than swimming 1,3 seconds faster in a 100 m race.

One solution is to improve stroke-cycle length and at the same time maintain stroke-cycle frequency, since swimming speed is the length of the stroke-cycle divided by the time per stroke-cycle. Only improving frequency will ultimately lead to a higher degree of metabolic fatigue. Thus improving joint-flexibility and the ability to apply pressure to the water in different positions can be explored. Another possibility is to minimize the loss of swimming speed by maintain a more streamlined position within and between all the stroke-cycles completed in the race.

Differences in time add up to be fairly large, when analyzing swim-time in the two different portions. Women´s 100 me backstroke SC has the smallest average difference of -1,74 s, when comparing the first half to the second half of the race within the group of competitors. The largest difference is 4,25 s for the men´s 100 me butterfly SC. These differences in absolute swim-time between the races are probably more due to the "degree of narrowness" of the competition in an individual event, rather than stroke, sex or course differences. Thus the magnitude of differences is affected by the competitiveness of the race and psychological aspects.

The "degree of narrowness" of a competition seems to influence the strength of predictability of placing based on split times or SS at fixed reference (see table 3). When there is a high "degree of narrowness" as in the men´s 100 free LC there are no variables that can predict the outcome, neither split time nor swimming speed at fixed reference points. Whereas in the women´s 100 free SC all variables has some degree of predictability. This predictability is however not constant, but varies in itself. Both split times and swimming speed at 65 and 85 meters has a higher predictability (90,6% and 94,1 %) on placing in the race than i.e. swimming speed at 15m (47,6%) and 95 m (60,5%). The different predictability coefficients are specific to each race, because it is influenced by the "degree of narrowness" and individual factors relating to the actual competitor´s physiological capacities and their ability to apply biomechanical principles when racing, due to fatigue.

The fastest swimmer in the race is not the fastest swimmer throughout the race. The data from men´s 100 m butterfly SC and men´s 100 m butterfly LC exemplifies this statement from two different perspectives. First, how fast is the winner swimming in relation to the others competitors in the race, and secondly who is the fastest swimmer, based on placings, at fixed reference points. The SC race has the following pattern based on the winner in relation to the other competitors, 1st at 15m, 1st at 35 m, 3rd at 45 m 1st at 65 m, 2nd at 85m and 4th at 95 m. So in the end of the race the swimmer who is winning is swimming slower than three other competitors, i.e. he is losing more speed at the end, either due to metabolic fatigue or mechanical efficiency. The LC winner is 1st at 15 m, 3rd at 35 m, 2nd at 45 m, 1st at 65 m, 8th at 85 and 95 m. So even though he will eventually win the race, the winner is swimming the slowest of all competitors from 65 meter to the finish of the race.

A second way of looking at this is; who is the fastest swimmer, based on placings, at fixed reference points. For the SC race, the order is 15 m (1st), 35 m (1st) 45 m (4th), 65 m (1st), 85m (2nd) and 95m (2nd). For the LC race the order is 15 m (1st), 35 m (2nd) 45 m (3rd), 65 m (1st), 85m (2nd) and 95m (6th). The same explanation can be applied in this perspective. The key is not answering the questions; but exposing the way of looking at how performance can be achieved in different ways.

We hypothesize, based on the objective data, that there occurs a loss of swimming speed from stroke cycle to stroke cycle. The loss of swimming speed is most likely due to a combination of mechanical efficiency and metabolic fatigue within the individual swimmer. These two factors are influenced by the physiological and metabolic capacity, biomechanical understanding of what creates the most energy efficient way to move through the water and physical attributes, in relation to body shape and flexibility for the individual swimmer.

The problem seems to be a multifactorial problem to solve. Research has its´ limitations, based on the fact that there needs to be a certain amount of control in order to explain how these different factors influence in other. The question of how to improve performance is left up to coaches to solve. However, we have put forth a different way of looking at the problem of improving swimming performance in 100 meter races, based on the results from the highest level of international competition. If swimming performance improvements can be scaled down to where the differences needed to improve performance are perceived as smaller than when comparing to absolute swim-time, different models of training for improvement can be developed and evaluated with more acuity.

It seems that the culture of training and evaluating performance, is more directed by the tools we utilize in training to measure performance and our perception of what is actually happening in the race that explains a winning performance, rather than what how the individual actually manages their technique and physiological capacities through the race, as influenced by the "degree of narrowness" of the race.

Conclusion

Based on a more complex definition of performance, a utilization of the tools of modern technology and our perception how time relates to speed, different ways of training to improve a 100 m race can be discovered. Rather than approaching training, from a physiological perspective only, measuring improvements in absolute time needed to win or break a record, we suggest a different way to approach training. By looking at changes in swimming speed during the race the importance of maintaining a higher degree of mechanical efficiency from stroke cycle to stroke cycle, includes both aspects of physiology and biomechanics. As long as the epithet holds true, "it´s performance that counts" and we award medals to the first three finishers in the race our methods of achieving these performances must evolve. As coaches we need to understand the confounding factors of our habits "in how we train and evaluate performance". For further understanding please read the research article in relation to this subject.