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Inter-analyst variability in swimming competition analysis

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Abstract

This paper quantified the inter-analyst variability in the time at which a swimmer reached a certain distance in a race, which is a key measure in swimming competition analysis. Prior to this paper coaches had assumed that differences in these times were solely due to changes in the swimmer's performance. This assumption was tested by asking four trained and experienced British Swimming analysts to calculate the time at which a swimmer reached four distances in ten randomly selected 100 m races. The inter-analyst variability was found to be between 0.02 s and 0.34 s.

Keywords:swimming; competition; analysis; variability

1. Introduction

Measuring the time at which a swimmer reaches a certain distance is a key requirement in swimming competition analysis. As described by Smith et al. (2002) a widely-adopted competition analysis process is to split a race into contiguous phases (a start, zero or more turns, a finish, and clean swimming between the start, turns and finish) with the boundary between two phases at a certain distance. Coaches identify strengths and weaknesses in a swimmer's performance by comparing the time taken to complete a phase in two or more races and this information is used to inform race tactics and training interventions.

An account of the analysis performed at swimming's premier competition, the Olympics Games, is given by Chatard et al. (2001a-c) and Girold et al. (2001). Twelve video cameras were used to film the semi-finals and finals of the men's and women's 200 m breaststroke and freestyle events. The resulting footage was replayed post-race and the time each swimmer took to complete the contiguous phases described in the foregoing were calculated.

These times were used to identify differences between the medalists, the non-medalist finalists, and the semi-finalists. Differences of between 0.21 s and 0.32 s in the start and turn phases were found to be statistically significant.

British Swimming, the national governing body for swimming in Great Britain, conducts analysis at competitions such as the Olympic Games, Federation Internationale De Natation World Championships, and its own national championships. They employ four analysts to do this work. As a result the data may be subject to inter-analyst variability. Therefore the purpose of this work was to investigate the inter-analyst variability in the time at which a swimmer reached a boundary between two phases. This research will allow a more informed use of the data, where, up till now, observed differences in the data have been attributed solely to changes in the swimmer's performance.

Nomenclature

HS   An instance in a breaststroke race when the centre of a swimmer's head is on the pool's surface
PB   A boundary between two phases of a race

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2. The British Swimming analysis process

A digital camcorder is used to film a race from a position in the stands, with the view panned and zoomed to follow a single swimmer. The captured footage is 50 frames per second and standard definition, i.e. 720 pixels wide by 576 pixels high. After the race the footage is analyzed in proprietary analysis software. Time is calculated from the frame rate. Therefore the time resolution is 0.02 s. Distance is estimated by referring to the colored sections of the floating buoys that separate the pool's lanes: the analyst counts the number of buoys to the nearest change in buoy color, which are usually at 5 m, 15 m, 25 m, 35 m, and 45 m in each lap. Each buoy is approximately 0.085 m wide.

The start phase of a race ends at 15 m, the turn phase is from 5 m before to 10 m after the end of a lap, the finish phase begins at 5 m before the end of the race, and the clean swimming phases occupy the distances between the start, turn, and finish. The swimmer is said to be at a PB when the center of the swimmer's head intersects a line interpolated across the pool's surface at the required distance.

In the clean swimming phase of freestyle and backstroke races the center of the swimmer's head is assumed to be always on the pool's surface. Therefore the analyst calculates the time at which the swimmer reaches a PB by selecting the frame in which the center of the swimmer's head is at the PB's distance. As a result the analyst has to make one choice at each PB.

Maglischo (2002) showed that in the clean swimming phase of breaststroke and butterfly races the swimmer's head moves up and down through the pool's surface in each stroke cycle. So, in most cases, the time at which the swimmer reached the PB cannot be directly measured. Instead it is estimated from the time and distance of two HS. We call these HS_i and HS_j and the time and distance (t_i, d_i) and (t_j, d_j) respectively. We also set the condition that t_i is less than t_j and d_i is less than d_j. A linear estimation is used;

$$t_b = t_i + \left(\frac{d_b - d_i}{S} \right)$$

where S is the mean speed between HS_i and HS_j and (t_b, d_b) is the time and distance at the PB. If d_i and d_j are both less than or both greater than d_b then the estimation is an extrapolation, else it is an interpolation. As a result, for breaststroke and butterfly races, an estimation of t_b requires the analyst to choose HS_i and HS_j, the frame in which the selected HS_i and HS_j occurred, and, for each selected frame, the buoy that is aligned with the center of the swimmer's head. In conclusion, the analyst has to make a total of six choices at each PB.