SPECIFIC STRATEGY FOR THE MEDALLISTS VERSUS FINALISTS AND SEMI FINALISTS IN THE MEN'S 200 M BREASTSTROKE AT THE SYDNEY OLYMPIC GAMES

Jean-Claude Chatard[1], Nicolas Caudal[1], Jodi Cossor[2] and Bruce Mason[2]
[1] Laboratoire de Physiologie, GIP Exercice, CHU de Saint-Etienne, France
[2] Biomechanics Department, Australian Institute of Sport, Canberra, Australia

The performances of the men's 200 m breaststroke at the Sydney Olympic games (final and semi-final) were studied using 12 video cameras. The four 50 m laps were analyzed to calculate the velocities, stroke frequency, stroke length, and turn velocities using a specific competition analysis computer program. The medallists swam faster than the non-medallist finalists in the third 50 m. In contrast, the percentage of the first 50 m swim duration was the longest. Compared to the semi-finalists, the medallists swam faster at all times except during the first 50 m. For the 16 swimmers, the 200 m breaststroke velocity was mainly related to the fourth 50 m lap velocity ($r = 0.71$; $p < 0.01$). From the stroke frequency and stroke length perspective, two different strategies were observed. However, these were not related to the final results.

KEY **WORDS:** swimming, biomechanics, performance, breaststroke, men

INTRODUCTION: The purpose of this study was to identify if there was a specific strategy for the medallist, versus finalists and semi-finalists to perform better at the Olympics. The start phase, velocity, stroke frequency, stroke length and turns were studied in every lap throughout the race and related to the final result.

METHODS: Subjects. Sixteen swimmers were studied. They were the swimmers that qualified from the heats to the semi-finals. Out of these 16 swimmers, 8 swam the final, and 3 were medallists.

Data Collection. During the Sydney 2000 Olympic Games, the 200 m Breaststroke was analyzed using a total of 12 video cameras. Eight of these cameras were located on the catwalk that ran above the center lanes of the pool, positioned approximately 18 m above pool deck. Seven of the cameras were Sony TRV-900E digital cameras operating at 50 Hz. The high speed camera was a Motion Scope PCI 1000 S Mono operating at 125 Hz. Following is a list of the cameras used and their positions:

1. 7.5 m from the start – looks at the first 15 m of the race (all lanes)
2. High speed camera at the 7.5 m mark to obtain more information on the race start (middle 3 lanes only)
3. 12.5 m from the start – looks at lanes 1-4 between 5 m and 20 m
4. 12.5 m from the start – looks at lanes 5-8 between 5 m and 20 m
5. 25 m – to obtain accurate information on the 25 m splits for each swimmer (all lanes)
6. 37.5 m from the start – looks at lanes 1-4 between 30 m and 45 m
7. 37.5 m from the start – looks at lanes 5-8 between 30 m and 45 m
8. 42.5 m from the start – looks at the turns (all lanes)

Two Sony lipstick cameras operating at 25 Hz were located beneath the pool with one at approximately 5 m from the wall at one end and the other at 12 m. These cameras covered the view from 5 m to 15 m for most of the lanes of the pool to give depth information on the starts and turns.

The last two cameras were located in the gantry above the first level of spectator seating and were positioned at the 25 m mark. These cameras were the Sony PC100E model (25 Hz) that were operated remotely by staff members in the analysis room using BNC cables over a length of approximately 140 m. Four cables were used for each camera to operate the tilt and pan functions. These cameras were connected to a laptop computer via an A-D card. These cameras were used to check the consistency of the information that was being produced by the digitalization process. Each camera could only compute the analysis information for one lane in a race.

The competition analysis computer program could perform analysis on all swimmers from any heat and lane. Variables that were determined from the competition analysis included the start time (time from the gun until the swimmer's head passed through the 15 m mark) and turn time (period from the swimmer's head passing the 7.5 m mark on his way into the wall and then return to this point after having completed the turn). Finish time was defined as the time that it took for the swimmer's head to pass under the flags (5 m from the wall) until the swimmer's hands touched the wall at the end of the race. The performance was also divided into 25 m sections in order to accurately determine the velocity through different phases of the race. Swimming velocity was measured for each 25 m section of the race while the free swimming time was the time within a 25 m section that did not include any start, turn or finish sections. Stroke length (meters) and stroke frequency (number of arm stroke cycles per minute) were also calculated in each free swimming section of the race. Stroke length was defined as the distance that a swimmer travels for a complete arm stroke cycle (right hand entry to right hand entry). The number of stroke cycles that would occur in one minute if the present rating was continued was defined as the stroke frequency.

The stroke length and interval velocity were calculated using two different methods and a comparison between the results of each was made. If the information provided by both methods was within a pre-determined variance, the analysis was accepted for the interval timing option and information was computed for the next race section. The first method of calculation was from the interval timing option. This used the race timing at the known locations e.g. 15 m mark from the start and the 25 m for the first race section. The distance and times were known so the velocity could be calculated for this interval. The stroke frequency could only be calculated using the digitizing option where the operator digitizes the swimmer's head at hand entry and then counts a number of strokes before digitizing the head at the same position in the stroke. Digitizing the head provided both the location of the swimmer in the pool and the race time at that location. Using this stroke frequency and the velocity calculated from the known distances and times, it was possible to calculate the stroke length using the formula V = SL x SF. The second method of calculating the stroke length and interval velocity was to involve the use of the stroke digitizing option, which was described to calculate the stroke frequency.

Statistical Methods. Means and standard deviations were computed for all variables. A one-way ANOVA was used to compare the results of the medallists to the non-medallist finalists and the semi-finalists. For the whole group, single and stepwise regressions were calculated between the 200 m velocity (independent variable) and the other studied variables (dependent variables) using Stat View 512+ program. In the stepwise regressions only the variables that added significantly to the prediction equation were retained. The cluster method was used to define the three main technique strategies used by the swimmers. In all statistical analyses, the 0.05 level of significance was adopted.

RESULTS: The comparisons of the main variables between the medallists, non-medallist finalists and semi-finalists are presented in the Table 1.

The medallists swam faster than the non-medallist finalists in the third 50 m. In contrast, the percentage of the first 50 m swim duration was longer for the medallists. Compared to the semi-finalists, the finalists swam faster at all times except during the first 50 m.

Table 1 Comparison of the Main Studied Variables (mean ± SD) between the Medallists (M), the **Non-Medallist** Finalists (NM-F) and the Semi-Finalists (SF)

	M N=3	NM-F N=5	SF N=8
200 m velocity (m.s-1)	1.52 (0.01)*	1.5 (0.01)**	1.48 (0.01)***
Start velocity (m.s-1)	2.01 (0.03)	2.04 (0.05)	2.04 (0.05)
1st 50 m velocity (m.s-1)	1.51 (0.01)	1.49 (0.01)	1.51 (0.02)
2nd 50 m velocity (m.s-1)	1.44 (0.01)	1.43 (0.01)	1.42 (0.01)***
3rd 50 m velocity (m.s-1)	1.45 (0.01)*	1.40 (0.01)	1.41 (0.02)***
4th 50 m velocity (m.s-1)	1.45 (0.01)	1.41 (0.05)	1.39 (0.03)***
1st 50 m SF (cycle.min-1)	35.7 (2.8)	37.4 (4.1)	40.76 (3.87)
2nd 50 m SF (cycle.min-1)	33.4 (1.9)	36.0 (4.6)	37.7 (2.9)
3rd 50 m SF (cycle.min-1)	35.3 (0.7)	36.6 (4.2)	39.2 (2.8)
4th 50 m SF (cycle.min-1)	43.4 (2.5)	43.8 (3.3)	43.5 (3.5)
1st 50 m SL (m.cycle-1)	2.55 (0.21)	2.42 (0.26)	2.24 (0.20)
2nd 50 m SL (m.cycle-1)	2.60 (0.17)	2.43 (0.34)	2.28 (0.19)
3rd 50 m SL (m.cycle-1)	2.46 (0.07)	2.33 (0.30)	2.17 (0.15)
4th 50 m SL (m.cycle-1)	2.01 (0.10)	1.94 (0.09)	1.94 (0.16)
Swim duration 1st 50 m (%)	23.28 (0.03)*	22.96 (0.12)**	22.59 (0.25)**
Swim duration 2nd 50 m (%)	25.54 (0.16)	25.49 (0.25)	25.52 (0.19)
Swim duration 3rd 50 m (%)	25.6 (0.22)	25.78 (0.2)	25.8 (0.12)
Swim duration 4th 50 m (%)	25.58 (0.06)	25.78 (0.46)	26.16 (0.39)
Turn velocity 1 (m.s-1)	1.61 (0.02)	1.62 (0.04)	1.62 (0.04)
Turn velocity 2 (m.s-1)	1.61 (0.03)	1.6 (0.06)	1.56 (0.04)
Turn velocity 3 (m.s-1)	1.54 (0.01)	1.53 (0.03)	1.51 (0.04)

SF = stroke frequency; SL = stroke length
* Significant difference between medallists and non medallist finalists.
** Significant difference between non-medallist finalist and semi-finalists.
*** Significant difference between medallist and semi-finalists.

For the whole group (n = 16), the 200 m breaststroke velocity was mainly related to the three last 50 m laps (r = 0.60; Figure 1; 0.64; 0.71; Figure 1; respectively, $p < 0.01$). To further investigate the relative importance' of these variables, stepwise regressions were calculated between the 200 m breaststroke velocity, the start, swim and turn velocities. The fourth 50 m velocity (V50-4) was the most important factor (r = 0.71), while the second 50 m velocity was the second most important variable. It increased the relationship between the 200 m breaststroke velocity and V50-4 from 0.71 to 0.89, following the equation:

$$200\ m \text{ breaststroke velocity} = 0.274\,(V50\text{-}4) + 0.576(V50\text{-}2) + 0.286$$

The swimming technique (stroke frequency and stroke length) was analyzed by the cluster method to determine the two main technique strategies used by the 16 swimmers (Table 2). T1 included the three medallists. The lowest stroke frequency and the highest stroke length in first three 50 m laps characterized it. In contrast, T2 included only two finalists and was characterized as the highest stroke frequency and the lowest stroke length in the first three 50 m laps. These strategies were not related to the performance.

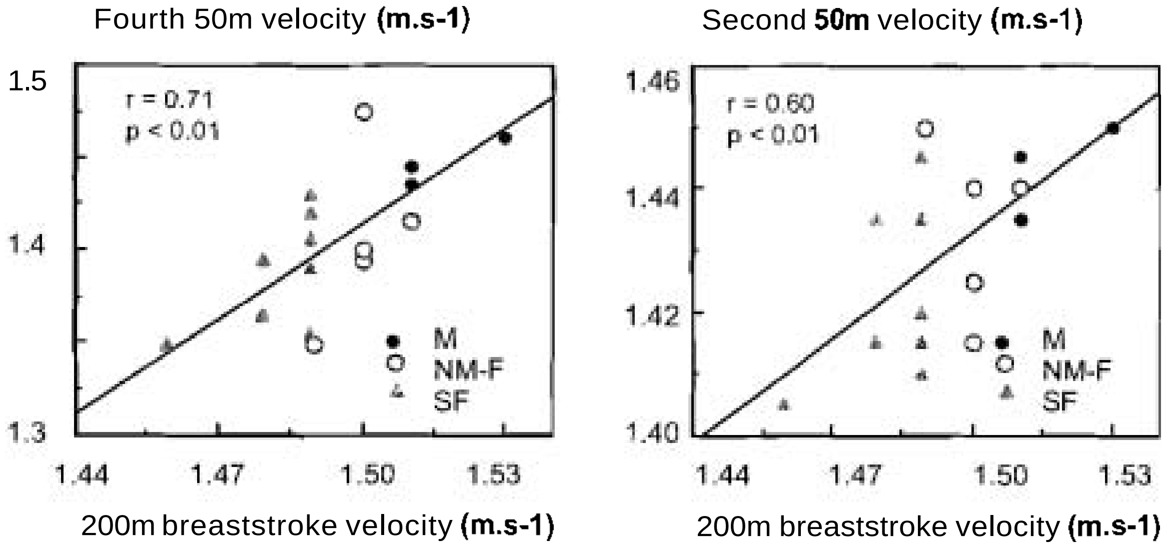

Figure 1 – Relationship between the fourth 50 m velocity, the second 50 m velocity and the 200 m breaststroke velocity.

Table 2 Description of the Two Main Technique Strategies Used by the 16 Swimmers

	T I **N=8, 3** medallists	T2 **N=8**
200 m velocity **(m.s-1)**	1.51 (0.01)	1.50 (0.01)
1st 50 m SF **(cycle.min-1)**	35.9 (2.5) *	42.5 (2.4)
2nd 50 m SF **(cycle.min-1)**	33.9 (2.9)*	39.5 (0.5)
3rd 50 m SF **(cycle.min-1)**	35.3 (2.5)*	40.7 (1.1)
4th 50 m SF **(cycle.min-1)**	42.8 (3.1)	44.6 (2.9)
1st 50 m SL **(m.cycle-1)**	2.52 (0.18)*	2.14 (0.1)
2nd 50 m SL **(m.cycle-1)**	2.55 (0.23)*	2.17 (0.04)
3rd 50 m SL **(m.cycle-1)**	2.42 (0.19)*	2.08 (0.06)
4th 50 m SL **(m.cycle-1)**	1.99 (0.11)	1.90 (0.13)

SF = stroke frequency; SL = stroke length
* Significant difference

CONCLUSION: In the men's 200 m breaststroke, for the medallists, the third 50 m was the most important part of the race. However, when expressed as a percentage of the race duration, the first 50 m was also of great importance. For the whole group (n = 16), the 200 m breaststroke velocity was mainly related to the third 50 m lap. The technique strategy was very different from one swimmer to another. Some swimmers swam with a high stroke frequency and a large stroke length while others swam with a large stroke length and a low stroke frequency. However, these differences were not considered of major importance for the final result.

ACKNOWLEDGMENTS:
The Pfizer/IOC Medical Commission Research on Sport Sciences funded the project "Competition Swimming Analysis at the Sydney Olympic Games".