TRACK START VS. GRAB START: EVIDENCE OF THE SYDNEY OLYMPIC GAMES

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Biomechanics and Medicine in Swimming IX. JC Chatard (ed.) Proceedings of the IX International Symposium on Biomechanics and Medicine in Swimming. 21-23 June 2002. University of Saint-Etienne, France. pp. 213-218.

ABSTRACT

Two concurrent swimming start techniques - Track start (TS) and Grab start (GS), are presently particularly popular among swimmers and researchers. Despite the relatively large amount of publications, the outcome as to which is remains inconclusive . The present study investigates those start techniques based on the outcome of the Sydney Olympic Games. There analyzed were the start reaction (1), the start efficiency - the time on the 15m mark (2), and the start mode – track or grab start technique (3). The final and semi-final performances in all strokes beside backstroke were analyzed and statistically compared by t-test with reference to the start technique, gender effect and whether distance had any influence. The outcome of the analysis revealed start technique particularities related to start reaction and efficiency, distance and gender specificity. The advantage of TS with regards to the start reaction was noted in major part of events. When start efficiency in TS was compared to GS there was an improvement in major part of events and in five events it was significantly higher.
Key words: *olympic performance, start mode, start reaction and start efficiency*.

INTRODUCTION

Analysis shows that racing start technique in swimming remains very disputable among the coaches, competitors and researchers. During the past few decades different start modes have been investigated and compared. At present at least six variations of technique are in use, both from the practical and scientific viewpoints, namely:
- grab start – scoop or whip, or no-resistance modification, when the swimmer's body enters the same place in the water where the hands entered previously;
- grab start – flat mode, when the swimmer's body enters the water at a slight angle (close to 20°) to the surface of the water;
- swing start with the full range of arm swing (this variation is widely used in relay);
- swing start with forward arm swing (this variation is still used for novices);
- track start with additional support for the rear leg (modification used by some researchers);
- track start, which is performed with the standard start block.

Despite a lot of researches and many publications relating to all the above start modes, there are many contradictory viewpoints. Since the 70`s grab start has been presented as more efficient than any other (Hanauer,1972; Bowers & Cavanagh, 1975). The track technique was offered by Fitzgerald (1973) based on general logic, biomechanical speculation and a pilot study. For the past three decades at least four serious scientific projects have been devoted to comparing track technique but no advantages for start efficiency (time to complete an initial section of distance) were found (Ayalon et al.,1975: Zatsiorsky et al.,1979; Counsilman et al.,1988; Allen,1997). The present study is purposed to investigate two concurrent swimming start techniques used by world-class Olympic swimmers - TS and GS.

METHODS

The present analysis was performed using the following data:
1) Start reaction (SR) – the elapsed time from start signal to takeoff - measurements were performed by the "Omega" electronic time system and presented in the official results book of the 2000 IOC;

2) Start efficiency (SE) - the time to complete the segment 15-m (the time taken for the swimmer's head to touch a digital line 15-m from the starting wall) - measurements were performed by research group of the Australian Institute of Sport and presented in the official book "Biomechanical Analysis";
3) Start mode – this variation of technique was identified from a video film made by the authors. All performances of the final and semi-final events were divided and analyzed according to one of two groups, TS or GS mode.
4) Data collection – the SR, SE and start mode of all participants in finals and semi-finals in 11 events, totally 151 female and 152 male performances were collected for further analysis.
Statistical analysis. Results were statistically compared by means of t-test for the start technique, gender and also whether distance had any influence. Correlation coefficient (R^2) was used to determine linear correlation for SR and SE. Least squares linear fits versus swimming distances were compared and the appropriate regression equations were computed. Statistical significance was determined at $P<0.05$.

RESULTS

Start reaction and start efficiency. It was found that the average start reaction in almost all events was shorter for TS than for GS (Tables 1-2). The advantage of TS was significant in a large number of swimming events.

Table 1. Summary of average start reaction and start efficiency for two start modes - men

	Start reaction ,s		Start efficiency (15 m time), s	
	GS	TS	GS	TS
50 free	0.81 (0.05) (n=8)	0.71 (0.04)* (n=8)	5.84 (0.12)	5.78 (0.11)
100 free	0.82 (0.03) (n=8)	0.76 (0.03)* (n=8)	5.98 (0.08)	5.98 (0.18)
200 free	0.82 (0.05) (n=11)	0.75 (0.07)* (n=5)	6.28 (0.14)	6.24 (0.30)
400 free	0.87 (0.02) (n=3)	0.80 (0.02)* (n=5)	6.86 (0.34)	6.55 (0.35)
1500 free	0.89 (0.06) (n=4)	0.79 (0.08) (n=4)	6.97 (0.26)	6.74 (0.38)
100 breaststroke	0.79 (0.04) (n=12)	0.72 (0.03)* (n=4)	7.06 (0.19)	6.90 (0.27)
200 breaststroke	0.83 (0.04) (n=12)	0.75 (0.06)* (n=4)	7.38 (0.17)	7.35 (0.18)
100 fly	0.81 (0.05) (n=9)	0.75 (0.04)* (n=7)	6.13 (0.17)	5.96 (0.17)
200 fly	0.80 (0.04) (n=12)	0.75 (0.05)* (n=4)	6.34 (0.26)	6.53 (0.19)
200 IM	0.80 (0.05) (n=12)	0.73 (0.10) (n=4)	6.54 (0.21)	6.49 (0.12)
400 IM	0.84 (0.05) (n=5)	0.72 (0.06)* (n=3)	6.85 (0.27)	6.63 (0.22)

* Significant difference between two starts ($P<0.05$). Differences between the results from the various conditions were tested using a Student test. The results are presented as mean (SD)

For men there were only two exceptions: the 1500 freestyle and the 200 individual medley; for women, there were five exceptions': the 200 and 400 freestyle, 200 butterfly and 200 and 400

individual medley. The start efficiency tends to be higher for TS, however, the significant benefit was marked in five female events only: 50 and 100 free, 100 and 200 breaststroke and 100 butterfly.

Table 2. Summary of average start reaction & start efficiency for two start modes – women

	Start reaction ,s		Start efficiency (15 m time), s	
	GS	TS	GS	TS
50 free	0.82 (0.05) (n=9)	0.74 (0.04)* (n=7)	6.74 (0.16)	6.71 (0.21)
100 free	0.82 (0.03) (n=7)	0.73 (0.05)* (n=8)	6.85 (0.16)	6.73 (0.16)
200 free	0.83 (0.04) (n=9)	0.79 (0.08) (n=7)	7.23 (0.17)	7.20 (0.13)
400 free	0.89 (0.02) (n=3)	0.83 (0.11) (n=5)	7.54 (0.06)	7.48 (0.17)
800 free	0.90 (0.04) (n=5)	0.82 (0.06)* (n=3)	7.83 (0.15)	7.51 (0.24)*
100 breaststroke	0.84 (0.04) (n=12)	0.78 (0.06)* (n=4)	8.25 (0.13)	7.90 (0.35)*
200 breaststroke	0.83 0.06) (n=12)	0.75 (0.03)* (n=4)	8.45 (0.20)	8.27 (0.20)*
100 fly	0.83 (0.05) (n=10)	0.77 (0.03)* (n=5)	7.11 (0.21)	6.81 (0.18)*
200 fly	0.84 (0.08) (n=9)	0.78 (0.05)* (n=7)	7.62 (0.18)	7.25 (0.37)*
200 IM	0.82 (0.03) (n=11)	0.79 (0.03)* (n=5)	7.43 (0.24)	7.38 (0.22)
400 IM	0.87 (0.06) (n=3)	0.82 (0.05) (n=5)	7.50 (0.22)	7.72 (0.29)

* Significant difference between two starts ($P<0.05$). Differences between the results from the various conditions were tested using Student test. The results are presented as mean (SD)

Relationship between starts reaction and start efficiency. The freestyle disciplines were correlated and analyzed (Table 3). Correlation coefficient (R^2) for different distances and pool values was calculated. There was strong relationship between start reaction and start efficiency with regard to all freestyle disciplines for both TS and GS in men and women. Also significant correlation was marked for women in the 50 m event.

Table 3. Variance values (R^2) related to start reaction and start efficiency for different distances and start modes in men and women.

Subjects		50 freestyle	100-200 freestyle	400-1500(800) freestyle	All freestyle disciplines
Men	GS	N=8, R^2=0.02	N=19, R^2=0.04	N=7, R^2=0.03	N=34, R^2=0.21*
	TS	N=8, R^2=0.01	N=13, R^2=0.07	N=9, R^2=0.19	N=30, R^2=0.34*
Women	GS	N=9, R^2=0.76*	N=16, R^2=0.24	N=8, R^2=0.02	N=33, R^2=0.50*
	TS	N=7, R^2=0.29*	N=15, R^2=0.02	N=8, R^2=0.27	N=30, R^2=0.35*

* - Significant Correlation Coefficient between Reaction time and first 15 m swim.
N is number of subjects

Distance length specificity was investigated within the range 50-800-m for women and 50-1500-m for men. The t-test was calculated for the 50 m. and every other distance separately for different start modes (Fig.1). Thus, in male swimmers three significant differences were

revealed for TS and one case only (1500 m.) for GS. In female swimmers one significant difference was found for TS (800 m.) and two significant differences for GS (400 and 800 m.). The dependence of start reaction time on the distance length was approximated by linear regression, where there was a good coincidence between predicted and real data. The graphs show that reaction time tends to be longer as the distance increases and this trend is more pronounced for GS, less so for TS.

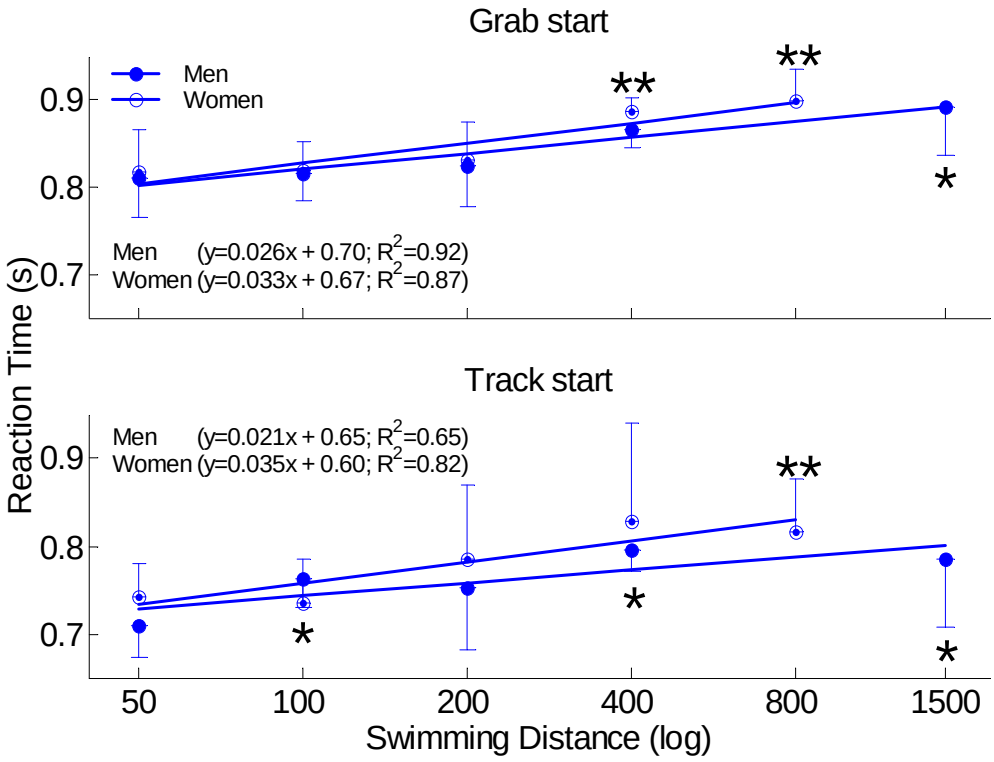

Figure 1. Average of Start Reaction time depending on natural logarithm of distance length. Vertical bars represent standard deviations; asterisks - statistically significant differences ($P<0.05$) compared to 50m.; * - men , ** - women.

Fig.2 displays start efficiency evaluated by average velocity on the initial 15 m. of the distance. Linear regressions demonstrate velocity decrease within the distances range. Remarkable, that this trend was more pronounced for GS, while for TS velocity the decrease was less for both men and women; t-test revealed significant differences between 50 m. and several other distances. For men, in both TS and GS the start efficiency decreased significantly from the 100 to 1500m., while in women - under similar conditions - the start efficiency decreased significantly only from the 200 to 800m

Sexual dimorphism. No difference between female and male swimmers has been found in start reaction. A comparison of how different strokes affect the start efficiency reveals the most pronounced sexual dimorphism among the breaststrokers.

DISCUSSION

Many start related publications can be subdivided into two unequal parts: studies in quasi-competitive conditions, where swimmers performed different start modes after preliminary

instruction and coaching (Table 4); and performance investigation during high-level competitions. The latter approach was used in a few publications (Miller et al., 1984; Thompson et al., 2000) but did not refer to comparison of start modes. A summary of selected publications (Table 4) demonstrates superiority of grab start modifications as compared with others.

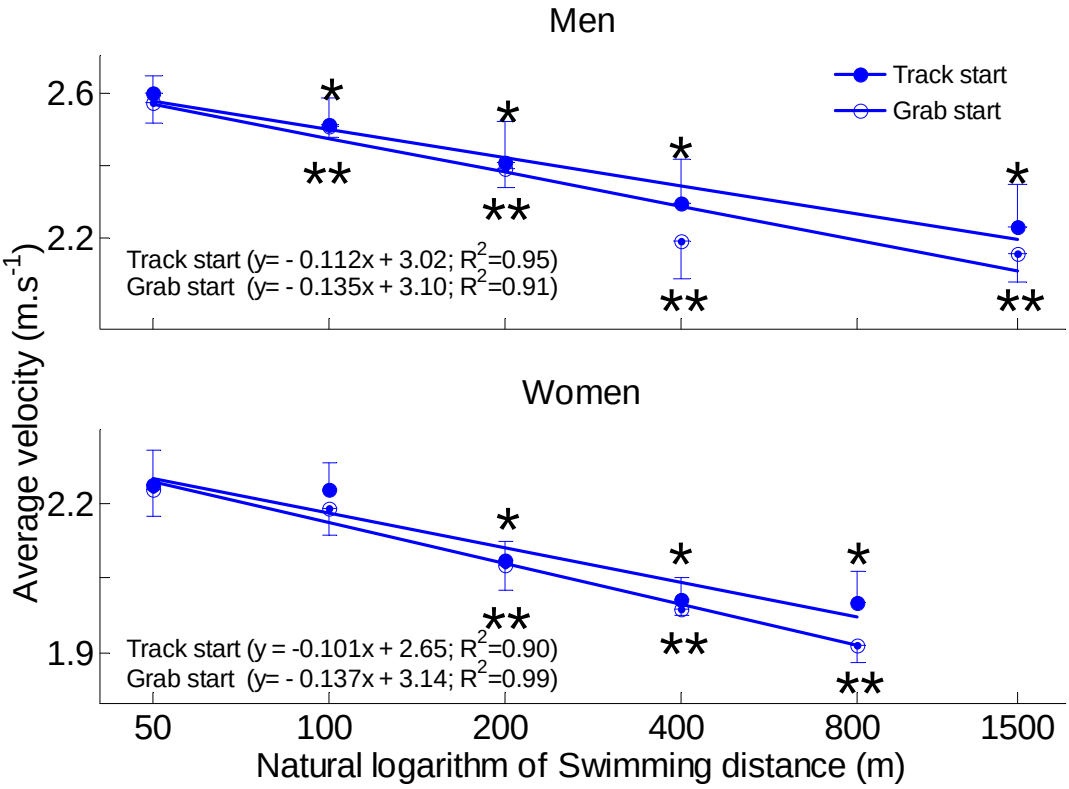

Figure 2. Average velocity on the first 15 m. regarding to natural logarithm of distance length. Vertical bars represent standard deviations; asterisks – statistically significant differences ($P<0.05$) compared to 50m; * - Track start, ** - Grab start.

Table 4. Retrospection of several studies related to swimming start variations

Source	The studied start variations	The main outcome
Hanauer, 1972	Swing start vs. grab start	Superiority of GS
Bowers & Cavanagh, 1975	Swing start vs. grab start	Superiority of GS - take-off and 10-yards time is shorter
Ayalon et al., 1975	Swing start, GS, bunch start, TS with support for rear leg	TS – time to leave block is shorter, no benefit on 5-m
Zatsiorsky et al., 1979	Forward swing, full range swing, GS and TS	Superiority of GS on the mark 5.5-m
LaRue,1985	GS vs. TS with support for rear leg	Superiority of TS at a completion of 4-m distance
Counsilman et al., 1988	GS flat, GS scoop, TS	Superiority of GS flat on 12.5 yd., TS is faster then GS scoop
Allen, 1997	GS vs. TS	TS – starting time (reaction) is shorter

Only one investigation revealed a significant benefit for TS, but this effect was found on completion of 4 meters (LaRue, 1985). However, this section is too short for evaluation. In

contrast, the number of world-class competitors who used TS, increased extensively and reached 40% among female and 37% among male swimmers in the final and semi-final races at the Sydney Olympic Games (authors' personal data).

Our results show a significant benefit for TS in start reaction. This is consistent with the results of several previous studies (Allen, 1997). As for start efficiency, the significant advantage for TS was marked in 5 female events. Therefore, there can be said to be a tendency to higher efficiency for TS. Three possible reasons for this might be noted here:

a) During the last period the effectiveness of the TS technique could be improved;
b) compared to previous investigations, where the participants did various unusual techniques after preliminary coaching for a relatively short-time, the Olympians performed their favorite kind of start only, which was perfect;
c) the database of the present study is on performances of the really best swimmers who were highly motivated and made the greatest effort.

The correlation analysis and R^2 calculation provides the conclusion that, in general, variability of start efficiency for 21-50% is explained by variability of start reaction. Therefore, the significant advantage of TS in start reaction may contribute into its higher efficiency. On the other hand, lack of correlation within several disciplines may be due to insufficient number of participants within these sub-groups.

Distance length specificity can be considered here, first of all, in relation to the general idea of this study. All linear regressions display a more pronounced decrease of start reaction and/or start efficiency for GS. Obviously, the longer the distance the longer the reaction time and the lower average velocity on the start section; however this tendency is less apparent for the TS technique. The lack of sexual dimorphism in start reactions is in line with the data by Miller et al., (1984), who did not find any differences in the reaction time between female and male swimmers.

In conclusion, despite contradictions in the results of the research projects, the TS is popular among top-swimmers. The findings of the present study give some credence to adherents of this start mode.

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