INVESTIGATION OF COACH RATINGS OF TECHNIQUE AND FORCE-TIME PROFILES IN ELITE MALE FRONT CRAWL SPRINT SWIMMERS

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The purpose of this investigation was to examine the relationship between assisted towing method (ATM) force-time profiles and coach ratings of front crawl technique. Nine elite male swimmers completed the ATM sprint swimming protocol to obtain active drag and propulsion values. Six coaches each rated overall technique from video footage and technique at each of four stroke events (entry, pull, push, and exit) from images captured throughout the ATM trials. Mean coach technique rating scores were then correlated against four performance measures (FINA point score, 100 m performance best time, active drag value and propulsion value). Results demonstrated weak to strong relationships between the ratings and performance variables for each stroke event.

KEY WORDS: active drag, propulsion, coach assessments

INTRODUCTION: The Assisted Towing Method (ATM) is a technique used to estimate active drag and propulsion in free swimming. This is achieved by comparing the velocity differences between a free swim maximal effort and an assisted (towed) maximal swim with regard to the added assistance used to tow the swimmer. A recent advancement to the ATM involves towing the swimmer with fluctuating velocity to match the naturally occurring velocity fluctuations present during the front crawl stroke cycle (Mason, Sacilotto, & Menzies, 2011). To date, literature on the ATM using fluctuating tow velocities have only presented whole stroke mean force-time parameters which have been shown to be reliable within participants (Hazrati, Mason, & Sinclair, 2013). To further the development of the ATM as a tool for assessment of swimming proficiency, greater understanding of the within stroke force-time profiles is warranted. One approach considered appropriate for interpreting the within stroke force-time profiles is to examine the relationships between technique proficiency and force-time measures at key stroking events. Therefore, the aim of this study was to quantify technique proficiency via coach ratings of technique and correlate these ratings against ATM active drag and propulsion values at selected events of the stroke.

METHODS: Nine elite male national level front crawl sprint swimmers (20.38 ± 2.88 yrs, 776 ± 57 FINA points, and 50.99 ± 1.17 s 100 m performance best time) completed active drag testing using the ATM protocol described by Mason, Sacilotto, and Menzies (2011). This involved performing a modified race warm-up which focused on short front crawl sprints, followed by three free swim trials across a 10 m interval to obtain a mean maximal swim velocity. Participants were then towed in a passive state (streamline position) at their mean maximal free swim velocity. A fraction of their passive drag force was then utilised to generate an individualised fluctuating tow velocity protocol. All participants performed three maximal swim effort assisted towing trials. The assisted tow trial with the median active drag value was selected and the second single stroke cycle from within this trial was chosen for analysis. Active drag and propulsion values were calculated from the force-time profiles using the equations described in previous work by Mason, Sacilotto and Dingley (2012). Following completion and analysis of the ATM trials, six coaches (two Gold and four Silver Australian coaching licenses) assessed and rated the technique of each swimmer. The overall assisted swim performance was assessed by a survey which required the coaches to rate technique from the sagittal and frontal plane video. Additional ratings were required from still images at each of the four events within the front crawl stroke. These events represented the start of the entry, pull, push, and exit stroke phases and were defined as: 1) Entry (first frame of the hand entering the water); 2) Pull (first frame of the hand moving backwards); 3) Push (first frame of the hand being directly underneath the shoulder); and 4) Exit (first frame of the hand exiting the water). Each event was presented to coaches as left and right side still images captured from frontal and sagittal plane video from the selected single stroke cycle. Coach ratings were made by indicating a mark on a Likert Scale ranging from 0 – 20 cm with 0 representing poor technique and 20 representing excellent technique for overall swim performance. Coach ratings were also collected on selected technique elements within each stroke event on a scale of -10 to +10, with 0 being classified as excellent technique and -10 and +10 indicating poor technique. This rating scale range allowed for classification of technique where performance could be less than ideal with regard to direction. For example, hand entry following recovery could be too narrow, ideal or too wide. These ratings were transformed post-hoc to a scale of 0 to 10, with 0 representing poor technique and 10 being classified as excellent technique. These elements included: hand position (HP), entry length (EL), trunk rotation (TR), depth of hand (DH), elbow positioning (EP), and exit length (EL). Each swimmer was critiqued on a total of 29 different technique parameters. Mean coach ratings for overall swim performance were then calculated and correlated against four performance variables (FINA point scores, 100 m performance best times (PB), active drag, and propulsion). For the stroke events the active drag and propulsion values used to correlate against coach ratings were instantaneous measures that corresponded to each stroke event. Pearson's product moment correlations were used to determine the relationship between coach ratings and

performance variables. Magnitudes of all correlations were interpreted using the following thresholds: low r = 0.10 – 0.30; moderate r = 0.30 – 0.50; and high r = > 0.50. The level of significance was set at $p < 0.05$ and indicated when $p < 0.01$.

RESULTS AND DISCUSSION: Nine swimmers were tested using the ATM protocol (1.89 ± 0.06 m/s swim velocity, 2.03 ± 0.08 m/s tow velocity, 150 ± 31 N propulsion, -150 ± 33 N active drag) and then assessed on their front crawl technique by six coaches. Results from correlational analyses demonstrate a range of relationships between coach's ratings of technique and performance variables. Table 1 shows the mean coach overall ratings correlated against the performance variables. A significantly high correlation was found between the FINA point score and the 100 m performance best time. This was an expected finding given the FINA point score is a ranking based on personal best time and the current World Record. Another expected significant correlation was found between the mean propulsion and the mean active drag values. As Mason, Sacilotto and Dingley (2012) outlined, the formula used to calculate propulsion includes the active drag value and therefore a high degree of relatedness exists. Aside from these expected findings, however, the overall coach ratings had negligible correlation to all four performance variables. This could be a function of the small sample of coaches and swimmers whereby relationships between variables are harder to demonstrate with fewer data points (MacCallum, Widaman, Zhang, & Hong, 1999). Alternately, this finding could be a reflection of the lack of relationship between coach rating of technique and the performance variables. If so, this demonstrates notable differences in opinion and high variability in coach ratings of good and poor technique.

Table 1
Correlations between overall coach rating of technique and the four performance measures

	Overall Swim Performance			
	Overall	FINA	100 m PB	Propulsion
FINA	.075			
100 m PB	-.074	-.965**		
Propulsion	.138	-.435	.262	
Active Drag	-.134	.431	-.250	-.993**

**= statistically significant at $p < 0.01$ level

Tables 2, 3, 4, and 5 identify the relationships between the performance variables and the coach ratings at each of the four stroke events. Within all four stroke events it was shown that all coach overall ratings when regressed against FINA point scores presented negative correlations. This is an unexpected finding and suggests that the higher the FINA point score, which is indicative of greater swimming ability, the lower the overall rating of technique. A similar relationship trend was observed between the overall rating at each stroke event and 100 m PB suggesting that the faster swimmers were rated to have poorer technique. A possible explanation for these findings could be that coach perception of what constitutes good technique is not consistent with performance. Or, as previously stated, large variability in opinion between coaches regarding their perception of good and poor technique existed which could have confounded the relationships. In addition, the small spread of performance best times and FINA point scores between participants could have also confounded these relationships. This is likely given the relatively small sample of coaches and swimmers who participated in this study.

Table 2
Correlations between overall and selected technique elements and the four performance measures at entry

	Right Entry				Left Entry			
	Overall	HP	Entry L	TR	Overall	HP	Entry L	TR
FINA	-.822**	.425	-.383	.654	*-.630*	*.336*	*.080*	*.640*
100 m PB	.740*	-.555	.293	-.551	*.628*	*-.478*	*-.019*	*-.502*
Propulsio	-.051	.718*	-.192	-.248	*-.359*	*.583*	*-.355*	*-.104*

n								
Activedrag	-.051	.377	-.267	-.038	-.555	.367	.067	.473

HP = Hand Positioning; Entry L = Entry Length; TR = Trunk Rotation; * = statistically significant at $p<0.05$ level; **= statistically significant at $p<0.01$ level

Mixed relationships were observed between coach ratings for the technique elements within in each stroke event and the performance variables. These correlations ranged randomly in strength of association and direction (positively or negatively correlated). However, TR was consistently positively correlated with FINA points (range r = .539 to .721) and negatively correlated against 100 m PB (range r = -.432 to -.561). This trend could indicate that a real relationship exists between the quality of TR and performance in all three underwater stroke events. When relating TR against the force data, no recognizable trends or patterns were found across the three underwater stroke events.

Table 3
Correlations between overall and selected technique elements and the four performance measures at the pull

	Right Pull				Left Pull			
	Overall	HP	DH	TR	Overall	HP	DH	TR
FINA	-.292	.827**	.411	.721*	-.348	.019	.472	.685*
100 m PB	.224	-.767*	-.233	-.557	.330	-.039	-.308	-.549
Propulsion	.210	-.090	-.437	.052	.287	.496	-.311	-.109
Activedrag	-.886**	.022	.341	.417	-.164	-.041	.009	.210

HP = Hand Positioning; DH = Depth of Hand; TR = Trunk Rotation; * = statistically significant at $p<0.05$ level; **= statistically significant at $p<0.01$ level

The results in Table 4 show the highest number of moderate to high correlations for all performance variables. This could be due to greater observable variation between swimmer techniques or less variation in coach perception of poor and good technique. The push stroke event represents the mid component of the underwater stroke and is a common point of focus for coaches. Therefore, the coaches may have been more likely to rate similarly which would result in stronger relationships between measures.

Table 4
Correlations between overall and selected technique elements and the four performance measures at the push

	Right Push				Left Push			
	Overall	HP	EP	TR	Overall	HP	EP	TR
FINA	-.342	-.091	.572	.601	-.773*	.398	.825**	.539
100 m PB	.344	.074	-.576	-.561	.775*	-.539	-.716*	-.432
Propulsion	-.527	-.388	.258	.093	-.114	.029	.367	.656
Activedrag	-.341	-.059	.145	.403	-.329	-.018	.673*	.631

HP = Hand Positioning; EP = Elbow Positioning; TR = Trunk Rotation; * = statistically significant at $p<0.05$ level; **= statistically significant at $p<0.01$ level

Table 5
Correlations between overall and selected technique elements and the four performance measures at the exit

	Right Exit		Left Exit	
	Overall	Exit L	Overall	Exit L
FINA	-.568	-0.64	-.321	.162
100 m PB	.505	-.020	.224	-.266
Propulsion	.455	.467	.861**	.433
Activedrag	.181	.174	-.069	.063

Exit L = Exit Length; * = statistically significant at $p<0.05$ level; **= statistically significant at $p<0.01$ level

Comparison of left and right side correlations between coach ratings and performance scores identified mixed associations within the stroke events and technique elements. These paired comparisons reveal correlation values that also vary randomly in strength of association and direction (positively or negatively correlated). Assuming there was consistent rating between sides by coaches, this lack of similarity between sides could indicate asymmetry in stroke technique within this participant sample.

CONCLUSION: This work represents a novel approach to interpreting the ATM force-time profiles in front crawl spring swimming. Correlations that ranged randomly in strength of association and direction did not provide for a clearer understanding of within stroke force-time profiles. Further investigation is required with a larger sample size of coaches and a greater range of swimmers to further explore the relationship between technique proficiency and ATM force-time profiles.

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