Table 2. Momentum (Ns) reduction in a full cycle and an average second of kicking.

	Large Kick			Small Kick		
	2.40 ms^{-1}	2.18 ms^{-1}	1.50 ms^{-1}	2.40 ms^{-1}	2.18 ms^{-1}	1.50 ms^{-1}
Total per cycle	44.40	35.04	9.59	38.03	31.24	9.74
Total per second	103.46	81.65	22.34	103.45	84.98	26.48

From the analysis results it can be seen that both kick techniques have a similar effect at 2.40 ms^{-1}. Although not quantified, it appears that for speeds of greater than 2.40 ms^{-1} there is a trend for the small kick to become more efficient. For speeds less than 2.40 ms^{-1} the large kick appears to be more effective, with approximately 4% better efficiency at 2.18 ms^{-1}, increasing to 18% more efficiency at 1.50 ms^{-1}.

When comparing the dynamic underwater kicking data to the steady-state results of previous studies (1), it can be seen that velocities around 2.40 ms^{-1} represent a cross-over point, whereby at higher velocities it is more efficient for the swimmer to maintain a streamlined position than to initiate underwater kicking. This is due to the swimmer creating more active drag than propulsion while kicking compared to remaining in a streamlined position, leading to wasted energy and/or a deceleration of the swimmer. Hence, although it is possible that the swimmer would benefit from a smaller kick at higher velocities, it may be even more beneficial to maintain a streamline position.

The main benefit of the large kick is the acceleration that is created on both the upswing and the down-sweep. The larger kick can create up to 50N more propulsion in these acceleration phases, whilst only creating 25N more drag in the non-acceleration phase. The main benefit of the propulsion is not coming from the feet where the propulsive forces are only marginally greater for the large kick but rather from the thighs and calves, where much greater propulsion is generated in the large kick compared to the small kick. A major point of drag on the large kick is when the knees drop prior to the main down-sweep due to the increased frontal surface area and flow changes, and creates substantially more drag for the large kick model. Movement of the upper body on the large kick also generates significantly more drag in phases of the kick cycle than that of the small kick. However, in the upswing of the feet, the body maintains sufficient momentum to offset some of the loss imposed by the high amplitude kick.

To illustrate the capabilities of the CFD modeling technologies, various scenarios were modeled by varying ankle movement in order to examine the effects on the swimmer's net thrust. In this case example three scenarios were examined with results in Figure 2:

1. The full range of ankle plantar flexion/dorsi-flexion of the test subject (pink curve).
2. A 10° shift in the ankle flexibility – referring to 10° less maximum plantar flexion and 10° greater maximum dorsi-flexion angle (green curve).
3. A 10° decrease only in maximum plantar flexion angle (blue curve).

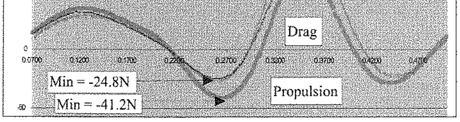

Figure 2. Net thrust graph highlighting the effects of ankle flexibility on propulsion.

The results in Figure 2 demonstrated that while the swimmer is traveling at 2.18 ms^{-1}, a 10° increase in ankle plantar flexion will create 16.4N greater peak propulsive force during the kick cycle. However, with 10° degrees more dorsi-flexion, the peak drag will increase by 31.4N. These results indicate that increasing ankle flexibility will increase the efficiency of stroke by approximately 1Ns per degree of increased flexion for this subject. Although this cannot be generalized, it highlights important information to coaches on the effects of flexibility on the generation of propulsion while kicking.

CONCLUSIONS

Although it shows the large kick has produced the better results of the two styles, this is based solely on the two kicking patterns analyzed and cannot be generalized to the large number of possible kicking patterns used by swimmers. However, this case study does highlight the powerful tool that CFD can be in optimizing swimming technique. The results have demonstrated the CFD can effectively be used as a tool, both to improve the foundational knowledge of swimming hydrodynamics as well as provide useful practical feedback to coaches in the short term on technique prescription. The benefits of using a modeling approach lies also in the area of technique modification strategies. Alterations in technique can be examined experimentally using the model, rather than 'trial and error' approach that typically is used.

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ANALYSIS AND COMPARISON OF SOME AQUATIC MOTOR BEHAVIORS IN YOUNG CHILDREN

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Several studies considered aquatic motor sequences in young children and their relations with some aspects of aquatic psychomotor development. The aim of this study was to understand if spontaneous swim movements of the child can evolve into an effective action, after a "keep doing" and a "free exploration" based methodological approach. Three groups of ten children, different in age (4-12 months, 12-24 months, 24-36 months), were studied. The presence of some motor skills pre and post a period of 10 events of free experience in a swimming pool were detected. No differences were found in the pre-post comparison within each group. Differences resulted in the comparison of the children aged 4-12 versus 24-36 months and in the children aged 12-24 versus 24-36 months.

Key Words: swimming, young children, motor behaviours.

INTRODUCTION

In literature there are many studies pointing out the presence of an ordered sequences in the aquatic motor conducts of young children (1, 3). This evolution comes from neuronal development of children, which keeps pace with evolution

related to development of the terrestrial basis motor patterns (3, 4). Some assessments were performed with electromyography and video analysis about lower limbs movements of young children (5) and some others about description of leg movements of children aged 3-20 months (6). Other authors assert that water experiences could improve specific skills (2).
The aim of this study was to understand if spontaneous swim movements of the child can evolve into an effective action, after a "keep doing" and a "free exploration" based methodological approach.

METHODS

This study involved 30 children divided into 3 groups (5 males and 5 females each), aged respectively 4-12 months (group A: age 10.8±1.8 months, weight 9.6±1.4 kg, height 74.7±4.44 cm), 12-24 months (group B: age 17.0±2.3 months, weight 11.8±1.7 kg, height 82.8±6.1 cm) and 24-36 months (group C: age 31.9±3.0 months, weight 13.7±1.6 kg, height 96.8±7.3 cm).
The study was performed with the same teacher, who proposed 10 lessons of 30 minutes each. The swimming pool had irregular edge, depth of 90 cm, Cl^- 0.6 p.p.m., pH 7-7.4, water temperature 33°-34° C, room temperature 29°-30° C.
The children experienced the water environment, freely playing. Several tools to increase their creativity and their imagination were placed in the water, such as mats, floating toys, slides, balls. No aids to floating, movement or programs to induce learning to swim were used.
The spontaneous behaviours of the children pre and post the period of free experience in the water were analyzed. The presence of the following six specific characteristic responses to the aquatic environment stimulation was observed and recorded by pictures and underwater videos: (I) a spontaneous submersion; (II) a balanced body inclination from 20 to 45 degrees; (III) a simultaneous action of the arms, (IV) an alternated action of the arms; (V) a simultaneous actions of the legs; (VI) an alternated action of the legs.
The criterion of scoring employed was: "0" when the characteristic was absent, "1" when it was present.
A comparison of the pre-post status within group and a comparison among the three groups for each characteristic observed, were conducted with a Mann-Whitney non-parametric Test, for $p<0.05$.

RESULTS

No significant differences ($p>0.05$) were found in the comparison between the pre and post experience analysis within group. On the contrary, in the comparison 4-12 versus 24-36 months, a significant differences ($p<0.05$) were found in all the characteristics evaluated, except in the spontaneous submersion action. In the comparison 12-24 versus 24-36 months, differences were found in the body position and in the arm movements (table 1).

Table 1. Comparison among groups with Mann-Whitney Test (= p<0.05; ** = p<0.01).*

Characteristics	4-12 Vs. 12-24 (months)	12-24 Vs. 24-36 (months)	4-12 Vs. 24-36 (months)
Submersion			
Inclined Body Position 20°-45°		*	*
Simultaneous arm movements		**	**
Alternated arm movements		**	**
Simultaneous leg movements			*
Alternated leg movements			**

DISCUSSION

From the results, it appears that no differences within group were noticed in the spontaneous motor actions observed. We can suppose that in young children aged 4 to 36 months, a free experience in the water environment does not produce effects in the aquatic motor behaviours considered.
On the contrary, variations appear in the comparison among groups. In the comparison of the children aged 12-24 versus 24-36 months differences were found in the body inclination and in the arm movements. The children aged 4-12 versus 24-36 months present differences in every aquatic motor behaviour observed, except in the spontaneous submersion action.
Based on the data from the present study, we can suppose that, *according to the literature (3), the aquatic motor development* of the young children should depend mainly on age.

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VALIDATION OF A CABLE SPEEDOMETER FOR BUTTERFLY EVALUATION

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Getting fast results from the evaluation of swimmers is one of the most important goals to achieve with technological development in the field. The purpose of this study was to validate a real-time velocimetric device (speedometer) through the comparison of their results with computer assisted videogrametry. The sample included 7 international level swimmers (3 females and 4 males). Each swimmer performed four 25m trials, two at 200m race pace and two at 50m race pace. For each trial, two stroke cycles were studied, resulting on a total of 28 cycles