Editors Digest referenced article
Table 2. Means, Standard Deviations, and within race speed changes (\(\Delta\)) for competition analysis data in Sydney 2000 Olympic and Paralympic swimming finalists (n = 8) with Intellectual Disability (S14), visual impairment (S13) and loco-motor disability (S10) (Competitions in long course 50-m pool).

<table>
<thead>
<tr>
<th>Race</th>
<th>S14</th>
<th>S13</th>
<th>S10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>2</td>
<td>2.2</td>
<td>3.3</td>
<td>4.4</td>
</tr>
</tbody>
</table>

It now appears that at least in long course races there is a typical race pattern used by all swimmers with sufficient race experience regardless of the absolute performance level. This is not influenced by direct external factors. Class S13 (see table 2), for example, are legally blind. Where persons without visual impairment can read normal newsprint at 1m distance, these athletes could only read this at 10cm. So the ability e.g. to "see" the opposing swimmer or the pool surroundings may not be as important as experience (movement rhythm, feeling of the water and perceived exertion) in employing a suitable race pattern. This further indicates that there is little tactical component to this particular race which may be an advantage to ID swimmers. Moreover a race is always conducted in the same manner and presently at high level competition problems such as poor lighting, cold or warm water and slow (turbulent) pools are somewhat a thing of the past. There are few "surprises" if the preparation is sufficient leading to the race. So a large number of extraneous factors are eliminated resulting in a race speed pattern that is distinct to the race at hand and not the individual.

Another factor supporting the hypothesis of only one general race tactic in the 100-m freestyle is the fact that there are no differences between groups in the amount of time spent starting or turning. Neither ID athletes nor those with visual impairment have more trouble than other athletes in turning for example. To confirm this further work is needed to examine the women competitors as well as heat swimmers, however. Closer study is also required on the differences between long and short course races. For visual impaired and ID athlete addition turns might add to the problems encountered.

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REFERENCES

CHALLENGES OF USING CRITICAL SWIMMING VELOCITY FROM SCIENTISTS TO COACHES

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So far, a few studies have been conducted on the Critical swimming velocity concept. The current available knowledge suggests there is merit in using CV for training. The model offers potential to swimming in that it is non-invasive and easy to administer. The CV concept appears as a useful tool for setting training intensities, monitoring training effects, and predicting performances. All these applications are reviewed in the present article.

Key Words: critical velocity, usefulness, assessment, training.

INTRODUCTION
The d-t relationship is almost strictly linear in swimming (Figure 1; Panel A; Equation 1). It has been verified in groups of trained adults (23) and children (9, 19).

Equation 1: \(d = a + CV \times t\)

Its slope has been called Critical velocity (CV) referring to previous works done on the muscular capacity (see (1, 11) for review). CV is also represented by the asymptote of the velocity-time relationship and is mathematically defined as the velocity that can be maintained (in theory) indefinitely (Figure 1; Panel B).

Figure 1: Schematic of the 2-parameter model (d-t relationship - Panel A; v-t relationship – Panel B). On Panel B is represented the distance (d1 and d2) covered during to events and equal to the sum of a plus the product of CV and time (t1 and t2).

The CV determination has been shown to be reliable even if exhaustion times are variable (13, 22) and physiological responses at CV have also been shown in swimming, to be reproducible (3). Further research is required investigating the

Indoor Swimming Championships. Available at www.swim.eu on December, 20, 2005.
CV concept but current available knowledge suggests there is merit in using CV for training. The model offers potential to swimming in that it is non-invasive and easy to administer. When being aware of its underlying assumptions (see complementary article; Dekker et al.), the CV concept seems a useful tool for setting training intensities, monitoring training effects, and predicting performances.

**PHYSIOLOGICAL MEANING OF CV**

CV has firstly been thought to correspond to a sustainable intensity and has been compared to parameters such as the maximal lactate steady state (MLSS; highest intensity that can be maintained without any drift in the blood lactate concentration ([La]) or the onset of blood lactate accumulation (OBLA; intensity corresponding to a 4-mmol.L⁻¹ of [La]). Wakayoshi et al. (24) and Brickley et al. (3) obtained steady [La] values during several 400-m blocks performed at CV (around 3-4 mmol.L⁻¹). But the 30-45 sec of rest enabling blood samples to be taken between the blocks could have helped the swimmer keeping his motivation, limiting the drift of [La] and maintaining a ‘relatively’ good efficiency. Stroking parameters have indeed been shown to change, with progressive stroke rate increases and stroke length decreases within and between the 400-m blocks (3).

Most authors today agree that CV does not correspond to a sustainable intensity. In fact, swimmers can hardly maintain their CV for longer than 35 min (unpublished data from our laboratories) and CV has been shown to be close to the velocity of a 30-min test (8) and higher than MLSS (7) and OBLA (9, 20, 24, 25). These results are in agreement with results obtained in 30-min test (8) and higher than MLSS (7) and OBLA (9, 20, 24, 25) at and below CV (around 3-4 mmol.L⁻¹). But the 30-45 sec of rest enabling blood samples to be taken between the blocks could have helped the swimmer keeping his motivation, limiting the drift of [La] and maintaining a ‘relatively’ good efficiency. Stroking parameters have indeed been shown to change, with progressive stroke rate increases and stroke length decreases within and between the 400-m blocks (3).

CV is today defined as the upper limit of the heavy intensity domain, i.e. the highest intensity that does not allow VO₂max to be attained during a constant load exercise (12). Above CV, because of the slow component phenomena, VO₂max should be elicited. This definition of has not yet been directly verified in swimming but is in line with several findings reported in the literature in swimming. CV is lower than the end velocity of an incremental test, traditionally identified as the maximal aerobic velocity (around 92-96% of the 400-m velocity). It is highly correlated to OBLA (23, 24, 25), the average 400-m velocity (23, 24, 25), and MLSS (7). The first belief that CV was sustainable for a very long period of time was a misinterpretation of the mathematical (and not physiological) definition of CV, i.e. the intensity that can be maintained indefinitely (asymptote of the velocity-time relationship).

**SETTING TRAINING INTENSITIES**

CV allows demarcating two different intensity domains and should be used as a reference to set training intensities. The 400-m pace is usually used by coaches for this purpose. However, two swimmers with similar performances on 400 m can have different aerobic potentials (Figure 2). One can swim a 1500 m quicker than the other one (and so, for short races). The physiological stress to exercise of long duration will be different for the two swimmers. It is important to properly individualise training loads to optimise the physiological adaptations while avoiding overtraining especially when accuracy in the definition of the training loads is required as higher levels of performance.

Using CV for aerobic training programs offers great potential. It allows better setting of continuous, long and short interval training for each. Continuous training (2000-3000m) and long interval training at and below CV (around 3-4 mmol.L⁻¹) would be buffered and La that would be oxidised in different body cells. An example of long interval training could be 6 to 10 x 400m swim at CV with 15-sec rest. Indeed, several 400-m blocks performed at CV can be swam with steady [La] values (around 3-4mmol.L⁻¹) when separated by 30-40s of rest (3). Among all acute adaptations, we could expect a great improvement of the buffering capacity and oxidative potential of several body cells on top of the muscular ones (10). Central and peripheral adaptations occur with training performed around CV but it can be expected that the peripheral adaptations induced by swimming at and below CV would be less predominant with the increase in the intensity; the central adaptations becoming even more important. Adequate long and short interval training above CV (20-30 x 100m at 110% CV, 30-s rest; 1min at 120% CV, 1min rest for 20 min) would enable VO₂max (very high heart rate and stroke volumes) to be solicited and maintained for a very long time. This could lead to optimise the improvement of VO₂max over time as suggested by Billat and collaborators (2). The short interval training is also of great interest as it allows swimming at high race paces while challenging the aerobic potential (200- up to 1500-m pace in this case). Training at race pace is important, especially in swimming where swimming coordination (21), energetic cost (5), and technical efficiency are changing depending on the velocity. Short interval training would enable to focus on the swimming techniques whose swimmers should attempt to maintain efficient while fatigue progressively develops during such long aerobic work performed around CV.

It has also been observed a drop of stroke length when swimming above the lactate threshold (17) or MLSS (6). Accordingly, when swimming several 400-m blocks at CV with steady [La] values, stroke parameters change, with progressive SR increases and SL decreases within and between the 400-m blocks (3). This leads to suggest that swimmers should focus on their stroke length (SL) / stroke rate (SR) ratio when swimming around CV in order to carry out a good qualitative technical work. Coaches should make an attempt to determine at which velocity and in which extend the SL and SR change. They could then train swimmers either to maintain both velocity and one of the other stroke parameters despite the increase in fatigue, or to maintain SL while increasing SR for a faster swim. As explained above, it is known that training at race pace is of importance for technical aspects of the strokes. Therefore, this training strategy relying on the multiple combi-
nations linking the stroke parameters ("task constraint" strategy) should be performed at any velocity of the race spectrum.

MONITORING TRAINING EFFECTS AND PREDICTING PERFORMANCE

The use of the CV concept to monitor training effects and predict performance still has to be investigated. A few studies have shown the 2-parameter model to be affected by training (14, 15). Swimming aerobic training has a positive effect on CV while the change in the intercept is consistent with the training performed (16). Indeed, the value of the intercept has been shown to be more affected by low variations of exhaustion times than CV (22) and its physiological meaning has not been yet confirmed (8, 18). Therefore, we would suggest being prudent when interpreting its value and change over training.

When knowing the equation of the d-t relationship, it seems possible to predict swimming performance. Again, this should be confirmed or inferred by further research. However, because of the good linearity of the relationship, coaches can try to predict performance as long as they are ranging between around 2 and 30 min (see complementary article; Dekerle et al.).

CONCLUSION

The actual knowledge on the application of the CV concept seems sufficient to underlie its interests for training. The d-t relationship seems a useful tool for setting training intensities, monitoring training effects, and predicting performances. However, "luckily" for researchers, further research is required to confirm its meaningfulness in swimming (responses at and above CV) and usefulness for training (among all, effects of training at intensities around CV, effects of training on the d-t relationship, kicking vs full stroke CV, prediction of performance). Almost all the studies conducted on the Critical Swimming Velocity have been conducted on trained swimmers whose 40-m performance ranged from 72-84% of the world record. It can be wished that the concept will soon be tested on groups of elite swimmers.

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REFERENCES

cal swimming velocity. In: Chatham JC (Ed.). Biomechanics and Medicine in Swimming IX. Saint- Etienne: University of Saint Etienne, 385-90


THE PROBLEM OF PEAKING IN VIEW OF EVIDENCES FROM THE ATHENS OLYMPIC GAMES

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The present study tested the assumption that several crucial factors, such as duration of the final stage preparation (FSP), gender, age, selection procedures, swimmers’ ranks, swimming stroke and distance account for swimming-time variance in the 2004 Athens Olympic competition. A total of 424 events performed by 301 Olympic swimmers were analyzed to obtain the relative performance gain (RPG%) that was computed as the differences between the entry swimming results and swimming time in the Olympic competition. The average RPG% gain equaled 0.58% (SD = 1.13%), indicating performance decline, embracing 68.2% of all the swimming events. Only two categories of competitors, the medal winners and swimmers ranked 4-8, surpassed their previous entry time; one-way ANOVA revealed significant (p < .04) superiority of the swimmers who were selected rigorously over swimmers selected liberally.

Key Words: peaking, Olympic performance, tough and liberal selection.

INTRODUCTION

The Olympic Games, as the athletic, social and cultural mega-events of our times, provide a unique experience, which require multi-disciplinary analysis and consideration, which are important both for science and practice. Such analysis is of particular importance when aiming at achieving the best individual outcome in a specific Olympic event. Thus, peaking obtaining by the best athletic performance at a particular moment, is of primary importance for any athlete. Peaking was usually considered with regard to tapering (1, 8), the wide spread approach presupposed evaluation of peaking by means of comparison of pre-taper and post-taper results. Such type of statistical treatment led to very impressive performance improvement ranging between 1.1 to 6.8% (7, 8). Another estimation approach being realized in a few recent studies prescribes comparison of results obtained during selection trials and ultimate achievements on Olympic Games’ performances (11, 12). The latter approach does not consider taper, as the short-term period, when the workloads are reduced, but rather the Final Stage of Preparation (FSP) as the specific period, where selected and especially organized group (team) executes a purposeful training program directed at the targeted competition. Therefore, the quality of the peaking process can objectively be assessed by comparing the results of the beginning and the end of the FSP Competitive swimming, as an Olympic sport with absolutely reproducible standard conditions and reliable and measurable performance evaluation provides a unique opportunity to study peaking.

METHODS

Subjects

301 Olympic swimmers (153 males and 148 females) representing 24 National teams, aged between 15-23 years, took part in a total of 424 events. Selection of the swimmers for analysis was based on the following criteria: (a) taking part in the Olympic trials and Olympic Games in the same event, or (b) obtaining an official result in competitions before entering the Olympic trials and Olympic Games in the same event.

The Final Stage Preparation was operationalized as a time period following the selection Olympic trials, or another competition where an athlete obtained his/her official entry time. Therefore, the length of the FSP varied between 29 (USA) – 151 (Italy) days. The training programs of the teams varied significantly; the teams with a relatively long FSP took part in several competitions including European Championships, and other international meetings. All swimmers practiced a drastic workloads reduction prior to the Olympic events – taper – lasting usually within the range of 10-25 days.

Performance results’ analysis: All competitions were organized in accordance with the regulations of the International Swimming Federation (FINA) exclusively in the Olympic standard 50-m pool. The results were registered by the electronic “Omega” system, and were collected from the official protocols of Olympic Trials and the Athens Olympic Games. In both cases the best result of the corresponding swimmer was taken for analysis. The absolute and relative differences between the entry swimming results obtained during trials and ultimate competition, and during the Olympic competition were calculated. Thus the main indicative estimate called Rate Performance Gain (RPG %) was obtained. The following factors were used as independent variables:

- selection mode – two modes were considered: tough selection, which has been used by the world-leading countries with official Olympic trials, and liberal selection practiced mainly by teams with small number of world-ranked swimmers, which can meet Olympic criteria during the whole Olympic year, and even earlier;