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THE MECHANISMS OF ULTRA-SHORT TRAINING: THE TRANSLATION OF CHRISTENSEN'S THINKING INTO SWIMMING TERMS AND ITS PLACE IN TRAINING PROGRAMS

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A major difficulty for swimming coaches is to consider how much work can be completed at a practice by each swimmer. The desirable amount would be as much work as possible on an individual basis: *What is a reasonable training load and what is not?* There are big differences in the work capacities of swimmers within a squad/club/team. It is proposed that USRPT has developed a procedure that allows individuals to complete work to their own capacities and avoid doing too much or too little of the activity.

In the past, coaches have used heart rate and oxygen consumption as indexes of work. Oxygen uptake supposedly indicates the absolute level of the training load and heart rate the relative load. Arguments have continued over which is more important. As well as being easier to measure, heart rate also reflects environmental conditions that are internal to the swimmer (e.g., dehydration, illness, mood) and external (e.g., time of day, water temperature). Despite heart rate having theoretical benefits, its use in actual swimming practice conditions has not fared well. It is just too variable and does not account for much of the variability of swimmers' training and competitive responses. Its predictability for performances is very low to non-existent. At best, it needs to be used in conjunction with other measures. If that is achieved, a considerable amount of time will be invested in measuring and recording numbers that still will not give an accurate indication of a swimmer's capacity to train, reaction to training, and/or performance in an impending competition. Often such testing is purely *testing for testing sake* so that science is seemingly being used to establish some credibility for a program but in reality the use of test results is bogus.

Figure 1 is an adaptation from the work of Astrand et al. (1960). It displays what happens to lactic acid production while riding a bicycle ergometer with constant work:rest intervals and workloads but the intervals being of different lengths. The left side of the figure illustrates three 1:2 work:rest formats. When work is of 60 seconds duration and rest is 120 seconds, the individual increases lactic acid concentration to such an extent that the effort is terminated before the maximum time of 30 minutes has elapsed. That shows if the work duration is sufficiently long enough and as much as double the amount of time is provided for rest, the ability of an individual to work at a higher level for a full planned duration is impaired. That is what happens to many swimmers who are set tasks such as 8 x 200 m at 90% of race time with two minutes rest. The expectation is that the 90% level of performance will/should occur in each repetition. The ability of the swimmer to maintain a constant pace in such a task usually is impaired and to avoid terminating participation, the quality of each succeeding repetition is lowered until a sustainable inferior performance is maintained and the task is completed albeit unsuccessfully. That results in a poor training experience with the main outcome being the swimmer learns to cope by swimming slower/easier so that the task can be finished. The main compromise is a diminution in the quality of the swimming performance.

When the duration of the work is reduced to 30 seconds (with 60 seconds rest), the task is completed with a moderate and somewhat stable elevation in lactic acid concentrations. It is likely that such levels are at the cusp of where modification/learning of new technical features of the performance is hindered or prevented.

When the task duration is reduced further to 10 seconds (20 seconds rest), the task is completed comfortably and seemingly in a submaximal manner. That is an example of what happens in ultra-short training when riding a bicycle ergometer. However, since swimming only works part of the body fully in high-intensity work, the duration of a swimming interval can be longer than shown in running or cycling tasks, the activities usually evaluated in early ultra-short interval research. Thus, 50 m swimming repetitions of ~35 seconds or less are accommodated well with work:rest ratios of 1:0.5. A substantial part of oxygen debt is paid back by submaximal working parts of the swimmer as the exercise progresses but the remaining debt is mostly repaid during a substantially shorter-than-normal rest period (when compared to gravity-challenged activities).

Figure 1 (right side) shows lactic acid concentrations when the work to rest ratio was increased to 1:4 for the same task. Lactic acid levels did not reach as high as with the 1:2 format but still the doubling of the rest duration only caused a modest drop. The shortest work duration once again kept lactic acid levels to submaximal effort levels. Increasing the rest periods relative to the work duration had only a moderate effect on the severity of the work. Less work (fewer work periods) were performed in this second example indicating that providing more rest is not much of a hedge against a performer experiencing "hard" exhausting work. It is the short work and rest periods together that provide the opportunity to perform a very large amount of high-intensity work with reduced circulatory and respiratory strain. That is the benefit of the USRPT format.

One of the most significant modifiers of swimmers' responses to training is the distribution of rest pauses in a session and to a lesser extent the total time of all the pauses. The most effective work output is achieved with short work and rest periods. In swimming, some coaches believe that working swimmers "hard" is most valuable. They are satisfied when swimmers finish a practice in an exhausted condition despite the fact that they might not have performed a maximal workload. At the other extreme are the coaches who want swimmers to perform as much specific/relevant/useful work as possible in preparation for competing while at the same time preventing the accumulation of exhaustion factors and states as a competitive season progresses. This latter orientation is that of USRPT adherents.

Ultra-short interval training takes a demanding onerous workload and divides it into short work and rest periods. It actually turns a daunting heavy task into close to a submaximal task. In swimming, it has been argued and supported by research studies that technique is the most important factor in increasing propelling efficiency and competition performances. If a coach followed that direction, it is important for swimmers to perform as many correct[1] strokes as

[1] Correct for racing, that is, a large amount of training improvements will transfer to racing situations. Such training is deemed to be "relevant" (for racing) as opposed to other activities that are only "believed" to be beneficial or have been shown to have no relationships with competitive performances despite them being continually offered at practices. Non-relevant activities are "irrelevant" activities.

possible. Since the practice equivalent of racing is "intense work", the greatest benefits from training will occur when short work and rest intervals are followed. Longer work and rest intervals result in: 1) a smaller number of correct strokes being completed, 2) the experience of being exhausted requiring longer recovery periods between practice sessions, 3) largely irrelevant-for-racing swimming quality (in terms of technique patterns and energizing properties), and 4) depletion of glycogen stores and the accumulation of high lactate levels in practices, conditions which do not favor performance improvements.

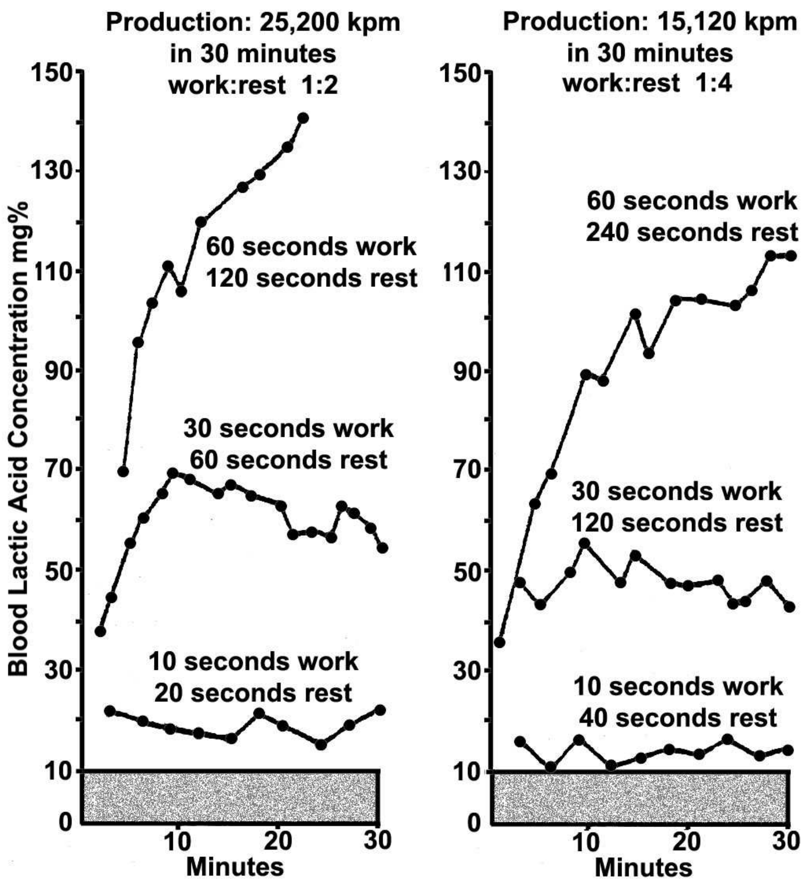

Figure 1. Blood lactate concentrations in two constant work-rate tasks with the same work to rest ratios for different durations. [Adapted from Astrand et al., 1960.]

An interesting feature of ultra-short training is low lactic acid values when working for short periods. One might expect increased anaerobic metabolism because oxygen transport during the intense work is always far below demand. With relatively long work and rest periods lactate builds and with intense work levels often constant-workload tasks cannot be completed within the total time of an experiment (Astrand et al., 1960). Christensen (1962) explained the virtual non-appearance of lactic acid in ultra-short work as follows:

> *In working with short periods at this high work load the oxygen transport during work is highly inadequate compared to the demand and definitely more insufficient than with longer periods of work. In spite of this, hardly any extra liberation of lactic acid took place, which had to be expected if the local oxygen supply of the working muscles was inadequate. Our conclusion is, therefore, that working with short periods allows for an adequate oxygen*

> *supply in spite of a highly insufficient oxygen transport during the active period. This again means that at the beginning of every new work period the muscles must have a certain quantity of oxygen at their disposal. We assume that oxygen bound to myoglobin constitutes such an oxygen store which is used during the initial phase of work before circulation and respiration allows for adequate transport.* (p. 12)

In intense ultra-short work, the demand for oxygen will be met partially by inspired air in the work period and the remainder of the "debt" will be met by inspiration during rests. At the completion of the last repetition in a standard ultra-short interval set, the demand for oxygen will not be that much different to the demand for oxygen at the completion of every repetition. The rest periods "reload" oxygen for the ensuing repetitions.

What is very important for swimming coaches is:

> *. . . one can obtain a great quantity of work done at an extremely heavy load with a clear submaximal load on circulation and respiration by suitable application of short work and rest periods. . .* (p. 13)

USRPT goes one step further than the standard ultra-short interval training format used in experimental settings. It establishes task demands that are so high that even with short work and rest periods the target number of repetitions cannot be met. That unreal demand is the application of the *Principle of Overload* (Rushall & Pyke, 1991) which is designed to improve performances by incremental elevations in performance quality that best matches the technique and energy demands of particular swimming races for an individual. Therein lie the conditions for swimmers to continually improve in swimming performances throughout a year. Experiencing the exhaustion associated with traditional training requires enduring: 1) depressed performances, 2) losses in swimming power, and 3) associated psychological problems, as well as needing a tenuous taper period during which performance restitution may occur. The absences of these factors are some of the benefits of USRPT when compared to traditional training formats.

There are other better values of USRPT when compared to traditional training (Rushall, 2013). Some rarely discussed factors are presented as final statements on the matter considered here.

- By having a swimming-quality goal for every repetition to be swum in a set, the basic need of good goal-setting is met. Every task has a criterion against which swimmers can evaluate their performance efficacy. That in turn produces sustained (more work is done) and consistent work.
- The absence of debilitating exhaustion associates many positive events with practicing for the sport. Training attendance is increased and the quality of training performances is always of the highest standard for each individual. Those factors influence swimmers' motivations greatly.
- When compared to traditional forms of swimming practice, swimmers overwhelmingly prefer USRPT to any other training options and activities (McWhirter, 2011). USRPT is relevant-for-racing training and its relevancy is obvious to swimmers.
- USRPT is associated with continual performance assessments between training sessions. Swimmers can tell by the total amount of work and the number of repetitions completed before the first failure to perform at race-pace in a set, whether or not they have improved over what was previously accomplished. This further adds to the richness of motivation that underlies USRPT.

References

Astrand, I., Astrand, P-O., Christensen, E. H., & Hedman, R. (1960). Myohemoglobin as an oxygen-store in man. *Acta Physiologica Scandinavica, 48,* 454-460.

Christensen, E. H. (1962). Speed of work. *Ergonomics*, *5*, 7-13.

McWhirter, G. (2011). *Swimmer perceptions of the value of training emphases*. A research project completed as partial fulfillment of the requirements for Gold License Certification for Swimming Coaching in Australian Swimming.

Rushall, B. S. (2013). Ultra-short race-pace training and traditional training compared. *Swimming Science Bulletin, 43,* http://coachsci.sdsu.edu/swim/bullets/Comparison43.pdf.

Rushall, B. S., & Pyke, F. S. (1991). *Training for sports and fitness*. Melbourne, Australia; Macmillan Australia.