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THE LEAST UNDERSTOOD FEATURES OF USRPT: RECOGNIZING USRPT PRETENDERS?

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Introduction

This article describes the most common errors in the prescription of Ultra-short Race-pace Training (USRPT) programs. It should explain why the failure to completely divorce oneself from traditional training concepts and contents causes the potential of USRPT training to be diminished significantly. Many coaches and programs are advertising that they follow the USRPT model but the errors of understanding and omissions of procedures are rife among such claimants. To be fully effective USRPT needs to be implemented exactly as described.

Traditional Swimming Training Programs

Counsilman (1968, p. 205) stipulated that four parameters should be included in prescribing interval training: i) the number of repetitions to be completed; ii) the distance to be swum; iii) the performance level to be swum; and iv) the interval of rest to be taken between repetitions. For the repetition form of training complete recovery and velocities faster than to be swum in a race were stipulated (p. 215). Maintaining a performance level, usually at competition performance quality, was a standard ingredient of classical/original interval training (Gerschler, 1963). Over time, coaches changed the way the interval was prescribed to become the total time of the work plus rest. An example of an item is: 16 repetitions of 100 m backstroke on 1:30. Often it was assumed that a swimmer would perform the set at some *"beneficial"* (i.e., purposeful) intensity.

Variations in training stimuli were developed (e.g., ascending and descending sets; broken-swims, etc.). They were based mainly on the assumption that they would produce performance improvements in swimmers while avoiding boredom. The absence of scientific verification of the efficacy of many individually-devised training sets has always been striking. The substantiation of their benefits was largely left to *"successful"* coaches describing what they believed to be the causes of outstanding swimming performances in some of their charges. That practice and attribution persists to this day.

A two-hour long-course training program for an age-group squad could be:

1. Warm-up: 400 FS stretch-out; 400 IM smooth; 200 first choice stroke. (Total: 1,000 m)
2. 16 x 100 m FS on 1:30. (Total: 2,600 m)
3. Kick 800, 400 each of first and second choice strokes. (Total: 3,400 m)
4. 32 x 50 of first choice stroke on 0:55. (Total: 5,000 m)
5. 4 x (4 x 100) IM order. (Total: 6,600 m)
6. Warm-down: Kick choice to close time.

Normally, swimmers would peruse the program and plan how they would distribute their effort applications (energy) across the workout. With such an orientation, swimmers would be hesitant to exert themselves maximally lest the cost of such work would make the remainder of the program very difficult. Most commonly, swimmers save their fastest swimming for the last swimming set. Even when the intensity of each program element is defined, swimmers still apportion their efforts so that they can *"survive"* the two-hour workout. Rarely are efforts at practice and in competitions maximal. After an extensive review of the literature concerning fatigue and its mechanisms, Noakes (2012) concluded: *"all forms of exercise are submaximal since there is always a reserve of motor units in the exercising limbs."* When swimmers confound that phenomenon with deliberate energy-saving, the level of exertion is rarely one that will produce metabolic imbalances that produce physiological training effects.

Although not in a refereed journal but still of acceptable experimental quality, Howat and Robson (1992)[1] found that when training-groups of swimmers were instructed to maintain a heart-rate range that implied aerobic adaptation that only approximately one in three swimmers reacted with aerobic adaptations. One-third of the swimmers in age-group and senior squads actually decreased aerobically and another third displayed no aerobic adaptation. Coaching theories that stipulate types of training and particular training intensities for specific forms of adaptation are hopelessly imprecise – and yet such orientations persist (e.g., lactate tolerance training, anaerobic training, back-end training, etc.).

Stewart and Hopkins (1997) observed the training squads of 24 coaches. They were divided into two groups: i) high-intensity, low-distance programs, and ii) control (usual) programs. Each was observed for one session. Swim distances, rest durations, and swim durations for at least one set of prescribed repetitions were recorded for 47 swimmers in the experimental group and 49 in the control group. Swimmers in both conditions complied with completing distances and holding rest intervals to a very high degree. However, there was very little relationship between the prescribed intensity of the swimming and the intensity displayed by Ss (***r*** = .30). The study authors recommended that coaches pay more attention to the intensity of training efforts as they are prescribed.

Young and Starkes (2006) made video-observations of swimmers' (N = 33) behaviors at nine practices. Actions that displayed reduced or incorrect participation were observed. Self-reports of the same classes of behaviors were obtained from all swimmers after every practice. For both high- and low-achievers, self-reports of practice behaviors and coach's-program compliance were inaccurate and/or biased. Self-reports of completed-practice behaviors and practice compliance were unreliable.

The assumption that swimmers will follow a coach's program as it is intended in a traditional program is naïve. Apparently, leaving the effort levels of each program item to be determined by swimmers in a meaningful and beneficial way is an erroneous practice. The non-compliance of athletes following coaches' programs is not only a swimming phenomenon. Hagen *et al.* (2013) reported that cross-country runners do not always train at the coach-intended intensities.

The freedom of swimmers to moderate the levels of their applications is one reason, among others, why the phenomenon of *"garbage yardage"* has arisen. Often, the intention of a swimmer when completing a program item is to survive the set rather than gain some benefit from it. Stone

[1] This study is not refereed. However, it is credible because it has confirmatory authors, is data based, and within the observational environment, two distinct subsets of subjects yielded similar results. Pre-experimental work of this type is worthy of expansive replication under true experimental strictures.

et al. (2012) experimented with cyclists and found that supposed *"all-out"* efforts very frequently were not maximum efforts. If a training set is described as being a maximum-effort set, unless there is an objective measure to indicate the level of effort, response and intensity variability are likely to yield effort levels that sustain an effort-capacity reserve. When swimmers suffer long-term training fatigue, traditional swimming practices provide few, if any, opportunities to improve race-relevant performance elements (Rushall & Pyke, 1991).

A further deficiency of traditional programs is that all swimmers complete the same program, a violation of the *Principle of Individuality* (Rushall & Pyke, 1991). Since individual swimmers are comprised of a unique mix of intra-individual quantities of psychological, physiological, and biomechanical factors on any given day, individualized training as opposed to an all-swimmers' program should not be neglected (Bartlett & Etzell, 2007; Savage *et al.*, 1981). Elite swimmers in particular need to train in an individual manner (Avalos, Hellard, & Chatard, 2003). Gender differences also warrant the development of multiple training programs (Rocha *et al.*, 1997). The inappropriateness of group programs for individual swimmers provokes non-compliance with a coach's training prescriptions. Heeding/believing a coach's descriptions of what his/her swimmers do is largely a fancy[2].

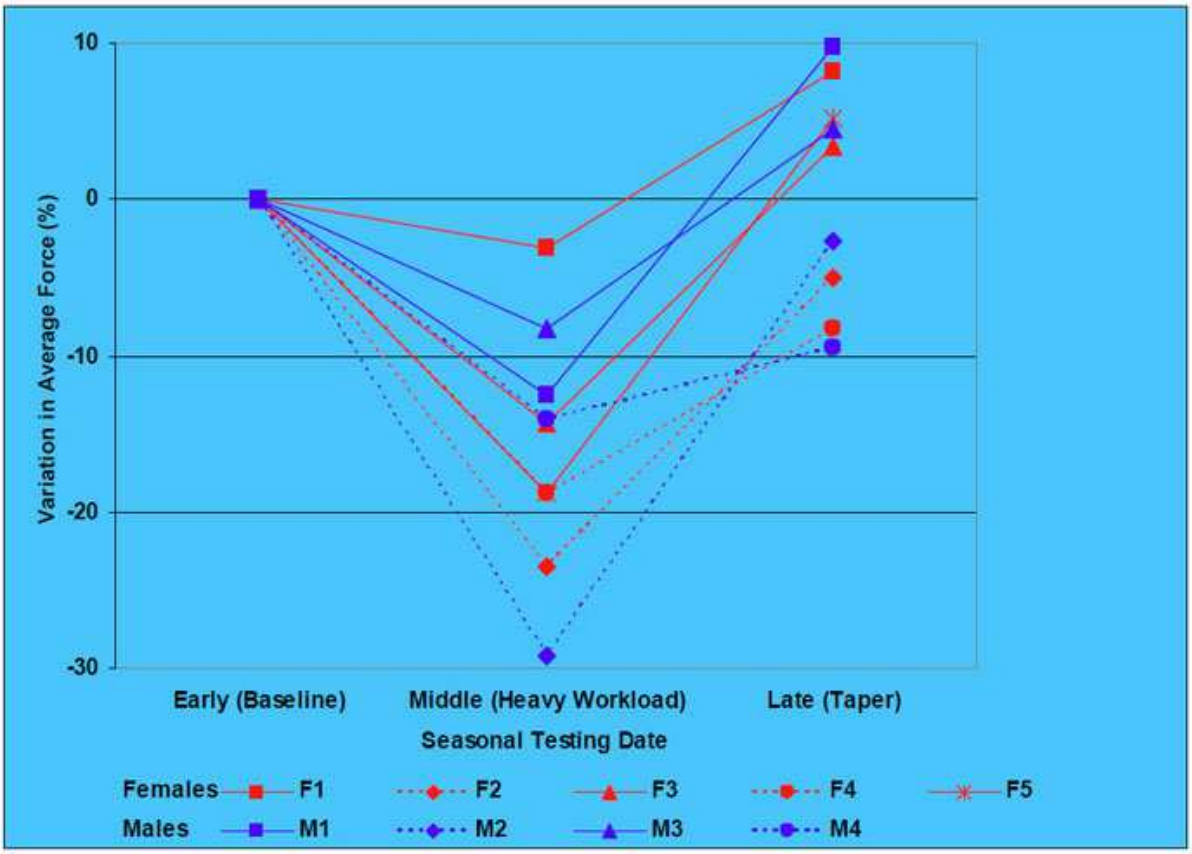
The assumption that group-training programs are valid and beneficial for individuals persists to this day[3].

The list of erroneous assumptions of group programs that have a mainly conditioning emphasis is more extensive than presented here (Rushall, 2009). The persistence with swim coaching as almost being exclusively physiological training persists and is shown in daily programs where no mention of technique or psychological skills training is made. Since most serious swimming programs cover 12 months, persisting with the belief that physiological adaptation can always be stimulated is commonplace. Bonfazi *et al.* (1998) showed that aerobic adaptation in swimming peaks after an average of 12 weeks of training. The nature of the training is not particularly important for provoking aerobic adaptation. If the stimulus is challenging enough to provoke a training response, then approximately three months is all that is needed to condition the *"aerobic base"* of swimmers. Havriluk (2013) showed that nine months of reputedly *"hard training"* depressed swimming force-production (strength) to the point that it could only be marginally recovered and improved after a taper. Almost half the subjects never regained their swimming strength to pre-training levels even with a taper. Figure 1 depicts Dr. Havriluk's observations/measurements. Noakes (2000) evaluated several models of physiological adaptation that are presented in sports in general. He stated *". . . until the factors determining both fatigue and athletic performance are established definitely, it remains difficult to define which training adaptations are the most important for enhancing athletic performance, or how training should be structured to maximize those adaptations"* (p. 141). That implication from Noakes' review of published physiological works is as relevant for swimming as it is for other sports that focus primarily on conditioning.

Although the above brief discussion does not do justice to the assertions that the conditioning of swimmers is not a year-round process and currently is overdone to the extent of making competitive swimming at the club level an unpleasant experience for many participants, it is the standardized recording and display of training items that is pertinent to this discussion.

[2] Fancy is used in the sense of it pertaining to the faculty of imagination.

[3] As witnessed by the content of coach-education programs offered by the American Swimming Coaches Association and the International Swim Coaches Association, among others.



Variation in average hand-force values by seasonal testing date for all swimmers. The solid lines connect data points for swimmers that had taper values greater than baseline. The dotted lines connect data points for swimmers with taper values lower than baseline. [From Havriluk, R. (2013). *Journal of Swimming Research, 21,* 8 pp.]

Figure 1.

Ultra-short Race-pace Training (USRPT)

The following discussion is relevant for all swimming coaches who are attempting to implement USRPT. It is particularly important for those who are transitioning from traditional training to USRPT.

The proper and latest method of communicating a USRPT training item is depicted below (Rushall, 2015). The content order and descriptors are different to those of traditional training. Unfortunately, many coaches cannot let go of traditional training behaviors or elements particularly as they pertain to communicating the structure of a training activity.

In the early publications concerning USRPT, there was a requirement to determine the maximum number of repetitions for each set. A considerable portion of Step 7 of the *Step-by-step Guide for USRPT* (http://coachsci.sdsu.edu/swim/bullets/47GUIDE.pdf) is reproduced below as Exhibit 1.

Exhibit 1

STEP 7: ASSIGN THE MAXIMUM NUMBER OF REPETITIONS FOR EACH SET

Table 1 indicates suggestions as to what might be the maximum number of target repetitions in a USRPT set when training for a race represented by the column heading. The reason why these are called *"target repetitions"* is that they appear on the swimming squad's information board when the swimmers review the session's program. In actuality, if programming has been determined correctly, no swimmer will complete the maximum number. Hopefully, in less than the maximum number of repetitions all swimmers will have experienced enough failed repetitions that they need to abandon the set. [Some coaches opt not to use the maximum number because it is easily confused with traditional training where the number stipulated has to be completed. In USRPT, completing the maximum number of repetitions is rarely contemplated. What is important is that in every USRPT set a neural-fatigue failure state is experienced. Without failure, no performance improvement is likely.]

. . . . . .

The number of target repetitions in a USRPT set is quite high when compared to traditional training sets. Given that swimmers will not complete the maximum number, what is experienced in the set is as follows. Assume the set being swum is 30 x 50 FS on 50 at 200 m race-pace (30 seconds per rep) concentrating on a 90° elbow-bend at the mid-propulsive phase.

1. When starting an exercise, it takes considerable time for all the body's functions to adapt to the exercise demands. With high-intensity exercise in trained individuals, the length of time before the body responds as well as it can ranges from 1.25 to 2.0 minutes. This initial disruption to the body's state and then the mobilization of its resources (e.g., circulation, respiration, movement coordination) happens with any exercise format including USRPT. Within the assumed set in this example, the first 4-6 repetitions will change functions within swimmers. When athletes are in that change-phase of the exercise, no training effects or skill learning can/will occur. In the targeted repetitions of the exampled set, one has to complete the initial adaptation repetitions before meaningful training effects can begin to be developed.

   The repetition-adaptation phenomenon normally does not occur after any extensive rest (for swimming that would be ~60 seconds or longer). Even in a traditional set that might allow up to two minutes rest between repetitions, a large part of each repetition would be re-adapting to the training task which markedly reduces the training value or potential of all set-repetitions. The longer the rest between exercise repetitions, the greater is the duration of re-adaptation in a set.

   In a USRPT set, the longest rest period in any set is ~20 seconds. During ~20 seconds rest, the aerobic system continues maximally and restores almost completely the stored oxygen and phosphate energy resources used in the repetition. The next repetition starts before the aerobic system has waned in any manner. Consequently, the brief rest period does allow some recovery of the energy resources within the swimmer but its highly taxed oxidative/aerobic capacity continues. When the next repetition is initiated, a swimmer's oxidative system is already functioning near maximum and does not require any time to get used to working in the swimming performance. The short-work/short-rest ultra-short training format prevents accumulations of time spent in readapting to the work, which is actually *"wasted"* time because it yields very little benefits for a swimmer. The extent of maximal oxidative/aerobic work in the USRPT format is the total of time exercising plus the total time recovering between repetitions. That amount of maximal circulorespiratory functioning far

exceeds anything that is possible in the longer work and rest period structures commonly seen in traditional programs.

TABLE 1. A SUGGESTED MAXIMUM NUMBER OF TARGET RACE-PACE REPETITIONS OVER PARTICULAR INTERVAL DISTANCES TO PRODUCE MAXIMAL USRPT.[These are purely guesses.]

	Race Distance[a]					
Repetition Distance	50	100	200	400	800	1500
15	**4 x 6**	-	-	-	-	-
25	**Frequent but indi-vidualized**	**30**	**40**	**40**	**50**	-
50	-	**20**	**30**	**30**	**40**	**50**
75	-	-	**20**	**24**	**30**	**30-35**
100	-	-	-	-	-	**25-30**

[a] Repetition distances are appropriate for yards or meters.

2. Once adaptation has occurred in the start-up repetitions in the USRPT set, the remainder involves valuable experiences for the swimmer. The body has *"warmed"* (adjusted) to the nature of the task and the training stimulus is exactly as planned. For a number of contiguous repetitions, the body learns how to energize the technique that is being repeated. The training is having an effect. It is hard to stipulate how many contiguous repetitions will be completed for a training stimulus (the set of repetitions) because there is such wide variation between swimmers. It is desirable to have swimmers complete at least 3-5 times the race distance in these steady repetitions before the first failure[4]. The work demands would have to be adjusted to allow that much practice. However, there will be some (possibly sprinters) who can only complete less than the average for the squad. Since the assumed set is for a 200 m race, apart from the initial 4-6 adaptation-repetitions, 12-16 more repetitions of 50 m would be the desirable minimum number of successful repetitions. When a USRPT set is first attempted or a new velocity is introduced it is likely that less than the minimum number of repetitions will be completed before the first failure.
3. A USRPT set contains three stages: i) several repetitions where the energy systems are progressively adapting to the performance standard requirements, which accounts for the first 4-6 repetitions; ii) an extended series of successful criterion swims where the training benefits are developed; and iii) the onset of neural fatigue and a requirement for high levels of exertion – finally resulting in two successive or a total of three failed repetitions. In this format the swimmer has been sufficiently stimulated to have incurred a specific training-effect for 200 m FS at race-pace.

[4] Why 3-5 times the race-distance? The work of Woldemar Gerschler and those who adopted his recommendations and even experimented further discussed this concept. As best as this writer can recall is that the total distance covered in the work portions of an interval set would be three to five times the race distance. That is how the "three times" reference here was made. The recommendation is also done within reason. One would not believe that three times a running-marathon is distance is what is needed in a practice session when training for a marathon race.

Apparently, there is widespread confusion about the possible maximum number of repetitions in a USRPT set. What are included in Table 1 are purely guesses on behalf of this writer as being the number of repetitions that approaches the 3-5 x race-distance volume-criterion for the various race distances. As was stated above, the maximum number of repetitions is a suggested upper limit for repetitions. It is hypothesized that any more would make training excessive and would yield no additional gains. If a swimmer has the physiological capacity to achieve 30 50-y/m repetitions at a 200 or 400 m race-pace, that swimmer's race-pace should be made more difficult so that fewer than 30 repetitions will be completed the next time the set is attempted. Over time and after the change, a swimmer should slowly adapt to higher levels of repetition achievements and the number of successful repetitions would improve although probably not to the level that existed before the race-pace change.

An unfortunate fact has arisen where coaches write a set as:

Maximum number of repetitions x distance – stroke – work and rest interval

e.g., 30 x 50 BK * 55 seconds

Usually, all swimmers are required to complete 30 repetitions trying to make the race-pace target time on the work + rest interval prescribed. If that is what is entertained, it is not a USRPT set but a traditional race-pace set. Unfortunately, when swimmers all complete the same number of repetitions even though a race-pace performance level is stipulated, the vast majority of swimmers do not practice at that race-intensity (the intensity of similarly structured sets vary in intensity (Stewart & Hopkins, 1997; Young & Starkes, 2006)). The other swimmer behaviors mentioned at the start of this presentation also exist. The point is that the *hard number* that leads the cryptic description of the practice set seems to be a carry-over from traditional training. The description is similar to a traditional-training *"race-pace"* set. In contrast, a hard-number should not introduce a USRPT set.

The prescription of a hard number of repetitions to be completed is one index of coaching behavior that suggests the coach does not adhere to the guidelines of correct USRPT descriptions. It is one of the most common features observed in coaches who do not strictly adhere to USRPT principles.

There are several unique factors that underlie the prescription and execution of USRPT sets.

1. Full sets are only completed when stipulated slower-than-race-pace repetitions occur. It is generally postulated that a total of three failures or two consecutive failures to exhibit race-pace or better repetition performances is when participation in a set should be terminated. Cessation should indicate that neural fatigue occurred. That is a level of fatigue that will yield a training effect for race-pace work, a phenomenon that is not accommodated when swimmers adjust their work efforts so that the stipulated number of repetitions will be completed. *The USRPT criterion of not stating a number of repetitions to be completed has several remarkable qualities*.

    - The capacities of every swimmer in the program are accommodated. Each swimmer works until the criterion of repetition-velocity failure is exhibited. That produces training effects that are peculiar to each swimmer. In contrast to traditional training when all swimmers complete the same number of repetitions, in USRPT the number of completed repetitions to the stage of neural fatigue/failure will vary quite markedly across the practice group. Thus, USRPT individualizes the training experiences for all swimmers in a squad.

- Swimmers are expected to record in log-books (*aka.* personal journals) their performances for sets completed at practices. A USRPT program has a definite number of constant-pace sets to be completed. On every occasion when a set is replicated, swimmers are expected to try and perform more successful repetitions than during the best previous set-completion. Thus, the goal of a practice set is to perform better than before. When a new *"best-effort"* is achieved, it can be inferred that the swimmer has improved in the ability to perform for a longer duration at race-pace than previously. The specific transfer of that improvement to racing should be that the swimmer should expect to perform longer in a race at a particular swimming velocity than ever before. That should result in the expectation of a race-performance improvement and the realization of that expectation in an actual race.
- The goal of performing more successful repetitions than before guards against swimmers producing less than beneficial training intensities and efforts. Continual implementation of that goal should yield a practice *"culture"* whereby swimmers are always trying to improve. There are no long periods where the overall strategy is to survive another practice. USRPT swimmers convinced of the need to keep improving should be encouraged to perform at least one personal-best set among the USRPT sets executed at every practice. When swimmers are suspected to have excessive fatigue at a practice, matching previous best set-completions is acceptable and even missing practices to foster greater recovery is often necessary.

2. USRPT sets should be completed with an emphasis on psychological involvement particularly of race-relevant thought structures (e.g., surface-swimming techniques, race-skill techniques, and race-strategy content). The neglect of relevant thought content when performing training sets is perhaps the most common feature of myopic[5] coaching that only considers the conditioning aspect of training. Elsewhere, this writer has made the case that there are three other coaching emphases that are more important than conditioning if swimmers are to continually improve (Rushall, 2016 - http://coachsci.sdsu.edu/ swim/ bullets/49DEFINED.pdf).

   The mental structures that accompany physical work at training will determine to a great extent how relevant training activities are for improving performances in a competitive setting. While for some attempts, race-pace can be sustained in a traditional race-pace set, if the accompanying mental activities are not task-relevant then performance will be depreciated (Chorkawy, 1982; Ford, 1982). *If a supposed USRPT set is described and there is no initial emphasis on the mental content to be used for the duration of the set, then the work is not USRPT-specific.* An absence of directed mental-activity in a set or race-specific repetitions will decrease the standard of performance-efficiency and is likely to train something else which in all likelihood would be incompatible with the highest quality of competitive performance.

   It has been demonstrated conclusively that thinking in particular ways during a task such as a swimming race, produces improved performances over non-specific-thinking executions. The general term for the content of that thinking is *"associative thought structures"*. The foremost element of a USRPT set is that thought activities are particularly relevant and the most important feature of the set. Mindless or *dissociative thinking* (thinking of non-swimming features) during a practice set does little to produce anything of transfer value to racing. Dr. Rod Havriluk and his associate Dr. Ted Becker

[5] Used in the sense of *lacking imagination, foresight, or intellectual insight.*

have reported that a vast majority of training swimmers engage in dissociative thinking or distraction thought-processes during all practices (Dr. Rod Havriluk, personal communication, April 23, 2016; https://www.youtube.com/watch?v=sK3Z4RTCusE). Non-specific thinking at practices, a hallmark of traditional training, is actively thwarted by a true USRPT coach emphasizing the mental activities of every training set and the strokes therein. *A failure to stress the cognitive emphasis in practice sets is a second feature of a coach pretending to conduct USRPT programs while ignoring a central feature of the total USRPT model that produces its obvious and accelerated effects.*

3. USRPT sets demand precise performance features from swimmers. Every repetition is required to be of a race-pace or better standard. Developing a self-control capacity to perform at the race-pace level leads to an appreciation of and skill for performing at even pacing which can transfer to races. When a swimmer becomes tired in a set and is approaching the best repetition number of previous sets, there is an incentive to harness abilities to sustain the race-pace level and improve on the previous best number of completions. Such a focus and capacity reorganization is left to each individual swimmer because it is something that a coach cannot accurately appreciate or direct. USRPT swimmers frequently report that they are learning what they need to do to finish races better than in the past. Consequently, *sets at practices that do not consistently manufacture improved resource-management within each swimmer do not produce this important swimmer-development process and thus, are not USRPT-specific.*

The above features indicate some of the important features that are indispensible in USRPT training. Failing to accommodate or present those features to swimmers diminishes any training effect that might result. Only when USRPT sets are conducted correctly will training effects and their associated performance improvements be realized. Exhibit 2 illustrates the recommended features for defining an exact USRPT set.

Exhibit 2

The Structure of a USRPT Set

A common method of writing a USRPT set follows. A USRPT repetition set can be structured as shown below.

Exhibit 2

Technique or Psychology Item	**Event and Stroke to be Swum**	**Repetition Distance**	**Total Interval Time (work + rest)**	Maximum Number of Repetitions (Optional)
Focus on quick initiation of movement on entry	200 FS	50 m with race finishes	Race-pace plus 20+ seconds	Until two failures in a row occur – one or more seconds difference

This is an example of a standard USRPT set of description elements. The first item indicates the cognitive content of each repetition. In this case, it is the maintenance of 200-FS race-pace that is required to be repeated as often as can be managed (hopefully in excess of what was performed in the previous attempt at this set). In this example that involves lessening the time from entering the water to attaining an arm-body position that produces more propulsive force than vertical and/or lateral force. The optional *"maximum number of repetitions"* is actually a description of when the set should be terminated. In this example cessation is warranted if two successive swims are slower than race-pace. It is acceptable to state that a failure is one second or more slower than race-pace, particularly when precise timing is difficult. That understanding subtly implies that any repetition is an opportunity to go faster than before. The training focus of discovering and adopting actions that lead to faster swimming in all USRPT-relevant practice items has to pervade every training session. In one way, the coach has to exhibit as much positive enthusiasm for improvement as any swimmer. The best time of performance in the set, how many repetitions were performed successfully before the two successive failures, and the technique or psychological feature used need to be recorded. Those values should serve as training targets the next time the same set is attempted. The final rest-interval stipulation is necessary for practice and resource organization. In this case, for the 50-m repetitions, there is a rest period of 20 seconds or more, but less than 25 seconds, to form the work + rest interval that will have the swimmers beginning each repetition on a 5-second clock interval (to facilitate swimmers leaving the wall at 5-second intervals).

The main features of the task illustrated above are as follows.

- Develop a clear understanding of what the cognitive content of each repetition should be.
- Perform as many repetitions as possible adhering to the stipulated recovery period between repetitions.
- When two repetitions in a row are one second or more slower than the race-pace time, the set should be terminated. When a time is less than one second slower the difference is tolerated because confounding variables that often exist at practice make it very difficult to perform perfect replications on every occasion. If one swim is more than one second slower than the target time but the second repetition is fast again (i.e., it is successful) then the monitoring of slowing starts again. This is a slight departure from the standard USRPT failure designation (i.e., two successive failures or a total of three failures to perform at the target time). It is an example of a modification of a USRPT set that might have to be made to accommodate complicating features of the practice environment (e.g., more than five in a lane).
- The performance standard of the set, the number of successful repetitions, and the cognitive content of the set should be recorded in a swimmer's log/journal.

At all times in all repetitions, coaches and swimmers should adhere to the expectation that no stroke or skill is executed without some cognitively controlled purpose. ***Non-purposeful strokes are largely a waste of time.***

Individualizing Training Progressions

There is more to USRPT than single sets of repetitions. USRPT has to continue throughout a 12-month program and stimulate performance improvements across that time. Improvements over longer periods are governed by a variety of factors and at various times in swimmers' developments different factors come into play.

Possible Improvements over 12 Months

The idea behind the original suggestion of a maximum number of repetitions to be completed (see Table 1) was to indicate when a swimmer completes a suggested number for a repetition distance for a particular race-distance a *ceiling level* of benefits from that set at that race-pace would be experienced. Any more repetitions would likely have quickly diminishing additive returns. When a ceiling level is achieved by a swimmer, the race-pace should be made harder for the swimmer. The faster repetition velocity would attenuate the number of repetitions that could be achieved in the same set, but with a faster swimming velocity than was exhibited when the theoretical maximum number was attained. Too much intuition was assumed in the description of swimmers attaining maximum repetitions for a particular velocity over a particular repetition distance. Realistically, only a few swimmers in a squad could finally achieve the maximum number stipulated in Table 1. Examples of different maximum-number-of-repetitions phenomena are provided below.

1. *The distance swimmer*. Imagine a male distance-swimmer in an age-group program who is very good at 1500/1650/800 races by virtue of the ability to hold a particular pace lap after lap. This swimmer is not quite as good at 400 m/y and very average in 200 m/y races. His average 50 y/m time in a 1500/1650 race is not that much slower than his average 50 y/m time in a 200 y/m race. Because continual 50s in the very long distance events average not much slower than 50s in 200s, it is likely that eventually this type of individual will be able to achieve the recommended maximum number of 50 y/m repetitions (30) for USRPT repetitions aimed at 200 y/m races at practices. This swimmer has loads of inherited endurance capacity but very average stroke power. Individuals with a better than normal swimming-endurance capacity are likely to hold more repetitions at race-pace in various sets than those not endowed with above average endurance capacity.

2. *The drop-dead sprinter*. Imagine a tall slender female sprinter who exhibits above average swimming velocities in 50 and 100 y/m events, average velocities for 200 events, and virtually no capacity for events exceeding 200 y/m. No matter what distance a set of repetitions employs, this swimmer cannot complete very many of them. However, in sprint tasks she would most likely excel. There is no point in trying to *"build"* this swimmer's endurance capacity because it is so limited. It is for this type of swimmer that *Sprint-USRPT* was designed (http://coachsci.sdsu.edu/swim/bullets/56USRPT50m.pdf). What happens in just about all sets for various races for this swimmer is that she quickly adapts to the training stress of the set and reaches the maximum number of repetitions that she can complete in a relatively short time no matter how often the set is repeated. Her limited endurance capacity limits the maximum number of repetitions that can be performed in a set. Usually, the maximum number completed is close to being the fewest in the age-group squad. Her training is better with an orientation toward improving performance quality than quantity.

   One of the misconceptions of traditional swim coaching is that swimmers should be swimming nearly all the time at practices. In USRPT the drop-dead sprinters cease to repeat a task very much sooner than those with a high inherited-endurance capacity. Coaches erroneously believe that the sprinters are *"wasting time"* by not swimming. That is untrue. The sprinters are recovering from neural fatigue that occurred much earlier in a set than in an endurance-endowed swimmer. They are getting as much out of the set in their few completed repetitions as do those who complete many more repetitions. On the other hand, in sprint work the sprinters work much harder than the endurance swimmers

because they have a much greater capacity for fast explosive work. In very high-intensity sets it is the sprinters who need a longer recovery time than the endurance swimmers. If a USRPT program is balanced and provides stimulation for explosive and endurance work, all swimmers will be accommodated. There is nothing wrong with allowing swimmers to recover *"too much"* at a training session. Their progress in performance improvement will not be hampered. It is in programs where no swimmers are given sufficient recovery opportunities within a practice session that are dangerous.

3. *The average age-grouper*. The majority of swimmers in an age-group program will fall between the endurance and drop-dead sprinter types. Most will train in the program but will never get to the ceiling level of an endurance swimmer but will exceed the small maximum number of the natural sprinter. If the endurance swimmer can complete 30 50s at 200 race-pace and the sprinter maximizes out at 11 50s, the normal age-grouper will range in the middle somewhere. It is hard to stipulate exact numbers but some coaches of average teams suggest 15-23 as being a range of maximums.

What happens throughout a year is that USRPT training is provided and swimmers reach a plateau of maximum repetitions (i.e., using the examples above, 30 for the endurance swimmer, 11-12 for the sprinter, and 15-23 for the bulk of the squad). When those levels are achieved and the maximum number of completions does not improve but varies to a minor degree over a period of three to four weeks, the swimmer can be deemed to have *"plateaued"* revealing to some degree the limited aerobic capacity in his/her physical make-up. When swimmers plateau in the number of successful completions in a particular set is the time for the race-pace target to be made slightly faster (e.g., for a 200 FS perhaps ~2 seconds for the swim which would translate into .5 seconds faster for each 50).

As a training year progresses, several plateaus are likely to be exhibited. There is an incremental change in the maximum number of successful completions within a set when plateaus are repeated. As the pace of the repetitions increases in a particular set for an individual swimmer, the potential maximum number of completions for that set decreases. The reduction is caused by the faster velocities requiring increasingly more energy per repetition. Holding a new faster race-pace increases the maximum energy utilization being achieved in slightly fewer repetitions. Perhaps Table 2 will illustrate this phenomenon.

TABLE 2. RACE-PACE INCREMENTS OFTEN LESSEN THE MAXIMUM NUMBER OF REPETITIONS FOR THE SET. AN HYPOTHETICAL EXAMPLE.

Cycle in 12-month Training Period	200 FS Race-pace Set Performance Target	Range of Number of Repetitions at Plateau
1-4 months	33.0 seconds	19-21
5-7 months	32.0 seconds	16-19
8-11 months	Less than 31 seconds	14-16

As swimmers grow, it is very likely that the number of repetitions in a plateau will increase. Particularly in age-group swimmers, a number of factors could work against plateauing for a set

(e.g., technique improvements, growth, incentives to improve, self-efficacy, etc.). It is for those reasons that coaches need to be aware of individuals' USRPT set performances, propelling efficiencies of the various strokes at different race-distances, and mental skills development.

No two swimmers are the same. Between-swimmer responses will be different and will vary often in an unpredictable manner because appropriate testing of influential variables does not exist at this time in sport history. In hindsight, it would have been better to not stipulate an opinionated maximum number of repetitions in USRPT sets in the initial USRPT introduction. It would be best to discard that concept. What is more accurate and viable for determining when training race-paces need to be shortened is to change to the only criterion for completing a set to be the demonstration of neural fatigue that prevents response-quality maintenance. Throughout the year, the phenomenon of swimmers being *"stuck"* on a narrow range of maximum repetition completions (i.e., a plateau) should be used as the cue to increase the quality of the race-pace for that particular set. The individualization that those criteria bring to training will affect virtually all swimmers in a positive manner which is a marked departure from traditional training which has nearly all swimmers completing the same training program with each swimmer adjusting response qualities to any number of variables.

Performance Expectations across Age Classifications of Swimmers

In a sweeping macro-classification scheme, swimmers who enjoy a life-time of participation in competitions can be viewed to pass through a number of developmental stages. Those stages are expanded below.

1. *Pre-pubertal developmental stage*. The transition through to puberty has been observed to occur earlier with each successive generation over the several recent decades. For such swimmers, only a minor improvement through physical training is possible (Borms, 1986) and training affects are not differentiated between the various energy systems (Bar-Or, 1983; Mero, Jaakkola, & Komi, 1991; Prasad *et al.*, 1995).

   Most authors agree that the sensitive skill learning period is between 9 and 12 years. [Recent opinions have indicated that the majority of children of both genders now go through the skill-learning phase from 7-9 years]. Very early training may produce learning of a less economical nature [Possibly five years and younger.] Later starters would soon catch up. One must not confuse performance with skill. Early maturers will compensate, usually advantageously, for lack of skill with strength and leverage (Borms, 1986).

   This writer has recounted elsewhere some of the research that justifies skill learning activities being experienced at high-velocities rather than over long drawn-out distances (Rushall, no date). Swimming training at the pre-pubertal ages in both genders should emphasize technique development and the learning of race skills (e.g., dives, turns, underwater swimming, etc.). USRPT is an appropriate training format for young swimmers. It is preferred by them over longer slower work (McWhirter, 2011).

   USRPT and its emphasis on the development of techniques and racing skills using faster mostly race-equivalent velocities is likely to develop in young swimmers: i) an appreciation for the need to excel in techniques and racing-skills; ii) the job of moving fast in a relatively efficient manner, and iii) a positive approach towards competing because of continual indications of swimming performance improvements at training and in races.

2. *Adolescence*. Adolescence usually refers to the stage of development from puberty to physical maturation. Growth is the most influential factor involved with swimming improvements in this stage. It is this writer's opinion that despite the coaching received, performances through age-group competitions improve because physical growth and its underlying hormones (e.g., testosterone) are substantially dominant in governing swimming performances to the point of masking irrelevant coaching effects.

   Aerobic capacity is the first physiological factor to develop fully (Troup, 1990) which is mostly completed by the time of onset of the adolescent growth spurt. Swimmers who are coached and do not develop performance standards much at all are likely to be the products of irrelevant fatiguing coaching programs. Taller swimmers are advantaged by greater leverage. Normal and late-maturers tend to go on to more impressive competitive accomplishments than early maturers (Troup, 1991). USRPT continues as an appropriate format for swimmers in this age-group. Swimmers prefer it over longer-interval and continuous training (McWhirter, 2011). It provides the platform for repeated cycles of technique and skill instruction which accommodate changes in swimmers' physical structures and thus leads to performance improvements. The combination of USRPT and growth in adolescents leads to accelerated performance improvements when comparisons are made to swimmers from traditional programs.[6] Physically large maturing swimmers are likely to improve each year because of growth and physical endowment. If a coaching program is ineffective, as maturation approaches performance improvements lessen markedly and may disappear completely. When growth has stopped and swimmers' performances stagnate or regress, the coaching received may deemed to be relatively useless.

   USRPT throughout adolescence produces appropriate levels of stimulation to fully develop the energizing properties of every swimmer in accordance with their techniques. The continued emphasis on technique instruction adapts the swimmer for every structural change that occurs during this growth period. Competition psychology stimulates the growth of self-efficacy and the motivations to train and compete.

3. *Maturity and beyond*. When maturity is evidenced, the capacity to improve performances through physiological adaptations stops. In collegiate female swimmers, changes in either aerobic or anaerobic energy production did not occur over a season of swimming. This supports the contention that when growth has ceased in trained swimmers no further changes in capacity of the energy systems occur (Novitsky, 1998).

   Costill *et al.* (1991) experimented with two matched groups of male swimmers each following different training programs over a 25-week period. The changes in endurance that occurred in the first eight weeks were independent of the training load (they were similar for both groups). From then on, there was no appreciable change in endurance

[6] This claim is made solely from observations made of the Carlile programs, particularly Cherrybrook Carlile Swimming Club, in Sydney, Australia. Performance accelerations across a club do not happen overnight. They are the result of the consistent provision of USRPT over several years. Of particular note is how USRPT swimmers compare to age-cohorts from traditional programs. USRPT swimmers in their younger age-group experiences perhaps qualified for a few championship events. After three or so years of USRPT, many swimmers are now state champions in the older age-groups in which they now compete. They improved at markedly accelerated rates when compared to cohorts. Some masters swimmers who adhere strictly to USRPT elements, are actually improving in performances in direct contravention of the expectation that masters swimmers' performances decline with advancing age.

fitness. One has to question the value of excessive training for sprinters if speed is reduced as was demonstrated in this study. These findings may not be applicable to male age-group (<16 yrs) or female swimmers. In considering the lack of demonstrated effects that are generally attributed to increased training by coaches the Costill and his colleagues suggested:

". . . our knowledge of the need for specificity in training might lead us to assume that such training may not provide the adaptations needed for optimal swimming performance. Since the majority of the competitive swimming events last less than three minutes, it is difficult to understand how training at speeds that are markedly slower than competitive pace for 3-4 hours/day will prepare the swimmer for the supramaximal efforts of competition." (p. 376)

For swimmers to continually improve performances, the avenues for doing so are swimming technique, racing-skill developments, and mental skills training and enhancements. These requirements continue through senior and masters swimming. If accomplished swimmers participate in programs that only consider physical training, performances will cease to improve.[7] Along with non-improvement, the phenomenon of annual increments of performance slowing, particularly after the age of 50 years, will occur if training intensities fall to a comfortable non-adaptive level.

USRPT promotes the ingredients for continued performance improvements across extended periods of swimming fitness training and competing. The fact that USRPT yields physical adaptations in at least one-third the time that needs to be devoted to longer-interval or continuous swimming training should make it particularly attractive to working swimmers. It should be possible to enjoy sufficient training stimuli under the USRPT format to continue competing at a serious but enjoyable level.

A failure to continually improve, although quite miniscule after the age of 50 years, indicates that training is relatively useless. On the other hand, if a swimmer stabilizes in performances then coaching can be deemed to be sufficiently positive to offset the decline that would occur with increasing age. If performances improve after 50 years of age, the coaching could be deemed to be quite effective.

Closure

The premises underlying USRPT are derived from evidence-based researches. That is the scientifically rigorous logical procedure of inductive reasoning. Since USRPT is such a complex and sweeping model, it would be virtually impossible to conduct experiments to compare USRPT with other training models. The implementation of the underlying structures and the control of extraneous variables establish impossible difficulties to overcome if conducting research using USRPT as an independent variable were considered. However, the fact that the underlying premises of USRPT are derived from scientific evidence establishes it as being irrevocably scientific.

What should be observable when USRPT training is used.

[7] It is interesting to consider the performances of outstanding swimmers (Gold medalists in particular from the London Olympic Games) in preparation for and at the Rio Olympics. When swimmers do not improve performances or even regress, one has to consider if the coaching received in the intervening four years has been more harmful than beneficial. Too many coaching reputations are made because of recruiting rather than performance changes.

1. Training intensities and levels should be higher than usually entertained in traditional training. Specifically, the performance level expected in every training item should be race-specific.
2. The use of very short intervals and rests produces a much more pleasant practice experience than that enjoyed in longer sets or continuous training tasks (the most frequent features of traditional training).
3. The physiological adaptations that occur with USRPT develop at a rate much faster than those produced by longer sets and continuous training tasks.
4. As a corollary to point #3, USRPT training produces more training benefits and better swimmer adaptations than do traditional programs.
5. The continual emphasis on technique and racing-skills instruction should produce obvious levels of skills that are better than swimmers who have participated in only traditional training programs.
6. The frequent instruction and practice of mental skills content that are race-specific should develop positive and enjoyable attitudes towards racing.
7. The USRPT coach should demonstrate a remarkably higher frequency of pedagogical skills during practice sessions than would be observed in any traditional coach.
8. For particular race-paces and sets, improvements occur only to plateau when a swimmer's physical capacity it taxed completely. The demonstration of a plateau signals the appropriate time to increase the race-pace for the set.

To achieve these benefits, correct USRPT training procedures need to be followed and implemented.

Finally, this paper has discussed training omissions and errors that indicate a training set is not of expected USRPT structure or quality. To correct those deficiencies, the following expected USRPT elements should be evident in every set of USRPT items.

1. The determinant for ceasing participation in a USRPT set is the inability to maintain the stipulated race-pace. That state indicates the onset of neural fatigue. The individuality of training responses across a squad of swimmers should result in a relatively wide range of number of successfully completed repetitions. Those features are not accommodated when a hard number of repetitions is stipulated and assuredly will not be evident if all swimmers complete the same number of repetitions in a set.
2. Training items that are not at race-pace and quality are not USRPT items.
3. Technique and psychological factors that are race-specific should be emphasized more than any other features of USRPT training. To ignore them or place only a minor emphasis on them guarantees that performance improvements from training will not match those which are possible with correct USRPT.
4. Maximum performance plateaus for particular sets should indicate when race-paces should be altered for faster swimming. Coaches must monitor the training set performances of all swimmers
5. A coach who does not change his/her training behaviors to being inclusive of the features of sport pedagogy will not be effective when teaching techniques or mental skills. A USRPT coach must become a good technique and mental skills instructor.

A USRPT program is not being offered if any of the above items are not included in a swimming coaching program. Examples of USRPT claimants who are actually pretenders are rife across the internet. One site that does not prescribe one element that falls within USRPT guidelines but falsely claims to be an adjustment of USRPT can be viewed at *http://proswimworkouts.com/workouts/usrpt-southwest-stars-style*. Beware of sites and programs that claim to be USRPT but fail to include one or more basic elements of the USRPT protocol in practice sessions. Recognizing USRPT program element omissions could indicate *"pretenders"* of USRPT coaching.

References

Avalos, M., Hellard, P., & Chatard, J.-C. (2003). Modeling the training-performance relationship using a mixed model in elite swimmers. *Medicine and Science in Sports and Exercise, 35,* 838-846.

Bar-Or, O. (1983). *Pediatric sports medicine for the practitioner (comprehensive manual in pediatrics).* New York: Springer-Verlag.

Bartlett, M. L., & Etzel, E. (2007). A single case design approach to monitoring the effects of intense training on immune function and mood state in swimmers. *ACSM Annual Meeting New Orleans,* Presentation Number, 2014.

Bonifazi, M., Bela, E., Lupo, C., Martelli, G., Zhu, B., & Carli, G. (1998). Influence of training on the response to exercise of adrenocorticotropin and growth hormone plasma concentrations in human swimmers. *European Journal of Applied Physiology, 78(5),* 394-397.

Borms, J. (1986). The child and exercise: an overview. *Journal of Sports Sciences, 4,* 3-20.

Chorkawy, A. L. (1982). *The effects of cognitive strategies on the performance of female swimmers.* M.Sc. degree, Lakehead University, Thunder Bay, Ontario, Canada.

Costill, D. L., Thomas, R., Robergs, R. A., Pascoe, D., Lambert, C., Barr, S., & Fink, W. J. (1991). Adaptations to swimming training: influence of training volume. *Medicine and Science in Sports and Exercise, 23,* 371-377.

Counsilman, J. E. (1968). *The science of swimming.* Englewoood Cliffs, NJ: Prentice-Hall.

Ford, D. (1982). *The effects of cognitive strategies on swimming performance*. M.Sc. degree, Lakehead University, Thunder Bay, Ontario, Canada.

Gerschler, W. (1963). Interval training. *Track Technique, 12,* 391-396.

Hagen, M. A., Bouchard, C. E., Donohue, J. M., Stenson, M. C., & Fischer, D. V. (2013). Do Division III cross-country runners experience the intended coach prescribed training impulse (TRIMP)? *Medicine & Science in Sports & Exercise, 45(5),* Supplement abstract number 1230.

Havriluk, R, (2013). Seasonal variations in swimming force and training adaptation. *Journal of Swimming Research, 21,* pp. 8.

Howat, R. C., & Robson, M. W. (June, 1992). Heartache or heartbreak. *The Swimming Times,* 35-37.

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: Canberra, Australia.

Mero, A., Jaakkola, L., & Komi, P. V. (1991). Relationships between muscle fibre characteristics and physical performance capacity in trained athletic boys. *Journal of Sports Sciences, 9,* 161-171.

Noakes, T. D. (2000). Physiological models to understand exercise fatigue and the adaptations that predict or enhance athletic performance. *Scandinavian Journal of Medicine and Science in Sports, 10,* 123-145. [*http://coachsci.sdsu.edu/csa/vol71/noakes.htm*]

Noakes, T. D. (2012). Fatigue is a brain-derived emotion that regulates the exercise behavior to ensure the protection of whole body homeostasis. *Frontiers in Physiology, 3(82),* Published online 2012 April 11. Pre-published online 2012 January 9. doi: 10.3389/fphys.2012.00082.

Novitsky, S. A. (1998). No change in energy systems power rate production constants over a competitive swimming season. *Medicine and Science in Sports and Exercise, 30(5),* Supplement abstract 613.

Prasad, N., Coutts, K. D., Jesperson, D., Wolski, L., Cooper, T., Sheel, W., Lama, I., & McKenzie, D. C. (1995). Relationship between aerobic and anaerobic exercise capacities in pre-pubertal children. *Medicine and Science in Sports and Exercise, 27(5),* Supplement abstract 640.

Rocha, J. R., Matsudo, S. M, Figueira, A. J., & Matsudo, V. K. (1997). Training program effect after detraining in young athletes. *Medicine and Science in Sports and Exercise, 29(5),* Supplement abstract 987.

Rushall, B. S. (no date). Commentary on the long term athlete development model for British Swimming and the misinformation it propagates. *Swimming Science Bulletin, 38,* pp. 21. [*http://coachsci.sdsu.edu/swim/bullets/LTAD38.pdf*].

Rushall, B. S. (2009). *The future of swimming: "Myths and Science".* An invited presentation at the ASCA World Clinic 2009 held in fort Lauderdale, Florida. Reproduced as #37 in the *Swimming Science Bulletin*, [*http://coachsci.sdsu.edu/swim/bullets/ASCA2009.pdf*].

Rushall, B. S. (2015). Sprint-USRPT: Training for 50-m races. *Swimming Science Bulletin, 56,* pp. 102. [*http://coachsci.sdsu.edu/swim/bullets/56USRPT50m.pdf*].

Rushall, B. S. (March, 2016). USRPT defined: After two years USRPT comes of age. *Swimming Australia, 32(3),* pp. 17; and *http://coachsci.sdsu.edu/swim/bullets/49DEFINED.pdf*.

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

Savage, M. V., Brown, S. L., Savage, P., & Bannister, E. W. (1981, October). *Physiological and performance correlates of training in swimmers.* Paper presented at the Annual Meeting of the Canadian Association of Sport Sciences, Halifax.

Stewart, A. M., & Hopkins, W. G. (1997). Swimmers' compliance with training prescription. *Medicine and Science in Sports and Exercise, 29,* 1389-1392.

Stone, M. R., Thomas, K., Wilkinson, M., Jones, A. M., Gibson, A. St. C., & Thompson, K. G. (2012). Effects of deception on exercise performance: implications for determinants of fatigue in humans. *Medicine & Science in Sports & Exercise, 44,* 534-541.

Troup, J. (1990). Developmental changes of age-group swimmers in *International Center for Aquatic Research Annual - Studies by the International Center for Aquatic Research, 1989-90.* United States Swimming Press, 1750 East Boulder Street, Colorado Springs, Colorado, USA 80909-5770.

Troup, J. (1991). Growth and developmental changes of the age-group swimmer in *International Center for Aquatic Research annual - Studies by the International Center for Aquatic Research, 1990-91*. United States Swimming Press, 1750 East Boulder Street, Colorado Springs, Colorado, USA 80909-5770.

Young, B. W., & Starkes, J. L. (2006). Measuring outcomes of swimmers' non-regulation during practice: Relationships between self-report, coaches' judgments, and video-observation. *International Journal of Sports Science and Coaching, 1,* 131-148.