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# USRPT AND TRAINING THEORY II: THE OVERLOAD PRINCIPLE

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**The Overload Principle:** *Whenever a swimmer is subjected to a training stimulus that causes strain (fatigue), the body will reorganize its capacities so that the next exposure to the same stimulus will produce less strain, given that sufficient recovery has occurred between exposures.* Adaptation occurs through a gradual development of the capacities required to tolerate the stimulus (*training effects* or *overcompensation*). The level at which strain occurs is called the *threshold capacity*. Once that is exceeded, there is a certain amount of fatigue that temporarily reduces an athlete's capacity to perform. As a result of that physiological and neurological disruption, the body reacts to increase its stimulus-tolerance capacity. With repeated exposures to a stimulus, the cost of accommodating the stimulus will be reduced. For sports training, the implication of the overload principle is that with repeated exposures to the same training stimulus, progressive improvements in performance could result. Performance improvement is higher the more frequently a swimmer is exposed to a training stimulus, provided the frequency is not so great as to stop training-effects/overcompensation occurring (Bompa 1986). For a particular level of stimulus intensity, performance eventually levels off. To improve performance further, the stimulus intensity should be increased. Multiple sets of repetitions should occur to each stimulus intensity-level up to the point of obvious diminishing returns before the next intensity increment is implemented.

The overload principle can be applied to both specific-training stimuli and to the more general fatigue-load build-up within a training session and accumulated fatigue across training sessions.

## Overload

Nothing good can be gained from swimming badly or in ways that are irrelevant for specific swimming races. The training of fitness for a particular swimming event involves the repeated exposure to *overload conditions* of the event stimulus followed by sufficient opportunity to recover to the point of producing a training effect. One has to think in terms of specific swimming events because the neurological and physiological demands of each event are unique. The level of overload that governs the usefulness of a training stimulus is inextricably yoked to the recovery requirement. Training benefits for swimmers will occur only if both processes are allowed to occur.

The effects of the overload of an event-specific stimulus in a planned event-microcycle diminish with each exposure to the stimulus. If there were too many repetitions of the same stimulus, the load intensity would diminish to the point where it no longer exceeded threshold capacity and performance improvements would likely cease. From a swimmer's viewpoint, at that stage the activity would likely be *"frustrating"* because high levels of effort would yield no performance gain. Generally, that stage indicates the swimmer has maximized the adaptation of personal resources to that stimulus. The variation in fitness capacities for particular events between swimmers is quite extensive across a typical seriously training age-group and senior squad. There are limitations on the ultimate event-stimulus overload that can be presented to a swimmer.

1. An athlete has a finite level of fitness that can be achieved for a race-pace being practiced for a particular swimming event. Once that is attained, further attempts to increase the fitness level yield little value and are potentially more harmful than beneficial. It is likely that a considerable number of event-training stimulus microcycles will need to be experienced before a maximal state of fitness for a swimming intensity and a particular event is reached.

2. The type of activity that is used to improve fitness affects the speed with which performance is increased. For complex activities such as swimming, where intricate learning has to take place, physiological increases do not occur until the neuromuscular reorganization of existing capacities and resources has been achieved. In those activities, early gains in the fitness component stem from more efficient use of existing capacities.

3. There is a level of fitness that can be attained which can be used fully in the execution of its tasks. Above these levels, the extra capacity cannot be used. For example, there are levels of strength and power that can be employed in swimming. However, it is possible to be very strong or powerful, but the activities of the sport are such that the extra capacity cannot be used.

4. It makes no sense to train physical components (e.g., strength, power, endurance) alone. Complex cyclic movements, such as competitive swimming strokes, will train all the neurological and physiological components in correct proportions that could yield the best swimming proficiency if USRPT is used. For example, Costill (1998) made the case for the best way to improve strength (i.e., force production) in swimming strokes is to swim with the greatest level of effort possible. Sokolovas (2000) found that no non-swimming activities were related to the development of USA national team sprinters and distance swimmers of both genders.

   In the early development of motor learning, a popular topic was part versus whole learning. The question asked was: *"Is it better to practice skilled movements in parts (i.e., drills, lead-up activities) or as the whole activity?"* It was found that full-body cyclic activities, of which swimming is an example, should always be practiced as the whole activity once the beginner stage of the activity has passed. Another motor-learning topic considered whether it is best to emphasize speed (i.e., velocity) of the movement and then work on skill or do the skill correctly and then increase velocity. Research favored attaining velocity first and then refining the technical aspects of the cyclic skill at that velocity. USRPT requires the velocity to be at race-pace because surface swimming techniques change with the velocity of the stroke practiced (Craig & Pendergast, 1979; Rouard *et al.*, 1977; Toussaint *et al.*, 1990). Correct swimming practices will follow the research implication that any skill changes should be made while executing the full activity (i.e., complete swimming strokes) at the velocity/intensity of that which is required for competitions. Part practices, such as drills, and irrelevant activities such as weight-training, and slower than race-pace training velocities are a waste of time for proficient swimmers (Costill *et al.*, 1983; Tanaka *et al.*, 1993).

## Overload and Unloading

There are three types of overload.

1. The most basic form of overload is the advent of neural fatigue in an event's race-pace set. Swimmers normally can complete a number of short-work short-rest repetitions before they are unable to maintain the race-pace velocity for the repetition distance being practiced. Since a single failure could be the result of a technique error (e.g., a slip on the wall in a turn) or a distraction, one failure is usually considered to be unreliable for the existence of diminishing performance through neural fatigue. Commonly, a total of three failures or two consecutive failures in a USRPT set are used as the criteria for terminating participation in a set.

   Neural fatigue is the state where the stimulation of correct neuromuscular movement patterns is difficult. In swimming, technique features such as shorter strokes, more floppy arm work, body movements occur in a normally stable body position, etc. indicate that the neural drive for correct swimming work is failing. With intense conscious effort, good technique might be restored for a few strokes but then fail again. Intense cognitive control of technique is required but often results in a slowing of progression. Even after some very concerted efforts to restore desirable movement patterns, the ability to hold swimming form gets less and less. In USRPT sets, before extreme neural fatigue begins to crossover into the next fatigue stage the criteria to terminate participation in the set would have been reached. Therefore, the criteria for failure are USRPT's safeguard against destructive fatigue.

2. The second type of overload is a more general form of fatigue that results from accumulated fatigue caused by each USRPT set that is completed in a practice session. When a practice is two hours long and three USRPT sets and 30 minutes of race-skill practice are completed, most swimmers commence the last event-specific set in a mild accrued-fatigue state. The influence of that fatigue normally is to reduce a swimmer's performance potential in the last set. Accrued in-session fatigue usually occurs despite in-session attempts to recover from the fatigue generated in each event-stimulus set.

3. The third overload occurs across training sessions. If a swimmer trains nine times a week (a microcycle of practice sessions), with a morning workout on Saturday, it is highly possible that general fatigue will accumulate as the week of practice sessions progresses. Often, quality swimming is more difficult to display on Friday than on Monday (after a 36-hour break following Saturday morning). Depending on the severity of accumulated fatigue, which might be caused as much by outside-of-swimming influences (e.g., exams, social activities, other demanding activities such as music or acting lessons) as by the fatigue of swimming elements in all practice sessions, rest will be required.

Overload is important because there cannot be any recovery followed by a training effect for an event-specific set of repetitions without achieving a state of neural fatigue. Neural fatigue is specific to the repetitions practiced whereas deeper forms of fatigue are mostly general and only have marginal effects on specific performances. The task for a coach is to plan and schedule training activities that stimulate specific adaptations and performance improvements for swimming events and to minimize accumulated fatigue at each practice or across a training microcycle.

If too much work is attempted by a swimmer, the amount of recovery required can become excessive. When the demand is excessive, but longer-than-normal recovery time is not planned, further within and between swimming practices become unsatisfactory in performance levels and amounts and usually have a negative effect on a swimmer's behavior (e.g., negative appraisals, withdrawal from swimmer-to-swimmer interactions, negative speech, avoidance of some practice activities, etc.). The planning of *unloading experiences* on a systematic basis is one way of heading off excessive fatigue states in swimmers. *Unloading* is the process of restoring the body's capacities to react to exercise overload so that recovery and overcompensation/training-effects can occur.

Three common forms of excessive overloading could occur within a squad of swimmers in training.

The first is specific to one event. If a swimmer cannot participate in all swimming events and has to repeat practicing for one or a few events while others are training for more events, the fatigue related to a particular event's race-pace could become excessive. Within a week's training microcycle, event-specific USRPT sets are swum with 36-48 hours between those sets. When a swimmer is purely a *"freestyler"*, the swimmer could do too much freestyle and incur fatigue general to that stroke and one or more racing distances. After a while (there is great variation between swimmers as to how long the period is) performances worsen rather than improve. In that case, respite from excessive freestyle is warranted. That occurs while less emphasized other-stroke sets continue to track in an expected beneficial manner. Respite from over-emphasized single stroke or event training is warranted. It is best to provide too much rest rather than too little.

The second is fatigue accumulation in a practice session (practice-session fatigue). For a considerable number of swimmers, a proportion of the fatigue from every USRPT set might not be dissipated during post-set recovery activities. As the session progresses, some general fatigue still remains once the specific fatigue from a set has disappeared through active recovery. With each USRPT set, the remaining fatigue accrues often causing the last USRPT set to be compromised and depending on its severity carries over to subsequent practice sessions. This more general fatigue is best eliminated by not attending practices or experiencing a sequence of successive reduced-overload practice sessions. Overload reduction is unloading and that can be achieved by programming more non-fatiguing racing-skill and surface-swimming technique instruction as well as doing race-pace swimming but avoiding getting to the stage of excessive fatigue. A common approach to alleviating accrued practice-session fatigue is to have swimmers perform two USRPT sets and then participate in a low-stress racing-skill practice or swimming technique instruction. With that activity usually taking about 30 minutes the general fatigue from the first two sets could virtually disappear. Then the final set might be near maximal in its training effect. The columns in Figure 2.2 indicate morning (*"M"*) and afternoon (*"A"*) programs of the three USRPT sets and one skill-development activity format for each practice session.

Practice-session fatigue is exacerbated by sources from outside of the pool. Attempts have been made to measure a swimmer's fatigue status before a practice session begins. A reasonably accurate measure of pre-practice state is to administer a very brief screening questionnaire. Figure 2.1 illustrates a checklist that swimmers complete as soon as they arrive for practice before they change into their training suits. The responses are reviewed by the coach before the practice starts.

The first two questions are simple assessments of how the swimmer feels at the moment in relation to how they felt yesterday at the same time. The comparison is not with the last practice session because feelings and circadian rhythms differ between morning and afternoon practices. There is convincing evidence that a single question to an individual about how they feel is a valid reliable estimate of the actual status of an individual. That is why these two questions are all that is contained in this checklist. The third question is to encourage the swimmer to provide an assessment of whether factors outside of swimming will influence the ensuing training session. *"Worse than normal"* factors will compromise a swimmer's performances in the training session. Training is embedded in the list to see if the swimmer recognizes practice-session fatigue as being excessive. The fourth feature of the checklist is a list of symptoms that might result from practice-session fatigue. Swimmers are likely to select different features to describe their state.[1]

It is recommended that the coach makes one of the following decisions based on what a swimmer's responses are on the pre-practice checklist.

**Figure 2.1. A pre-practice checklist to assess a swimmer's readiness to train.**

**CHERRYBROOK CARLILE SWIMMING CLUB**

**Name:** ____________________________________ **Date;**___________________

**Check one answer to each question.**

1. ***Compared to how I felt at this time yesterday, at this moment I feel:***

   ☐ a. Worse

   ☐ b. About the same

   ☐ c. Better

2. ***I think that my swimming today will be:***

   ☐ a. Worse than yesterday

   ☐ b. About the same as yesterday

   ☐ c. Better than yesterday

3. ***If things outside of swimming are stressful for you, check those areas that are affecting you (if none are then leave all blank).***

| | | |
|---|---|---|
| ☐ Diet | ☐ Home-life | ☐ School/college/work |
| ☐ Friends | ☐ Training | ☐ Climate |
| ☐ Sleep | ☐ Recreation | ☐ Health |

4. ***Think about what you are feeling at this moment. Check the symptoms that are worse than normal.***

| | | |
|---|---|---|
| ☐ Muscle pains | ☐ Tiredness | ☐ Boredom |
| ☐ Unexplained aches | ☐ Technique strength | ☐ Enough sleep |
| ☐ General weakness | ☐ Training effort | ☐ Temper |
| ☐ Arguments | ☐ Likability | ☐ Irritability |
| ☐ Need for a rest | ☐ Have not recovered since my last training session | |

**When completed, place this on the pre-training checklist pile.**

1. If the responses are markedly negative send the swimmer home. There is no value for a swimmer if he/she has a bad practice.

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[1] The third and fourth sections of the checklist are taken from the *Daily Analyses of Life Demands for Athletes (DALDA)* originally published by Rushall in 1981 and later in 1990.

2. If the responses are negative but insufficient to warrant sending the athlete home, plan on having the swimmer only participating in a subset of the scheduled USRPT sets.
3. If the responses are slightly negative, have the swimmer participate normally. The coach should then monitor the quality of the swimmer's responses to the USRPT sets and make a future decision based on what the swimmer displays.
4. If the responses are not cause for any concern have the swimmer participate fully in the practice session.

The third form of excessive overloading is fatigue build-up as a week-long microcycle progresses. After a number of practice sessions, general fatigue can accrue and interfere with the quality and number of event-specific sets that can be completed. When fatigue accumulates across sessions, a rest from swimming is advisable. In normal settings, not practicing on Saturday afternoon and Sunday will allow recovery from any extra fatigue accumulated over the weekdays.

There are three types of unloading that are appropriate for the three forms of excessive overload. If unloading is planned whether or not the coach is aware of a swimmer's need for it, it will act as an insurance package against worse states developing in swimmers.

1. *Transient specific-event fatigue.* Figure 1.6 in the previous *Bulletin* (#60a) showed four exposures to the same training stimulus during one event-specific microcycle. The planning of those exposures constituted a segment (i.e., a segment of the week's work devoted to a particular swimming event) of all the types of work experienced in the microcycle/week of training. A week-long training microcycle is designed to accommodate having Saturday afternoon and Sunday off. Event-specific microcycles have to be planned to fit in the week's training. At the basic level, the program for a week should provide repeated exposures to a large number of event microcycles, particularly in non-specialized age-group swimmers. When USRPT has been implemented fully and swimmers are exposed to three or four USRPT sets in a practice session, a large number of events can be trained in a meaningful way.

   Figure 2.2 illustrates a planned week of USRPT for non-specialized age-group swimmers. The letters *"s"* and *"l"* refer to the type of rest to be used. *"s"* refers to rests equal to or less than 15 seconds for 25 y/m repetitions or equal to or less than 20 seconds for 50 y/m repetitions. *"l'* refers to rests equal to or more than 15 seconds for 25 y/m repetitions or equal to or more than 20 seconds for 50 y/m repetitions. The last numerical value in each table cell is the distance covered in the repetition. Half-sets are discussed below. The illustrated program has three USRPT sets and one racing-skill set per session.

   Swimmers are responsible for recording and monitoring their USRPT performances. It is possible for one or more events to have reached a transient stage where any more sets of the same intensity will not improve in the number of successful completions or will even deteriorate. Swimmers should be instructed to bring to the coach's attention any such occurrence. The coach should then decide what would be the best remedy to restore the swimmer's performance capacity. Some corrective options are; i) tell the swimmer to stay home and not attend the next practice session; ii) attend training but miss any set that involves the stroke and race distance; iii) perform a *half-set* (i.e., the swimmer begins as if a full set but when half the previous best number of successful repetitions is reached the swimmer terminates participation in the set); and iv) perform the set but miss every third repetition). Those work reductions might be sufficient unloading ploys to allow the restitution of the swimmer's capacity for the set.

**Figure 2.2**

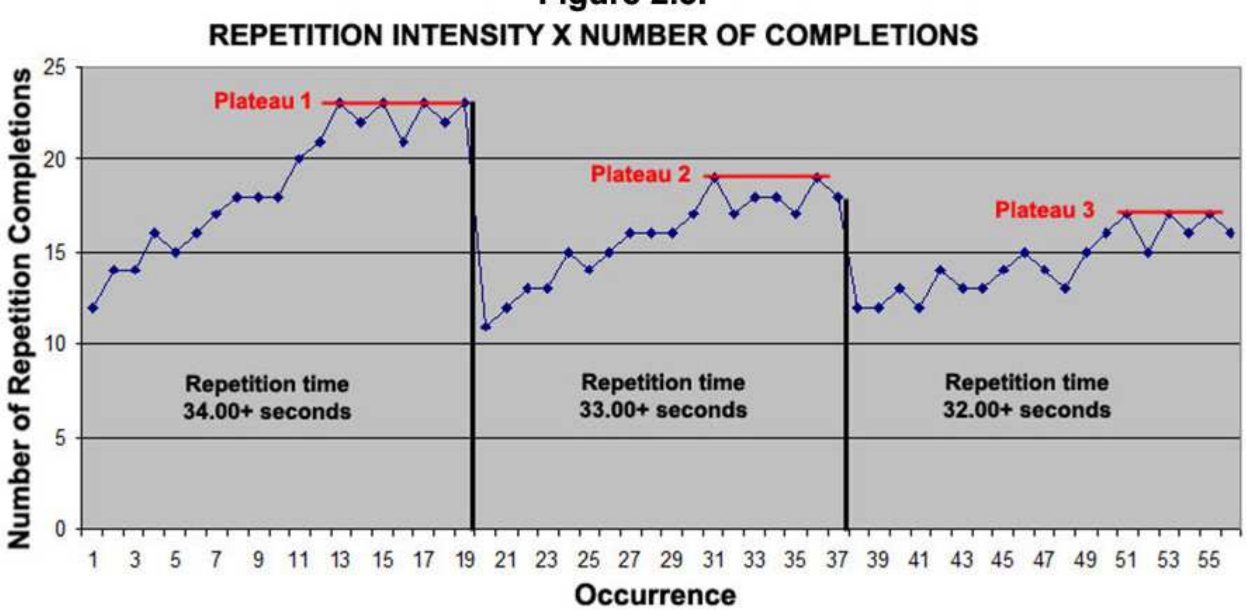
**AN HYPOTHETICAL SPREAD OF TRAINING STIMULI FOR ONE WEEK FOR NON-SPECIALIZED AGE-GROUP SWIMMERS**

| Item | Mon | | Tues | | Wed | Thurs | | Fri | | Sat |
|---|---|---|---|---|---|---|---|---|---|---|
| | M | A | M | A | A | M | A | M | A | M |
| 1 | FS200s 50 | BF100s 25 | BK200l 50 | BF100l 25 | BF200s 25 | FS200l 50 | BF100l 25 | BK200s 50 | BF100s 25 | Half sets |
| 2 | BR200s 50 | FS100s 50 | BR200l 50 | FS100s 25 | FS200s 25 | BR200l 25 | FS100l 25 | BR200l 25 | FS100s 25 | 50s |
| 3 | Skill Turns | Skill Turns | Skill Turns | IM200 | IM200 | IM200 | Starts | Starts | Starts | Relay starts |
| 4 | BK200l 50 | BR100s 25 | FS200l 50 | BR100s 50 | BK100l 25 | BK200l 25 | BR100l 25 | FS200l 50 | BR100s 25 | Hal sets |

Technique concentration is on stroke finishes

The transient event-specific fatigue state should not be confused with the state of maximum adaptation for the event. Over time and repeated specific microcycles a swimmer reaches the stage where no more improvement in successfully completed repetitions is possible. The performances at this maximal adaptation vary from exposure to exposure. This phenomenon is caused by no more capacity-potential being available for any more adaptation. Despite rests and modifications of workloads, no further training

**Figure 2.3.**



performance improvements occur. A swimmer in this state has reached a ceiling-level of training adaptation for an event. Figure 2.3 illustrates this maximized phenomenon. It is a challenge for coaches to differentiate between transient event-specific fatigue and maximized ceiling-level. The transient state responds to rest or overload reduction. The maximized state does not respond to those actions. When the ceiling-level of an event-specific USRPT set has been reached, the next coaching step should be to increase the repetition velocity in the set. This phenomenon is mentioned in *Swimming Science Bulletin 58* (Rushall, 2016a).

The left side of Figure 2.3 shows the progression of total successful completions of 50-m long-course freestyle repetitions with 21 seconds of rest. After the thirteenth attempt at the set no further improvements occur with four of seven executions yielding 23 successful repetitions. That is termed *Plateau 1* and indicates the swimmer's maximum capacity for the type of work was reached. Once a performance-plateau is reached, the velocity of swimming should be increased. The center panel of Figure 2.3 shows an initial reduction in swims completed to criterion and then gradual adaptation. [A change of one second in repetition velocity almost cancelled out all the gains made when repetitions were one second slower. The specificity of training is obvious.] A second plateau is reached for repetition velocities of 33.0 seconds. The higher intensity swimming used more resources per repetition and so the ceiling number of repetitions for the new swimming intensity was lowered to 19. The right panel shows performances for a further increase in swimming velocity. The ceiling number of repetitions was lowered further to 17. This demonstrates that as the intensity of repetition swimming increases, the number of successfully completed repetitions decreases.

The more common reason for event-specific set completions not improving is transient fatigue rather than a ceiling-level of performance. The latter is usually incurred after a swimmer has been practicing with the same set parameters for an extended period (at least for six to eight weeks). Since USRPT swimmers keep track of their training performances when improvements do not occur across four sets of a specific event, they should bring the situation to the coach's attention.

2. *Accumulated training-session general fatigue.* If all sets in the practice session are completed poorly, the cause might be the swimmer is suffering general fatigue which could be influenced by outside-of-swimming sources and/or the early stages of *swimming exhaustion.* Unloading opportunities to recover to a normal state need to be instituted immediately. Possible options are: i) have the swimmer miss one or more consecutive training sessions until the swimmer reports or shows signs of recovery; ii) have the swimmer complete the full program but only participate as half-sets (see above); and iii) attend only afternoon training sessions participating fully in each practice. In the last option, the missed mornings might be sufficient to allow enough recovery from the evening training session and prevent any accrued general fatigue.

   If the frequency of training session *"failures"* is high across the squad, which is more likely to occur in the early adoption of USRPT rather than after it is a fully adapted form of training, it might be advisable to institute an unloading practice session in the middle of the week-long training-microcycle for all swimmers. Many squads do not train on Wednesday morning and so if an unloading training session was scheduled for

Wednesday afternoon's practice, sufficient recovery likely would occur and both Thursday and Friday's practices will be fully beneficial. The likely form of the Wednesday afternoon practice would be an unloading session employing USRPT work of half-sets.

At any time, if a coach observes a considerable number of swimmers struggling with their USRPT sets, instead of waiting until Wednesday, one or more unloading workouts could be inserted starting at the next training session.

3. *Accumulated training-microcycle general fatigue*. If USRPT has different fatiguing effects across a squad and across a week-long microcycle of training (a *"training microcycle"*), a partial solution to alleviate general fatigue would be to always have Saturday morning practice sessions as unloading opportunities for the whole group. It may also provide an unloading opportunity for specific-event fatigue. A common format for such practices is to only swim half-sets. The usual practice session in full training comprises three or four USRPT sets. A half-set is; the swimmer begins as if doing a full set but when half the previous best number of successful repetitions is reached the swimmer terminates participation in the set. A half-set should take approximately half the time of a full USRPT set. Consequently, an unloading practice session which unloads some of the fatigue accumulated during the week could contain six to eight half-sets. That would result in the specific race-equivalent swimming for six to eight events. An unloading practice of this form rarely has many swimmers missing their completion targets. For the majority of the swimmers, the half-set session is very successful which has a positive affect on swimmers' self-efficacy. As well, completing the week with only fast swimming also has positive effects on swimmers' attitudes and confidence. Some better-reasoned traditional swimming programs that follow the outmoded format of *"periodization"* also schedule the last practice of a microcycle as an unloading stimulus.

There are several ways of increasing the overload demands of a training microcycle in USRPT programming. If three USRPT sets are practiced at both sessions everyday, for a few days four sets could be attempted. That would seem to be a minor gradation, which it is. It exhibits caution rather than exceptional excess that could result in many squad members being unable to cope with sudden unreal increased demands. Another possibility is to require more practice sessions to be attended in the week without any session changing its overload value. The extra session would be a significant stress because routines and recovery opportunities would be disrupted. A final unloading microcycle consists of training sessions being reduced in overload value and increased in recovery opportunities.

Since it is in recovery and overcompensation that the benefits of training overload are derived, it is a sound philosophy to program training conservatively, that is, to provide more unloading opportunities rather than too few. Swimmers' training performances will never suffer from the judicious application of lighter training loads on a 1:3 ratio as has been suggested above. If a swimmer is having performance or behavioral difficulties at practice it is good coaching to see if the anomaly occurs again in the next training session rather than assuming that one instance of the unusual swimmer behaviors is a serious condition. When two sessions yield similar negative features in what a swimmer does it is then that the initial diagnosis can be deemed to be true and unloading remedies applied to that swimmer's program. Now that USRPT and some traditional coaches have increased the intensity of swimming tasks, it is possible that for a significant number of swimmers the increase is excessive. To guard against problematical fatigue, many coaches have instituted no Wednesday morning swimming and Wednesday evenings being predominantly focused on speed of swimming. Thus, Wednesday as well as Saturday afternoon and Sunday are unloading/rest opportunities for all swimmers in a squad. If a coach is to make an error in programming it should be on the side of offering too much rather than too little unloading.

## Recognizing Overloads

The allocation of training overloads should conform to the *Roux Principle*: small stimuli are useless, moderate stimuli are useful, and excessive stimuli are harmful (Stegeman, 1981, p. 266). The most perplexing problem confronting a coach at practice is to determine the correct amount of overload for a training stimulus for each swimmer[2]. What is required of a coach is to provide a training stimulus that exceeds threshold capacity but does not become so excessive as to be destructive. The following two features are suggested as criteria for judging the correct overload dose that stimulates adaptation but does not produce detrimental effects.

1. When a swimmer's technique in an event-specific training segment starts to deteriorate, while performance levels remain intact, the threshold capacity has been exceeded. This means that the capacity of the central nervous system to stimulate accurate neuromuscular patterns has been exceeded but the energizing potential of the fitness component of the activity is still accommodating the overload. At this level there is a trade-off: skill is deteriorating but fitness is still adapting.
2. After technique degradation, when performance begins to change for the worse, the training stimulus overload has become excessive, and the stimulus should be stopped. At that stage neither specific technique nor fitness is adapting and any further training with that stimulus provides no benefit for the swimmer. The USRPT criteria for cessation of participating in a set of repetitions decide the point where the swimmer terminates participation in the set.

The guidelines for judging acceptable stimulus overloads encompass the monitoring of technique precision and performance levels. Diminished technique levels as a result of a specific-event overload are often acceptable but disruptions of adequate performance levels are not. By maintaining training segment demands within those two bounds, it is believed that an adequate amount of overload is produced to spur an optimum level of adaptation. Coaches should adhere to the *Roux Principle*.

## Variations in Overload

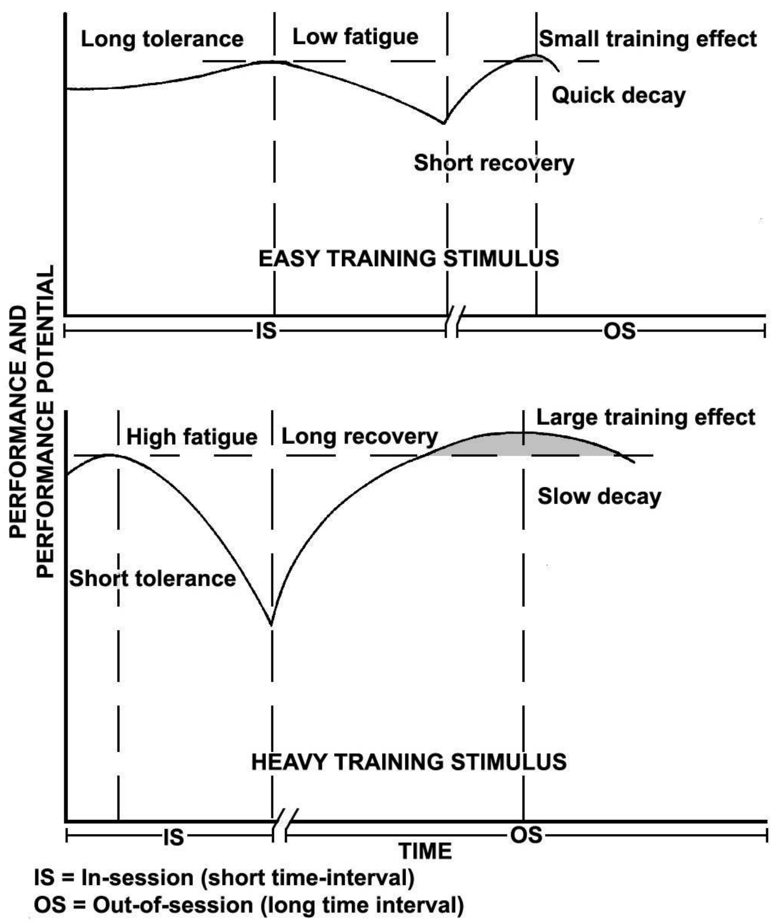
Figure 2.4 illustrates the reactions to two levels of segment overload. Some of the outcomes of each have been verified by research while others still remain hypothetical. The general features of a comparison of easy and heavy overloads follow.

1. When an easy training stimulus is experienced, the time spent in the tolerance stage is long, low levels of fatigue are incurred, the length of the recovery period is relatively short, small training effects result, and the training effects decay quickly.

[2] Fortunately, USRPT allows training stimuli to be in accord with each swimmer's need for an overload.

2. When a heavy training stimulus is experienced, a short tolerance period is exhibited, high fatigue results, the recovery period is long, the size of the training effect is comparatively large, and the training effect is more durable.
3. When overload stimuli are excessive, such as participating in *"hell weeks"* in swimming, the effects on the athlete are destructive. It is possible to train too hard.

**Figure 2.4. Comparataive effects of hypothetical easy and heavy training stimuli.**




One of the features of the art of coaching is to be able to estimate the correct amount of overload to develop an athlete at an optimum rate of progress. There is currently no exact answer to that challenge. However, it can be assumed that the correct rate of overloading for an athlete will be peculiar to that individual. For one athlete it might be best to program many small load increases and microcycles, which would result in many small-training effects. For another it might be more efficient to have an overall heavier training program which would cause fewer but larger training effects to occur. For others, a mix of heavy, moderate, and easy loads might be best. Unfortunately, there is no definitive principle that can be followed by coaches for developing athletes to their fullest potential in the most efficient manner when they train as a single group. USRPT encourages coaches to form subgroups with special training requirements and have them occupy one or more lanes. Programming for disparate groups requires more work on behalf of a coach but it is an implied obligation that goes with the job and the results are worth it. Coaches can only attempt to achieve the greatest level of efficiency through their knowledge of known principles of USRPT and the capacities of the individual (see a later *Bulletin* for a discussion on individuality). Fortunately, USRPT modifies training overloads for the coach. In every USRPT set, swimmers perform to their own level of neural fatigue, that is, their innate work capacity is stimulated. Since set responses are recorded, swimmers monitor their performances and notify the coach only when something atypical occurs.

## A Training Perspective

Much of modern sport-fitness training is based on the belief that physical capacities can be trained in isolation and yield valuable results. The cyclic nature of competitive swimming strokes, the posture in which they are executed, the resistance load incurred, and the physical capacities required for effective performance set swimming apart from almost all other sports. Any form of training for swimming is best achieved in the actions of swimming. Dry-land exercises working against gravity yield training effects that are foreign and unusable by competent swimmers. And yet, many swimmers are subjected to such irrelevant activities which produce fatigue levels that can interfere with actual swimming training particularly if they are engaged in before a swimming-training session. The transfer of simple isolated capacity-training activities to a more complex different posture and environmental conditions activity, such as swimming, to all intents and purposes is nil.

There are two major variations of USRPT stimuli that produce overload. They are race-pace intensity (quality) and race-pace volume (quantity).

*Race-pace intensity* refers to the total amount of work performed in a single event-specific *repetition*. The more work performed, the greater is the intensity of the training stimulus. The greater the intensity of a training stimulus, the greater is the muscular tension and nervous energy required to complete a repetition. Overloads based on increased intensity usually occur when a ceiling-level of repetitions in a set is reached. When training is altered by intensity but between-repetition rest intervals are maintained, fewer repetitions will be completed before failure. The intensity of a training stimulus will affect the degree of fatigue that is developed, the size of the training effect that can be achieved, the time between sessions of repeated exposures to the training stimulus, and the capacity to engage in other training activities.

*Race-pace volume* refers to the total amount of work performed during the completion of a USRPT event-specific *set*. When a high number of repetitions of a set of race-pace intensity is experienced, the training effect achieved is characterized more by maintenance of performance than by changes in performance amplitude. The determination of training volumes is modified by the specific requirements of each swimming event. However, once a ceiling-level of repetitions is reached no more training at that race-pace will yield any greater volume of successful repetition completions. The swimmer is as fit as he/she could be for that race-pace.

Successive event-microcycles can be modified by variations of overload due to changes in repetition distance. A particular race-pace can be sustained in sets that require swimmers to repeat 25s, 50s, and for some events 75s and 100s. *The most basic objective of any event-specific activity is to swim as many correct strokes as possible at a particular velocity.* The number of strokes is the important parameter for learning or altering surface-swimming techniques and racing skills. Peak race-specific conditioning is achieved in significantly fewer strokes than the alteration of technique/skill factors. It is acceptable to downplay a focus on conditioning when technique and skill developments are given a higher priority in a swimming program. In the quest to achieve a huge number of technically correct repetitions, maximal conditioning will occur on the way to that goal.

A basic building-block of a USRPT program is to perform as many strokes for a specific-event as possible at the intended race-pace to achieve a training effect while working on swimming technique, racing skills, and/or the psychological content of races (i.e., race strategies – Rushall, 1979, 1995).

There is a reciprocal relationship between segment volume and intensity. The harder the work, the less the volume of repetitions that can be completed. When the intensity of a training stimulus is excessive, the volume of work at that stimulus level should be reduced. On the other hand, high volumes of work require low levels of segment intensity. As a general rule, the following interpretations can be given to the two parameters of overload: *intensity* affects performance quality and magnitude, and *volume* affects performance stabilization and persistence.

The overload of a training stimulus is increased when the activity is first introduced. Novel activities not only require physiological work to be done, but there is also an added cost involved in learning and getting used to the new activity. Fatigue occurs more quickly when activities are new than when they are familiar. Thus, the introduction of new training segments needs to consider the stress of adaptation to novelty as well as the stress of adaptation to the actual load of the segment.

The above considerations of overload are relevant to the institution of a training segment. Once a segment of a training session is completed, recovery starts to occur. If a segment is completed early in the session, recovery for that activity proceeds even though other event-specific sets are pursued. There is some possibility of a succeeding activity, which taxes similar fitness components, retarding the recovery process. Thus, the full recovery period includes time both in and between sessions. After a training session is completed, there is a general accumulated state of fatigue. The overall state affects the ability of an athlete to perform in subsequent training sessions, meaning that an athlete's response to a segment training load will be influenced by both the specific fatigue that resulted from the previous exposure to the segment as well as the state of general fatigue developed by all the overloaded session activities that exists. Generally, the greater the state of general fatigue, the worse will be the performance on specific segments of training. Consequently, coaches have to monitor both fatigue from specific-training segments, and accumulated overall/general fatigue.

## How Much Overload?

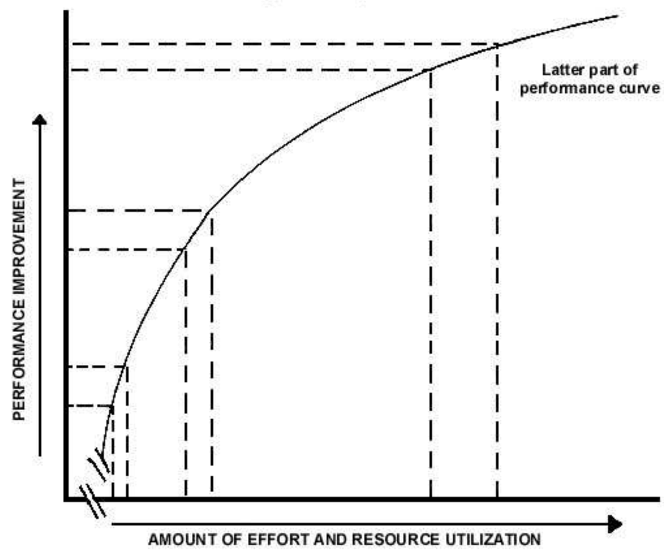
Although improvements in swimming performance occur only in the recovery plus training effect phase of a work-recovery practice combination, the amount of overload governs the nature of the post-work stage of the training response. There are two general effects of practices that judiciously employ the alternation of work and recovery experiences in swimming.

The first set of overload experiences is designed to enhance the performances of specific swimming events. Any improvements will be governed by the specific training-effects generated by the same set of short-work short-rest repetitions that mirror the techniques of swimming at the velocities of intended races. Specific-race performances are not improved optimally or close to maximally by swimming slower than intended race velocities, by working at exercises which are in the water but do not involve free-swimming (Wakayoshi *et al.*, 1992; Wilson *et al.*, 2004), or by working on land (Breed *et al.*, 2000; Sokolovas, 2000). USRPT is the training format which provides the greatest training volume of event-specific swimming (when compared to longer work and rest intervals or continuous swimming which are common in traditional training), it provides an accurate measure of when to halt the overload to promote a training-effect and convenient quick recovery, and it allows concentrations on and the use of sound teaching principles to develop surface-swimming techniques and racing-skills. It also provides remarkably faster physiological adaptations involved in conditioning than those achieved with slower-than-race-pace longer-distance swimming. Thus, the first overload type involves improving specific-race performances that is, making swimmers better racers.

The second set of overload experiences is to develop swimmers into being better competitors. Some important characteristics of competitive swimmers are: i) improving upon heat performance times in finals, and ii) as multi-day swim meets proceed swimmers perform as well at the end of the meet as they did at the start.

So far in this presentation, the emphasis has been on event-specific performance improvements. To be a successful competitive swimmer specific performances need to be of a high caliber and so emphasizing USRPT for events in which swimmers compete is the primary focus of practices. Specific-performance improvements can be improved relatively quickly up to a point. The better the performance level of the swimmer, improvements occur more slowly usually in smaller increments with those changes demanding increased resource usage to reap the improvements. Figure 2.5 illustrates the requirement for greater resource utilization to yield smaller performance improvements the higher the level of competitive achievement performed by a swimmer. The ability to train and use more resources to continue to improve in swimming races is somewhat governed by the second use of overload.

**Figure 2.5.**
A hypothetical relationship between performance improvement and effort-resource costs during the latter part of development. As the function decelerates, greater costs are incurred to maintain appreciable improvement.




Age-group swimming performances are mostly governed by growth and maturation. Poor coaching very often is not enough to halt swimming performance improvements in developing-swimmers (Rushall, 2016a). In the face of performance improvements, coaches often make the mistake of assuming they are coaching well and among other things, forget to train their swimmers to be better competitors. An index of this error is that when swimmers achieve maturity that is, their performances no longer are governed in a major way by growth, performances stagnate and improvements no longer occur. USRPT attempts to change that by demanding the first emphasis of coaching to be on swimming techniques and racing-skills with a second emphasis on mental skills that are appropriate for racing (Rushall, 2016b). Conditioning is mainly a by-product of those two emphases in the USRPT format.

Developing competitive swimmers requires the judicious use of general and event-specific overloads. Two forms of competitiveness need to be developed. The first is being able to compete well in a morning session and then perform better in the evening. The second is being able to compete well on the first day of an extended meet and then perform just as well or even better as the meet progresses. Both forms of competitive health are determined by how much swimming is performed consistently by swimmers over very long periods of time.

*Improving from heats to finals.* The body has the capacity to learn when it is expected to perform and anticipate when that learned response is about to occur. The rhythm of learning when to exercise and when not to exercise is likely to occur in a day is termed a *circadian rhythm.* Other events that occur regularly and solicit notable metabolic changes (e.g., meals, sleep, defecation, passive travel, attentive schoolwork) also cause anticipatory metabolic changes throughout a day. The anticipation of particular events is superimposed on a general change in swimmers' performance potential throughout the day. Rodahl, O'Brien, and Firth (1976) observed that swimmers performed significantly faster in the late afternoon than early in the morning. Evening practice swims should be expected to be faster than those at a morning practice. Baxter and Reilly (1983) measured swimming performances at five different times of the day between 06:00 and 22:00 hours. A steady improvement in performance standards was demonstrated as the day progressed. Sinnerton and Reilly (1991) found that swimmers performed better at 5:30 PM than at 6:30 AM. Freestyle improved by 3.6% over 400 m and 1.9% over 100 m. Reilly and Marshall (1991) recorded distinctive circadian rhythms of pulse rate, rectal temperature, alertness, and power. Peak power values were usually after 4:00 PM. Power, and therefore sprinting capability, had differences between the highest and lowest values of 14% for mean power and 11% for peak power. Arnett (2001) found swimming performances and tympanic temperatures were different between morning and late afternoon practices. Swimming performances should be expected to be better at evening practices than at morning practices. Kline *et al*., (2006) and Kline *et al*., (2007) found there was a significant circadian pattern in swimming performance. Performance peaked five to seven hours before the first minimum body temperature (~23.00 hours) and was worst one hour either side of early morning minimum body temperature (~05:00 hours). The swimming circadian rhythm was independent of environmental and behavioral *"masking"* effects.

It is important for swimmers to train in the mornings and late afternoons/evenings. That establishes a circadian rhythm that somewhat mirrors the daily competitive phases of swim meets. For swimmers accustomed to training twice a day, the alternating sessions have little effect on performance and bodily responses (Arnett, 2000). The scheduling of such swims should be consistent and swimmers must adhere to the patterns of exertion that occur. An increasing number of swimmers vary the days and times of their morning swims which makes the morning definition of swimming more vague than it should be. It has already been shown that morning swims are of a lesser performance capability when the circadian rhythm is stable. If the morning activity is less precise then the standard of performance will be worse because full anticipatory activation in the circadian rhythm will not occur. At important meets, some champion swimmers known to this writer needed to swim in the morning to satisfy their circadian rhythm activation although they were not competing in the morning. Most frequently, that occurred when relay finals were scheduled for the evening and that was the only time the swimmer performed on that day. Sensations of discomfort or mild anxiety that result from not being active when the body expects to be active will be thwarted by a morning mild swim when competitions are only at night.

Morning swims can be expected to be of a lower standard than evening swims. A dedicated race-preparation strategy can have a minor effect on the performance potential of swimmers in morning races. That effect could be sufficient to boost a swimmer's preliminary placing to be in an *A* rather than a *B* final. It is good practice for coaches to stress to swimmers that they need to work hard to be fully aroused prior to the starting signals of morning races. Depending upon the physical arousal and the self-efficacy level of a swimmer, the potential for enhanced performances exists.

It is a noted practice among some high-performance swimming teams that:

1. Before going to a serious competition, as soon as the time line for the meet is available, training times are altered to mirror the competition's two daily sessions.
2. When a time-zone shift is required to attend a serious competition, the training times at home are altered to match the time line of the meet plus or minus the hours of time-zone shift.
3. When possible, sleep and afternoon rest opportunities and meal times also should be matched with what will occur at the serious-competition site.

The above timing adjustments are conducted to minimize established circadian rhythms clashing with unusual performance times at the meet. Such clashes likely would be detrimental to a swimmer's performance.

Training in morning and afternoons is the opportunity for swimmers to learn to compete twice per day when heats and finals are held at swimming meets. The matching of the daily sequence of events that will occur at the serious-competition site is a feature that could cause performance changes that will alter the outcome of potentially close races. Twice daily training needs to be predictable and without variation to establish a strong circadian rhythm. Actions such as having three training sessions on Tuesday and Thursday and two on the other days will make it very difficult to establish a consistent daily rhythm with the extra sessions not providing the advantage they were supposed to yield. Consistent morning and afternoon sessions is the foundational way to prepare swimmers to participate in heats and finals on the same day.

A coach has to be constantly vigilant with swimmers practicing twice a day. Excessive fatigue could easily occur. In those two daily sessions as much beneficial USRPT work as possible should be attempted. However, for swimmers with little endurance capability, general fatigue could rapidly accumulate. Managing the workloads of a considerable number of swimmers developing fatigue at different rates presents a problem for a coach. Some management of fatigue by stalling its onset can be achieved if swimmers are instructed to swim half-sets or even not participate in a training item within a practice session. The training microcycle unloading session on Saturday morning followed by Saturday afternoon and Sunday off usually will accommodate recovery in most swimmers. Some lower capacity swimmers might only train four days per week with three days off. Others will do four days with Wednesdays off. The time management of unloading experiences for swimmers with moderate- to low-stress tolerance has to be addressed and administered because that group is likely to contain some very good sprinters – swimmers who react best to quality training rather than quantity/volume. There are no definite rules for providing unloading experiences among a large group with many varied needs. Despite the periodic need to dial-back the expected training participations of many swimmers, with USRPT requiring work of only race-pace quality over short work and rest periods to a level of neural fatigue, USRPT programs provide a huge amount of race-relevant training when compared to that which is achieved in traditional race-irrelevant training programs.

The role of consistent two-a-day training sessions is important for developing one aspect of competitive swimming, that is, the ability to swim well in the mornings (heats) and better in the evenings (finals). Despite the compromises that have to be made so that individuals will swim twice a day, although many with modified USRPT loads, preparing serious swimmers for full-day competitions is something that needs to be programmed and implemented in a competitive swimming program.

*Sustaining performance standards over long meets*. Access to the most important swimming meets (e.g., Olympic Games, World Championships, Pan-Pacs) is gained by performing as one of the top two place-getters in an individual event final. Preliminary events precede those finals. If a swimmer attempts to qualify in any of multiple events, all being spread out over eight days of competition, it is imperative that a swimmer is a strong competitor on the last day as much as he/she was on the first day. Insufficient training will not develop the capacity to continually exhibit the best performances of which a swimmer is possible in long meets. Although a swimmer might develop excellent standards in multiple events, that excellence will not be demonstrated in most events if the capacity to endure and recover appropriately in extended meets is not developed.

The capacity to sustain performance standards over an eight-day meet develops slowly and requires a commendable volume of work. Most top coaches begin preparing for an Olympic Trials and Games two years before the actual competitions. That is a common standard among coaches who do develop international champions. The adage of *"putting in the hard yards to earn a place on the Olympic Team"* appears to have considerable anecdotal credence although no substantive research has been conducted to evaluate its reliability. Unfortunately, traditional swimming training includes very much more irrelevant physical activities and swimming which have little to no effect of improving individual swims. After almost two years of dedicated traditional training, many swimmers are exposed to enough work to sustain performances without producing performance improvements.[3] If USRPT is programmed correctly, performances should improve over any period of time.[4] It only follows swimming techniques for the personal best velocity of each and every event, it promotes developing and practicing mental strategies for every event, and it programs huge amounts of race-relevant yardage in short-work short-rest formats to ensure irrelevant training remains virtually non-existent.

Whether traditional training or USRPT is followed, current wisdom dictates that a huge volume of swimming be achieved to become a successful 8-day meet competitor. Just what the ideal volume is has not been discovered. However, the one feature that is sure is that swimming to the swimmer is an activity that has to become as natural as walking/running. When an otherwise healthy human is deprived of upright locomotion for some time, that deprivation is stressful. It results in the person not feeling *well*, exhibiting rashes that are generally labeled as *uticaria*, enduring disruptions to normal living patterns, suffering a running nose, sore throat, and other allergy symptoms, etc. The solution for the removal of these symptoms is to start exercising again. If a swimmer is fully adapted to the level required to be a successful competitor, a similar

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[3] In 2016, London Olympic 200-m freestyle champion Allison Schmitt qualified for the USA Olympic Swimming Team as a relay swimmer and did not reach the standard she set in 2012 to earn the Gold Medal. The unmatchable Michael Phelps earned five Gold Medals in Rio but all his swims were slower than those he recorded at the London Olympic Games. There is no doubt these swimmers put in the *hard yards* but one has to ask were they the *right yards*?

[4] USRPT is increasingly popular with masters swimmers. Physiologists state that performances deteriorate with age particularly after 50 years. However, several serious masters swimmers, well into their sixties, appear to be getting faster with age, contrary to what research on sedentary aged-adults suggests. When performances among sexagenarians improve to surpass those recorded when in their 50s or in some cases even in college, something must be the cause. Further, when these swimmers have unsuccessfully tried other forms of swimming training (e.g., high-intensity interval-training, traditional training, etc.) and it is only when USRPT was started that performances were reversed and improvements, #1 rankings, and national championships were achieved, that support for USRPT being the preferable form of training for masters swimmers was accepted.

reaction would occur if swimming was prevented. A normal person needs upright exercise to maintain a healthy outlook on life. A totally-trained swimmer needs upright and aquatic exercise to maintain a similar healthy outlook. A properly prepared competitive swimmer is *"allergic"* to not swimming.

A USRPT coach developing talented individuals for the highest levels of swimming competitions needs to foster swimmer attitudes toward training fully in terms of the number of practice sessions attended per week, accepting the importance of morning training sessions, and accepting the tenets and goals of USRPT. Those features have to occur against a background of overloading and unloading with the view of preventing undesirable fatigue which inhibits the development of training effects and the learning of techniques and racing-skills.

*Why swimmers have to train so much.* To understand why swimmers have to train so much, much more than most other sports, it is worthwhile to compare running with swimming. Runner's spend much of their non-training time in an upright posture moving limbs in all manners and often moving around at a slower than race-pace velocity. Running is a *phylogenetic fundamental motor skill* coded into human DNA. With or without deliberate learning, persons will grow and run as a very natural pursuit. The running skill can be modified slightly by instruction. Among the population there are sub-populations who have running skills the produce different outcomes (i.e., sprinters versus marathon runners). Thus, everyday activities exercise the muscles used in running and the elementary movements associated with it. In a very remote way, active daily living does partially support the maintenance of trained running states. De-training is slowed by active life-styles. On the other hand, swimming is not a natural activity; it involves *ontogenetic skills* that depend upon learning and environmental opportunities. The horizontal fully supported posture of swimming along with the arms being the prime movers and the legs playing only a minor supporting role, make it a very unusual activity. An everyday terrestrial active lifestyle almost never replicates in part or in whole, competitive swimming strokes. There is no out-of-the pool activity that fully transfers to the swimming performances of higher-level performers (i.e., serious age-group and senior swimmers). Runners usually train only for a very limited number of events which mostly require the same skill. Swimmers have a variety of race distances for four different competitive strokes. Each change in distance and stroke requires a set of discrete movement patterns in the brain. A swimmer is more like a decathlete rather than a single-form runner. In track and field, decathletes train the most of all the sport's competitors.

When runners are injured or ill and have to have bed-rest, de-training of their trained state is maximized. The many but minor stimulations of all manners of running that are provided by an active life-style do not occur. Bed-rest then is the worst situation in which runners could find themselves. In contrast, swimmers when out of the water even when demonstrating an active life-style are essentially in the swimming equivalent of bed-rest. Swimmers need much time to learn and constantly refine the techniques of their competitive strokes (just like decathletes). However, what is learned and practiced in the water is not partly replicated on land. The only way to get sufficient trials to change skill techniques and to sustain the appropriate physical conditioning for each skill is to swim. Thus, to maintain or better improve in swimming, large amounts of pool-time are warranted. When that is reconciled with the need to do as much relevant swimming training as possible, so that swimming becomes a natural part of a swimmer's life as much as are terrestrial activities, a large amount of a swimmer's life needs to be spent in the water. Two classes of activity, swimming and upright land-based activities are crucial to the make-up of a successful swimmer. Prevention of either class of activity would invoke a stress or allergic reaction in a swimmer. That does not occur nearly to the same degree in a runner.

The need for serious swimmers to put in the *hard yards* is ever-present. What is now known is that the work of serious swimming should not be race-irrelevant or excessively fatigued. Nothing good happens to swimmers when training that way or experiencing that state brought on by too much swimming. Given that swimmers need to train 4-6 hours per day for the equivalent of five days a week, bad swimming (i.e., slow velocity with poor technique) prevents improvements and should be avoided at all costs. Individuals' variations in stress-tolerance capacity will make it impossible for some swimmers to achieve in several of the more demanding swimming events. The less the physical capabilities and constitution of a swimmer, the fewer are the events in which such a person could achieve. However, since swimming success is determined to a large degree by swimming technique that is precise for the racing-velocity attempted, high-levels of skill can offset to a degree a lack of physical capacities.

Anecdotal evidence suggests that adolescence is the age when capacities to produce good training over two sessions in one day and sustained performance over a multi-day meet are developed. The changes are primarily in the endocrine system rather than in physiological capacities. Further anecdotal observations show those capacities do not change once maturation is reached.

USRPT is a coaching model that is best suited for swimming and other skill-dominant sports. Swimming coaches need to consider all these factors and use a tiered structure of decision-making when determining the contents of a squad's swimming program, individuals' swimming programs, the facilities needed to provide the environment in which swimmers will thrive, and the coaching skills required to be an effective teacher and work-level monitor. Coaching swimming is not easy nor is it simply a matter of overloading and unloading swimmers' experiences although those two factors are basic to coaching and swimmers' successes.

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