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Professor Emeritus Brent S. Rushall, San Diego State University

USRPT AND TRAINING THEORY III: LONG-TERM EXHAUSTION

Brent S. Rushall, PhD

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A Review of Overload to this Point

At this time it is perhaps worthwhile to reflect back on the overload-unloading discussions covered in *Bulletins 60a* and *60b*. After this review, there is one further phenomenon that needs to be discussed.

Event-specific Stimulus (Training Segment)

1. An *event-specific stimulus* (i.e., a *training segment*) is the most basic USRPT item designed to improve the performance of a swimmer in a single, specific competitive-swimming event. The overload level is moderate and is that which displays some technique degradation and the early slowing of set repetition times. Neural fatigue is the specific-event fatigue that causes technique to be detrimentally altered. Usually, a swimmer can hold a few more repetitions at race-pace if the effort level of swimming is raised despite the loss of swimming efficiency caused by the poorer technique. The elevation of effort level lowers the proficiency of the specific swimming task and brings some general fatigue into the overall fatigue experience of the set. A good proportion of the event-specific fatigue recovers very quickly and might only take as long as 10 to 15 minutes. The remaining minor proportion of specific fatigue lingers for some time. General fatigue developed by increased effort recovers much slower as it requires the restitution of the physiological costs of the extra-effort applied to the training set.
2. It is advocated that event-specific sets be repeated with 36-48 hours between repetitions. Each week's swimming should consider 3-4 repetitions of each event-specific set. To guard against the accumulation of fatigue that will influence swimming performances and swimmer behaviors, it was recommended that a calendar week be deemed an event-specific microcycle. It contains three sets of trying to complete more repetitions than the previous set with the last training session of the week providing an unloading experience of a half-set. This should be the plan for all event-specific tasks across the week. For a while at least, the multiple-unloading training items on the last day of the week's training (i.e., Saturday morning) and the one and a half days of rest that follow, should be sufficient to restore swimmers' performance capacities for the next week. The unloading

training session comprising unloading event-specific training tasks usually is a positive way to end the week-long microcycle.

3. Event-specific tasks continue with the same race-pace mostly varied over 25 and 50 y/m until: i) the number of successful repetitions ceases to improve and hovers around a high number for a swimmer (the ceiling-level of event-specific adaptation), or ii) more rarely a very high number of repetitions is reached. In both cases, the coach should increase the swimming velocity of the event-repetitions resulting in fewer repetition completions and the new set being viewed as challenging once more. Quite often, the new velocity to be swum for an event is faster than the previous race's average velocity.

4. In USRPT concepts, the instruction of technique and race-related mental skills while swimming at race-pace is the most efficient and direct way to improve swimming performances. All other activities practiced around swimming programs rarely enhance performance and if they do, improvements are meager.

Training-session Overload

1. Within a training session, general fatigue accrues across the completed training items. The amount of recovery between each training item will determine the volume of general fatigue that accumulates. If too little time is allowed for post-set recovery, the ensuing training items will suffer. With practice and familiarity, a coach should develop a feel for how much rest and active recovery is needed for each training segment. If fatigue accrues then the last training item will suffer and very little beneficial work will be done. As was stated in an earlier *Bulletin* (*60b*), if USRPT experiences are planned for a two-hour practice, it was suggested conduct two USRPT sets in the first hour, start the second hour with skill-practice or technique work which will foster considerable fatigue abatement, and then with 20-30 minutes to go in the practice implement the third USRPT event-specific set. Recovery after the last set can occur after the practice as the swimmers get dressed and then travel home.

2. Within-practice fatigue can be controlled between the first two sets, during the third skill-practice activity, and after the practice finishes.

3. An aim of practice could be to have as little residual fatigue as possible leave the pool with the swimmers. Traditional training very often has swimmers leave with observable general fatigue effects. After USRPT sessions, the remarkable and distinctive features are the lively interactions between swimmers, often described as *chirpiness*, and the positive attitudes of all swimmers. If swimmers feel good when they leave the pool they will be motivated to return – a feature that is important when a coach wishes to increase the two-a-day attendances across all swimmers.

4. There is considerable variation in the reactions of swimmers to the work of USRPT sets. Some swimmers have little capacity for endurance work and so when performing mainly 200 and 100 race-pace sets, they always finish early and need long recoveries. One should not worry about the few swimmers who do not do as much work as other swimmers. Hopefully, the work they do will be to neural fatigue and will extend their very limited training capacity. Mostly, those swimmers are sprinters and the USRPT sets with relatively few successful repetitions still will build something into the backend of 50 and

100 y/m races. Traditional training usually requires limited-capacity swimmers to do lots of yardage although at a totally race-irrelevant velocity. They are the ones who could build considerable general fatigue even in a well-planned USRPT session. However, the swimmer's self-control over how much USRPT swimming is completed in a session will not result in the debilitating fatigue levels that are so characteristic of traditional training. For those swimmers, Sprint-USRPT[1] should be planned and included in a practice whenever possible. Swimmers should not be made to swim many yards in a heavily fatigued state.

5. Leaving a USRPT practice with a good attitude is important for every swimmer.

Weekly Training-microcycle Overload

1. Because of the varied capacities for stress-tolerance across swimmers in a squad, there are likely to be quite a few swimmers with some degree of fatigue (stress) that has built up over a weekly microcycle of training. With each session having the potential to leave some element of general fatigue in many swimmers, those amounts accumulate and grow as the week progresses.
2. Perhaps more than 20 years ago, coaches ran practices for the whole week with the knowledge that swimming and practice performances would worsen toward the end of the week. This was particularly so when the work level was raised at various times to further stimulate swimmers. However, the program of having Monday and Tuesday as full-training days, Wednesday as a recovery day mainly through there being no morning practice session, and Thursday and Friday as full-training days, with Saturday being a variety of unloading experiences, was one attempt to have more days of quality swimming with perhaps better swimmer attendances toward the end of the week.
3. Also more than 20 years ago, coaches ran practices all week and then went to a weekend swim meet. After the meet, the only respite swimmers had was to normally have no training on Monday morning. Despite it being reasonably obvious, swimmers did not revert back to normal swimming after the full-week training plus weekend meet experience until later in the week after the meet. This focus on *work at all costs* was in concert with the beliefs that *"miles make champions"* and that missing a full training session of *normal work* was detrimental to the swimmer. Griffin and Unnithan (1997) showed that a weekend of intense competition produced a state similar to acute overtraining in elite swimmers. Since overtrained swimmers need rest, it has now become a more accepted practice to have swimmers have light sessions for two to three days after a seven-day period of training and competing.
4. The introduction of an unloading practice session on Saturday morning is becoming popular. What the coach has to do is as best as possible assess the fatigue states of all swimmers and offer some variation in the amounts of unloading that are appropriate for subgroups of swimmers. It was suggested that USRPT half-sets should be the basic staple of Saturday swimming. Only doing some, not all, of the planned half-sets is perhaps the

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[1] Rushall, B. S. (2016). Sprint-USRPT: Training for 50-m Races. *Swimming Science Bulletin, 56*, pp. 103. [http://coachsci.sdsu.edu/swim/bullets/56USRPT50m.pdf]

lightest unloading that might be offered. On the other end of the scale, some full USRPT sets could be substituted for some of the half-sets to make the program only slightly less stressful than normal.

5. USRPT does a lot to alleviate the degrees of fatigue accrual within practice sessions and across weekly-training microcycles. Fatigued swimmers are not as prevalent in USRPT programs as they are in traditional programs, particularly those which are still run by coaches with a twentieth-century training philosophy.
6. Perhaps after four to six weekly microcycles of training, it is prudent to plan a week or reduced-stress practice sessions (an *unloading microcycle*) to allow some recovery from the previous multiple-weeks' work. It is prudent to plan such reduced workloads for school holidays or extended public holidays, times when swimmers will want to miss some training sessions for *family obligations*.

It should be obvious that coaches have to be aware as much as possible about every swimmer's need for rest and recovery, full-load USRPT, and incidental recoveries. It should be remembered that fatigue comes as much from outside of the pool as it does in the water (Carle, Tyree, & Strasser, 2001). To ignore the opportunities for rest is to deny swimmers with the opportunity to improve. Excessive fatigue prevents skill learning, suppresses performance standards, and alters swimmers' moods and behaviors (Berger *et al.*, 1997; Morgan *et al.*, 1988; Raglin & Morgan, 1994; Snook, Jerome, & Petruzzello, 2002). It should also be remembered that females respond differently to overload when compared with males (Koltyn, O'Connor, & Morgan, 1991; Rushall, 1994; Tobar & Morgan, 2002, 2005). Monitoring overloads and unloading is a serious challenge for swimming coaches. It might be one of the most important coaching duties undertaken. Unfortunately, traditional coaches mostly do not see it that way but USRPT coaches do (or should do).

The Reasoning behind USRPT

Training theory is largely predicated on established/traditional practices. Features of training theory were formulated mostly by listening to the opinions of experts in coaching and appropriate exercise sciences. Aspects of theory are researched to verify or refute one or more features. When research does not support a theoretical concept, the theory is modified in light of the discovery. The theory restricts what is researched. Interesting findings from works outside of the theoretical scope are largely ignored. It is possible that those *"irrelevant"* research facts actually do have relevance for the development of swimmers. The sticking point is that they do not fit into the theory. The philosophical form of argument for that approach is *deductive reasoning*. Inferences of particular actions and events for coaching are drawn from appealing to (i.e., understanding) the general theory. Predicting from generalities (e.g., training theory) to specific instances (e.g., what to do with a particular swimmer) is dangerous and invalid. In contrast, USRPT was developed by spending a considerable amount of time reviewing published data-based research. When works with common findings were drawn together and generalized in verbal terms, aspects of what was to be labeled USRPT began to mount. There were some fields of research that were not conclusive. Some studies in the same field showed significant results while others were non-significant or contrary. Inconclusive areas of research usually mean that all the influential variables in the area were not known or controlled adequately by the researchers. Poor research designs can result in conclusions that show type I (a *false positive*) and type II (a *false negative*) errors.[2] Dubious research results were ignored in the formulation of USRPT (Rushall, 2013). USRPT was *"generalized"* from many specific research findings (instances of fact). That is completely the opposite to the formation of training theory. The logical name for the developmental process of USRPT is *inductive reasoning*. When taking the concepts of USRPT and applying some or more of them to individual swimmers, the likelihood of them working is much greater than applying theoretical implications. What causes that difference is that the concepts of USRPT are nothing more than verbal descriptions of actual facts. Theories on the other hand, originate often from the imagination of the initial proposer. Despite this significant difference, since this series of *Bulletins* does involve training theory, it is necessary to discuss at some length concepts and theoretical structures that mostly are appropriate for traditional training and inappropriate for USRPT. The reader should keep this in mind, particularly in this paper.

Fatigue/Stress-tolerance Capacity

Each individual is endowed with a certain finite capacity to handle stress (Selye, 1950). The stress-coping capacity is shared among all of life's stresses. The events of everyday living, such as fatigue from work, emotional involvement in interpersonal relationships, deprivation of rest, as well as the training stress of sports participation, all subtract from the finite ability of an individual to tolerate life's stresses. The state of fatigue that results from session-training stress and the demands of other life stresses all compete for the finite resources when attempting to produce recovery and adaptation. If total stresses exceed an individual's capacity to cope, then physical and behavior disruptions occur. Since the capacity to tolerate and adapt to stress is limited, the more stresses which occur outside of swimming, the less capacity there is for tolerating and adapting to the stress of physical activity. One's training capacity is reduced when one ormore demands outside training are excessive.

Over time, when a consistent level of stress associated with life and training is very frequently present, the body's reservoir of stress-coping capacities deteriorates and both performance and behavior problems occur in a swimmer. The pattern of response to the accumulated effects of outside-of-training and general fatigue from training is not new. Carlile (1955) proposed the adoption of Hans Selye's *General Adaptation Syndrome - GAS* (1950)[3]. Prokop (1963) also classified response *"cycles"* to the stress of training. Selye's model is still popular and has endured the test of time.

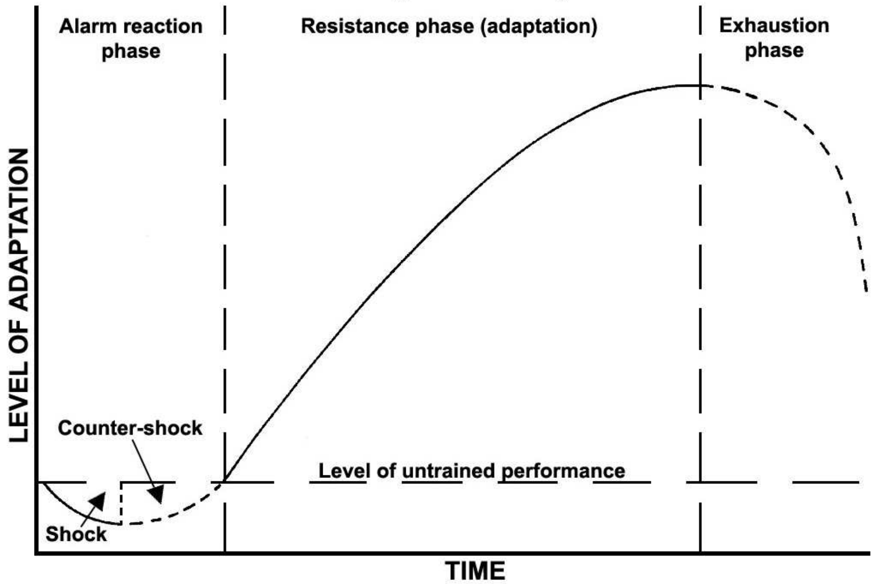
Training loads have generalized non-specific effects superimposed upon the specific effects of training segments. Under the influence of loads, the body adapts itself by exhibiting a complex of symptoms. It has particular response patterns to each training stimulus, and a general pattern (GAS) to the combined effects of the training stimuli. The GAS response can be differentiated into three phases: the *Alarm Reaction Phase*, the *Resistance Phase*, and the *Exhaustion Phase*. Figure 3.1 illustrates the phases and shape of the GAS. The illustration depicts the phases through which a swimmer passes when at the commencement of training the swimmer is in a completely untrained state (e.g., a masters swimmer taking on a competitive program, a former

[2] A type I error is the incorrect rejection of a true null hypothesis (a *"false positive"*). A type II error is incorrectly retaining a false null hypothesis (a *"false negative"*).

[3] The GAS pertains to general fatigue, not event-specific fatigue which is limited to neural fatigue in the specific activity. General fatigue is common in traditional training with its varied stimuli and excessive amounts of irrelevant swimming.

swimmer coming back into the sport after a period of retirement). As will be discussed below, the whole of this curve is mostly inappropriate for year-round trained swimmers.[4]

Figure 3.1. Stages of the General Adaptation Syndrome as a Response to Prolonged Hard Training



The *Alarm Reaction Phase* is divided into two sub-phases, *Shock* and *Counter-shock*. Shock represents the athlete's initial response to a sudden exposure to unusual workloads. The most noticeable of these reactions occurs when an athlete starts to train after a long lay-off (any vestiges of a previous trained state have dissipated). In the first one to two weeks of training work is difficult, fatiguing, inefficient, and low in total output. Performance potentials drop below those that were possible prior to the commencement of training[5]. As in *general shock*, the body responds excessively and inefficiently to seemingly mild work demands. With consistent attendance at training sessions, these symptoms are gradually lost, as the body begins to adjust to the overloads of swimming training. The initial adjustment after the *Shock Reaction* is the *Counter-shock Reaction*. In counter-shock, the physiological changes of shock reverse and soon the adaptive mechanisms in the body proceed at a greater rate than the destructive processes. Performance potential begins to increase and returns quickly to the pre-training level. Faulkner (1964) showed that when unfamiliar exercise stresses were encountered, the shock response of the individual was much greater than when the stress was familiar. For practical purposes, this means that untrained individuals exposed to moderate to high levels of exercise stress exhibit more of a shock reaction than do swimmers who are untrained but have a history of training in swimming behind them. Training histories in swimming generally decrease the Alarm Reaction Phase, resulting in quicker specific adaptation to swimming training. This phenomenon was evidenced by Prokop's adaptation syndrome for experienced athletes, in which a phase that resembled Selye's Alarm Reaction Phase was omitted.

[4] In this writer's opinion it is important for coaches to know about the complete stress-adaptation response although it might only be applicable to USRPT swimmers on a few occasions.

[5] The performance level of an untrained athlete is better without training than it is after the first two weeks of training when the body is still shocked by the introduction of challenging fatiguing work.

After the Alarm Reaction Phase, a training swimmer enters the *Resistance Phase* (*adaptation*). There is an increased resistance to swimming stress, and decreased resistance to all other stresses. Performance potential increases during this phase. The duration of this second phase is dependent on training loads. It is quickest in USRPT programs in terms of specific-event physiological adaptation and not so fast in the accumulation of general fatigue. Even in traditional training, heavy to excessive training loads produce quick general adaptation, but result in a less than ultimate level of performance. The moderate workloads of USRPT produce fast physiological adaptation because of the high-intensity work but because of reduced general fatigue allow a swimmer to proceed to higher ultimate levels of performance as well. The individual variation that exists between swimmers is great with regard to what training stresses can be absorbed and tolerated.

While a swimmer continues to resist the stress of training loads, vulnerability to other stresses is heightened. If the swimmer's finite stress-coping capacity is exceeded through having other life-stresses increase, an alarm reaction may be superimposed physiologically on the resistance reactions. This phenomenon could be called *"phantom overtraining"* because the symptoms are similar to those that occur in overtraining, but training is not the cause. Thus, during a planned training program it is possible to have complete disruption of training adaptation due to other factors. In the training situation it becomes necessary to eliminate or minimize other stresses which could detract from the adaptation potential of the athlete since every stress consumes adaptation energy. The Resistance Phase exhibits increased levels of performance while the demands of training and life remain within an athlete's stress-coping capacity which they should be in a properly conducted USRPT program. However, the ability of an individual to tolerate increased training and/or stress loads is limited. There comes a phase when further increases in the severity of training loads exceed a swimmer's absolute capacity and he/she enters the final phase of the adaptation syndrome.

The *Exhaustion Phase* represents the non-specific reactions resulting from prolonged overexposure to USRPT stresses to which adaptation has been developed but can no longer be maintained. It usually results from excessive increases in the general overload of training and life demands. In this phase, all resistances are low and further excessive stresses usually cause chronic effects in the swimmer. Those effects indicate a state of *overtraining*. In the Exhaustion Phase, performance capabilities deteriorate rapidly and are accompanied by undesirable psychological and physiological problems.

USRPT continually demands that swimmers perform to their neural-fatigue maximum in every set, every session, and every weekly training microcycle. The type of work in USRPT is short-work and short-rest which accommodates volumes of high-level specific-event work. While coaches should be monitoring signs of excessive fatigue in all swimmers as evidenced by their training performances, as well as deliberately providing unloading experiences mid-week or on weekends or after a series of weekly training microcycles, all with the intention of dissipating accumulated general stress, the Exhaustion Phase can still occur. When the phase is entered, the swimmer is vulnerable to diseases, infections, social problems, a decline in the standard of everyday functions among other life changes, as well as notable performance losses.

There are several implications of the overload principle as it applies to long-term general exhaustion associated with repeated training sessions. Remember, this is for individuals who start training in a totally untrained state.

1. Training should commence slowly and progress gradually. A swimmer would then be eased through the Alarm Reaction Phase until some resistance and adaptation developed. On the other hand, if an athlete started from a low level of fitness, an immediate high volume and intensity of training early in the program would cause very rapid onset of fatigue and ultimate exhaustion. The overload principle would be better termed the *"principle of progressive overload"*, for that would better suit its implications for designing rational and sound training programs.
2. The training stress (volume/intensity) should be elevated gradually in a step-like fashion.
3. The training stress should be cyclic in that harder sessions should be alternated with easier sessions. This will prevent the athlete reaching a state of exhaustion earlier than should occur.
4. The coach should be aware that multiple sources of stress combine to cause exhaustion. The effects of factors such as emotional stress, lack of sleep, or poor diet accumulate, along with hard training and, if severe enough, would cause the swimmer to break down.

Selye's GAS offers the first hint that there might be some limits to the ability of the body to adapt to training. There is a common belief in Western sporting nations that if some training is good, more training will be better. Then coaches try and outdo each with the macho inclination to work swimmers harder than other coaches under the mistaken belief that continual hard work makes better swimmers[6]. Increases in both the volume and intensity of training can amount to some extremely heavy training loads. It is not uncommon to see modern swimmers training 10 to 12 times per week for a total of more than 30 hours during highly stressful episodes that are popularly known as *"hell weeks"*. Elite distance runners usually cover between 150 and 250 kilometers per week. Both these examples usually result in athletes breaking down through overuse or overstress injuries. It is problematical whether such excessive exploitation of the overload principle is needed for maximum adaptation.

The above discussion is primarily directed at traditional training. In USRPT, overload is governed by each swimmer in the form of striving to complete more repetitions than before at a relevant race-pace. Only when the number of repetitions reaches a ceiling-level or some high number is the training intensity altered. In USRPT, it is volume of race-pace swimming first with intensity only altered when the work at race-pace is maximized. However, even in USRPT programs, particularly those with high swimmer numbers, long-term exhaustion can occur but not nearly as frequently as with traditional training.

The *General Adaptation Syndrome* is likely to be observed less at this time than it was in the past. Many nations in the 1950s and 1960s only trained in the summer. Swimmers would enter the summer program totally untrained and would exhibit all phases of the GAS during the part-year program. At that time, the USA was perhaps the only major swimming-nation that had swimming year-round with indoor and outdoor seasons. Competitive swimming nations now

[6] At a two-day seminar held at the University of Kansas in Lawrence, Kansas in January 2013, an attendee offered the anecdote that in a city with two competitive swimming teams one coach boasted that his team did 10,000 m of training in a session. Not to be outdone, the other coach had his team cover 11,000 m in a session. What idiocy! Swimmers do not belong to clubs to help coaches compete against each other in nonsensical irrelevant exercise. The result of the 11,000 m day was that parents and swimmers rebelled and left the club to start a USRPT program which has been growing and successful ever since the day of ridiculousness.

have year-round programs and so serious swimmers never de-train completely. In these times, the GAS is seemingly more appropriate for swimmers re-entering the sport after retirement, after an extended illness (e.g., glandular fever) or injury, or masters swimmers beginning to take an interest in competitive swimming again after years of inactivity. For those individuals, a coach should be aware of the GAS and recognize its phases when swimmers pass through them.

Year-round Training

Today's swimmers, if coached correctly, rarely reach an untrained state. A 2-4 week break at the end of each season is insufficient for complete de-training to occur. While a level of trained state exists in swimmers coming off a break, the early phase of the GAS (the *Alarm Reaction Phase*) does not occur and the swimmers commence in the *Resistance Phase*, the actual level depending on the residual trained-state that existed at the end of the seasonal break. There is great variation among swimmers for the level of tolerance to general stress. Even with USRPT, the demand of training does require resources that eventually wear-out. For example, after several macrocycles of USRPT, the stress-tolerance capacity of some swimmers will be depleted and they could quickly enter the *Exhaustion Phase*. On the other hand, some swimmers appear to be impervious to the long-term exhaustion that entering the final GAS phase represents. The only recourse when the Exhaustion Phase is entered is rest from swimming in particular but also minimizing stress from the other life-sources. The one tool that measures sources of stress in an athlete's life is the *Daily Analyses of Life Demands of Athletes* (*DALDA* – Rushall, 1981 and 1990). The sources of life-stress that can be accurately and reliably measured are: Diet, Home-life, School/college/work, Friends, Training and exercise, Climate, Sleep, Recreation, and Health. Because stress-tolerance consists of mainly general stress and to a lesser degree, specific-exercise stress, any addition of one or more life-stresses can cause an almost immediate incursion of the symptoms of the Exhaustion Phase. If those extra stresses are short-lived (perhaps a week), as happens with exam-week at school, or brutal changes in the weather (heat or cold), etc., the exhaustion symptoms are transitory. When they finish, a swimmer's training responses recover and performance is restored. However, when the stress of swimming has existed for some time and the specific stress-tolerance and general stress-tolerance capacities of the swimmer are exhausted, the athlete is truly exhausted/fatigued. Continued challenging swimming training will only make the condition deteriorate more rapidly. The addition of extra outside-stresses that are enduring (e.g., the swimmer's parents are divorcing; the family moves to a new location which requires new schooling and the building of new acquaintances, recovery from exhaustion will be slowed. Once again individual variability is marked in the restoration capacities of swimmers within a squad. After deciding that rest is needed, swimmers should still swim but for only 2-3 times per week without incurring fatigue until they are fully recovered.

The *DALDA* provides a list of symptoms that could emerge when a swimmer enters long-term fatigue. More symptoms are evident in *true exhaustion* than in *transitory exhaustion*. Each swimmer will have a number of symptoms of exhaustion when in the long-term condition but there will be a distinct pattern of the sub-set of symptoms for each individual. The symptoms of detrimental and long-term fatigue/exhaustion follow. They are judged by the swimmer to be worse than normal, normal, or better than normal.

Muscle pains	Techniques	Tiredness	Need for a rest
Supplementary work	Boredom	Recovery time	Irritability
Weight	Throat	Internal	Unexplained aches
Technique strength	Enough sleep	Between-sessions recovery	
General weakness	Interest	Arguments	Skin rashes
Congestion	Training effort	Temper	Swellings
Likability			

The following are links to other web-site descriptions of the *DALDA*.

http://coachsci.sdsu.edu/csa/vol13/rushall2.htm

http://coachsci.sdsu.edu/csa/vol13/rushall8.htm

http://brentrushall.com/index.htm#psytests

Traditional swimming training, with its emphasis on race-irrelevant training items and compulsion to complete every item in a session's program, produces states of long-term exhaustion in many more swimmers than does USRPT. In many cases, it has been the continued exhausted state of a swimmer that has forced parents to seek a better alternative. The following is a description by a very concerned parent that shows what can happen in a traditional swimming program. It is representative of a considerable number of emails received by this writer.

> *It was several years ago when I realized something was wrong with our oldest daughter. She is fifteen now, 6' 2.5" and a natural born sprinter. For some reason, as the fastest sprinter on the team, she could never survive practice, never refine her strokes, never compete in distances of 100 yards or more, always complained of shoulder tightness, badly sick before a Winter State meet, depression, loss of appetite, unable to fall asleep, falling grades, psychological "fogginess", social problems, anxiety, and more. You know the symptoms. The warnings culminated her freshman year of varsity swim in 2014. I watched her react very late to the starter's tone in the 50 FR and once in the water her arms moved sluggishly. There have been rare moments as a father when I knew that I knew something concretely about my children. That day, I knew. When she climbed in the car with me after the meet, she looked over with a couple of huge tears falling down her cheeks and said, "I must not be a very good swimmer." That was the first time I'd ever seen her anguished.*
>
> *I went home on a mission to find out what was wrong. I typed into the computer something to the affect of tall, female swimmer, something's wrong, tired. I found your works, and quite honestly, it was as if our daughter was your test subject and you wrote those works on fatigue for her. I can tell you I cried on the keyboard when I realized what had been done to her through ignorance, my own included. I used to ask her to tell me what kind of sets she was doing, but she could never remember them. Imagine my shock when I read your bit on rising ph in the chemistry of the brain and how it parallels memory loss in diabetic patients. She had countless missing assignments from school. She couldn't think. She couldn't remember. She didn't want to eat. She thought she was stupid. And the worst of it all, she thought she was to blame. It is difficult writing this email...remembering what she endured. I've had to stop several times. It was clear she had entered a catabolic state. She was a disaster caused by the cascading ripple effects of*

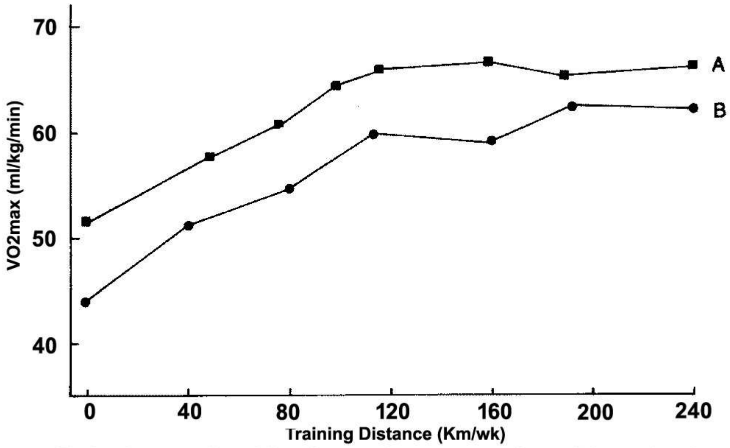
deep fatigue. Mile after mile in the water, weights in dry-lands, 3-4 hours a day for three years. You know the type of program; you described it perfectly in "Fatigue in swimming: The good, the bad, and the ugly".

Long-term exhaustion results from excessive work well beyond a microcycle. Even in USRPT it could occur primarily because it is such a huge challenge for a coach to monitor the states of all swimmers in his/her squad. Additionally, the symptoms of long-term exhaustion emerge slowly to the extent of dulling a coach's awareness of very subtle changes. To aid coaches to locate troublesome patterns and numbers of stress symptoms, the *DALDA* is a self-monitoring technique that requires swimmers to evaluate deviations away from normal day-to-day variations in reactions to the specific and general stresses of swimming practices (see Internet links above).

Training to Increase Fitness

A too-common belief in traditional swimming coaches is that the physical fitness capacities of swimmers can be changed by doing great amounts of or more intense volumes of swimming. Coaches who make that belief a cornerstone of their programs are likely to push swimmers into the Exhaustion Phase at various times in a year-round program. This occurrence is noticeable particularly in female sprint-abilitied swimmers and young people who have grown up to believe that if they do more work than anyone else, they will be better than anyone else. The self-driven hard workers are often the outstanding trainers in the pool but more often than not do not excel in competitions. There are also other reasons why swimmers *"fail"* in competitions while performing satisfactorily at practices, but overwork is one relatively easily recognized cause.

Figure 3.2. Changes in VO2max in the training of distance runners as a result of increased distance overloads.

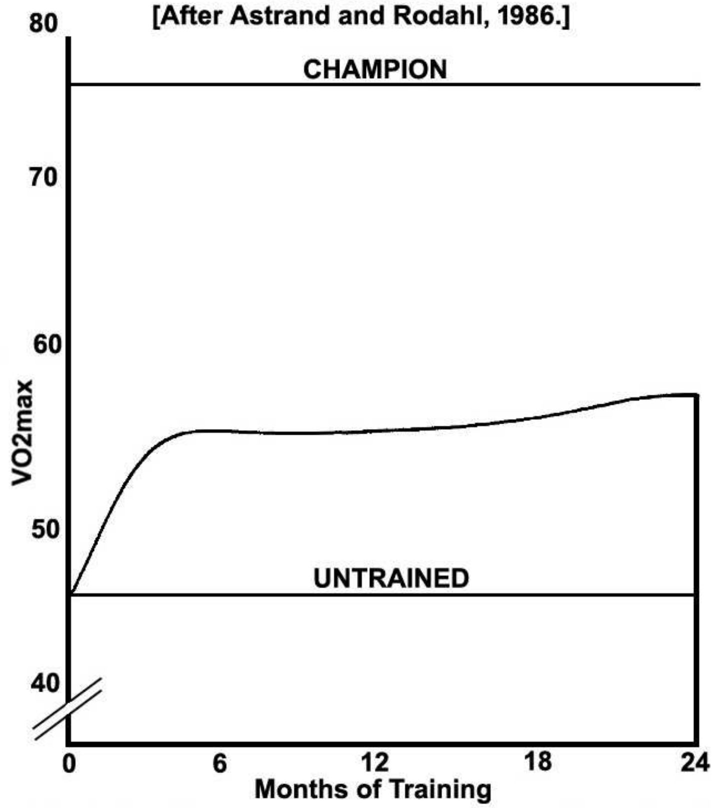


Further increases in training distance do not necessarily result in continued improvement in aerobic power (after Costill, 1986)

Professor David Costill (1986) presented data on two marathon runners who recommenced training after a six-month lay-off. Muscle biopsies and treadmill VO2max tests were conducted as they gradually increased their weekly distances. Figure 3.2 shows that there were significant increases in VO2max when they increased their training distance up to 40 and then to 80 kilometers per week. A subsequent increase to 120 kilometers per week produced maximal VO2 values. Running distances beyond this, such as to 160 and more kilometers per week, resulted in greatly diminished returns and no change in aerobic power/capacity. This led Professor Costill to conclude that the running distance needed for maximum endurance training benefits for the two subjects was between 100 and 140 kilometers per week. That range of distances is less than the current popular practice of modern élite distance runners. Although this example is for runners, it is a characteristic of training volumes that pervade all sports – *there is a maximum amount of training that can be done per week; any increase over that amount yields no further physiological capacity development.*

The work of Professor David Costill was with running. Studies in other sports have found similar phenomena. Astrand and Rodahl (1986) knew of the aerobic power (VO_{2max}) values of top Swedish cross-country skiers. Sweden has a history of producing the world's best distance cross-country skiers. They reported work with a normal aerobically-endowed untrained cross-country skier. For two years, the aerobic capacity of the skier was followed. Figure 3.3 illustrates the results of the case-study.

Figure 3.3. The trained level that is achieved (the "ceiling-effect") is markedly below the characteristic level of a champion endurance cross-country skier. No amount of training would raise the lesser skier's aerobic power/capacity to anywhere near that of the champion. [After Astrand and Rodahl, 1986.]



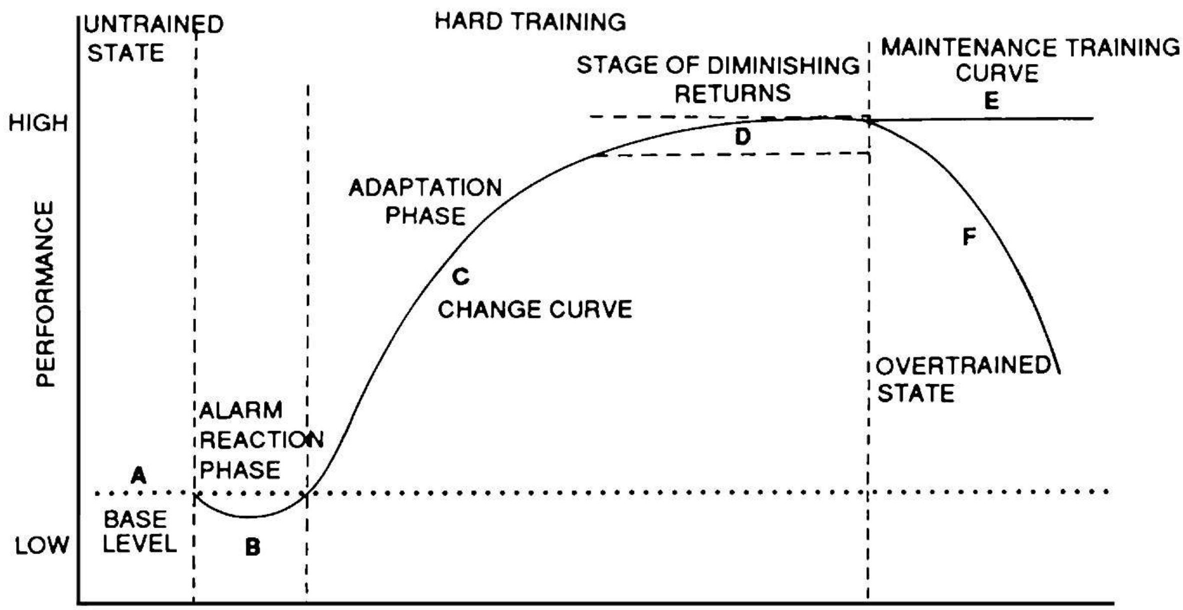
Within six months, the skier's maximum aerobic uptake value had been achieved. Further training failed to increase the VO_{2max} value further. Toward the end of the two years a slight increase in the capacity value was recorded but judged to be nonsignificant.

Implications of the Overload Principle are appropriate for increasing training loads until a certain level of adaptation is reached. However, the relationship between the magnitude of the training load and sporting success is not linear. Despite increasing the amount of training, there comes a phase of diminishing performance returns as well as the onset of the Exhaustion Phase.. Thus, improvements that can be expected from hard training in the early part of a season will be much greater than those towards the end of the season. As a season progresses, coaches are advised to spend more time on technical, tactical, and psychological skills rather than striving for further gains in performance from fitness (which could not happen).

Maintenance Training

Only a small amount of training overload is necessary to maintain fitness once a high-level has been attained. During the early part of 1965, the great Australian distance runner, Ron Clarke, toured the world and produced a series of world-record performances over a considerable time-span without involving himself in hard training. The competitive efforts and a few training sessions between them were sufficient to maintain the peak fitness he had attained prior to the tour. Another example of the ability to maintain peak fitness over a lengthy period without being involved in large amounts of traditional training was shown in the performances of the Russian National Swimming Team in 1978. After performing creditably against the East German team, the Russians traveled to the USA and two weeks later recorded a number of Russian national records in a dual meet against selected US swimmers. These were achieved without any demanding training between the two competitions. The same team then traveled to Canada and 10 days later set 17 Russian records in another dual-meet against selected Canadian swimmers. Those performance improvements were achieved without returning to sustained hard training. It seemed that the stimulating effects of hard competitive efforts and reduced interim training were sufficient to maintain previously attained fitness levels. After a high level of fitness has been developed, the same amount of hard training is unnecessary to maintain that level. A reduction in training frequency to about half to one-third is suitable for maintaining endurance capacity. Training intensity should always be maintained. It is possible that even greater reductions could be tolerated for strength and power activities. Selye's adaptation curve and the concept of fitness change and maintenance training is shown in Figure 3.4.

Figure 3.4. Training progression phases and alternatives.



Source: **Rushall and Lavoie 1983**

The state of training ***A*** is the base level of adaptation and performance in an untrained state. ***B*** is the reduction in performance capability that occurs in the Alarm Reaction Phase in the early phase of training. ***C*** is the performance change in the Resistance Phase of the stress adaptation curve, that is, the phase where fitness is changing (sometimes referred to as *"change training"*). The improvement in performance, within certain limits, seems to be directly related to the magnitude of the training overload. ***D*** indicates the phase of diminishing returns where further hard training does not result in commensurate gains in performance through fitness variables. ***E*** is the plateau phase where fitness peaks: further hard training would not result in greater fitness and may even push a swimmer into the Exhaustion Phase. This level of fitness is maintained by fewer frequencies of hard training sessions (usually termed *"maintenance training"*). ***F*** indicates the reduction in performance that would accompany overtraining if maintenance training was not instituted. This would have resulted if further elevations in the training overload occurred at stage ***D***. The graph illustrates two important forms of training. The first is *"Change Training",* where the results of training overloads produce changed fitness levels. Since the amount of change that can be achieved is inherently limited, it serves no purpose to maintain the frequency of loading that produced the change when no further change is possible. Thus, after as much change in fitness as possible has been achieved, the training emphasis is altered to focus on other swimming emphases rather than hard work (Rushall & Lavoie, 1983).

The aim of training should be to maintain the highest levels of performance possible. *Maintenance Training* requires different overloads from Change Training. There are a number of possibilities for maintenance training in USRPT. All possibilities sustain the race-pace levels (swimming intensities) and vary the frequencies of event-specific training segments so that the overloading factor that promotes change training is reduced and the state of maximum fitness is maintained.

1. Fewer training sessions with full USRPT programs. However, this could be contrary to the development of morning-evening performance training and week-long consistent performance training (see *Bulletin 60b*).
2. Reduce three-times-per-week event-specific training segments to twice per week for specialty events and once per week for non-specialist events. The released time can be used for Sprint-USRPT, surface-swimming techniques, and/or racing skill instruction. The normal number of practice attendances should be maintained.
3. Increase the number of half-sets for all events that have been trained. While this is an option it misses the opportunity to develop swimmers as USRPT intends – technique instruction first, psychological skill development second. Fitness will take care of itself with the reduced frequency of dedicated training segments in accord with the implications of maintenance training.
4. Mixing the above possibilities is an option.

The major decision that has to be made by a coach with regard to planning training overloads is whether to keep increasing the workload and run the risk of eventually overtraining/exhausting a swimmer, or to reduce the workload and maintain the fitness states and benefits for all the specific swimming events that have been attained.

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