STROKEARCS

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STRENGTH TRAINING

FACTORS AFFECTING STRENGTH

In a recent post on m.f.w, Mr Deadlift said, "Increased strength can come from two sources... Increased muscle size, and increased neuromuscular efficiency. I replied by saying "In my experience, strength can be augmented in many more ways than this, and in fact MUST be if you're ever gonna break any records! I then went on to list 38 factors (certainly not exhaustive of the possibilities) that affect strength. Some of the factors I listed are either so subjective that one can
only ponder their significance, or so new that hypotheses relating to their applicability cannot easily be made at this time. They are there simply to pique interest.

Further, I made it CLEAR that while not all of the listed factors can be anipulated, most can. Spector, in his typical tongue-in-cheek (easily mistaken for caustic sarcasm by some on m.f.w) fashion, pointed out that he had a problem with some of the factors. That's ok, considering the fact that his background is not the same as mine -- we all have our unique contributions to training methodology that we can make, which is why the m.f.w newsgroup exists. So, I will attempt to explain some of them, as I understand that not all of the people on m.f.w have similar backgrounds. We all, however, have a similar PASSION to lift -- and to learn -- no?

FACTORS AFFECTING STRENGTH

"Gotta go train" is a phrase heard by spouses everywhere. What does it mean? Save for the crafty pencilneck who uses it as a convincing excuse to go out carousing (the spouse is easily duped because his/her spouse is obviously in desperate need of training), it typically means going to a gym to lift weights.

Tch tch! Lifting weights is NOT training! It's certainly an integral part of training, but there's so much more. Let's lay down some simple guidelines as to how each of the factors affecting strength can be augmented. Let's concentrate on the critical factors, as they are the ones that will give most of us the greatest returns in limit strength and speed-strength for both immediate and long-term sports excellence.

Your job is always going to be to identify -- and apply -- those technologies which BEST augment each of the respective factors, and arrange them into a coherent, integrated training program for your sport. Perhaps then you'll see the wisdom of the opening paragraph ("Lifting weights is NOT training!").

Let me back up a moment, and consider the word "apply." How many times have I met lifters who know something is beneficial, but don't take advantage of it? This is sick! If you KNOW that massage following lifting is beneficial, then DO IT! If you KNOW that eating 5 or 6 meals a day is better for muscle growth, then DO IT! Even if it's only good for 5 pounds on total, it's WORTH it! That is, IF you have PASSION for what you do.

All of these factors can be augmented, manipulated or in some way made more efficient through various and timely applications of one or more of the eight "technologies" of training (defined below). Clearly, some are not alterable (e.g., fiber arrangement or insertion points of muscles). That doesn't mean you can't make use of your knowledge of this limitation in structuring your training, in avoiding less-than- fruitful practices, or in some way manipulating them to your advantage.

Bear in mind that many of the factors affecting strength are inextricably interrelated and may be directly or indirectly, positively or negatively, affected by your attempts to augment or in some way manipulate any of them, regardless of which technologies are employed in training. For example, long, slow distance running (aerobic) will invariably hamper your efforts to achieve maximum starting strength. There are many, many similar scenarios, and the wise coach or athlete will learn to avoid this often costly kind of mistake.

The eight technologies of training are the branches of science of greatest consequence to athletes and fitness enthusiasts alike. Each represents a different approach to solve training problems, and each has its advantages with respect to how effectively it will aid in augmenting any one (or more) of the factors which affect strength (listed above).

Remember that there are only so many hours in the day, so prudent use of the technologies that will yield the greatest returns to you are the ones you must opt for. The basic rule of thumb in choosing the technologies that will give you the most "bang for your buck" is to zero in on the most important training objectives for the training mesocycle you're in. Then, through a multiplicative approach that incorporates the concepts of "integration" and "synergy," you choose the methods that will get you to your goals most safely, quickly and to the greatest extent possible.

THE EIGHT TECHNOLOGIES OF TRAINING

1. Weight Training: Dumbells, barbells, fluids, pressurized air, elastic devices, springs, and the host of devices designed to provide "heavy" external resistance to one's musculoskeletal effort all constitute "resistance training."

Tradition has it that exercises designed to be performed with dumbbells and barbells (and the technologies designed to simulate traditional dumbbell and barbell movements) constitutes "weight training." The existing categories of weight training technologies are 1) constant resistance devices, 2) variable resistance devices, 3) accommodating resistance devices and 4) static resistance devices. New technologies will be developed in time.

2. Special Forms of Resistance Training: Running, swimming, calisthenics, aerobic dance, plyometrics -- there are many more -- all are special forms of "light" resistance training. When bodyweight alone is the source of resistance, tradition and reasons of clarity dictate that they be referred to by their individual names. Cycling, rowing, stair-climbers, and similar forms of training which utilize "light" external resistance collectively constitute a second category of light resistance training which are also referred to by their respective names.

3. Psychological Techniques: Self-hypnosis, mental imagery training, transcendental meditation and a lot of other "mind games" can help improve your strength output capabilities in sports and training.

4. Therapeutic Modalities: Whirlpools, electrical muscle stimulation, massage, ultrasound, music, intense light, and a host of other therapies can have a very positive effect on your strength training efforts, both indirectly (how quickly you can recover from your previous workout), and directly (greater force output).

5. Medical Support: Periodic checkups, exercising preventive care, chiropractic adjustments, and even clinical use of prescription drugs are sometimes indicated for athletes in heavy training when medical problems arise. Only qualified sportsmedicine specialists are able to prescribe such support.

6. Biomechanics (Skill Training): Performing your skill perfectly will almost always result in greater force being applied, whether it is applied to an object, opponent or the ground. Good skills execution involves the efficient sequencing of activation/inhibition of prime mover, stabilizer and synergistic muscles. Your sequencing efforts involve factors of position, direction, timing, rate, speed & effect of force application.

7. Dietary Practices: Athletes don't eat only to stay alive and healthy; they eat to excel at their sport. Their eating is designed to assist in achieving specific sports/training objectives. There are many nutritional techniques that will ensure greater force output capabilities both immediately as well as over time, thereby improving your training and competition efforts. Despite your most dedicated efforts, however, you will not be able to gain ample nutritional support from food alone, a point which has been supported time and time again in sports nutrition research.

8. Nutritional Supplementation: Most often, eating is not sufficient to give you all the nutrients you need in order to achieve your sports/training objectives. This point is widely disputed among sports scientists and nutritionists alike, who would have us believe that eating "three square meals" per day is ample fare for athletes in heavy training. They overlook at least three important points: 1) many state-of-the-art supplements are designed to take your body beyond normal biochemical functioning, 2) no one on Earth consistently eats "square meals," and 3) myriad research reports clearly show that deficiencies most often exist in athletes' diets for many well-documented reasons.

MATCHING TRAINING TECHNOLOGIES TO TRAINING OBJECTIVES

In your quest for fitness, your job is always going to be to identify -- and apply -- those technologies which BEST augment each of the factors that affect fitness, and arrange them into a coherent, integrated training program. Clearly, some factors are not alterable (e.g., fiber arrangement or insertion points of muscles). That doesn't mean you can't make use of your knowledge of these limitations in structuring your training, in avoiding less-than- fruitful practices, or in some way manipulating them to your advantage.

Bear in mind that many of the factors affecting strength and fitness are inextricably interrelated and may be directly or indirectly, positively or negatively, affected by your attempts to augment or in some way manipulate any of them, regardless of which technologies are employed in training. For example, long, slow distance running (aerobic) will invariably hamper your efforts to achieve maximum starting strength. There are many, many similar scenarios, and the wise coach or athlete will learn to avoid this often costly kind of mistake.

Remember that there are only so many hours in the day, so you must choose the methods of training that will yield the greatest returns to you. Zero in on your most important training objectives, and integrate the training methods that will get you to your goals most safely, quickly and to the greatest extent possible.

Matching Training Methods To Fitness Objectives

1. Muscle Fiber Arrangement: Sorry folks, nothing you can do about this one. You can, however, take advantage of your knowledge about how the fibers of each muscle are arranged. Some are made for speed, some for great limit strength, some for stability and some are made for all three. Train them that way! (Once in awhile, at least.)

2. Musculoskeletal Leverage: Nothing you can do short of radical surgical procedures will change your leverages. But, by knowing how best to take advantage of your leverage systems' structure, efficiency in lifting techniques (and thus your strength output) will be optimized.

3. Tissue Leverage: Interstitial and intracellular leverage stemming from fat deposits, sarcoplasmic content, satellite cell proliferation and the accumulation of intracellular fluid all provide a sort of "bloat" factor to your body. Believe it or not, the big boys in sport -- the super-heavyweights – can benefit in limit strength output from being "bloated." For the rest of you, it's not a tenable source of improved fitness.

4. Freedom of Movement Between Fibers: Adhesions and scar tissue between muscle fibers and between gross muscles can limit your muscles' ability to contract fully. Simple massage can reduce this condition.

5. Tissue Viscoelasticity: All of your muscles have a certain amount of "elasticity." That is, when you stretch them, they tend to return to their resting length. This tendency can be dramatically increased by rapid stretching, much the same as rearing back sharply before throwing a punch. If you rear back slowly, the muscles' natural viscoelasticity will not aid in the return movement.

6. Intramuscular/intracellular friction: As the actin and myosin myofibrils slide over one another as the result of cross-bridging, friction is taking place resulting in heat production. Fast movements create less friction than slow ones, and eccentric movements create far more friction than concentric movements. High friction during muscle contraction has a negative effect on force output.

7. Ratio of Fiber Types: Explosive athletes have fast twitch muscle fibers (Types IIa, IIb or IIc), and endurance athletes have primarily red muscle fibers (Type I). Proper training can actually enhance your muscle fibers' ability to do their respective job, although little can be done to convert one type to another type.

8. Range of Motion: Impaired flexibility stemming from either congenital factors, inactivity or poor training habits can limit the amount of force you can apply in many sport-related and training-related settings.

9. Freedom From Injury: An injury can keep you from your fitness goals. Even miniscule ones can nag you enough to prevent you from getting more fit. so avoid them!

10. Connective Tissue Structure: Tendinous and ligamentous mass and their structural characteristics all contribute to your potential strength level. Did you know, for example, that the collagenous matrix comprising various ligaments and tendons are susceptible to change through highly specialized training?

11. Stretch Reflex: Your muscle spindles -- highly specialized muscle cells which detect stretch -- react when stimulated by making your muscle contract involuntarily. This involuntary contraction can, if applied correctly, augment total force output to a small but significant degree.

12. The Feedback Loop: Your muscles' force output potential far exceed the threshold at which your brain tells them to shut down. It's easily changed -- lowered -- with weight training.

13. Endocrine System Functions (hormones): Your hormones ebb and flow according to little understood circadian rhythms. You can indeed control many of them, and doing so requires a full understanding of that circadian rhythmicity.

14. Extent of hyperplasia (cell splitting) or fiber fusion: As yet not totally confirmed is the notion that fibers (especially Type IIb fibers) fuse with surrounding satellite cells for greater hypertrophy. As for hyperplasia, there is no concrete evidence that it occurs in humans. In either case, there is no defined connection between either processes and greater strength.

15. Extent of myofibrillarization: The contractile elements within your working muscles are called myofibrils. Weight training increases the number of myofibrils inside each cell.

16. Motor Unit Recruitment: Firing as many muscle fibers as possible instantly is how speed is produced.

17. energy transfer systems' efficiency

18. extensiveness of capillarization

19. mitochondrial growth and proliferation

20. stroke volume of the left ventricle

21. ejection fraction of the left ventricle

22. pulmonary (ventilatory) capacity

23. efficiency of gas exchange in the lungs

24. heart rate

25. max VO2 uptake (ml/kg bwt/min)

Factors 17-25 are affected by training. Remember that they positively affect the force output -- footfall-per-footfall -- of the aerobic athletes acquiring them! This same form of training would NEGATIVELY affect the force output efforts of explosive athletes.

26. Freedom from disease: PREVENTION includes sound nutrition and medical support.

27. Arousal Level ("psych"): Psychological and psychosocial strategies can often aid you in training.

29. Ability to concentrate ("focus"): Your mind is said to be the master of your body. Again, psychosocial techniques as well as sound nutrition can help.

30. Incentive (motivation): In short, you've gotta WANT it bad enough to work for it!

31. Social learning: Overcoming learned inhibitory can be a monumental undertaking, especially in light of the fact than your Mamma scolded you for years not to lift something, run too fast or whatever -- because it'd hurt you.

32. Coordination ("skill"): Efficient movement involves carefully planned activation or inhibition of muscle contraction. Factors of position, direction, timing, rate, speed & effect of force application are all part-and-parcel to skill training.

33. "Spiritual" factors: Without becoming embroiled in a philosophical discussion regarding the merits of one religeon or another, my strong belief is that if you are spiritually at peace with your Creator, all things are possible. If you don't believe in and practice this in your everyday life, then how can your life -- and your quest for fitness -- even have meaning?

34. The "placebo" effect: Theories abound on this phenomenon, most citing various psycho-social factors. The effect is nonetheless real.

35. Equipment (use of "the best" available tools): Are you able to take full advantage of your body's leverage with crummy shoes? A bent bar? Poor equipment? ...the list is endless.

36. Environment (Temperature, humidity, precipitation, wind, altitude, etc.): Train in a cold gym? Does the high humidity get you down while training? Altitude training for aerobic athletes and hyperbaric training for strength athletes surely aid in performance.

37. Effect of gravity: Clearly, gravity exerts its influence on your force output efforts. You can't change that, but you can certainly take advantage of it! For example, putting a shot at around 45 degrees, the shot will travel further than if you put it at (say) 30 degrees. Another example: When you throw someone to the ground (wrestling), you do so with greater force than if you threw him in the air. Gravity assists (adds to the force of your effort) in both examples.

38. Opposing and assisting forces (e.g., opponent's efforts may add to your force output vis a vis Newton's three laws of motion): Get a guy moving in your direction, and you will find it more easy to throw him than attempting to do so while he is stationary. Myriad examples of this simple tenet abound in the martial arts and all other sport endeavors.

TRAINING PROGRAMS

INSTITUTIONALIZED OVERTRAINING

Overtraining has been of concern to coaches over the past few years since training loads have been increased to the point of often being excessive.

The avoidance of overtraining has been a central focus of sports science and sports medicine education . There are two common scenarios with regard to coping with overtraining in sports.

1. If a coach develops an annual plan that includes predicted periods of lessened training stress as a precaution to avoid overtraining or maladaptation, it is possible that athletes will come to expect periods of reduced strain. They usually learn th at they must have such "recovery" periods otherwise they cannot perform well.

2. If a coach frequently quizzes athletes about the symptoms of overtraining or maladaptation, it is possible that athletes will be sensitized to such symptoms and will exaggerate their slightest existence. In more extreme cases, they become neurotic and imagine the symptoms even though they really do not exist at a critical level. Athletes learn to be weaker rather than stronger in the face of continued exercise stress and overtraining symptom emphasis.

Both the above illustrations exaggerate the symptoms and onset of overtraining. The institutionally validated emphasis on appropriate symptoms and the state causes athletes to expect to feel stress symptoms, often in a neurotic manner. Some athletes even become obsessed with transitory and minor symptoms, particularly those which originate from stresses outside of the sport. That obsession often becomes strong enough to the point that activity is limited because of the way the athlete feels even th ough assertive activity may be the best therapy to alleviate the outside-of-sport stress symptoms themselves. Thus, the well-meaning coach who does not want to push athletes into excessive and unnecessary long-term fatigue states may actually be producing a counter-productive psychological state in athletes. An athlete's ability to work to the fullest potential is compromised by anticipations of the symptoms and fear of overtraining.

The term "institutionalized overtraining" is used to label this effect. That label recognizes that the origin of the complicating sensitization and expectation is derived from the directing body (i.e., the coach).
Modern coaching actually requires athletes to endure greater amounts of relevant work because the overall volume of training is still one of the most significant factors associated with sporting success.

Institutionalized overtraining is counter-productive to this aim.
To avoid its occurrence, the following steps can be taken.
(a) Do not plan periods of decreased overload for "recovery" purposes.
(b) Do not plan transitional training phases where fitness is partially lost.
(c) Instead, demand consistent high quality technical performance at practices. When performance quality deteriorates, allow athletes to terminate participation in that practice segment. This facilitates each individual's capacity to tolerate particular levels of strain, avoids performing in detrimental excessive fatigue states, and allows athletes better in-session recovery.
(d) The orientation of athletes is turned from trying to complete all training, to completing the greatest volume of quality training possible.

This is particularly beneficial for avoiding maladaptation and has the concomitant benefit of increasing the volume of quality performance and decreasing the volume of inferior performance.

(e) Since athletes are encouraged never to enter excessively fatigued states, the likelihood of their entering an overtrained state is greatly reduced. With that reduction, it becomes unnecessary to plan for unloading macrocycles.

(f) Athletes are continually challenged to do more quality training. The neurotic imagination of symptoms that happens with nstitutionalized overtraining is avoided.

(g) The success of this approach is dependent upon the sole criterion for cessation of a training stimulus: When performance decreases, despite a compensatory increase in effort, the practice item should be terminated.

(h) For the coach, the following decision making activity is appropriate:
i. Take note of the performance standard that is initially displayed in the training segment.
ii. When an athlete's technique begins to deteriorate note its effect on performance.
iii. When performance deteriorates despite increased effort on behalf of the athlete, terminate the athlete's involvement in that segment.

This procedure will stimulate athletes to perform the greatest possible amount of quality training while avoiding overtraining or excessive maladaptation. They will not become neurotic about overworking, but rather, will be encouraged to continually "push the envelope" of performance capacity by (a) overriding natural and/or cultural inhibitions, (b) increasing performance efficiency so that a greater volume of work can be accommodated given a finite performance capacity, and/or (c) increasing the volume of beneficial training and reducing the amount of irrelevant training. It is the last item that is perhaps the most important. Since an athlete has a finite capacity for exercise and performance, it is in his/her best interest to use as much as possible of that capacity in relevant training. Many modern sports programs are being side-tracked by "circus" training, that is, activities which have little to none to counter-productive relationships with intended competition performances. Examples of c ircus training are: attending "specialized training" camps where programs are not related to the long term program of development hopefully being undertaken by serious athletes; altitude training camps where the requirements for performance are altered fr om those required at sea-level; performing "test sets" of training stimuli which have no relationship to actual competitive performances; training with heavy weight programs when such activities have been shown to have little benefit for or relationship to performance and may even be the seeds of injury; competing in contests which do not fit with training objectives; and performing activities to indulge sports science "testing." These examples of dubious activities

which are creeping into modern trainin g programs all interfere with consistent training and detract from the opportunities to indulge in relevant activities. This alternative approach to training will not produce overtrained states because athletes should never be overstressed. Each training stimulus will terminate when its benefits (the repetition of a particular quality of work) are no longer evident. Even when outside-of-sport stresses are transferred into practice, the diminished capacity of an athlete on that day will be accommodated by this approach.

This procedure contrasts markedly with the consistently excessive training program, the extended program that eventually produces overtraining, and the neurotic expectation of overtrained states and symptoms. With the consistent expectation to perfor m with quality there may be no ceiling to possible performance improvement. This training orientation is very dependent upon the motivation of athletes to do quality training. It demands that if quality performances cannot be produced then recovery is the next best option. Large percentages of training time performing less than optimal exercises and technique would be forsaken. Some critics would claim that this description is a disguise for a high quality -- low volume orientation.

Nothing could be further from the truth. It is a method for generating the greatest volume of quality training. Appropriate motivation will be developed if contingencies that support quality performance are constructed. This most probably will need at least some behavioral goal to be set for every training segment, and at a minimum, perhaps a weekly evaluation of performance change (improvement).

Athletes need to have the incentive to constantly strive for the greatest volume of quality training possible. As soon as a below-quality performance occurs they are encouraged to recover rather than to persist with degraded quality

while accruing greater levels of detrimental general fatigue.

There are two high profile coaches who program this form of training.

Mike Spracklen, arguably the best rowing coach in the world, the current Head Coach of Men's Sweep for US Rowing, and Gregg Troy, the Head Coach of Swimming at The Bolles School in Florida, employ each ingredient of the model.

In San Diego, California, prospective members of the US Men's Eight-oar Crew train mainly in pair-oar boats. At most training sessions all crews row together and are able to see how they are faring in comparison to each other. That competitiveness i s an incentive to perform with quality. Each week, all crews perform a time-trial over racing distance.

Over time, those athletes with the best technique, physical capacity, and psychological strength will be identifiable. It is those athletes who will be selected for the USA's main boat. Within Mike Spracklen's program there is nothing said about athletes who drop out of a segment of a training session or have a practice off to have extra recovery. The system that finally locates the athletes with the greatest capacity to do the high est quality of race-simulation type training, will eventually discover those athletes with a lesser capacity.

It also should be recognized that Coach Spracklen also programs periods of moderate stress so that the volume of quality rowing actually perform ed in a season is extremely large when compared to other high profile rowing programs. This is not a "survival of the fittest" program for it is remarkable how many young men are able to adapt to the increased volume of high quality work, something which they have never before experienced.

Coach Spracklen goes further. He attempts to program training sessions which avoid excessive debilitating fatigue. Instead of falling into the traditional pattern of training early and late in the day with long sessions, he ensures opportunities for his rowers to get adequate night and between-practice-sessions rest. Recognizing that in a two-hour practice session it is usually the last half-hour that is of the worst quality but the greatest fatigue, he often programs three practice sessions a day, each being approximately one and a half hours. The detrimental latter portion fatigue of the two-hour practice is avoided, the less stressful shorter practices require less recovery between sessions, and so a greater volume of adaptive and quality training is performed each day and across the particular training phase.

The underlying feature of Mike Spracklen's coaching is the relentless pursuit of vast amounts of excellence in technique. No weakness is institutionalized into the US Men's Sweep Rowing program.

Gregg Troy attempts to extend the work capacity of his swimmers to their greatest levels (Rushall, 1994).

1. He does not allow his swimmers to ever lose conditioning. There are no days off for recovery.
2. During the winter he does not like his swimmers to enter many competitions. If there are too many races, then swimmers do not get the opportunity to "set up" properly for racing," which he implied, is an important skill and set of procedures.
3. Coach Troy's programs are long-term oriented. He wants his swimmers to compete well on only a few identified occasions. He stressed that it is of no value to sacrifice training for lesser level competitions.
4. Any recovery that occurs is done on an individual basis. There is no planned "team" recovery period.
5. During a taper or period of rest, Coach Troy and the athlete work together to determine the most successful course of training. He cited the example of how little work Greg Burgess does in the last week of a taper and yet he still performs well in races.

This alternative perception of overtraining, on the surface, appears to contradict popular approaches to the phenomenon. However, it is an improvement. Current practice usually has athletes working hard for the full duration of a training session. When the session is completed, usually because no more time remains, athletes are then released to recover before the next scheduled practice. There is no guarantee in this form of time management that: (a) athletes will recover between practice sessions ; (b) the total work of the individual practice session is beneficial; (c) the physical stimuli experienced are accommodated for each individual; and (d) athletes will not become preoccupied with tolerating general fatigue and its personal manifestations.

Those weaknesses are removed by this alternative approach to handling training stress and the phenomenon of overtraining. If a sporting program emphasizes overtraining and the fear of it, the ability to sustain quality training and to explore alternative methods for extending exercise tolerance capacities will be weakened.

TRAVELING

JET LAG: SYMPTOMS & TREATMENT

Symptoms

The feelings of disorientation encountered as a result of crossing time zones are known as jet lag. Symptoms include fatigue and general tiredness, inability to sleep at night, loss of concentration, loss of drive, headaches and general malaise. Jet-lag occurs when biological rhythms are disrupted as a result of rapid transitions across multiple time-zones. Such desynchronization of rhythms also occurs in nocturnal shift work employees who transfer to night shifts.

A classical rhythm is represented by a sine wave, fluctuations occurring cyclically about a mean value rising to a peak and half a cycle later dropping to a trough. Twenty-four hour rhythms are known as circadian (about a

day). An example of a biological rhythm is core temperature. We can find the characteristics of rhythms using the mathematical technique of cosinor analysis to determine the mean, the peak, the amplitude, and the time the peak occurs (the acrophase).

Circadian Desynchronization

Following a journey across multiple time zones the body's rhythms at first retain the characteristics of their point of departure. However, the new environment forces new influences on these cycles, the main factors being the time of sunrise and onset of darkness. The body attempts to adjust to this new context but core temperature is relatively sluggish in doing so. As a rough guide it takes about one day for each time zone crossed for body temperature to adapt completely. The individual may have difficulty in sleeping for a few days, but activity and social contact during the day help in accelerating the adaptations of the arousal rhythm. Thus arousal adjusts more quickly than does body temperature to the new time zone. Until the whole spectrum of biological rhythms adjusts to the new local time, the performance of exercise may be below par.

Allowing for individual differences, the severity of jet lag is affected by a variety of factors. In general, the greater the number of time zones crossed, the more difficult it is to cope. A 2-hour phase shift may have marginal significance but a 3-hour shift (e.g. British or Irish teams traveling to play European football matches in Russia or Turkey or a Californian sports team traveling to play on the east coast of the US) will entail desynchronization to a substantial degree. In such cases the flight times time of departure and time of arrival - may determine the severity of symptoms.

The severity of symptoms may be worse 2-3 days after arrival than on the day immediately following disembarkation. Symptoms then gradually abate, but can still be acute at particular times of day. There will be a window of time during the day when the period of high arousal associated with the time zone just left overlaps with the arousal high point at the new local time. This window may be predicted in advance and should be utilized for timing of training practices in the first few days at destination. Our observations on footballers traveling from Britain to the South Pacific indicate that morning training sessions suit players best over the first few days.

Such a practice has also proved successful for cross-country runners. The direction of travel affects the severity of jet lag. It is easier to cope with flying in a westward direction compared to flying eastward. In flying westward the normal cycle is temporarily lengthened and body rhythms can extend in line with their natural freewheeling period of about 27 hours and thus catch up. Observations on traveling to Korea (9 hours in advance of British Summer time) and Malaysia (7 hours in advance of British Summer time) are that periods of 9 and 6 days respectively may be inadequate for jet lag symptoms to disappear. In contrast re-adaptation is more rapid on returning to Britain. When time zone shifts approach the maximum 12-hour change, there may be little difference between eastward and westward travel. The direction of travel can be a relevant consideration when going from coast to coast to compete in North America. When going eastward the mean performance is depressed more and the peak performance declines more dramatically than is the case on traveling westward. The reason for westward travel being easier is because the natural period of circadian rhythms is greater than 24 hours, so each rhythm adapts more quickly when the day is artificially lengthened. Altering training times for a few days prior to travel to take into consideration the time of competition in another time zone is known to be beneficial.

Young individuals have a better tolerance to desynchronization of rhythms, owing to a better regulation of biological clocks. Physical fitness also seems to play a role: active subjects demonstrate higher amplitudes in existing rhythms than age-matched controls, a difference indicative of superior regulation. But other than these factors, there has been little success in attempting to predict good and poor adapters to long haul flights. Furthermore, the fact that an individual escapes lightly from symptoms on one occasion is no guarantee that he or she will do so again on the next visit.

Reducing Jet Lag

Scheduling Travel

If it is possible to do so, flights should be scheduled so that athletes arrive well in advance of competition. One day for each time zone crossed does leave a cushion of safety, even traveling eastward. The time for adaptation may be shortened by exploiting the external factors that reset biological clocks: rest/exercise, darkness/ light, meals and social influences. The key is to tune in straight away to the external influences of the new environment.

It may be beneficial to shop around to find the most convenient travel schedules. Consider departure from regional airports if appropriate and also alternative carriers. The routines prior to departure, on the plane, and after arrival, can be planned once the itinerary is

established. In consequence coping with jet lag will not be the hit or miss affair it might otherwise be.

Before and During Travel

On lengthy journeys it is unlikely that any maneuvers will eliminate jet lag, but with careful planning the symptoms can be attenuated. In the week prior to departure it may be possible to adjust the time of arising and going to bed, the adjustment depending on the direction of flight. An alteration of more than two hours is likely to be unproductive, since this would interfere with the pattern of social and domestic engagements during the day. Besides, the major synchronizer of human circadian rhythms--natural daylight--remains unaltered.

The evidence from simply altering time of retiring to sleep is that shifting the sleepwake cycle does alter rhythms in accord with the direction of the shift, but motor performance is compromised during the course of such adaptive changes.

Manipulating the sleep-wakefulness rhythm prior to traveling abroad to compete therefore may not be the best strategy. Once flight times are known, a routine on the plane may be planned. In day time flights it will be necessary to stay awake, keep mentally active and perhaps watch the in-flight movie. On long haul flights that entail traveling during the night it will be necessary to get some sleep on the plane. The timing of this should be decided in advance so that some meals on board can be missed. Transit or transfer episodes en route should be taken into consideration. It is a good strategy to set one's watch to local time at the next point of landing, once on board the plane: in a single haul flight this would be the local time of the country of destination. The important thing is that the traveler mentally tunes in to the new local time straight away and adjusts behavior accordingly.

To compensate for the dry air on board flight, copious rehydration is advised. Fruit juices are best, fizzy drinks should be avoided. Alcohol should not be taken, since it acts as a diuretic (increases urine production) and also affects the normal circadian rhythm in renal function. Caffeine in coffee also stimulates water loss, and its arousal effect on the central nervous system means it should not be taken if sleep is desired.

One suggestion is that the last meal prior to the time allotted for sleep should be high in carbohydrates and low in protein in order to induce drowsiness. Carbohydrates provide the substrate for serotonin, a neurotransmitter that regulates sleep. Caffeine and a low-carbohydrate high-protein breakfast would help raise the level of arousal and prevent a relapse into sleep.

Athletes may feel stiff or cramped because of their restrained posture on board flight. They can perform isometric exercises for arms, trunk or legs while in their seats. It is even better to walk down the aisle of the plane and occasionally do flexibility or stretching exercises at the back of the plane.

British sports teams traveling to Australia have used sleeping pills to induce sleep while on board. Although such drugs as benzodiazepines are effective in getting people to sleep, they do not guarantee a prolonged period asleep. Besides, they have not been satisfactorily tested for subsequent residual effects on motor performances such as sports skills. They may also be counter-productive if administered at the incorrect time. A prolonged nap at the time the individual feels drowsy (presumably at the time that he or she would have been asleep in the time zone departed from) simply anchors the rhythms at their former phases and so resists the adaptations to the new time zone.

Strategy upon Arrival

On reaching the country of destination a key factor is to fit in immediately with the phase characteristics of the new environment. Athletes should already have worked out the local time for their disembarkation. There may be other environmental factors to consider such as heat, humidity or even altitude. Having traveled westward, players may be allowed to retire to bed early. Early onset of sleep will be less likely after an eastward flight. In this case a light training session on that evening would be helpful in instilling local cues into the rhythms. Besides, there is some evidence that exercise does speed up the adaptation to a new time zone. For the first few days in the new time zone, training sessions should not be all-out efforts. Skills requiring fine co-ordination are likely to be impaired and this might lead to accidents or injuries if, for example, games players conducted sessions with the ball too strenuously. Where a series of tournament engagements is scheduled, it is useful to have at least one friendly match during the initial period (before the end of the first week) in the overseas country.

In this period of adaptation a few caveats are noted. Alcohol taken late in the evening is likely to disrupt sleep and so is not advised. The alternation of feasting and fasting recommended for commercial travelers in the USA is unlikely to gain acceptance among footballers. Nevertheless they could benefit from biasing the macronutrients in their evening meal largely towards carbohydrates. These would include vegetables with a choice of chipped, roast or baked potatoes, pasta dishes, rice and bread. These should include sufficient fiber to safeguard against constipation.

In the early days in the new country athletes should be discouraged from taking prolonged naps. A nap at the time they would have been asleep had they stayed at home would make subsequent sleep more difficult and retard the adjustment of the major biological clocks to the new regimens. Exposure to bright light, preferably natural daylight, is a useful antidote to drowsiness in such circumstances.

Taking drugs can alter biological clocks, depending on the time they are taken. Caffeine (in coffee) and theophylline (in tea) are stimulantsm of the central nervous system. Taken in the evening they would help in recovery after flying eastward and in the afternoon after flying westward. The minor tranquilizers, benzodiaepines, affect neurotransmitters that have a role in arousal. These include serotonin, noradrenaline, acetylcholine and gamma- aminobutyric acid (GABA). As already indicated,

they are effective in inducing sleep but not necessarily good in ensuring the state of sleep. Also hangover effects cannot be excluded, even in some so-called short-acting hypnotics.

Administration of melatonin, which is a pineal gland hormone, has shown good results in treating Scandinavian patients suffering depression in the winter. This clinical condition is known as seasonal affective disorder. The lack of stimulus from natural light for the pineal gland to secrete melatonin is a recognized cause of this entity. Prolonged exposure to bright artificial light has also proved effective in those patients. Subjects who took melatonin tablets on a trip from Britain to Australia experienced a reduction in jet-lag symptoms, improvements in sleep quality, and a faster readjustment of cortisol and melatonin rhythms.

These findings received further support from results of a simulated eastward flight across nine time zones. It seems that administration of melatonin in the afternoon or evening causes phase advances of circadian rhythms whereas a phase delay (required after a westward flight) results from administration at night or early morning. However, toxic side-effects of this substance cannot be discounted and besides, it is not yet readily available in tablet form.

There is also a suggestion that the amino acid tryptophan is helpful in coping with jetlag. It is a precursor of the sleep hormones, but there is no evidence that it improves the quality of sleep. Besides, it has achieved bad publicity in the early 1990s due to impurities being found in commercially available products and its use is no longer recommended.

It is more effective to use light or behavioral measures to resynchronize circadian rhythms. Natural daylight and bright artificial light help to increase or maintain arousal as well as contribute to returning endogenous rhythms. For athletes exercise is a powerful resynchronizor. It stimulates catecholamines and alertness. It is recommended, even on the day of arrival, except late in the evening local time.

Exercise at a light intensity is adequate for stimulating resynchronization of rhythmic characteristics as exercise that is too strenuous may disrupt rather than promote sleep.

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TRAINING METHODOLOGY

WORK HARD + RECOVER WELL = BEST PERFORMANCE TRAINING

Introduction

Training sessions are designed to bring about improvements in athletic performance. This is achieved in part through overloading the body systems. A potential problem with modern sports is that the increasing importance and international prestige associated with elite performance may pressure athletes to train harder and harder to an extent that they are more likely to develop overuse injuries, traumatic injuries, disease susceptibility (immunosuppression), over-reaching, chronic fatigue and overtraining (Fry et al., 1992a,b).

Exposing the athlete to levels of exercise stress that are slightly greater than those he or she has previously encountered within the training program has been termed overload training (Fry et al., 1992b). In order for athletes to adapt to the overload training stimuli, the training programme must allow adequate rest, and large

immediate increments in the degree of stress imposed must be avoided. Otherwise the athlete may enter an overtrained state characterized by fatigue and non-recovery from training sessions. A well-planned training programme may be the key to preventing overtraining, as it provides a system for including overload training within exercise tolerance levels and regeneration periods in proportions that will optimize training improvements and avoid overtraining (Fry et al., 1992a,b).

The purpose of this overview is to summarize the literature in the hopes of providing a solid framework for developing training programmes which must suffice until scientists can affirm or refute the ideas presented.

Fatigue from voluntary motor activity
Fatigue can be defined physiologically as the inability to maintain power output. To an athlete, fatigue is the insuperable need to reduce pace. The factors that contribute to fatigue from voluntary activity are numerous and interact in a complex multifactorial phenomenon.

Virtually every step in the chain of events that leads to muscular contraction has been studied under a variety of circumstances. The lack of a single factor inducing fatigue across the gamut of sporting activities points to the multitude of mechanisms that protect muscle from a relentless progression toward irreversible rigor (Kirkendall, 2000).

An underlying tenet in the exercise sciences is the concept of specificity. A specific type of training results in a specific type of physiologic response that, if performed repeatedly, will lead to a specific adaptation. The concept of specificity must also be extended to include fatigue: specific exercise also leads to a specific mechanism of fatigue.
The various mechanisms of fatigue in relation to voluntary activity can be summarized as follow: (1) central fatigue (neurotransmitters, nutritional aspects, choline/acetylcholine, brain dopamine, cytokines, ammonia) , (2) peripheral fatigue (neuromuscular junction, sarcolemma, excitation-contraction coupling), and (3) metabolic fatigue (exhaustion hypothesis of ATP, CP and glycogen; accumulation hypothesis of hydrogen ions, inorganic phosphate and ammonia) (Kirkendall, 2000; Wilmore & Costill, 1994).

Modelling training
The evolution of modern training methodology in both individual and team sports has been largely based on the periodisation of training volume and intensity. Despite this notion, here is no common theory of training processes that describes the type, the quantity, or pattern of a certain stimulus or a particular training program , which is necessary to achieve a given performance response for an athlete. The main knowledge is basically empiric (Steinacker et al., 1998).

However, in most endurance sports there is a consensus that training and performance are related by a dose-response relationship. Structural and functional adaptations in organs and muscles are the result of an optimal interaction between work and recovery. Improvements in performance are primarily achieved through a sequential increase in the volume and intensity of training, with a concomitant need for increased recovery and regeneration. In conceptual terms, the training stimulus can be considered as a combination of the positive (fitness) and negative (fatigue) influences of training on performance. An imbalance between training loads and recovery is a major contributor to the onset of fatigue, illness and overtraining in highly trained athletes (Morton, 1997).

Recovery
Recovery is that part of the training process where the benefits of training are maximized through practices which encourage natural adaptation to the training stimulus. Training hard and training smart are not always synonymous. Recovery is one of the basic principles of training, but is one of the most frequently forgotten in training programmes (Calders, 1996).

Recovery can be seen from two points of views: (1) training intervention strategies, and (2) behavioural and self-management strategies.

Training intervention strategies
The major factor influencing athletic performance is still training. Athletic performance improves as the athlete adapts to progressively increasing training loads. This structural and functional adaptations occur after training or during periods of reduced training, termed recovery or regeneration. It is essential that adequate recovery time be included in training programmes so that adaptations can be achieved. Different training methodological means are available to realize an optimal interaction between work and recovery. Numerous coaches and sports scientists have emphasized the benefits to athletes in planning and structuring training programmes in accordance with the principles of training (Individuality, Specificity, Disuse and Overload) (Wilmore & Costill, 1994).

Overcompensation
Adaptation to the training stimulus or workload is evidenced by improved performances. Positive adaptation to a training stimulus is referred to as overcompensation or supercompensation. If there is sufficient recovery before the next workload, the underlying system or fuel store stressed during training can improve its capacity to cope with the next stressor (Calders, 1996).

Planning and periodisation
Planning training (athlete's career, quadrennial plan, annual plan), in a well-organized methodological and scientific manner, is perhaps the most important tool in assisting an athlete to achieve success. The long-term training process must adequately prepare the athlete in all aspects of elite performance in his/her specific event. Systematic planning of athletic training has become known as periodisation (Rowbottom, 2000). Periodisation of training is the process that devides a complete training into distinct, smaller periods of training [(a) training units (individual training sessions), (b) microcycle (1-week blocks of training), (c) mesocycle (3-6-week block of training), (d) macrocycle (preparation, competition, and transition)] of more manageable size, each with specific performance or development targets (Fry et al., 1992a).

Periodisation of training is the process that has the potential, if used correctly, to assist coaches and athletes to optimise performance while minimizing the risk of overtraining.

Taper
Empirical observations and studies investigating fluctuations in performance indicate that structural and functional adaptations of organs and muscles occur during periods of reduced training, termed taper. Taper can be defined as the reduction of the amount of training during a variable period of time before the main competitions. The main goal during taper periods is to maintain the physiologic adaptations achieved during intensive training, while the negative impact of training resolves (Mujika, 1999).

Cross-training
Cross-training can be defined as: (1) the participation in an alternative training mode exclusive to the one normally used (i.e. not task – or sport specific); or (2) combining an alternative training mode with task-specific training. Both types of cross training are practised, with the intent of deriving a physiological and performance benefit similar to or better than exclusive sport-specific training. Cross-training has been recommended as an adjunct to sport-specific training for athletes wishing to improve performance or reduce the risk of injury, illness or overtraining.

For performance and aerobic benefits, cross-training with dissimilar modes would be effective for participants with lower aerobic capacity. The more highly trained individuals will profit more from similar-mode cross training (Loy et al. 1995).

Behavioural and self-management strategies
Adaptation to training is accelerated when fatigued functions are restored to normal operational levels as quickly as possible after training. Planning appropriate recovery activities as part of the training programme accelerates adaptation to the training stimuli by reducing the time it takes for an athlete to reach the overcompensated state (Calders, 996).

Daily monitoring of training and testing
Encourage athletes to maintain a daily training log to record training activities and loads, physiological responses, well-being and healthy status. Implementation in the planning of a regular program of performance, physiological and psychometric testing can help to avoid injury, illness and overtraining.

Personal hygiene and nutrition
Reinforce strict personal hygiene practices. Review dietary practices (fluid and fuel for recovery) and educate athletes on issues specific to training and competition. Adopt a balanced diet of macro- and micro-nutrients.

Recovery practices and sleep
Incorporate sufficient rest and recovery into training programs. Explore the full range of recovery practices including active and passive recovery, massage, and therapeutic support. Organize quiet and comfortable sleeping quarters. Allow time for adjustment to jet lag.

Summary
One of the basic principles of training adaptation is that performance improvements are achieved by progressive increases in the training stimulus. Unfortunately, many athletes may be prone to training excessively and incorporating insufficient recovery periods into their training programmes. Finding a balance in training programmes so that the best performance can be realized without the athlete breaking down has often been difficult because many athletes and coaches are unaware of the role and benefits of recovery. Training intervention strategies (overcompensation, planning and periodisation, taper, cross-training) and behavioural and self-management strategies (daily training log, physiological and psychometric testing, personal hygiene, nutrition, recovery practices and sleep) can be used to assist coaches and athletes to optimise athletic performance while minimizing the very real risk of injuries, illness or overtraining.

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Association of Rowing Coaches

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