The Updated Training Wisdom of John Kellogg

A collection of John Kellogg's writings spanning several years and many topics

Compiled by John Davis between May 2009 and April 2012
johnjdiv@gmail.com
http://runningwritings.blogspot.com

****

"Why do I pose as 'Oz'? Because I know which mission to assign to help runners discover their potential. But I can't give them any results through magical powers; I'm just a human like the little carnival man from Kansas. I can only guide them." —John Kellogg

Preface

The goal of this project was to compile as many of John Kellogg's posts on LetsRun.com as possible. I profoundly admire his training advice and his knowledge, and applying his principles to my own training brought me to new heights as a runner.

Why John Kellogg, and not any of the other highly-regarded figures in the running world who have posted on LetsRun.com over the years (Renato Canova, Nobby Hashizume, Jack Daniels, et al.)? Perhaps because of his mysterious, guru-like reputation, or perhaps because of the sheer difficulty of assembling the range of posts. I also felt that it had to be done, that it would be a great loss for this knowledge to fade into obscurity over the years.

John Kellogg seems to revel in the anonymity of the internet, and has posted under probably dozens of different "handles" over the years. In all likelihood, the writings here represent only a fraction of his total contribution to the online running community. Though his words sometimes fell on deaf ears, the power of the internet preserved much of his writing. My collection grew as I tracked down relevant posts by John Kellogg on the LetsRun.com message boards, mostly using Google to trawl for old threads. However, it is highly likely that I have missed many threads and am oblivious to many of his pseudonyms. But thus is the nature of scholarship. His writing style is very distinctive and hard to miss, and he is still using a few of his nicknames from time to time, so I've omitted them here in case he wishes to preserve his anonymity. But the volume of long, detailed posts has dropped off sharply after about 2007, so the time is long overdue for a collection of John Kellogg's posts to be put together. I have also added John Kellogg's articles written for LetsRun.com's main page and the contents of his long-defunct website, paragonrunning.com, which were retrieved using the Internet Archive Wayback Machine. I have only included posts that contained substantive training advice; he often posted short, witty responses to discussions on everything from drug use in sport to astronomy to classical music. John Kellogg also authored a chapter in Run Strong, Kevin Beck's 2005 book.

Sometimes, the context of the post is not clear, so I have added a few words or comments in brackets [like this]. I may or may not eventually rearrange the posts in some sort of by-topic scheme. I do, in fact, have a life outside of internet-guru scholarship, so the odds of that happening are not good. They are not arranged in any coherent manner as of right now, and I have not included any other posts from the threads in which I found them, unless John Kellogg quoted them himself. If you wish, a Google search of LetsRun.com for one phrase from a post in quotes will often turn up the entire thread. For example, to find the entire thread from which the very first post in this collection comes, Google **site:letsrun.com "The average high school runner adopts it unwittingly"**. Finally, I am indebted to Tim Galebach, whose 2003 collection of John Kellogg's posts from the old LetsRun.com message boards was the inspiration for putting together this project. His collection appears in Appendix C.

---John Davis, April 2012

Table of Contents:

This [Will Freeman's "diamond model" at Grinnell College] approach has been around a long, long time. The average high school runner adopts it unwittingly, since the less-than-serious high schooler doesn't normally come into the season with the base associated with the "pyramid approach," but instead starts doing a few 20-30 mile weeks near the end of the summer. An extremely prominent NCAA cross-country powerhouse (as well as a number of other universities) has used this basic scheme for decades, with most runners coming in fresh at 50-60 miles per week of mostly relaxed running and ramping up to 85-90 miles per week of predominantly strong aerobic running, touching more and more on the specific areas of fitness throughout the season and not reducing the mileage very much in order to taper. Tapering instead involves hitting the same speeds as on "hard" workouts, but using fewer reps or otherwise truncating the effort.

I used to call this the "tree structure" in the 1980s, since the addition of mileage and of specific workouts during a season resembled a thin "trunk" (fairly low mileage during the off-season, composed of basic easy running) which spread to various "branches" (more running with different types of workouts added) and slightly tapered again at the very top. But the term "diamond model" actually seems more fitting, since if its done correctly, the "base" of the diamond broadens faster than a tree trunk does, and the notion of a diamond allows you to talk about "facets" when you refer to types of workouts.

This model seems to work pretty well within the constraints of high school and college running and during the time frame involved (4-8 years). Not surprisingly, a bigger "diamond" (more running at all stages of the process) is better than a small one. Those less-than-serious high schoolers are usually employing a small diamond, but they still manage to round into shape near the end of the fall season. They often surpass some of the more serious runners who did put in the "pyramid model" base stage and who try to taper by cutting way back on mileage near the end of the season. On first inspection, this leads to a conclusion that the diamond model is basically more effective than the pyramid model. Stepping back to view an entire running career, however, reveals that regular inclusions of very extensive low- to moderate-intensity phases, as in the pyramid model but downplayed in the diamond model, is invaluable. The petering out of the "pyramid-trained" runners at the end of a season is usually a result of losing the fitness they achieved early when they do less running throughout the season (thereby providing too small a stimulus to even maintain what they had). Over-tapering just tops off the loss of fitness.

So which model should we adopt? It turns out that the best model of all for long-term development is one which I term "progressive periodization." This begins a career with a few diamond-type patterns, which makes use of the fact that initial gains in performance are heavily concentrated in increase of max VO2 and in running technique. Then the path follows an ever-widening series of traditional pyramid patterns, which include increasingly higher amounts of "base" running and which also include a few of the tapers (lower mileage and faster speed) that the diamond approach considers ineffective. These taper periods actually do turn out to be less effective for the moment, but the strict periodization allows for safer, more relaxed development of all the facets of running that are always done concurrently using a strict diamond model. Realize that "periodization" does not mean only long, slow jogging is done during the initial stage. Runners should stay in touch with short speed and somewhat faster aerobic running throughout, although emphasis is on relaxation and mileage. Attention should also constantly be paid to maintaining a relatively quick, light stride frequency, even on the easiest runs. This pattern of successively larger pyramids with less dramatic tapers is continued until the athlete can basically get by with a very small rest stage of a few weeks of down time (formerly, these stages were a few months of easier base building). Such a runner can rely more on maximum steady state running for aerobic development than the less experienced runner, who requires more easy running to relax, develop correct efficiency of small motor neurons, and recover sufficiently, and who can still access glycogen at slower speeds.

The most experienced world class runners never seem to have periodized stages; instead, they are always a few weeks away from a good race. Becoming that type of runner, one whose default fitness level is

extremely high, doesn't usually happen overnight. It may take many years which include stages of that lower-intensity development, which means some more traditional periodization is needed in the formative years. The diamond model fits well within the high school and college setup and can be used later in a career as well, but its effectiveness (and that of any model) is amplified over time with the addition of some huge base periods.

--*

Drills are actually best as a preseason or early season prelude to fast hills. Nearly every benefit that drills and weights supposedly bring to your running can be accomplished *better* by running short, fast hills. Regular easy to medium speed runs which include hills are also advisable before phasing in fast hill reps.

What drills (if properly done) can do for you is help you relax and gain some initial neuromuscular properties which will let you get more out of your hills when you start doing them. Three main purposes of fast hills are 1) to create a quick pre-stretch of the ankle (which enables a more explosive toe-off), 2) to accentuate the "drive" phase (i.e., exaggerated hip flexion and extension) and 3) to create a high intramuscular pressure on the blood vessels in the legs, which in turn forces the heart to work harder, precipitating left ventricular hypertrophy.

Most people find it difficult to jump right into fast hill work without having some weakness in the qualities needed for effective hill sprinting. Usually, this shows up as either too great a forward lean (into the hill) or as a tendency to remain in the "plant" phase too long on each step (kind of "sinking" into the hill with a plodding feeling). It is desirable to *reduce* the time spent in the plant phase, since the faster your eccentric pre-stretch is, the more explosive your toe-off will be.

You want to "pop" off the ground when doing hill sprints. The best way to prepare yourself for doing this on a hill is to *first* become comfortable with similar recruitment patterns on a level surface. That's why some "body weight" exercises (which stress eccentric loading and balance) and some loose, relaxed form drills are good precursors to more stressful hill work. Sprinting - especially uphill - requires a complete summoning of motor neurons (all the slow twitch fibers and all the fast twitch fibers are recruited), so becoming adept at the basic motions involved allows you to relax a bit more when doing the real thing.

Running economy (the amount of oxygen required to sustain a given pace) is a term which has been in vogue for some time. One factor in improving running economy (though not the only factor) is reducing ground contact time. Think about it - if you remained in your plant phase for a full second on each step, you'd be "frozen" in place, standing on one foot, and your forward propulsion would be *noticably* worse. Similarly, if you had zero horizontal component to your toe-off (drive), you'd be running in place and would squander energy while never achieving any forward velocity. Since running economy is a measurement of velocity relative to oxygen uptake, your economy would be horrendous! These are rather extreme examples, but even if you reduced your ground contact time and translated it into forward propulsion by 5/1,000ths of a second per step, you'd chop 5 seconds off your time in a 1,000 step race, as long as your other aspects of fitness reamined the same. It's a good thing, therefore, to develop an explosive yet efficient stride.

There is no need to do drills more than three times a week. Training is definitely a *refined recipe* of ingredients, not a mere *mishmash* of ingredients, so you want to get the right formula. You can use the drills as part of a warmup prior to a fast workout or as an adjunct following a fast workout. Either way is fine, but there are times when it's better to do them in the warmup and other times when it's better to do them after the other fast work.

Squats are a completely closed-chain exercise which involve more compressive force and recruitment (emphasis on number of motor units involved) rather than rate coding (emphasis on frequency of movement within a given recruitment pattern). Talk about prolonged ground contact time! While maximum force squats are probably helpful for those who specialize in events no longer than 400m, as the race distances become longer, economy depends more on the contribution of aerobic metabolism. In fact, running economy is normally defined by measuring oxygen consumption at speeds which maintain a steady VO2, although energy costs (in terms of caloric expenditure) can also be *estimated* for faster speeds by measuring the amount of lactate produced.

Improvements in flat-out short sprint speed may certainly be made from increased recruitment due to pure strength, but improvements in *economy* from explosive strength training are due to neural adaptations rather than muscle hypertrophy. Thus, the need to effect an increase in maximum *force* in the muscles being trained is negligible. If you wanted to use a form of weight training to improve running economy, you'd be better off replacing those aforemetioned squats with *rapid* leg presses.

If hill sprints are done for the recruitment rate effects, other exercises used in the Paavolainen explosive strength training paper (i.e., plyometrics, ballistic weight training, flat sprinting) as well as proper drills need to be done (particularly for distance runners not routinely doing weekly track sprints) so that ground contact time does not become longer due to slower neural patterns.

This concept is mostly true. Uphill work should not *replace* level-surface speedwork. You need to do that, too. You may also benefit from some fast strides on a gentle *downhill*. This will certainly improve your recruitment rate with a full (or even exaggerated) stride length. But uphill sprinting is unquestionably an effective workout procedure if used 6-8 times during a one-month stretch in the early part of a season. Plus, if you are a cross-country runner or a roadie, running fast uphill *is* an action you will probably replicate in actual *competition*. Even though the recruitment pattern is slightly different than that used in level-surface track racing, you'd best prepare yourself sufficiently.

We need to remind ourselves that all this "neuromuscular facilitation" stuff is only ancillary work and constitutes a minor aspect of the overall recipe for success.

Drills and hills should be included in the same manner as sprinkling a pinch of salt on food rather than pouring on an entire mound. Remember, salt by itself is not very flavorful, and adding too much can ruin a meal, but the right amount is both tasty and nutritious. The meat and potatoes of this sport is *running*. Drills and hills can only *enhance*; they can never provide the *substance*.

Getting the *perfect* amount of drills and hills in your recipe is about as important as wearing the right type of shoe for the surface you'll be racing on. You're obviously better off if you get it right, but it won't make you a *fit* runner if you're currently *unfit*.

You'll never do any of this perfectly, anyway. People aren't machines. Moreover, some people will benefit more from certain aspects of drills than others will. Some runners with choppy strides, for example, may achieve a slight boost from performing drills which emphasize the drive phase, whereas some runners with long levers for legs may have loping strides and could stand to use drills which target rapid movements. Others cannot seem to eliminate tension when changing gears or when they encounter hills on the course, and they may need to spend more time on the simplest drills (which make relaxation easier to achieve) before moving on to more advanced ones.

--*-*-*-*

Weekly mileage of 100 is not high. It's moderately high for a freshman in college, but nothing over the top. But the number itself shouldn't be the goal. Getting in better shape in the idea. If you need a few days

or a couple of weeks lower, take them. If you feel good and can do a little more, why not?

You will only decrease your economy if you allow your stride frequency to deteriorate into a slow, loping or plodding gait, letting yourself stay in your plant phase too long. You could fall into that trap at any weekly mileage if you don't do something about maintaining a light, quick turnover. So 100 miles per week or 150 or whatever doesn't automatically reduce running economy. Some short strides a few times per week, concentrating on rapid turnover, along with keeping a fairly fast frequency even on easy runs, will preserve your economy. If you do those simple things, you'll actually improve economy by running more, since the constant repetition of lower-intensity movements will improve the function of muscle fibers responsible for fine motor control, eliminating wasted motion and unnecessary tension.

Another way to improve running economy during "high" mileage periods is to toss in a Fartlek workout every week or two in which you barely touch on some longer "speedwork" by doing 4-6 reps of 1-3 minutes at a time at 3k to 5k race pace, taking pretty much complete recovery between reps so as to feel fresh and avoid struggling, which would promote tension and improper mechanics. These Fartlek workouts should be pretty easy. The racing season is a few months away, so just get familiar with the kinds of speeds you'll be running later for long enough segments to maintain some sort of rhythm (with a stronger breathing pattern and higher heart rate than you have on normal runs) and don't hammer anything yet.

Running economy is a measure of the energy requirements needed to sustain a given pace.

When the effort is stablized at a steady VO2, the aerobic component of the energy demand can be found by measuring the VO2. The lower the VO2, the better the economy is for that pace. Since glycogen supplies more energy than fatty acids per unit of O2 consumed, it is the preferred energy substrate for higher workloads. Since 5.0 kilocalories of glycogen substrate are utilized for each liter of O2 consumed, the actual glycogen requirement for the aerobic demand of a given pace can be estimated. Figuring in the contribution of fatty acids or amino acids would be more problematical, requiring the respiratory exchage ratio to determine the percentages of CHO and fat which are being used as substrate, but running economy is normally determined by measuring the VO2 for a given pace. A runner who requires 48 ml of oxygen per minute per kg of body mass to sustain a pace of 16 km per hour has a better economy at that pace than the runner who requires 54 ml per kg per minute at the same pace. Economy can also be expressed in VO2 required to cover a certain distance in a certain time. If you took 3 minutes to run one kilometer and maintained a VO2 of 60 ml/kg/min in doing so, your economy could be expressed as 3 x 60 = 180 ml/kg/km.

Note that mechanical work accomplished and running economy are not necessarily synonymous; if the mechanical work is not translated into forward propulsion (velocity), and energy is wasted, running economy is lower. This may be due to vertical oscillation or excessive knee or ankle flexion, causing a great deal of work to be done with a possibly low VO2, but not a very fast pace to be sustained at that VO2.

Running economy can theoretically be evaluated at efforts requiring a high anaerobic demand. In measuring lactic acid produced and O2 saved by glycolysis, energy expenditure is roughly 220 calories per gram of lactate formed. Measuring this would be an invasive process, however, and is impratical, so running economy is normally measured at speeds below the respiratory compensation point, where the VO2 remains steady long enough to attain accurate and meaningful measurements.

Hope that clarifies a few of the fundamentals for the "n00bs" out there.

Anything else you want to know about it - and I do mean anything - stay tuned.

--*-*-*-*-*

Why did I prescribe rapid turnover work to improve economy?

Well, remember how I said mechanical work and economy are not necessarily synonymous? **Efficiency** is the percentage of chemical energy converted to mechanical work. Running economy refers to ... running ... (no surprise there), so it is a measure of energy converted to **forward velocity** (which is not always a direct measure of work), not energy required to bend your knee while standing on one foot or to wobble from side to side or even to run in place with an extremely fast cadence. Ergo, you would like to eliminate those wasted motions as components of your running mechanics. A slower, lazier gait contributes to poor running economy.

This is partly because prolonged ground contact (support) time usually contributes to greater vertical displacement, which in turn increases mechanical stress from jarring during the plant phase (this increased orthopedic stress results in increased metabolic cost), reduces forward (horizontal) propulsion, and increases the overall running time simply as a result of staying fused to the ground longer with each stride. Overbending the knee during the plant phase also contributes to wasted effort, since more time is required to straighten the leg during the drive phase. Basically, what is desired is a rapid eccentric load followed by a forceful drive, enabling you to pop off the ground quickly but avoid an excessive vertical component. Running short, fast, relaxed strides or near-sprints is the best exercise for developing this trait.

Why did I advocate running more?

For a given running velocity below the lactate threshold, higher frequency with lower power generation invokes more Type I (slow twitch) motor units and results in increased running economy. Slow twitch muscle cells have greater oxidative capacity, although oxidative properties can be acquired in fast twitch units. Runners who exhibit predominantly slow twitch characteristics generally have better running economy at speeds below the lactate threshold. Not surprisingly, running economy as measured by oxygen uptake is more important in longer distances (and is a better performance predictor for those distances) than it is for shorter distances. Also, the amount of time you spend at a given speed, as long as the effort is not so frequently intense as to invoke wasted motion or tension, has a great bearing on your economy at that particular speed. Middle distance runners like Joaquim Cruz have exhibited extremely high economy at 4:20 per mile or faster, while marathon runners exhibit excellent economy at 5:00 to 6:00 per mile, but each group's economy becomes worse relative to the other group when running at the other's preferred pace. This, of course, is borne out in race performances as well as in measurements of economy.

Runners with natural talents for middle distances will normally see almost immediate benefit to their oxidative capacity by doing increasingly larger volumes of slow running during a "base" stage, as long as they stay in touch with short speed and explosive strength drills. Natural long distance runners, however, probably need to introduce a somewhat faster normal "easy run" pace since they already possess oxidative properties in their muscle cells, and a very slow pace would only require fat metabolism, which would produce little stimulus for improvement in the oxidative capacity of most muscle fibers.

A relaxed but relatively rapid stride with near-perfect stability is ideal for converting energy to forward velocity. Long distance running fosters the development of the smallest motor neurons which control

stability and also have a high capacity for endurance.

Why did I say to incorporate Fartlek runs of gradually increasing intensity?

Improving lactate clearance via the monocarboxylate transport system can increase economy by virtue of use of lactate as a fuel, which reduces the load of oxidative phosphorylation. Certain muscle fibers can be trained to use a higher percentage of lactate for aerobic power. Your "engine" uses both aerobic and anaerobic metabolism in a different balance than the next guy's "engine," but you need to ensure all systems are working together in the ideal balance. To do this, you must possess some ability to process lactate as a fuel, so you can siphon from the aerobic tank and the anaerobic tank simultaneously.

--*-*

Somebody like jtupper will have the inside scoop on most of the physiology and heredity behind this stuff, but I'll get the ball rolling.

It is said that VO2 max intervals really help most by increasing your heart size. Is this true? Or does it increase blood volume which forces your heart to be bigger?

It's from working at maximum stroke volume. This induces hypertrophy of the left ventricle. See below. It takes about 9-14 days post-workout to begin to realize the improvements, but a small volume of work at the pace normally associated with sustainable VO2 max can be done up to 3 days prior to an event to maintain coordination and to briefly activate the heart and respiratory muscles so as to feel in the groove on race day.

Is a large heart the most important determinant of VO2 max?

Make that a large, powerful left ventricle. The left ventricle powers peripheral circulation, while the right ventricle directs pulmonary circulation. The size and strength of the left ventricle is probably the main determinant in stroke volume - and, by extension, VO2 max - but other factors, such as capillarization, mitochondrial and cytochrome enzyme activity, number and size of mitochondria, etc., can obviously affect O2 extraction from the blood.

What things limit how large your heart can grow?

You'd probably have to go all the way to hereditary facters and mRNA to get to the bottom of this one. Some people can have abnormally enlarged, albeit (sorry, that should be "although") unhealthy hearts, whether from cancer or drug use or other troubles. So at some stage, a heart can be too large. Normal bodies tend to protect themselves from this state by making minor adjustments in other ways. You obviously can't train yourself to an ever-increasing heart size or strength, just like you can't keep getting better at bench pressing to the point of being able to bench press the great pyramid at Giza. So don't worry about it. Just run and let the improvements occur as they will.

Can you be a decent endurance athlete if you don't have room in your chest for your heart to grow? (i.e. if you have a small or sunken chest). Can a small heart compensate by beating faster?

Apparently, beating faster is exactly what happens. I've known elite endurance athletes whose max HR was around 224 bpm. They probably had smaller than average hearts.

Once your heart has grown to it's maximum size, does it make much sense to do VO2 max intervals anymore (other than as occasional maintenance)?

Yes, it does. If you continue to improve other areas of fitness, which contributes to a better baseline pace for any level of energy requirement (a.k.a. improved running economy), the speed which elicits VO2 max can also become faster. By spending more time at this new speed, you will accelerate mitochondrial biogenesis, enzymatic activity, and monocarboxylate transport isoforms in the muscle fibers doing the work at the new speeds. You also become more economical (use less energy) at the faster speeds by spending more time at those speeds.

I've heard that VO2 max is reached fairly quickly in one's career and then levels off but other factors continue to improve for 10 years (like threshold etc). Wouldn't this seem to prove that your heart stops expanding and is limited fairly quickly by something?

Running economy generally continues to improve for several additional years after other physical markers level off. This is most likely due to cumulative repetition of the activity.
Rather than worry about maximizing the variable called running economy, focus on improving the variable called performance.

The way economy has traditionally been evaluated is by measuring oxygen uptake to estimate the energy required to run at a certain pace. But we all know energy is available from many sources, and new information is always forthcoming about how these energy systems interact. For example, increasing expression of the monocarboxylate transporters (MCTs) can reduce the load of oxidative phosphorylation by making it possible to process more lactate as fuel. Developing a more efficient stretch-shortening cycle can also reduce the energy cost per footstrike. But how much attention do you need to give to each of these factors and will this particular combination of efforts produce a tenable end result? If by fixing a weak link in your chain, will other links rust out from lack of attention? Is it even possible to make them all strong at once?

It can become complicated to try to piece together the answers by scrutinizing each part so closely at the risk of ignoring the whole. In fact, no one will ever get it right using this approach. It's like trying to copy artwork by taking the approach of examining each square millimeter of a masterpiece with a microscope to reveal "important new findings" about the mixture of oils and the texture of the canvas and the brushwork, usw., all the while not ever stepping back to look at the picture to even see what the subject is!

You can improve your **performance** without improving your economy as measured by oxygen uptake. You **will** be improving your ability to translate energy potential into velocity, but it might not come as a result of lower oxygen uptake at that velocity. Muscle cells often have different innate characteristics and people also have different structural traits, all of which allow runners to use their internal engines and access neural pathways in slightly different fashions to move at a given velocity. So over time, you must work at a **wide spectrum** of speeds and durations in order to truly improve "economy," and to maximize **performance** (the ultimate indicator of success), you must obviously spend some time at race pace to become better able to cope with it both physically and psychologically.

Also remember it is the recipe, not merely the ingredients, that creates the finished product.

--*

For high school runners, it is easy to overdo the work done at race pace. Remember how I said "... over time, ..." a few sentences above? Young runners or beginners will improve maximal oxygen uptake quickly just by virtue of running, period, and will expedite the process by running a weekly race of 2 miles to 5k. So they have many seasons (or perhaps years) to develop to their full potential; hence, a full-fledged workout of medium distance reps at race pace (e.g., 5 x 1,000) once a week might be overkill at this stage. Sure, they're young and are high in testosterone and growth hormone and they'll recover adequately in the short term (a season), but it's fine to merely touch on that type of pace here and there with a few 2-3 minute segments. Most of their time can be spent going longer at a relaxed pace (but avoiding a low stride frequency), with the "hard" days involving short strides and drills or stronger (but not laborious) aerobic running. Strong aerobic running can be done continuously as a "progression" or can be broken into segments with short rest periods (about one-fourth to one-third the duration of each run period) and should still be done slower-to-faster most of the time. Rarely should this involve struggling or extreme hyperventilation. A workout involving mainly strides and drills can also include a few reps of 2-3 minutes each at slightly faster than 2-mile race pace. Those fundamental elements of running are sufficient at that age. As long as they're getting generally fit, they'll race themselves into racing shape.

--*-*-*-*

Faster speeds are actually preferable for mitochondrial development, as long as chronic acidity doesn't result.

A faster pace also normally necessitates quicker stride frequency, which (along with the high volume of running done in the workout) contributes to improved running economy at most speeds, but particularly at speeds near those used most often in training, again as long as chronic acidity is not an outcome.

Another benefit of the faster pace is the greater likelihood of **briefly** exceeding the lactate threshold on many of the reps, effecting an increase in monocarboxylate transporters (MCTs) - specifically the MCT-1 isoform, which is instrumental in the reuse of lactate as fuel in the "fast twitch oxidative" or Type IIa muscle fibers employed during middle distance running.

Of course, the great risk with high-speed repetition running is that chronic acidity **will** result. It is extremely easy to abuse a system involving a great deal of moderately fast to very fast speeds. You are correct that this approach is a quick fix. But if you somehow hit on the right speeds for your own talents and can find an adequate recovery scheme, it can be a **very good** quick fix. This is apparently what happened with Ryun, at least up until the point when his ability to recover was finally exceeded. In fairness, though, most of us, regardless of how we approach things, manage to overtrain at some point in the search to find our limits.

But perhaps he was a precocious athlete who matured quickly as a runner and would have peaked in his early 20s in any event. Having said that, I'm pretty confident Lydiard's program would have allowed him to have a longer career and an even higher peak than he ever actually achieved, had he handled it structurally. But how are we to know if a protocol involving more continuous running at slightly slower speeds would have been a plan Ryun could have withstood from the standpoint of mechanical stress? For Ryun, more running at those slightly slower speeds might have contributed to lazy stride mechanics, longer time spent in the plant phase, slightly more exaggerated knee and ankle flexion, poorer economy

across the spectrum of running speeds, and increased risk of injury. There are a few things he could have done to reduce the likelihood of those maladies, but it's unlikely anyone at the time knew about them or how often to incorporate them (one is a conscious attempt to maintain a quick stride frequency even on the slowest runs; another is use of some running drills which promote a short time spent in the plant phase and increase the explosiveness of each footstrike).

The bottom line is that running was still in a more experimental stage in the 1960s. Training an athlete with the phenomenal abilities of a Jim Ryun represented uncharted waters. But history has shown that, at least in the pioneer days, the people without charts have often been the ones who have gotten the farthest. And we can all agree Jim Ryun got pretty far.

--*

Oh, I didn't mean to imply that at all. Timmons might have applied the best knowledge **he** had available or was willing to use, but the chances that routine was the best one for ultimate career development are rather slim. Though there are no guarantees, a program which allowed more continuous easy running and prioritized periodization probably would have prolonged Ryun's career, which would have given him more opportunities to race, reload, and perform at an even higher level.

What I did say is that Ryun's rapid rise, though perhaps costly later on, was probably good for him at that time in track history. I also stated (or implied) that a lot of his faster running was predominantly aerobic. For him to run 10 miles worth of repeat 440s at 85% of his PR mile pace with rest periods is little different than a 4:30 miler running an equal number of 380y (347 meters) reps (average time duration of 69 seconds each) at about 5:20 mile pace. It's not too stressful in terms of anaerobic demand. In the same vein, 5:30-6:00 mile pace on the off-track runs represents about 67% to 72% of Ryun's top mile speed. For the 4:30 miler, a comparable effort would be at 6:15 to 6:42 pace. That's not jogging, but it usually isn't damaging in the short term. In fact, it's normally helpful in the short term to provide some sort of aerobic pressure like that.

I'll reiterate, though, that I do think for the **long** term, Ryun probably didn't get adequate recovery and therefore hammered himself into the ground at some point. I believe that's the notion you're also trying to convey.

--*-*-*-*

Use stuff like 6 x 1:00-1:30 or 4 x 2:00-2:30 once every two weeks [prior to more targeted VO2 max workouts on the track]. Take full recovery. Each one should feel better than the previous. Run them comfortably fast but never tie up. The time durations don't have to be exactly predetermined, either. So if one starts getting hard after 1:17, just stop it there. Do 6-10 minutes worth of running at those speeds. It won't make a huge change in your ability to process oxygen, but it might influence it a little. What you're mostly looking for is getting comfortable and efficient for a couple of minutes at a time, while you're breathing strongly and your heart rate is reasonably high.

Don't forget to do short strides every few days throughout the preseason. It's important to get efficient before you do anything longer.

--*-*-*-*-*

Hence, we time things. We have performance depth charts to see where we stand against both our contemporaries and our predecessors and to set qualifying marks for the more exclusive meets. And we also have those "silly" conversion charts which attempt, albeit imperfectly, to measure the quality of a performance against those achieved in different events. It's in our nature to question whether Steve Scott's mile record is actually a better performance than Jim Ryun's former record run on a cinder track. We also wonder if Muhammed Ali was a better boxer than Mike Tyson, Evander Holyfield or Lennox Lewis. In boxing, the question of who's the all-time best is virtually pure speculation. In track and field, we have objective measurements available to help us make our speculation a bit more scientific. There are some excellent statistical methods for comparing performances in different events, as well as methods which give a pretty good idea of how much people tend to slow down as the race distances get longer. And enough people have run on both cinder and all-weather tracks that the guesswork in comparing times on the two surfaces can at least have some reasonable ballpark numbers to back it up.

A conversion chart is just an attempt to provide a kind of Rosetta stone to "translate" performances. Certainly you can determine how you stack up aganist the competition in several different events by racing people in all those events or looking at your position on a depth chart, but what does that tell us about events that are less-contested? Comparing time-for-place in races or using all-time lists doesn't tell the whole story as to how strong a one hour half marathon is compared to a 13:00 5,000. There have been many paced 5,000s, while the half marathon is a relatively new event as a global championship and the best runners in the world haven't tackled the event nearly as often, so we can't tell if the half record is weak simply by looking at the all-time lists. But we can use deep lists for the more widely-contested traditional events from the mile through the marathon and can determine on average how much runners tend to slow down as the races get longer. Since many races of the same distance are run on both the track and the road, we can also use statistics to make reasonable adjustments for track vs. road. And this gives us a more numerical insight into comparing performances in different events. It stands to reason this is at least somewhat more accurate than saying the world record for 30k on the track is comparable to the 10,000 record. We all know it isn't, but just how weak is that record? Having a more reliable basis for comparison might prove useful when determining qualifying standards for meets or when assigning point values to performances, as in the decathlon. "Age-graded" performances attempt to do the same thing.

So think of it as "silly" if you like, but some people are interested in conversions, perhaps to come up with a ballpark time or pace to shoot for in an unfamiliar race distance, to see which events really are their best ones, to assess where they stand in some kind of local or regional "performance points" seasonal competition, to choose which race they should run (or try to qualify for) at an important outing, etc. You can't always tell these things by racing other people.

The only reason old farts cling to the past is out of necessity not desire. We want these guys to set a new standard. We want these guys to achieve more than Shorter, Viren, Mills.

And since today's runners can't race those of other eras when everybody was in peak form, we use the stopwatch as one way of comparing eras. It isn't perfect, of course. Track surfaces are faster, shoes are better designed, travel is easier, rabbits are plentiful, competition is deeper and money is on the table (and maybe some drugs). But the stopwatch tells us there can't be much doubt that Bekele is running at a much higher level than Zatopek or even Viren or that numerous high school runners today can run faster than Nurmi ever did. And records at any level (personal, school, meet, state, national, world) do serve as tangible challenges for athletes of all abilities - like you said, to set a new standard.

--*-*-*-*-*-*

Likewise well put. Comparing performances in different events is still mainly guesswork, and few individual runners are going to precisely post their "expected" times in several different distances, but stats can at least give us some expected times based on races run by hundreds or thousands of runners. For every Seb Coe, whose race times for 3,000 and longer were not within a moon shot of his 800-to-mile times, there is a Bill Rodgers, a guy who knocks off some of the best long races but never competes at the same level in short ones, and there are some Gebrselassie types who seem to be the best or nearly the best at every distance from the 1,500 to the marathon. So the top performances, the 10th best, the 100th best and so on tend to pan out to a workable average, even though the individual runners themselves are all over the charts. That is, until you get to events like the 30k and, to a dwindling extent, the half marathon. Those races haven't seen their heyday yet and we still have to estimate what kind of times in those distances would be comparable to times in other distances.

I think we can guess pretty close, but until more stats pour in, some of it is still just guessing. Maybe if enough people ran distances from 10 miles to 20 miles more often, we'd find they don't slow down as much as we'd expect between 10 miles and 15 miles, then they slow down more than we expected between 15 and 20. The best we can do in the absence of many world-class race times from these "intermediate" distances is try to use a best fit curve on the results we have. We can also theorize using gas exchange data and other physical processes, and see how those methods line up with the best fit curve from gathered race stats. But there are a lot of gaps in the stats for distances between the 10,000 and the marathon, particularly between the half marathon and the marathon. How many 25ks are there? How many 30ks. Are there any 37ks? All we can say with certainty about how a runner should expect to fare at a 37k race is that it will be run at a slower pace than a half marathon and at a faster pace than a marathon (given equal fitness, equal conditions and ideal efforts for all of those distances).

A champion of the past, would more likely than not be a champion today. Whereas a high school kid that runs a time comparable to Paavo in no way means that they possess the heart of a champion.

Yes, the greats from the past would raise their game today. They did what it took to beat their contemporaries, and you can only beat who shows up, so their combination of talent, training, and will to win was the best at that time. But we can't really know if Nurmi was a 27:00 runner who won in a 30:00 era. Maybe he wasn't even the most talented guy around back then. Maybe he wasn't in the top 1,000

talents. Maybe he was one of the least talented in his major races. Certainly people existed who were just as talented as most of the top runners today but they never ran a step in competition. Was Nurmi capable of 27-something in today's running world, or was his training load - paltry by today's standards but "psycho" back then - far enough above that of his more "talented" rivals that he beat them by outworking them? It's more likely we'll determine who Jack the Ripper was than we'll know exactly how Nurmi or Zatopek or Snell or Viren would really stack up against the top fields today. It's safe to say they'd at least be running faster even if they didn't win or weren't in the mix. Champions don't just fold; they rise up to a different level if they have to. How high could some of them have gone? No telling.

--*-*-*-*-*

KudzuRunner wrote:

I never worried about pace. Instead, I experimented with different amounts of leg lift and arm drive. The workout was as much for leg strength as it was for heart & lungs.

I did about 8-9 of these workouts.

You found the right effort, duration and number of workouts to create the desired changes. This type of hill running trains additional neuromuscular engagement (a.k.a. recruitment), which is the primary purpose of resistance training and which should precede more explosive work involving the same activity (in this case, hill running). That is, hill running should initially involve slow to medium speeds to develop structural properties such as coordination, stability and eccentric strength before hill sprints are introduced.

Another benefit of medium speed hill running for several minutes at a time is in working the heart. Pressure on the peripheral circulatory system (i.e., the blood vessels in the legs) is greater when running uphill, requiring a higher stroke volume and promoting higher oxygen uptake in the heart (myocardial VO2, or MVO2).

---

encharito wrote:

how steep would the ideal hill be for longer workouts and/or hill sprints?

The longer, easy to medium efforts in hills normally use grades of about 4% to 6%. You could go up to 8% on some sections, but running too long at a time on a steep grade can induce Achilles tendon trouble and also involves prolonged excessive bending of the knee and ankle joints, which contributes to sloppy mechanics and increases the time spent in the plant phase. It's best to use a few minutes at a time of

comfortable to slightly challenging uphill running, followed by a few minutes of flat or downhill running, curtailing each uphill section (and the workout as a whole) while you're still fresh enough to feel like your form is sound.

Hill sprints should progress in difficulty throughout the preseason. Begin with easy workouts like 2 sets of 5-6 reps of 10-12 seconds each on a medium grade (6% to 8%), jogging down between reps and jogging 5 minutes between sets. Work up to 3 sets of 10 reps. The grade can be 10% to 12% for maximum effectiveness. You might use up to 14%, but that's almost unrunnable due to the amount of time you're on the ground and the lack of distance you can cover with a stride. Always supplement hill sprints with short (10-15 seconds) level surface or gentle downhill (1% to 2% grade) speedwork so your plant phase is shorter, your stride rate is faster and your mechanics stay as sharp as possible.

*-**-*-*-*-*-*

[advising a runner hoping to run sub 34 (10K) and sub 16:20 (5K) on 30 miles per week]

This topic is analogous to boiling water at room temperature, but ...

This will total 67 to 75 miles in two weeks. And that's the lowest total I'm willing to let you haggle me down to. Take it or leave it. If you want to knock off some jogging before or after the longer workouts or not run at all on some of those 3-4 mile days, maybe you can slice it to 30 per week. Just don't let me know about it. You basically get out of this sport what you put in.

Day 1: 1.5 miles of warmup jogging, 4-8 strides, 2 x 800 on track at current 10k race pace with 2 minutes recovery after each one, 20 minutes on road (include a couple of easy hills if possible) at current 10k race pace, 3-5 minutes walking/jogging, 800 in 2:40, 1 minute recovery, 800 in 2:35, 1 minute recovery, 4 x 400 starting at 77 and getting faster (last one as fast as possible without tying up) with 1 minute recovery after each one, 1 mile jog (about 9.5 to 10 miles total)

Day 2: 3 miles on a soft surface at 7:00 per mile or slower (3 total)

Day 3: 4 miles at a slow to medium pace plus 4-6 short strides at the end (4+)

Day 4: Same warmup as Day 1, 3 x 1,000 on track in 3:20 with 1 minute recovery after each one, 3 x 1,000 in 3:12 with 2 minutes recovery between each one, 4 minutes walking/jogging after the last rep, 2 x 600 - first rep in 1:50, second rep pretty much all-out with 1:30 recovery between reps, 1 mile jog (7 total)

Day 5: 4 miles at a slow pace (4)

Day 6: 7 miles at a slow starting pace and a medium general effort but picking up the pace to comfortably fast during the last 20-25 minutes, 1 mile jog with 6-8 short strides at the end (8 total)

Day 7: 0-3 miles at a very slow pace (0-3)

Day 8: 3 miles at a slow to medium pace plus 4-6 short strides (3+)

Day 9: Warmup, 10 miles at a strong pace (within 30 seconds per mile of current 10k race pace), 1 mile jog (13)

Day 10: 0-3 miles very slow on a soft surface (0-3)

Day 11: 4 miles at a slow to medium pace plus 4-6 short strides (4+)

Day 12: Warmup, 12-16 x 400 starting at current 5k race pace and getting faster (most around 3k race pace) with the last 2-3 reps as fast as possible without tying up with 45 seconds recovery between reps, 1.5 miles jog (6-7 total)

Day 13: 3 miles at a very slow pace on a soft surface (3)

Day 14: 4 miles at a slow to medium pace plus 4-6 short strides (4+)

--*-*-*-*-*

Resistance exercises as a prelude to running-specific supplementary drills or speed work should also closely approach recruitment patterns used during running. Bleacher step-ups, forward traveling lunges and relaxed running in hills all involve additional recruitment which may help form the foundation for explosive strength work later. With a few weeks of these introductory exercises, use of skips or bounding, rapid high knees, hopping uphill on one foot at a time and short uphill sprints will work on explosive strength. Short fast strides on level surfaces or even down a slight grade are always necessary in order to foster economy for level-surface running. Exclusively working on uphills allows the ankle and knee joints to bend excessively and promotes a longer time spent in the amortization (plant) phase of the stride. Basically, short level-surface sprints are the best "supplementary" exercises for improving level-surface running, so focus more on those as the season progresses. Some of the drills can still be used throughout the season as warmup exercises, but they should take a back seat to short sprints and races as devices for improvement.

Any resistance work which doesn't employ a running-related action only burns fat post-exercise and might stand in for long, easy running from an overall metabolic perspective, but not in a way that specifically promotes running efficiency. In general, if you have the energy to include a regular and comprehensive weightlifting routine, you aren't running enough.

--*-*-*-*-*

JY wrote:

However, since these fibers are active during running, you are already training them to increase their aerobic capacity every time you go for a run, so it does not seem that you would need to perform additional activities to increase the opxidative capacity of fibers that will not be active while running, and will thus not enter significantly into lactate clearance.

Exactly. Lactate metabolism is related to the degree of involvement of the fibers in question. Upper body muscles are in use during running but at relatively low levels. When you run at any given pace, you are already training the heart and all active skeletal muscles, whether they are prime movers (such as the gastrocs) or are only in use in a secondary fashion (upper body muscles). Moreover, you are training these muscles in the exact manner necessary for running at the chosen speed. Non-running exercises will always be inferior to actual running when it comes to improving the ability to run.

Increased recruitment can be accomplished through hill work and drills which employ slow movements (such as traveling lunges and stepping up and down bleachers or plyometrics boxes). A weighted vest could be worn while running, as well, but too much devotion to any of these techniques will eventually reinforce incorrect recruitment patterns for flat-track running. Increased frequency of movement ("rate coding") can be practiced through rapid drills. "Speed strength" or rapid force production can be improved through drills which require a strong footstrike with a short plant time. These drills must closely replicate running motions in order to be useful. Bounding or hopping forward on one foot with attention to a strong footstrike are examples of these drills. Reducing time spent in the plant phase can improve running economy.

Upper body resistance work can be useful at times, but the exercises used should involve the back and abs to promote stability. If you run marathons, you will be carrying your arms in a bent position for over two hours, so you might benefit from some upper body work if your arms or shoulders are extremely weak. But this is a structural issue more than a metabolic issue, so attempting to improve O2 uptake or lactate clearance in your arms through weightlifting isn't going to carry over to running as well as actually running will.

--*-*-*-*

I know guys like that too. I used to see them work out and think the good races they had been running were just freak occurrences and the bubble would burst next time. But the good races kept coming, so I came to expect good races out of them even when they couldn't run for squat in a workout. So if you feel good in the races and they go fine, there's something to be confident about. Just tell yourself, "Even if my workouts have been crappy, I know I can do what I need to do in the race." That doesn't mean totally sandbagging the tough workouts will continue to yield the good race results. You still need to give yourself a chance to improve by working hard when you need to.

As to why you can't find the same level in workouts, perhaps the atmosphere or the imagery of competition is the trigger you need to produce sufficient adrenaline or other neurotransmitters or to call up all the mental signals required to run your best. Some people run much better on relays than in open

competition, not only because they get a running start and get to hug the rail a little more as the race spreads out, but because the team depends on them and the competitive drive they feel as individuals is heightened by having four races at stake rather than one. That all adds up to a different set of mental commands, a different sequence of neurotransmitter release, and facilitated access to certain energy sources during the race.

So things could be worse. You could be one of those workout kings who runs 10 seconds a mile slower in races. Even that isn't the end of the world. At least people who run great workouts are in good shape. They just need to find the right races to prove it, to overcome the aversion to competing (or to losing), and to get some confidence. But you already know you can beat people who do the same or better workouts, so racing shouldn't be a source of negative anxiety. You can see it as a chance to show that the other guys might be awesome on Wednesday, but you'll be ahead when it counts.

--*-*-*-*

The Shorter/Rodgers years were characterized by the masses running a lot more mileage. Serious marathons and other regular long road races were in; road 5ks and marathon walk/jogs were not. Boston was the biggie; nearly every American from 2:09 to 2:45 wanted to run it and PR there. One hundred miles per week was standard fare, not "out there." Even high schoolers were doing that much and post-college roadies were doing more. And it wasn't a bunch of jogging; people trained their butts off. Media influences reflected the training trends of the day. But this kind of running became a lost art and nearly disappeared for awhile in America. The last of the old-school sub-28:00 holdovers, Bickford, Eyestone, Nenow, Sandoval, et al, exited the stage in the middle or late 1980s. Sixty miles per week with "VO2max work" was all you supposedly needed. Track was in. Road racing, except for the occasional local 5k that could be won in 15:20-16:00, was out. By the 1990s, fewer people found success. Fewer people cared. There weren't enough runners at that time who knew how to make a proper commitment to running even if they wanted to.

But there are a lot more now. The internet has brought access to the knowledge base America's heyday was built on and has created a huge, enthusiatic virtual running club. The high schoolers of the early internet days in the very late 1990s began bringing the high school depth charts back to 1970s levels, they went to college in the early 2000s and continue to make college running the best it has ever been, and now some of them are out there sticking with it because they have a reason to. The difference between the 1990s and now is that more of today's runners have found the joy of training like runners should, more have had success through that training, more have had a virtual support group along the way, more see hope and more know what they have to do to keep it going. They know they have to run like the 1970s animals used to run, like the only world class long-distance Americans of the 1990s (Williams, Kennedy, Lawson, Morris) ran, like Ryan Hall, Brian Sell and Alan Culpepper run - lots and lots of mileage, some strong, long tempo running, and a good amount of old-fashioned, butt-busting hard work. They also have a lot of perks these days and can use heart rate monitors, pace charts, core strength work, recovery drinks and can apply as much theoretical science as they like, but they should never think those things will replace old-school running or will be shortcuts to success.

--*-*-*-*

[advising mile repeats for a 27:50 xc runner hoping to run 4:30/9:00 indoors]
If you aren't racing for a couple of months, do the following:

15-20 minutes progressive warmup
6 x 15 seconds strides (slower to faster)
2 x 600 in 1:45, taking full recovery after each one (probably 2-3 minutes)
4 x 1,600 at whatever pace you could currently run for 40 minutes in a race, with 1-2 minutes shuffling jog between each one (start each rep once you feel ready to go)
1 x 400 in 70, taking full recovery after it (probably 2-3 minutes)
1 x 1,000 in 3:00 or faster
5 minutes jog
4-6 x 15 seconds strides (medium speed to very fast)
10 minutes jog

This will probably be close to 11 miles of running. The 4 x 1,600 is way less than 40 minutes of running at 40-minute race pace and has rest periods, so it doesn't seem like it would do much, but it will if you're doing everything else right. It's just a December workout. It only needs to be aerobically stimulating. There are a few reasonably hard reps in addition to the 1,600s and a few short sprints, so you get to touch on 3k race pace or faster without risking overkill.

Well, if your base is not established well enough yet, give yourself about another month before doing the workout I suggested with the times I gave for the 600s and the 1,000.

You could do the same basic workout in the meantime, but use all 2 x 400 at 70-72 pace instead of 2 x 600 and 1 x 600 at the same pace instead of 1 x 1,000. The 4 x 1,600 with 1-2 minute rest periods don't even have to be timed if you know what effort to run, but it's better to be on the controlled side than on the struggling side. If you think the times on the 1,600s would be discouraging, don't time them at all. Just run under control on those, getting an aerobic training effect, and focus on hitting 3k goal pace or faster on the shorter reps.

--*-*-*-*-*

Who says that's [running long and slow] the motto around here? They might preach going slow when you start out as a beginner or slowing down when you make a big jump in mileage, but the motto here is generally strong aerobic running.

--*-*-*-*-*-*

Most of the improvement in performance [while barefoot] is probably due to the removed shoe weight, but the ground contact time may also be shorter without shoes. For a start, the sole of a shoe presumably adds an additional layer of shock absorption vs. the bare foot. In addition, the footstrike may shift to more of a heel-to-toe pattern when wearing shoes. This also increases the ground contact time as the foot rolls

more. Moreover, the recruitment pattern may be different in shoes, with a possibly greater pre-stretch of the ankle, which would further contribute to time spent in the plant phase. If you have access to sophisticated enough measurements (and you find there are differences in RE unaccounted for by shoe weight), try testing these hypotheses.

The increased lactate in the barefoot trials, if significant, may simply be a result of unfamiliar (untrained) mechanics and a slight difference in fiber recruitment.

--*-*-*-*

---

vo2max pace can be sustained for 9mins tops.

This pace is somewhat theoretical, being extrapolated from measurements of VO2 at other speeds, so it depends a little on the testing method used to determine it. "VO2max pace" (using the classic definition) may actually be sustainable from 6 to 13 minutes, depending on the training status, running history and physical characteristics of each individual.

What "Tike" may be alluding to is the fact that VO2max can be reached during a 40-minute effort in which the pace is even throughout. If you were to run a hard race of longer than about 42 minutes and used an even-pace strategy, you would not be able to achieve VO2max. The pace for a 40-minute race normally requires an oxygen consumption (VO2) of 91% of VO2max. It has long been known that running at this level of effort or O2 consumption can effect changes in VO2max. In order to maximize the time spent running at this effort, use segments of 3 to 8 minutes in length, with recovery periods about one-fourth to one-third the duration of the run periods, and with 25-35 minutes of total time spent running.

--*-*-*-*-*-*-*

The idea [of using a weight vest] would work best for short speed or drills where the time spent in the plant phase is low. If you add weight and do longer runs or lactate-intensive work which causes you to tie up, there's a good chance your stride mechanics, posture and cadence will suffer. So use the weight vest (make sure the weight is evenly distributed) to increase resistance during very short sprints or drills, making sure to keep a rapid cadence and a short foot contact time. It's probably also best to work your way up to 20 lbs. starting with 5 lbs. extra, then 10, then 15, using each new weight for a couple of weeks

--*

Lifting sessions should be treated like forest fires. Leave them to the professionals or you might get burned. And for Heaven's sake, try not to start one yourself.

--*

That actually looks pretty good for a canned program.

Three things:

One, on the second of the two easy runs between harder efforts, you might feel better on the next day's workout by adding a few strides at the conclusion of the last run of the day. Don't do this every day before a harder workout, though. Give yourself a chance to conserve a little more energy sometimes and find out what makes you feel best for a hard workout or a long run.

Two, practice taking fluids on the run on many of your longer runs, particularly the ones done at marathon goal pace. Have cups or bottles set out on a table if possible (either in front of your house or at a track) and do loops of 3-5 miles. This should go without saying, but try to avoid stopping for any extended periods (or making several stops) during pace runs. You'd be surprised how many people stop several times during long workouts and then have problems trying to run a long distance continuously. Also occasionally use the shoes you plan to wear in the marathon itself and do some long runs in the kind of terrain you expect to race in. Basically, this paragraph is to say "get the feel for what you're in for" so there will be as few surprises as possible on race day.

Three, it might be a good idea to do two or three hard 5k-15k road races or even a half marathon in the two months prior to a goal marathon, with at least one of the races out of town. Virtually all the top marathoners for the last several decades have done so. It gives you exposure to things like changing time zones, the meal the night before or the morning of the race, sleeping out of town, race day jitters, executing your race when in the heat of competition, and so on. If you're an advanced runner, a marathon will be a race for you, not just another long run, so it's always good to have some real competition under your belt.

Those are just some details that can make a difference, but the meat and potatoes of the schedule itself looks pretty good.

--*-*-*-*-*

Here's the best bit of help with Horwill's couch theories that you'll ever get: Write it all down on some blank typing paper and use the paper you wrote it on, print side up, to housebreak a puppy suffering from a worm-induced intestinal disorder. That use is actually too good for Horwill material, but I'm assuming you don't have an incontinent hippopotamus to housebreak.

To shed light on the original question, date pace and goal pace both have their uses. How often you use each depends on your running history. The first thing to ensure is that general fitness takes precedence over any specific fitness. If you work on race pace without having a high level of general aerobic endurance, you might as well run two measly reps of 200 at mile goal pace and agonize more over what color your stopwatch needs to be for best race results.

So use some stuff at current race pace and balance it out with some other workouts at goal pace. Avoid

killing yourself most of the time. Every two or three weeks, do a workout at goal pace that is extremely hard and simulates or even exceeds a race effort.

--*-*-*-*

Training for the steeple is about *fitness first*. Being a strong, tough runner must always take priority over having good barrier technique or working on special race tactics. Good cross-country runners are often good steeplers since they are generally fit and must be able to run in a slight to moderate state of anaerobic distress from the start and must respond well to interrupted rhythm.

Here are a few rudimentary things to do while getting a base in the off-season:

Hills are golden. Incorporate them throughout the pre-season. They don't even have to be deliberately used as hard work (occasionally they should be); just do them regularly.

Also regularly do hurdle drills and a few run-throughs over 1-2 hurdles. Some of these drills are standing or walking drills; these should normally be done after some of your faster-paced runs, so you are still a bit fatigued and must concentrate to execute them properly. There is no need to go into the standing/walking drills here; you can get standard hurdle drills from any hurdler or hurdle coach (the simplest ones include the walk-up to a fence stomp or wall stomp over a hurdle, "lead leg only" run-throughs at the side of a hurdle, repetitions of trail leg while standing next to a hurdle, "trail leg only" run-throughs, walk-throughs with hurdles crammed together). Just do the basic ones (and some run-throughs with full clearances) and spend most of your time developing fitness. Once proper technique is acquired, try to relax as much as possible during the drills and run-throughs, minimizing muscular tension and establishing the motions as second nature. You want barriers to be a normal part of your race, things you can literally take in stride or even use to your *advantage* in a tactical sense. They should not loom as imposing threats to be feared.

Include as one of the drills some dry run-throughs which work on water pit technique. The water jump is akin to running up a flight of about 10-15 stair steps in terms of the interruption in rhythm and the shift to anaerobic energy, and late in the race, this shift becomes exponentially noticeable, so having a smooth technique is helpful here so the early part of your race can stay less demanding. Start with a plyometrics box (shorter than barrier height) in the infield. Run up for about 30 meters and run past for about the same distance. Get in the habit of making a minor pace increase just prior to the barrier so you can get a good distance on your takeoff. Push forward more than up, but look ahead and not down. Your landing should be a quick (almost "rolling") one-two step so you can resume normal gait quickly. Jarring with either one foot or with both feet simultaneously is inefficient and tiring. Practice these details with the lower plyo box on a soft landing surface first so they will become easier to do over an actual water barrier (and you may slot into a technique that works better for you). You should usually lead with your strongest or most coordinated leg on the water jump, but practice pushing off with the other leg every so often - just in case.

During some of your normal easy runs in the off-season, get a regular track hurdle set to steeple barrier height and finish your run with a mile or two on the track, going over the hurdle each lap with a minor pace pickup for 15-20 meters before and after reaching the hurdle (you might progress to two hurdles per lap, then to four). This begins getting you acquainted with marshaling an effort to hurdle during a continuous (albeit slow) run. When your legs are ingrained to the slow pace of the easy run, you will have to call up a completely different set of mental commands to enlist the motor units necessary for hurdling, which is exactly the type of task you face in the middle and latter stages of a steeple race. Of course, you have anaerobic distress to deal with in a race, but the shift in *concentration* is what you are working on here. Your aim is to gain the ability to clear hurdles in a flowing, effortless manner, as though they are nothing more than part of normal running. Do *not* get in the lazy habit of clipping hurdles - while these

practice ones may tip, actual steeple barriers almost never do, and you will probably eat the track if you fail a clearance, so try to get over cleanly every time.

Practice leading with both legs. If you can easily see a barrier 20 meters in advance, you can adjust your stride to lead with your best leg, but if the pack is tight in a race, you may not see the barriers 20 meters out, but will instead see the runners just ahead clearing them; you may then not have time to stutter-step and shift to your better lead leg.

For the regular season:

A staple session for the steeple is one involving reps (usually over five barriers per lap with no water jump, occasionally over four dry barriers and the water jump) of 2:30-3:00 in duration (usually 800m to 1,000m), starting at current (or presumed) race pace and progressing to goal race pace or faster by the final rep. Practice accelerating slightly going into and coming off of barriers. Run about 6 reps, resting about 70%-90% of the run duration between bouts, then tack on 4-6 x 170m accelerations in which you go over the water jump and another hurdle, working on accelerating throughout, especially coming out of the pit for that finishing drive.

Working at race pace and practicing clearing that final water pit and final dry barrier when shifting to kick mode are both invaluable in this event; do not neglect either. Make sure to get a thorough warmup, including a few run-throughs over a single hurdle, as this is always crucial when incorporating barriers into a session.

You may also run 3-4 x 400m (over five regular hurdles, no water jump) at about 8-10 seconds faster (per lap) than race pace, with 3 minutes of active recovery between reps, following with some standing/walking hurdle drills. This is a rather high-intensity session similar to one an 800m specialist might use (except with hurdles), but it is beneficial for the steeple, as this is an event which requires you to briefly process higher-than-normal amounts of lactate as a fuel (or buffer it) during the race and return to equilibrium quickly. For the sake of safety, use regular hurdles and no water jump on this faster work.

If you have never done an all-out 3,000m steeple, you might try a 2,000m race or a 2,000m-2,400m "dress rehearsal" time trial (including water jumps) prior to your first 3,000m race so you will get a feel for when (or how quickly) the pace becomes difficult. Start at your presumed 3,000m pace and see if you can pick it up (and by how much) in the last couple of laps. If your 2,000m steeple was all-out, your 3,000m pace will normally be about 2-3 seconds slower per 400m, depending on race pace. Owing to the varying configurations of steeple courses, accurate 400m splits are sometimes hard to get, but the 200m split during the first (non-water jump) portion of each lap can always be at hand (of course, it might be a tad faster than your overall pace *including* the water pit).

This is not that difficult - the steeple is just an endurance race, so focus primarily on becoming a good all-around runner with horse-like endurance. Become familiar with barriers and with race pace over those barriers (with bouts of about 800m or 1,000m during training), so you are comfortable and confident and know what to expect when the gun goes off. But there is no need to get too fancy by spending three hours per day working on special drills or searching for nonexistent magic steeple workouts, especially if it means neglecting fitness.

--*

Doing 6 or 7 reps at 5k pace (or about a second per 400 faster near the end of the session) and taking a walk/jog that's just long enough to let your pulse drop to about 65% of maximum is sufficient. That's "not extreme or anything." The recovery periods will probably be about 2/3 to 3/4 of the run periods, but you'll

get to the point where you can judge it just by when you feel ready to go again and find a challenging effort which increases in a steady, linear fashion and only becomes a bear by the last couple of reps.

I've seen numerous world class runners from the 1970s to the present do up to 10 reps of 1k at close to 5k pace with just over a minute of "shuffling" between reps, so that's doable for some runners but it's liable to fall into the extreme zone if you try at all costs to hit 5k pace and maintain exactly a minute rest. Many of the world's elite are very proficient at metabolizing lactate as a fuel, which is one trait (among others) that lets them recover very quickly between reps, so they can often do repeats that boggle the minds of average runners even more than some of their world class race times. Some runners just have that ability. You can train it for sure, but some people will always be better at those types of workouts just like some people will always be faster than others in absolute terms. So don't force yourself to do 10 x 1k at 5k pace with a minute rest just because some other guy did it. Also remember that even if you can do something, that doesn't necessarily mean you should every time you attempt it. If you feel like you're pulling a bulldozer on the last 100 meters and you're tying up, gasping and grabbing your knees after 5 reps, 10 reps won't be any better than 5 or 6.

Nearly any running that's providing enough of a stimulus to train you at all will help improve your oxygen uptake to some degree. The main benefits of working at 3k to 5k pace are 1) those speeds familiarize you with the pace for commonly run race distances and 2) the reps can be of just the right duration to lock into a good, fast rhythm that keeps your heart rate and respiratory rate high for a couple of minutes at a time (and you can operate at that pace for a total time that's longer than the duration of your race).

If you really want a session that works your heart's ability to pump large volumes of blood for several minutes at a time (one of the main determinants in maximal oxygen uptake), try running on an uphill of about 6% grade for 2:00 to 2:30 at a time at the same effort you'd run 6 to 8 800m to 1k reps on the track, turn around at the top, do a slow jog halfway down, then run a stronger (but not hammering) pace the rest of the way down, walk/jog for 1-2 minutes at the bottom and repeat 6 to 8 times. Make sure you're already accustomed to hill running before doing this - you don't want to get an Achilles tendon injury from the uphills or bang your joints and strain your quads on the downhills by just jumping right into the workout with no prior hill running under your belt. And don't do this one too often; that means do it two - maybe three - times a month. This works the heart better than level surface repetition running.

Workouts like these are just like notes in a musical piece - be careful that you don't become good at playing the notes but meanwhile miss the music.

... we (almost) all have the ability be to very proficient at metabolizing lactate as a fuel, this is a natural process for survival not just a metabolic trait of highly trained endurance athletes.

We also (almost) all have the ability to sprint. It's a natural survival mechanism present in most people, not just world class sprinters. But the best sprinters are better at sprinting than the average Joe ... and Joe can get better but won't ever reach the Olympic level. We can all consume O2 to produce energy and we can improve our general capacity and sport-specific capacity for doing so, but each of us has our own ceiling. Processing lactate similarly has a different ceiling in different athletes whose hormone levels (testosterone, thyroid hormone, etc.) and fiber composition allow for expression and manifestation of lactate transport proteins. Thyroid hormone, for instance, dramatically increases expression of certain lactate transporters. Almost anyone can train this aspect of exercise, but certain runners will always be better at it and/or will receive more benefits in that area through training at certain speeds they are suited to run at.

The reason highly trained endurance atheltes can recover quickly is simply because they are more efficient at holding the right amount of neuro-muscualar co-ordination for longer, whereas a less well trained runner loses that concentration sooner requring more effort to maintain the pace.

This is part of it for sure, but it's likely the flip side of the same coin as lactate metabolism. Of course, when we delve into pabulum like this, we're starting to play notes and not music. That aside, we have to recognize the athlete is a whole organism whose systems compliment each other - the ability to run efficiently (or economically) at certain speeds runs somewhat parallel to the ability to process lactate, whether or not there is a cause/effect relationship between these two variables. For example, a high Type IIa fiber composition is normally accompanied by a high level of the transport proteins which deliver lactate into those fibers which are invoked at 5k race pace. The 13:00 runners are able to use their engines in a certain way which makes them economical at 62 seconds per lap, and this has to do with more than simple mobilization of motor units. In extreme cases, athletes like Joaquim Cruz are much, much more economical at faster speeds than at slower speeds (relative to runners as a whole), while the Dick Beardsleys of the world would never be able to acquire this type of economy at 4:00 mile pace no matter how much they worked on it.

Is this due to structural matters? To fiber distribution? To a naturally high (or low) O2 uptake? To an innately high (or low) ceiling for lactate metabolism? Some or all of the above? In the end, for the runner trying to do x reps of y distance at z pace, it doesn't matter. Either he can run all of those reps at that pace or he can't. So what if Haile G can run 10 1ks at faster than 5k race pace? If you can't do it, just run 5 or 6 or 7 of them and keep trying to get fitter. And if you can get to the point of doing 10 reps at faster than 5k pace and none of your performances are getting any faster or you're not becoming a better racer, what did you accomplish? You were just training to train. Of course, some people might be happy with that accomplishment on its own merit, but most people would prefer to get 5k and 10k personal bests. So don't worry about copying the world record holder's workouts, even with corresponding pace alterations. They may not be right for you yet ... or may never be.

The so called aerobic benefits or VO2 Max training effect of the training efforts mentioned in this and other threads is over stated. Once an athlete is fit enough to do theses kinds of workouts, they can no longer expect to see an increase in oxygen uptake.

Pretty much true. Once you have a high enough level of general conditioning (read: "unscientific," hard-ass, old-school training), have a stabilized weight and a healthy diet and sleep patterns, almost anything you do will work for you. You can make decent music out of your available notes.

Another point I disagree with is the idea that hill running can cause achiles problems, this is extremely unlikely since the speed is low. In most cases it is speed which causes achiles problems in runners due often to too much tensions in the calf muscles.

Could be that hill running itself isn't a root cause of Achilles trouble, but even so, a muscular issue which could lead to an Achilles problem will still be more likely to become symptomatic when doing uphill repeats without having first developed the necessary structural and muscular health. Regardless of speed, the mechanics change on hills, creating a greater pre-stretch to the ankle when going uphill and resulting in much more sudden eccentric loading to the quads when going downhill. Jogging speeds shouldn't pose a threat even for a runner 6 months removed from looking at a hill, but there's no way sane runners would do 6-8 reps at 5k pace uphill as their first steps taken on a hill in the last several months. No "root cause"

explanations necessary - this is plain common sense, much like not trying for an end-of-summer tan on your first day at the beach.

The main benefit that I see from hill running is exactly this, a reduced impact on the muscles which allows hard training to be continued in the days after faster paced workouts, thus ensuring good recovery, whilst maintaining intensity.

It's resistance work that ultimately improves running economy (by minimizing the GTO inhibitory mechanism and reducing the electromechanical delay) as long at it's complimented by later plyometric work and short speed to optimize the stretch-shortening cycle. Maybe that jargon is just another way of saying the same thing.

Well, in typical message board fashion, we've discussed a few individual notes and failed to teach anybody how to make it musical. So let's add this: Run more. More. Still more. Start running some of it faster. That snippet of advice right there is worth all that came before it.

--*-*-*

This workout [30-40s] (or variations of it) was very popular among runners in the 1970s. The original version was supposedly 12 laps of alternating 220y in 30 with 220y in 40 for a 3M time of 14:00 (the fastest runners would continue beyond 3M). I saw an elite roadie do this session and run 13:53 for the 12 laps. A world class miler I often ran with did 8 laps in 8:57 by alternating 27s with 40s.

Twists on these variable speed things pop up in running lore from time to time. John Walker reportedly ran 2M in 8:45 by "floating" the curves and sprinting the straights. Alberto Cova was said to run 12 x 400m (with rest periods) averaging 58 while alternating fast and slow 100m segments. Then there is the DeCastella version, which uses a moderately fast 400m followed by a "float" 200m (12 laps total). Deek used this one year-round, running fairly strongly but within himself when not readying for a race, and focusing more on speed as a goal race neared.

--*-*-*-*

The Portland Beaver wrote:

There are some that would argue the 40/30 workout is a threshold session but I wouldn't expect the Letsrun crowd to grasp that one...

Actually, it's a "crest load" session - the prinicpal physical benefit is probably in the area of removing lactate from some fibers and transporting it to other fibers (or to the heart) to be used as fuel. There can be a psychological benefit, too, since anything that boosts confidence in the ability to handle the stress of varied-speed running can be useful as long as it's not abused to the point of hypertraining.

--*-*-*

Lactate levels are more dependent on intensity and duration of exercise than on length of the recovery intervals between bouts.

For most exercise intensities which exceed the onset of blood lactate accumulation (OBLA), a shorter recovery interval between bouts will result in higher muscle lactate but lower blood lactate as the session is in progress. Longer recovery intervals will increase the lactate in the blood as it diffuses across the muscle cell membranes and has less opportunity to be taken up by the heart and skeletal muscles. Following the session, of course, the blood lactate will rise (as will the respiratory exchange ratio) as the oxygen debt is collected.

So what is happening with these various speeds, durations and recovery intervals? Plenty of things, but from the standpoint of dealing with lactate, an effort intensity which exceeds the lactate threshold and holds steady at the respiratory compensation point for a few minutes at a time should effect an increased expression of the so-called "monocarboxylate transporters" in predominantly Type I (slow twitch) muscle and in the heart. The "MCT-1" isoform is more prevalent in the ST muscles and is the only isoform present in the heart. The recovery intervals should be short (about one-fourth of the run periods) for this type of work and some jogging should be done during the recovery, if possible.

Using a much higher exercise intensity (e.g., 2 x 1 minute all-out with 1 minute walking rest between bouts) should effect increased expression of the MCT-4 isoform which is prevalent in glycolytic muscle fibers. The oxidative fibers will also be recruited during this type of work but will not contribute as much to force production.

From the old Soviet Union circa 1970 comes a session of 350m-300m-250m-200m each all-out with a 400m walk between reps. Although it wasn't known at the time, this session will mainly boost the bicarbonate buffering system but will also marginally influence expression of the MCT-4 isoform. This type of session is what is normally called "lactate tolerance training" in runner's jargon.

Note that the longer recoveries target buffering of lactate, while the shorter recoveries target "clearance" of lactate. All these types of sessions are useful at times and are actually synergistic if you know how to sequence them correctly. Improved lactate buffering can allow you to spend more time in that stage of exercise which exceeds the LT and hovers near the respiratory compensation point, since it is predominantly the bicarbonate system which prevents the blood pH from falling too low once the OBLA is exceeded. Operating too long (or too often) with low blood pH puts you on the Möbius strip of overtraining.

--*-*-*-*-*-*

Some good stuff here. Balance is indeed a key to improved performance and continued career development. There are now many well-known "training zones" as well as established (and popular) individual sessions which target these zones. That is why so many workout plans look similar to each other, when in fact they may be worlds apart in effectiveness. Once you know the fundamental principles, it is the amount of time spent in each zone at different stages of your preparation, as well as the intelligent *sequencing* of your workouts, which assumes utmost importance. This necessitates design wrought by wisdom and experience. Someone once said, "It is not enough to learn; you must become." Some message board posters refer to this process of "becoming" as finding your "sweet spot."

balance wrote:

All training is based on training muscle fibers. You need to train the muscle fiber or you will not have any adaptation.

Well, ... while muscle fibers are always *involved*, adaptation also occurs in cardiac output, respiratory function, and so forth. Zones should be selected which target improvement in these areas *along with* training properties of muscle fibers.

Also, efficient *selection* of muscle fibers is trainable. This involves summoning the requisite fibers to achieve the desired power output, allotting them to their ideal function, and setting the stride frequency for optimal use of oxygen.

Achieving your ideal weight is also important for attaining economy of movement and experiencing that weightless, effort-free sensation.

Long slow runs in most cases will only train you slow twitch fibers to be oxidative. If you want to train your fast twitch fibers to be oxidative you need to run at fast enough speeds for the fibers to become recruited.

"In most cases" is a good qualifier there. Depletion can occur in slow twitch and fast twitch fibers *without* recruitment of the fast twitch units. Even moderate depletion can precipitate changes in oxidative properties across the spectrum of muscle fibers.

As well as creating oxidative adaptations in the muscle cells, repetitive low-intensity running reinforces the ability of slow twitch fibers to contribute effectively to stability and posture, which is crucial even during high-intensity running.

--*

---

balance wrote:

There are definitely better ways of achieving our goals than relying on them to occur by running long and slow all the time. I understand that we may be able to achieve all the necessary adaptations by just training long and slow, but this is probably not the best way, and may take to dam long.

That may depend on your age, where you are in your career, and how much longer you want your career to last. There is good evidence that slower running (this means extremely slow, in the fashion of a Japanese marathoner's second or third run of the day) does make achieving fitness take a longer time, but that it also results in better ultimate fitness over a period of several years. If you wish to get fit and be fast quickly, you should by all means expedite the process with more purposeful running on your "easy" days. This is what the top college programs use. Very slow running works toward developing aerobic endurance, too; it just doesn't work *as* well within the two to four years that college teams need to win in the here and now. If college championships are to be the be-all, end-all of your running career, your best bet is to find that pace that's at the upper limit of easy and use that as your baseline pace (a la Arkansas, Wisconsin, Iona, etc.). Doing this may also preclude mileages higher than about 90 per week, especially for a college student balancing athletics with the occasional late-night cramming or partying. Inclusion of more slow days (as long as an adequate amount of that quicker threshold running is also accomplished) will normally cause a temporary slowing of the improvement curve, but will better prepare you for more focused work in later years.

In most cases we need a way to test and monitor progress. Olbrecht uses lactate tests.

Lactate tests are probably the best objective measure available. If at all possible, they should be correlated with heart rate values and the HR data used as a numerical measure to stay within desired effort levels on days where a specific effort is desired. HR measurement is non-invasive, less time-consuming and less expensive. Of course, HR training isn't perfect, either, since cardiac drift and other day-to-day fluctuations can affect the data. The *best* method for assessing effort is *subjective* - listening to your body's own internal dialogue. Most running aficionados are familiar with Lydiard's story of Dick Tayler doing repeats on an unmarked field and without a stopwatch. Tayler knew what effect was the proper one for this session, knew by acquired familiarity what that felt like, and knew when he had had just enough to get the maximum benefit from it. He *also* knew by feel (and by trusting Lydiard's experience) how that effect would blend with other recent sessions and his background work.

If you find you did not progress in the desired way or even saw your fitness decline you would want to question whether or not the training you just did was actually any good for you. If it was not, you wouldn’t want to continue to do it. That would be a waste of time. By monitoring your fitness over time you can eventually find out what works best for you and only do the training that is going to help you achieve your goal. If that means running less or more based on what your testing has told you then this is what you should do.

It is true that testing can provide an objective measure of certain specific indicators of fitness, which can be referred to later for comparison. How are we to tell from testing at six-week intervals (or any other

short arbitrary time segment), though, if a temporary *decline* in some of these markers (due to dramatic emphasis on certain workouts to the near-exclusion of others) would eventually result in *better* overall fitness (and better performance) once the other training procedures were introduced and carried to their completion? Achieving complete fitness isn't a "dynamic programming" scenario, in which maximizing the objective function value at each individual *stage* of the process is the goal. The goal is to maximize the objective function value - your running performance - 1) over the course of your career and/or 2) at the dates on which your most important competitons occur. I say "and/or" since many people try to achieve aim 2) in high school or college and wind up doing so at the expense of aim 1).

Science has been unable to explain why running slower seems to also aid in fitness, but my guess is it is all about aiding in recovery from faster running. Increased blood flow opens up the capillaries and brings new nutrients to the muscles. This can be very beneficial in aiding regeneration, and in most cases will be more beneficial than just taking a day off.

That's part of it. Once accustomed to daily running, and as long as overuse injury is not imminent, people do recover more fully (and faster) if they do some light running the day following a stressful effort. For beginners who are not every-day runners, a no-impact exercise such as easy swimming or easy biking can be substituted to facilitate recovery and to become accustomed to daily exercise.

There is the issue of relaxation at very low intensities, which fosters precision of movement and elimination of wasteful tension. This is a fundamental tenet of Oriental martial arts, and you can see the same practice occurring with many of the Asian marathoners. It's un"proven" in a laboratory setting, but this priniciple of practicing high-repetition, low-intensity movement for the purpose of ultimately achieving maximum speed and power is a time-tested and well-known principle. More on this later.

--*

Antonio Cabral wrote:

That's quote illogical.
In the first item - that one of the effort training - you advise "Listen to your body" when you know that we have a few estimates of the training effort - heart, rate, lactic acid meter or simply the chrono time to estimate the effort.

To elaborate: The objective data can be used in lieu of subjective perception *until* the athlete is experienced enough to correlate the readouts (mmol/l or HR or RER or what have you) with that internal perception of effort. The gadgetry can be used on a near-daily basis if necessary, but at some point this becomes unwieldy and in most cases is impractical for racing; ergo, the internal sensitivity is *required* for

complete understanding of personal capabilities. People are not robots. It is not enough to learn, you must become.

In the second item, - that one of the recover runs versus rest/regeneration day off - you prescribe easy intensity runs or no-impact exercise, Why don't you let each runner decide by his own by "Listen to your body" as you did in the first item?

Oops, my bad. I should have said that *most* people recover faster with some activity the day after a stressful effort. Recovery and regeneration are complex enough that certain *aspects* may *always* be facilitated via light exercise soon after, but this benefit may be offset in certain individuals by other (often intangible) factors which would be more of a setback than an asset as a whole.

The point of all this rambling goes back to the initial idea of *balance*. Familiarizing yourself with your own body's needs over time is important, but general guidelines are also useful as starting points until you know something about your capabilities, limitations, recovery needs, etc. Objective meaurements from gizmos provide needed assistance for runners who are *not* yet sensitive enough to tune in to a subtle internal dialogue, or for runners who are impatient enough to *ignore* that dialogue if they did hear it. And yes, this perceptive ability (as well as patience) is sometimes lacking in very accomplished runners, just as it is in high school people. Portable lactate analyzers and pulse monitors are made for these people.

In the arena of balance, respect general time-tested principles of preparation. Play the odds intelligently by using those sound priniciples as your main path up the mountain to success. Veering from one side of the path to the other and even forging small side trails is fine if you discover along the way that you need to do so.

It's not really illogical - find your sweet spot, but do it within a framework of intelligent, proven design.

--*

Antonio Cabral wrote:
Of course that you writes in good english intersting sentences but that doesn't mean/argue nothig against my comments.

I am aware that all you have said is *correct*! You are, as we would say in the States, "preaching to the choir." There is no point of contention in my posts and I am not arguing. I am attuned to the fact that some runners do learn to recognize effort states without external data, while others require that data. Also, recovery is a gestalt, and individuals should learn their own needs as opposed to adhering to hard-and-fast rules.

Consider these proverbs:

"Those who do not learn from history are doomed to repeat it."

and ...

"Smooth seas do not make skillful sailors."

The first quote refers to learning from the past so you will not ignorantly or stubbornly make all the mistakes your predecessors made before you finally realize there was a lesson to be learned at all.

The second quote refers to the fact that *you* need to experience difficulties in your *own* process of trial-and-error discovery in order to become first competent, then masterful, at handling all the situations you might face.

At first glance, these maxims would appear to be giving contradictory advice. You might even say it is *illogical* to apply both at once. But, looking closer, it becomes apparent that the first quote instructs you to learn lessons from mistakes which have been repeated enough times that the lessons can be considered *fundamental* in nature. The second quote says that the *specifics* of your situation will often be different, as well as your ability to handle those specifics with your personal attributes. Though you should learn from your predecessors, they cannot handle your present situations *for* you, so it is up to *you* to become proficient at micromanaging the details which arise in your personal challenges.

So you see I am saying experience is paramount, but objective data can still be used as a frame of reference for effort levels. Rules are also useful, although most rules are bendable. There is no absence of logic and no point of contention present.

Exercise science will always pale in comparison to experience (both that of others and your own), as it is restricted and normally one-dimensional, failing to even identify, much less control, all the variables of human performance. But *some* laboratory findings can at the same time be used to intelligently tweak and nugde our workouts.

--*

Antonio Cabral wrote:

... in my land we say something similar - another idiomatic sentence but that's a resume to your 2 last proverbs. It goes like this "there are more waves in the ocean than sailors to go to the sea for sailing". ... What that means about training ? That means that the occasions that have to face a decision from a certain issue (train by feeling versus intensity accuracy or innactive versus active recover) are more frequent than how many concepts we build about each training issue.

Then should the *waves* dictate the sailing procedure, or should the *skills of the sailor* dictate the procedure? Or should the *sea* itself, as an entity to be navigated *in its entirety* (something which is greater than the totality of its waves) take first priority? If so, should the sea as a whole remain the first priority as *each wave* is encountered, or should the imminent wave take precedence in the mind and actions of the sailor at that moment?

All good questions. And the answer to the whole problem, of course, is that attention must be given to all concerns at once.

In my thinking, the "prime directive" (to borrow a military term) is successful navigation of the *entire* body of water you intend to sail. To do this, you must recognize that the waves are not the sea, although they are part of it. To change metaphors, many people "cannot see the forest for the trees."

I realize I am deviating from the original meaning of the proverb here, but there are many sailors who wish to cross the sea yet will acquire neither a seaworthy vessel nor the sailing skills to be successful. These are some of those concepts which must *always* be addressed for *all* individuals, and which no experience could ever deny.

How does this apply to running? It means that effective training is *both* steady *and* dynamic. Note that "steady" in this case is not synonymous with "unwavering," and "dynamic" is not interchangeable with "ephemeral." This brings us back to balance - not only in workout procedures themselves, but also concerning concepts/experience and events/individuals.

--*

---

balance wrote:

I am not a huge fan of intensity for the sake of quick fixes. Like I said before, I am a huge fan of Lydiards training, and I understand the importance of patience, and passing on early moderate success while focusing on the long term goals which might be loftier.

Good on ya!

I'd like to point out that Olbrecht recommends that at least 80% of your training volume be long slow regeneration running. The other 20% or less is more intense, but again it is not in large volumes and in the

base phase and is not meant to get a runner in race shape. Again for Olbrecht, the longer the base the better.

Good on *him*!

... The purpose of this training in the base phase is to make the fast twitch fibers more oxidative, therefore increasing V02max not just in the slow twitch fibers, but also in the fast twitch fibers. I know you are going to say that we can do this by just running long and slow, but I don't believe we can do it as effectively and I don't believe the small amounts recommended are going to hurt your long term goals. In fact I believe they will help them.

Variety in the off-season is crucial for many runners. It's been awhile since I looked at any of Jan Olbrecht's writings, but I remember his research was predominantly done with swimmers and a few triathletes. In his last book (oriented toward swimmers, if I'm not mistaken), he did mention the high aerobic energy demand in events as short as the 100m free (which only requires about 48 seconds for the best in the world). The energy distribution was nearly two-thirds aerobic for this event. I'm no swimming aficionado, but I've always guessed that it is more difficult to recruit as many fast twitch fibers in the water as is possible when running over land, since 1) a swimmer cannot turn a stroke over fast enough to invoke the most glycolytic fibers and 2) more slow twitch fibers are involved for *stability* in a high-technique sport such as swimming, where there is no time spent in a "flight" phase as in running. If this is true, a greater burden falls on the slow twitch units when swimming, thus making a 48-second swimming event more aerobic in nature than a 48-second running event. Of course, ST units can have both oxidative and glycolytic properties, but the involvement of the FT units is probably highest in swimming during the start or during a push-off following a turn. The fact that short course records are significantly faster than long course records illustrates that turns (and the subsequent few seconds of recovery) probably contribute to more speed through the water than the actual strokes do. Again, I'm no swimming expert, so this is all theory as far as I know.

It is interesting that Olbrecht, having come from a swimming background, recognizes the need for variety during base work. Another physiologist who works with triathletes, Dr. Philip Maffetone, advocates base training which is always kept below the athlete's LT. I realized a few decades ago that a small amount of regular variety in base training was extremely beneficial in running - probably *more* important than in a no-impact endurance sport. There are a number of reasons why this may be so, but in a very crude sense, it is simply wise to prepare the body in successive stages to handle faster speeds before a period of specialized, race-specific work begins. Furthermore, common sense dictates that lack of variety in range of motion and distribution of impact forces can quickly lead to overburdening connective tissue, as well as muscles and even bones. From another purely subjective standpoint, running faster on occasion may also reduce boredom and help runners feel "snappier," giving them a fresher and more enthusiastic outlook on the otherwise monotonous chore of slogging out the miles.

From an objective standpoint, economy of oxygen consumption is marginally influenced by improvement in certain anaerobic capabilities, both in the use or metabolism of lactate *and* in alactic fiber recruitment which accesses the high-energy phosphates. Variety in neuromuscular patterns, particularly rapid movements which replicate running motions (e.g., fast high knees) is known to contribute to slight improvements in economy. Even high-intensity training during the off-season - as long as it is restricted to very small amounts and repeated rather infrequently - is not the devil many runners set on pure aerobic training believe it to be. Prudent allocation of such training during the base phases can actually *enhance* aerobic development and allow an athlete to smoothly segue into a stage of specific preparation.

--*

Antonio Cabral wrote:

One runner want's to run and compete in running distance. The first thing I teach him is that apart from the talent he needs to train. Remember that the main target why the needs to train that's to compete and face the competitions.

In perhaps a larger sense, runners train to make the most of the abilities they have been given. This desire to excel dwells within some before they ever begin to train (or often before they begin to run!) and others find that passion along the way, having been "bitten by the running bug," so to speak. Competition serves as a catalyst, raising the bar higher (metaphorically in running, literally in vertical jumps), and assists in the achievement of those personal goals. Realize that this refers to competition in *fair spirit* and in *fair play*. Cheating with drug use or other means adulterates the purpose of making the most of ability, with the goal then becoming something fleeting, such as fame, money, the physical medals, et cetera.

Of course, to reach fruition as an athlete, we must train! It has been said that "the will to win is not as important as the will to prepare to win." To take this further, the will to prepare to win is not as important or as fruitful as the will and *knowledge* to prepare *properly*.

One of the main strategic training elements of training – without what he willn't be a good competitor that's Pace Running.
If I consider the larger problem that's is done by most of the long distance runners that's pace ignorance and that or they train in different paces thay should train or they compete in different paces they should done – usually by start too fast according the main event pace. Don't you see that mistake during the runs ? I've seen that for decades and lots of running generations. As I also have seen inexpedient runners that simply they start the run routine session in one pace and they end in another –they run in positive split all the time. Ther's no solution if not to teach that runners to use and control and pace by any mean.

I was a witness to extreme cases of poor pace judgment on more than one occasion. In one instance, a runner asked me to act as a rabbit to help him manage his pace during a session of 6 x 600m. He did this specifically because he *always* ran too fast at the beginning of his workouts and his races and he wanted to try to *correct* this error. On our very first 600, he sprinted ahead of me and I yelled at him to stay behind me. Despite the fact that he knew of his usual pacing mistakes, and despite the fact that he had enlisted me to serve as his rabbit to *prevent* those mistakes, he continued to run way too fast on the first 600, finishing over seven seconds ahead of my correct pace. His second and third bouts were slower, and he had difficulty staying with me. His fourth rep was his last. He struggled from the first 100, and by 300, he had fallen off the pace. In spite of his own awareness of his poor pace management, he still could not find the discipline to follow his own rabbit and had to abandon the workout without getting much good out of it!

A few times you need to teach the runner to run slowly – as van Aaken says he did when he did meet Norporth – "My first advise that was to teach him to run slow".

It is said that Ron Clarke also needed this re-education at one point in his career. Having been introduced to easy running, then progressing to steady running at a faster pace, he was able to become fitter - and ultimately faster - than he had been previously.

Then as you know we have several options to pace accuracy – the chrono and the distance, and the HRM etc, etc.

Recent race performances or time trials are also good barometers for assigning target paces for workouts. These can be used in conjunction with other data (HR, etc.) and the numbers cross-checked to ensure the pace guidelines are the right ones. For race-pace work, a loud "beeping" device can be set to beep at regular intervals, and cones placed along the track (or other course) every 50m or 100m so the runners reach the cones when the beeper sounds if they are at the proper pace. This device should be placed in the center of the field as opposed to one side of the track, so as to keep the time the sound travels to each cone as consistent as possible.

... your season periodisation strategy advises you to run that in an outdoor terrain unmeasured course instead of a track.

Yes, use of "feel" pace management is normally done with outings which remain at or below the athlete's

threshold. Most of these sessions occur during a period of *general* conditioning, in which specific *speeds* can take a back seat to acquisition of fundamental fitness. As you are probably aware, some runners have trouble staying slow enough even when *no* minimum pace guidelines are imposed! These aspiring athletes certainly need teaching, lest they squander their time spent running! As a period of specialized conditioning approaches (where familiarity with race pace is paramount), many methods and mechanical devises exist which can assist with pace management.

... Dick did win in a sub 28:00 defeated Juma, Dave Bedford etc.

I believe the winning mark was 27:46. Bedford was all over the track that day, visibly overstriding at points, and refusing to relinquish the lead in the early and middle stages of the race. At one point, he even bolted so forcefully around another runner who had briefly taken the lead that he stumbled slightly and veered to the inside of the rail for a couple of steps. Bedford was a tough, brave runner, but his tactics in that race were atrocious.

... if you feel tired ther's nothing as to take a day off. Ther's no contradiction here. You may have a high volume mileage schedule with lots of slow runs in between workouts but you may have a day off from times to times. A van Aaken said: that will be good to take a day off from times to times.

Yes, I have also recommended that an athlete have a day off - even a *scheduled* day off every two weeks (or at a different interval) - and count 90 miles in six days as having the same benefit as 100+ miles in a full week. The therapeutic effect of the rest day is sometimes as beneficial for the athlete as running those extra miles.

--*

Some thoughts on adaptability:

Lactate is either buffered or is reconverted to other metabolites through various pathways (involving MCT proteins or dehydrogenase enzymes, etc.) There may be some genetic ceiling to each athlete's ability to "clear" lactate. Hence, there is a point in the training of each athlete at which raising the maximum lactate value will likely come at a *detriment* to the goal of shifting the "lactate performance curve" to the right (i.e., being able to attain a faster "lactate threshold velocity"). While improvement of both capacities at once is possible (and desirable), each athlete may make use of these traits in a different balance. The author Michele Ferrari describes this as an athlete using "his own motor in a different way."

To further delve into the *art* of preparation, some of an elite athlete's work (particularly that which hovers within a few percent of race pace for the primary distance) should ideally point toward being able to

handle rounds and being able to handle sudden accelerations (as in championship races). In addition, some runners need to be able to judge their own race pace (without the benefit of a rabbit or a pack) and run hard yet intelligently *alone* in the event they find themselves with either a sizeable lead or large deficit in a relay race. This is to say that while it is of importance to train for fast times in rabbited races, it is of equal importance to prepare for solo efforts and for kicker's races. Hence, sessions which target each *physiological* aspect of fitness (oxygen consumption, metabolism or buffering of lactate, etc.) should not only work synergistically to each runner's needs, but they should also take *racing* into consideration.

Once you spend enough time researching the whys and wherefores of various training procedures in an attempt to fine tune your training as much as possible, you will come to the realization that you cannot *perfectly* maximize every aspect of endurance or sharpness at the same time. At this point, you will concede a couple of things: One, there is a heirarchy of the importance of training procedures, related to the aspects of fitness they target and related to the cost-effectiveness of time spent training. Two, *periodization* is crucial in order to ultimately achieve an ideal blend of workouts, and a period of *general* conditioning must precede stages of *specialized* conditioning.

Once foundational principles of development are understood, the "art" plays a major role. If you are an athlete, you can use the tried-and-true fundamentals as your basic template and tweak your workouts in the right direction once you discover enough about how you respond - how your "motor" works. If you are a coach, you must pay attention to the signals your athletes send when it comes to responsiveness and recovery. While everyone has plenty of things in common, we aren't clones (not yet, anyway), and the path to excellence is a wide path with plenty of room for individual idiosyncrasies. Each *season* may also present new variables. These include weather conditions, hours of daylight, diet and hydration, sleep patterns, availability of facilities or trails or hills, jet lag, ... the list goes on. So be flexible - there may be some rules you don't want to break, but you should learn how and when you can bend them.

--*

---

balance wrote:

Renato believes ... that long slow runs don't really contribute to true endurance.

He probably does realize that long, slow runs can contribute in a more developmental mode, but is trying to drive home the point that they do not do as much for an experienced and aspiring elite runner's specialized conditioning. The long, slow running certainly does play a role as early groundwork, inasmuch as adequate balance of the fat/glycogen substrate utilization is most safely and efficiently acquired through use of slower running as a prelude to faster long runs. However, for an experienced elite marathoner to piddle along at three minutes per mile slower than race pace for two-and-a-half hours every week or two is a waste of at least two of those hours. Among other things, endurance training precipitates a "glycogen sparing effect," so with increased endurance comes a need to run *faster* to access the

glycogen within the FT muscle fibers. Slow running alone won't cut it forever. This illustrates Renato's point that the same stimulus only brings about adaptations for a given time before you need to modify it.

As for the hard 20-40 minute hard runs, these are definitely tempo runs or anaerobic threshold runs. They may be run just under the threshold or right at it. They may even be over it a little bit.

If they are done effectively, they will *certainly* exceed the threshold, but only for a short time. This faster running is better than slow running for increasing mitochondrial enzyme activity, although the slow running is also required for recuperation, weight stabilization, lipid metabolism, and for summoning the smallest motor neurons, which are instrumental in stability, posture and cultivation of the most efficient, effortless, subconcious ("zen state") stride patterns. This slower, relaxed running is de rigeur for complete development, but running moderatley long as *fast* as possible without experiencing undue difficulty or acidosis is more cost-effective in terms of developing *most* facets of endurance. It is possible to exceed the threshold briefly without laboring or hyperventilating, but knowledge and discipline are required to play this daredevil's game of brinksmanship - laughing in the face of acidosis, so to speak - without going too hard too often.

Continuous runs of 20 minutes which finish slightly above the threshold can be balanced with somewhat longer runs (35-40 minutes) which feature the majority at a fractionally slower pace but which still exceed the threshold for a brief period near the end. Interchanging these sessions provides diversity in the routine and yields a slightly different stimulus from workout to workout. Moderately long repeats with rest periods which are short relative to the run periods can accomplish the same purpose.

--*-*-*-*-*

The main benefit of short uphill sprints is probably neurological. As long as the grade is not so steep (about 14% grade is close to the upper limit) and the duration of each sprint bout not so long as to significantly alter or even impair stride mechanics, this represents as high a level of motor neuron recruitment as you can get in a running-specific context. The combination of speed and resistance produces an extremely high degree of both recruitment and "rate coding" in synergistic muscles. Believe it or not, when it comes to improvement, the speed is more influential than the resistance offered by the hill. But when speed and resistance are combined (and balanced in appropriate conjunction with level-surface sprinting or even gentle downgrade freewheeling), the ability to regulate force through proportional control is topped off.

Any exercise which recruits large motor neurons within major muscle groups can promote the release of growth hormone as long as nutritional requirements are met to supply amino acids. Squats and dead lifts do the same thing, but they obviously aren't sport-specific.

You might be feeling stronger as a result of a growth hormone boost, but it's just as likely you feel lighter and snappier because of the improved neural allocation (the benefits are noticed fairly quickly), because of having fortified your phosphocreatine system (which facilitates the warmup process) and because of the sheer variety in the routine.

To effect the best boost to the phosphocreatine system (and to improve proportional control at speed), work up to 3 sets of 5 or 6 of the short uphill sprints (you don't have to spend 12 seconds on the actual hill for this; a run-up of 2-3 seconds on a flat section to establish some speed before starting the hill is best for form retention, followed by about 8-9 seconds on the hill) with a slow jog down and a little extra time at the bottom, for a total recovery period of about a minute between reps within a set. This format allows for partial restoration of the phosphocreatine (starting with roughly 80% replenishment and dwindling with each successive rep) while still applying a functionally continual stress to the system. Take about 5-7 minutes (walking for a couple of minutes, then some jogging, then about another minute of walking) between sets to "almost completely" restore the system.

If you're a pure middle distance runner, you can use this session once a week during the last half of the off-season. For another supplementary addendum, tack on a single set of about 8 reps of short hill sprints (use about 3 reps to warm up to speed and get accustomed to the hill) following a medium-effort "tempo" type of workout on another day of the week (it's best to include some dynamic drills and several level-surface or gentle downslope high-speed buildups in your warmup prior to the "tempo" effort if you're going to approach top speed afterwards). So you can get two days per week which incorporate hill sprints - one is a full-fledged workout which is started completely fresh; the other is as an annex to a moderate-effort "high end" or "threshold" workout to briefly summon the full spectrum of motor neurons following mild to moderate fatigue of the more resistant oxidative muscle fibers.

In regards to oxygen uptake, sprinting for short distances with recovery periods, even when repeated dozens of times, can affect single stroke volume, but this has only a marginal effect on O2 uptake. The muscle fibers involved in full-speed uphill sprinting are of larger diameter than those used in sustained running and more space within these fibers is devoted to contractile structures designed for force production, leaving less room for mitochondria or blood vessel supply. In fact, when they are recruited, their contractile force is often great enough to constrict their own blood supply, meaning they are forced to rely on their own stores of anaerobic energy, which is one factor contributing to their quicker fatigue. Furthermore, the heart, being a "twitch" muscle rather than a "tetanic" muscle, requires a few minutes of continuous exercise to reach the kind of sustained stroke volume employed during fast continuous running. Such sustained delivery of oxygen is generally required for significant improvement to take place in O2 uptake.

Running-specific myocardial O2 demand (which stimulates the ventricular hypertrophy contributing to higher O2 consumption) is best created from segments of about 2 to 2.5 minutes of uphill (6%-8% grade) running at an effort similar to 5k race pace on the track. This does place a more continual pressure on the blood vessels which supply the race-specific (oxidative) muscle fibers, forcing a higher prolonged stroke volume than level-surface reps of the same duration would accomplish.

--*

"The best way to improve your kick ...

... is to PRACTICE doing it at the end of your RACES. Really dig as deep as you can and DO NOT FEAR the outcome. It will hurt. Bad. BADDER than bad. But once you nut up and suffer this hurt a couple of times, the ability to kick (even when you think there's no way you can merely hold pace) will begin to get easier, and it'll actually become like an old friend. You'll know you've encountered it before

and you'll be sure you can deal with it. And pretty soon, you'll be finishing FASTER, not hurting as much, and not FEARING the hurt as much. There ARE some WORKOUTS you can do which will help your kick, but you won't be able to put any of them to use if you are unwilling to endure serious pain to beat the guy who's challenging you. You must envision WINNING and you must be FEARLESS.

Some workout suggestions

From a physical standpoint, your kick is a function of your raw speed, your ability to accelerate, AND how deeply you've had to rely on anaerobic energy production up to the point in the race that you launch the kick. Bearing that in mind, having a high AEROBIC capacity will give you a greater speed RESERVE (how much of your maximum sustainable oxygen debt you still have to "give away") than many runners who are flat-out faster than you are over 100m or 400m or whatever. So you should primarily train for aerobic endurance. The guy who trains ONLY for the kick shouldn't be close enough to you to use it, anyway.

As far as speedwork goes, you should ALWAYS be doing a little something about your turnover, even during a base-building phase. I refer to these workouts as "speed maintenance". They provide variety in footstrikes, muscle fiber recruitment, etc., which can not only keep you in touch with some speed, but can also help prevent injury.

Examples of speed maintenance workouts are simple buildups and strides and some form drills. You might try two to three sets of 5-6 buildups of 15-25 secs. WITH THE WIND (if any), jogging back (or jogging an equal distance) between each, and jogging 5-10 min. between sets. The first buildups in each set should be the slowest, but each set can be started slightly faster than the previous one (since you're going to be more warmed up). Every 2-3 weeks, you should tack on a fairly fast 2-7 min. run following the last set of buildups. The purpose of this is to get your heart rate up NEAR its maximum (also close to VO2max) WITHOUT tying up very much. Only run the 2-7 min. thing at about the pace you could run for TWICE the selected distance at first (e.g., run 3 laps at the pace you COULD currently run for 6 laps in a race).

Another speed maintenance session could be 2 sets of 5-6 x 30-35 secs. progressively faster EVEN-SPEED strides. Jog the same distance between each and jog 5-10 min. between sets. These can be run as 200m reps on a track (with the wind, if any) or they can sometimes be run DOWN a very gentle hill (keep the surface soft, perhaps on a golf course) to concentrate on a light, quick turnover. The purpose of emphasizing turnover on occasion is as a prelude to quick accelerations. You can also run some UPHILL reps, but they don't necessarily need to be FAST. Just using the correct form (hips beneath the torso - NOT leaning too far into the hill with the buttocks back) will work the correct muscles for hill running.

At some point near the start of a competitive season, the speed on sessions such as these can be deliberately WORKED a little more. You can also do about 10-12 progressively faster 12-15 secs. uphill repeats, finishing really fast. BUT - you should avoid tying up horribly in any case. Make sure you can hold form. The more you practice relaxation at close to top end speed, the easier it will be for you to recruit the necessary motor units (muscle cells and their connecting neurons) when it's time to kick it in at the end of a race.

Provided you've stayed in touch with your speed in the above fashion during a non-competitive season (or during the early part of a competitive season), and provided you've done some form drills (an entirely separate topic) you can introduce some "creatine phosphate" training. This initially entails a thorough warmup followed by 2 sets of 2-3 x 7-10 secs. all-out (take about a 20m running start before rally blasting the next 7-10 secs. - you don't want to strain anything!), with 30-60 secs. walking rest between reps and 8 min. rest (water break) between sets. After you've done this workout a couple of times (maybe once per

week), you can add a third set to the above for one outing only.

Having completed 3 of the above "acceleration" workouts (remember to cover other training bases as well!), you should then proceed to a workout of 3-4 x 150m at 98%-100% effort with 30-60 secs. walking rest between each. Following this session (allow enough time for recovery and to include one or two other hard days), proceed to 3 x 300m at 98%-100% effort with 2-3 min. walking rest periods. The next "kick-specific" workout (about 4-5 days later) should be 2 sets of 2 x 400m at 98%-100% effort with shorter rests (near 1 min.) between reps and full recovery (8-ish min.) between sets. You may need to jog some and add a couple of light strides at the end of the 8 min. rest period in order to prevent straining anything at the start of the second set of 400s. These longer sprints work lactate "clearance" and use the creatine phosphate stores simultaneously. These two energy systems are precisely the systems which are invoked when you kick at the end of a race.

I might repost the drills if I can find the floppy disk I stored them on. There are also some more "advanced" workouts which involve pace changes, but those aren't really necessary unless you're at the highest levels of the sport."

--*

"Speedwork for distance runners

Always include relaxed buildups, strides, and hills (and possibly drills) in your routine, even during base training. Buildups or strides should be EMPHASIZED 1-2 times per week, and they should also be done before and after many high-end aerobic workouts. If you're at altitude above 8,000 ft. and can't get to sea-level, you need to do some of these "quickies" nearly every day. As the competitive season approaches, these buildups and strides can be run with a little more determination (i.e., WORK on your speed, as opposed to merely "staying in touch" with it). Every now and then, include a time trial of 2-7 minutes at 90%-95% effort after your buildups (this keeps a small middle-distance component in your base work). Another middle distance workout consisting of structured Fartlek (repeats of 1-3 min. at a fairly fast but still predominantly aerobic pace) can be substituted for a workout of strides once every 2-3 weeks.

Anyway, SPEEDWORK. Assuming you've been doing the above speed maintenance stuff, you might start your PURE SPRINT work with 2 sets of (2 x 7-10 secs.) nearly flat-out. Get a running start before you blast the 7-10 secs. portions. Take about 1 min. walking rest between the two reps in a set and take 8 min. walking rest between sets. That's basically the whole workout right there (not counting a thorough warmup and a short cool-down).

The second time you try this workout (about 10 days later), increase the number of reps in each set to 3.

The next sprint workout (another 7-10 days later) can be along the lines of 4 x 150m at 98% effort, with 1 min. walking rest between each.

From there, proceed to 3 x 300m at 98%-100% effort with rest periods of about 3-4 min. of walking.

The next sprint workout is 2 sets of 2 x 400m at 95%-98% effort, with only about 1 min. between reps and full recovery (nearly 10 min.) between sets. You may have to jog a little or do a few "high knees" steps prior to the start of the second set to feel like you're ready to go again.

If you survive those workouts, you ought to run a time trial of 700m full-blast (start out very fast, only pacing yourself a tiny bit) about 5 days after the 2 x (2 x 400m) workout (include another hard but lower-intensity workout in between those two). About 2 days later, run a time trial of 1,000m. Again, get out

FAST on this thing.

It's tricky sometimes to fit in other key workouts and races while doing this really fast stuff. You don't know for sure if you'll get sore from sprints like these; nor do you know how LONG you'll be sore. But if your schedule allows, these workouts can fortify your "quick energy" systems (creatine phosphate) and can enable you to buffer (and reuse) lactate better during races of all distances."

--*

Speedwork

Running buildups SLOWER than all-out is meant to foster mechanical efficiency and relaxation. This will ULTIMATELY help with top-end speed by virtue of recruiting the motor units in the most economical fashion. Buildups are smooth accelerations which are designed to preserve a good deal of your creatine phosphate (quick energy). This way, you can do an adequate number of repetitions to promote neuromuscular reinforcement, but without form breakdown or risk of injury. And when doing sets of buildups, the first few in each set should be the slowest (i.e., you should not accelerate to as high a speed at the end of your first few reps in each set). But a couple of the latter reps in each set can involve an acceleration to FLAT-OUT speed (for about 20-30 meters). If you do these things correctly, you'll warm up gradually and enlist a wide variety of muscle fibers without any lactate accumulation and without exhausting your creatine phosphate reserves.

Even-speed strides (up to about 35 seconds) should follow the same format - the slowest ones are done at the beginning of the first set so you'll warm up properly and can set a precedent for running relaxed and with decent form throughout the remainder of the workout.

Bursts of 7-10 seconds should normally be done after FAST buildups and strides have become a COMFORTABLE part of the routine, and a few weeks prior to lactate-intensive (anaerobic tolerance) training. They shouldn't be used year-round. Buildups and strides (even fairly fast ones) CAN be done year-round.

It's important for a distance runner to focus on distance running; therefore, only a minor to moderate emphasis needs to be placed on the kind of workouts which attack 100m-400m speed. Stay in touch with SOME speed even during base training so it will be there for you when you begin race pace repetition running later. Only spend 3-4 weeks on honing your all-out speed. PRACTICE kicking HARD at the end of your races. Train in this fashion whether your primary event is 1,500m or 10,000m."

--*

You can definitely improve your mechanics with regular attention to the issue, but be wary of believing you can force your form to adopt an ideal standard.

There was an old cartoon by Terry Gilliam (former Monty Python animator) that was presented on the International Festival of Animation, hosted by actress Jean Marsh (co-creator of "Upstairs, Downstairs"). The premise concerned the history of aviation and one of the early efforts came from a king who tried to teach his subjects to fly. His revolutionary method consisted of having a guy stand at the edge of a cliff, at which point the king, seated comfortably in a chair behind the subject, would shove the sole of his foot into the guy's butt and yell "FLY!" as the man sailed over the edge. Splat! It didn't work. So he had another guinea pig step forward and he booted that guy off, ordering him to "FLY!" as the guy fell screaming to his death. This went on for awhile ... (Boot) "FLY!" (Boot) "FLY!" ... until the king got frustrated with the gross ineptitude and treasonable disobedience of his subjects and decided the obvious solution was to yell "***FLY!!!!!***" in an even louder, more exasperating and more demanding voice. Same

result. Eventually he ran out of subjects and the experiment in human flight was temporarily abandoned.

It all illustrates the fact that humans are not structurally capable of performing some tasks. Commanding them to fly in the most urgent, "obey your king, you stupid fool, and flap your arms harder!" voice won't solve the unsolvable problem. Now a vulture can fly for sure, but trying to force it to fly like a hummingbird won't work either. Its skeletal structure and its muscle fiber type are not designed for rapid wing movements. A woodpecker and an egret have different flight mechanics as well. You see where this is headed.

Form would be simple to assess and correct if we could all eventually adopt the same "perfect" stride mechanics. But we might not be able to force our form to mimic (and eventually become) that of Paul Tergat or Seb Coe. One guy might be bowlegged, another might have a leg length discrepancy, another might have some scoliosis, another might have a tiny twist in a few of the vertebrae in the thoracic spine which cause a tightness or "hanging up" of the column all the way down to the hip, making the neck of the femur sit in a rotated manner within the cavity of the acetabulum. For the bowlegged guy to consciously work on making his knees stay closer together might be futile and injurious. For the coach of the guy with the slightly off-center hip joint to bark, "You! Can't you get that left knee pointed forward, not outward? Then do it, dammit!" (or even to gently suggest, "Try keeping that leg pointed in the right direction when you think about it, will ya?") might be analogous to the stubborn king ordering his subjects to do something they shouldn't be trying.

The point? Consciously working on your running form can improve your stride mechanics within the framework of your structural limitations, but not beyond. If you aren't symmetrical, your efforts will only take you so far. An obvious structural problem might need to be addressed by someone trained in biostructural correction. Or a simple change in footwear could do the trick. But if you aren't fundamentally built for it, forcing your form to the mold of the latest archetype might not work for you anymore than it would for the heron trying to fly like a sparrow.

So what can every one of us do regardless of our limitations? Basically, we want to feel upright, weightless and gliding yet "popping" with a minimal ground contact time. Focusing on some drills and maintaining a little short speed (with attention to mechanics) year-round can do an adequate job without having to eat into your running time too much. For example, having a stride frequency which is too low (160 steps per minute would qualify unless you're something like 6'6" or taller) can be almost always be improved at least a little with the right drills and short speed without having to radically alter skeletal structure or fiber type. Having a short, choppy stride can also be corrected to some degree, as can a stride that is too long and loping. "To some degree" is the qualifier. Remember the buzzard that can't flap its wings like a hummingbird ... overall size, skeletal configuration and muscle fiber type and distribution all limit us from exactly copying the next guy, albeit with a much more subtle distinction than with the big soaring bird and the little hovering bird. Changing fiber type to that degree isn't possible through training alone (it's more feasible through chronic stimulation), but most fibers can acquire some of the characteristics of other fibers, or at least work synergistically with each other, through balanced training.

It's mostly variants of explosive drills and short speed supplementation that will create the light, quick, gliding/popping strides. Another thing to do is to make sure you keep a decently-quick stride frequency at all paces, even on easy runs. People with certain physical characteristics often think mileage "ruins their speed" and it's usually because they adopt lazier mechanics the slower their pace and because they don't stay in touch with the short strides and basic drills that train the nervous system, maintain an efficient stretch-shortening cycle and keep the routine livened up.
--*-*-*-*

Alright, then, back to the subject of form.

Basically (and not surprisingly), your ideal form will be the form that gets you from the start to the finish of an all-out effort the fastest with the least squandering of energy. Since we're all unique in structure and fiber composition (if only by degrees), it's like I was saying - you can't know if that form will be exactly that of the fastest runner out there or even the "smoothest looking" runner out there. Instead, unless you can have extensive structural evaluation, muscle biopsies and gait analysis, you will have to discover much of it for yourself. Rather, you'll have to wait for your body to reveal it to you. So, in a sense, people are correct when they say lots of running will naturally get your body to slot into the form that's right for you. But you can deliberately nudge it along the way to adopt some of the mechanics that are known to be universal characteristics of correct form, and to prevent your stride from becoming lifeless during periods of otherwise long, easy running. What becomes too comfortable and thoughtless at 7:30 per mile might not be as functional and economical at sub-5:00 per mile.

Why explain the reasoning behind these supplementary procedures like drills and strides, which should really take up less than 8% of your workout time each week and are therefore just an afterthought compared to the far more important act of running, running and more running? After all, when you go to the dentist, you simply want your teeth to be straight, white and free of decay, right? You usually aren't interested in hearing the dentist explain how to interpret an X-ray, why gutta percha is such a good filling material for a root canal, which antibiotic is most effective against Streptococcus mutans or how to use all those implements and materials you see lying around on those trays and in drawers (and you sure don't want him to strap you into the chair, put a bite block in your mouth, turn on a drill and ask you, "Is it safe?"). But the dentist needs to know dozens of times more than meets than the eye to make even the simplest procedures go without complications and discomfort to you, the patient. Your dental history plays a role in every one of those simple procedures as well - which X-ray angles might be necessary, what dose of sedative to use, what surface and which angle to begin drilling and which type of filling material to use when filling a cavity, whether or not to make you pay the bill in full on the spot since you stiffed him the last five times he put you on a payment plan ...

While you can be just fine without learning anything about dentistry other than to follow the dentist's instructions, your running is something you have to take an active role in every day, often responding to how you feel at the time to get the specific effect you need. You can't always rely on an exact protocol for even the day at hand, and you certainly can't reasonably rely on a series of unmodifiable workouts planned out weeks in advance, even if they're brilliant on paper. You will be better off learning why you're doing something so you can have a focal point for each procedure, each day, each week, etc. - to know exactly where you're headed - and so you can learn how to recognize when you've arrived. Knowing what you're looking for actually gives you more of a purpose and makes it easier to act with a central idea in mind as you visualize the process of stimulation/adaptation occurring.

So in regards to form, rather than having the emulation of some fast, "pretty" runner be the true goal, the aim should be to develop the stride characteristics (explosive footstrikes, ideal frequency, minimal "dead time," etc.) which allow your unique physiology to get from start to finish fastest.

Drills (the running kind, not the dentist kind) can serve numerous purposes. Among them is a dynamic range-of-motion warmup which circumvents pre-workout static stretching that may "take some of the tension out of the spring," so to speak. But when examining types of drills (let's include strides here), we might as well assign them a limited number of purposes, so it will be easier to find what we're looking for:

* We seek to **minimize** the inhibitory effects of the "Golgi tendon organ," which prevents excessive muscular force which could damage the involved joint or connective tissues. The GTO's autogenic

inhibition reflex is activated during normal muscular activity, not only when high levels of force are involved, as was once thought. During movement, this reflex helps allocate workload evenly across an entire muscle; that is, if some of the fibers are taking up more of the load than others, their GTOs will be more active, which will tend to inhibit the contraction of those fibers and cause other muscle fibers to be involved with the workload, resulting in more efficient energy distribution.

Slower movements which involve both eccentric and concentric actions and which feature added resistance are good for reducing the GTO inhibition. These include traveling lunges and one-legged squats (with appropriate opposite arm action and breathing dynamics) in which the lowering and raising movements eventually (later in the season) become rapid but you "catch" yourself and hold the "down" position for a second or two. Single-leg or alternate-leg exercises are preferable for all drills once they can be performed correctly and comfortably. Things like wall sits, dead lifts and "bethaks" (deep body-weight squats where the heels come up off the floor and the knees go lower than the toes on the down position) also work on this aspect, but they're less sport-specific.

The improvements that take place during sport-specific resistance training are at least as much neurological as they are in the realm of muscle hypertrophy. This is especially true in repetitive activities like running, which require global, continuous (and often long-term) involvement of motor neurons responsible for fine motor control. Good luck **not** training the nervous system, since it regulates all movement, and you'll be training it every time you go for an "old school" run anyway. Why not have it functioning optimally for its desired purpose?

If you want to put additional resistance to a movement for the purpose of developing efficient allocation of workload, you can either do the movement slower or do it on an incline or both. In fact, when drills are first introduced to the routine, using slower movements for the "resistance-oriented" drills is preferable to using more rapid ones.

* We look to **increase** the potential of the "myotatic reflex," which is the mechanism by which a muscle reflexively contracts with a force commensurate with the degree of pre-stretching occurring in the spindles. Alternate-leg bounding or one-legged bounding are good for this. Again, the double-legged exercises like depth jumps (using boxes) are somewhat less effective for runners, since stabilization of movement is allocated to both legs at once, but they accomplish the same basic purpose.

* We want to **increase** neuromuscular coordination and proportional control (force regulation) by training motor units to act optimally in concert. All short strides which achieve a variety of speeds, including top speed, work here. Uphill sprints have received a lot of attention, and they represent the maximum level of motor neuron recruitment possible during the act of running. If the grade is above 14% (this may be variable depending on height/weight/leg length or unusual leg muscle traits), the stride mechanics (normally frequency) are usually altered too much to be running-specific. Downhill running at a grade of about 2% at top relaxed speed is also very helpful at times. But mostly, relaxed, short strides (through many speeds all the way up to full speed) on level surfaces will be your friends and allies when it comes to developing your optimal running form. After all, rapid and economical forward propulsion **is** your goal, right? - not bouncing up and down or holding a bent-knee position for a second or hopping uphill on one foot.
Here's an example of a simple routine for drills starting about 4 weeks before a competitive season begins (precede it with 12-20 minutes of progressive warmup jogging):

<u>Phase 1 (4 weeks)</u>

High Knees: 2 x 30m (2 weeks), 4 x 30m (2 weeks)
Quick Steps: 2 x 15m (2 weeks), 4 x 15m (2 weeks)

Heel Walks: 2 x 10m (2 weeks), 2 x 15m (2 weeks)
Goose Steps: 2 x 40m (2 weeks), 4 x 40m (2 weeks)
Traveling Lunges: 2 x 15m (1 week), 3 x 15m (1 week), 4 x 15m (2 weeks)
High-Knee Skips: 2 x 40m (1 week), 3 x 40m (1 week), 4 x 40m (2 weeks)

Phase 2 (5 weeks)

High Knees: 2 x 30m (5 weeks)
Rapid High Knees: 2 x 20m (5 weeks)
Heel Walks: 2 x 20m (5 weeks)
Goose Steps: 2 x 40m (5 weeks)
One-Legged Half Squats: 2 x 10 each leg (1 week), 2 x 15 each leg (1 week), 2 x 20 each leg (3 weeks)
High-Knee Skips: 2 x 30m (5 weeks)
Alternate-Leg Bounding: 2 x 40m (1 week), 3 x 40m (1 week), 4 x 40m (3 weeks)

Phase 3 (4 weeks)

High Knees: 1 x 30m (4 weeks)
Rapid High Knees: 1 x 20m (4 weeks)
Heel Walks: 2 x 15m (4 weeks)
Goose Steps: 2 x 40m (4 weeks)
One-Legged Half Squats: 2 x 10 each leg (4 weeks)
High-Knee Skips: 2 x 30m (4 weeks)
One-Foot Hops: 2 x 30m (2 weeks), 2 x 40m (2 weeks)

* Do drills and warmup strides with the wind (if any)
* Focus on technique but relax, relax, relax as much as possible and breathe, breathe, breathe
* Recover well between each set of drills so as to maintain mental focus and preserve proper technique
* Follow the routine with 4-8 progressively faster 10-15 secs. buildups or even-speed strides to regain specificity of running
* The number of drills reduces (often replaced by more buildups or strides) in Phase 3 because mid-season workouts become more demanding, and to get accustomed to requiring a less extensive plyometric warmup routine
* The warmup routine (drills and strides combined) is tailored to personal preference for the remainder of the season following Phase 3
* Recommended to cut total number of reps in half prior to the hardest or most important running workouts and prior to important races (also subject to personal preference)
* Pre-workout static stretching should be very light if done at all, normally stopping slightly short of full range of motion for any given stretch

This is an example of a routine for mainly long distance runners. It looks like a fair amount on paper, but the entire routine (including all the recovery periods between the drills and strides but not including the warmup jog) should take no more than 25 minutes (usually less). If done twice per week (prior to a medium effort or hard workout), the total should amount to no more than 8% of weekly workout time for mature runners at normal adult mileage levels. This illustrates the place of drills and strides in the hierarchy of the overall running routine - it's still a very minor part, isn't it? But this small devotion to variety can help you warm up pretty effectively and thoroughly and can make some inroads into developing explosive strides with minimal ground contact time. Just think of it as getting a complete warmup, because that's mainly what it is for distance runners.

So how would that warmup routine fit in with the bulk of the running?

Here are three examples of 2-week periods (leading up to races) for a good journeyman college 5k runner (who hit 14:21 indoors and 14:08 outdoors) during the very early indoor season, for the middle of the season and for the peak of the season (schedule does not include secondary runs of two-a-days):

Early season

Su Medium length easy run

M Warmup jog, **drills**/strides, 3 x 15 min. starting @ high-end pace (easier than a focused "tempo" effort), progressing to tempo pace, then to crest load pace (about the pace for a 40-42 min. race) / 2-3 min. rest periods, 4 x 150m @ 24-ish / 45 secs. rest periods, cool-down jog

T Medium length easy run

W Warmup jog, **reduced drills**/strides, 60 min. progression to high-end pace (about 35 min. at high-end pace), 3 min. rest, 6 x 15-20 secs. progressively faster buildups, cool-down jog

Th Medium length easy run

F Warmup jog, **drills**/strides, 8-10 x 1,000m starting @ 3:10-ish and progressing -> sub-3:00 / 60-90 secs. rest periods, cool-down jog

Sa Medium length easy run

Su Medium length easy run with a few light to medium speed buildups included near the end

M Warmup jog, **reduced drills**/strides, 60 min. progression to high-end pace (about 35 min. at high-end pace), 3 min. rest, 6 x 10-15 secs. progressively faster buildups, cool-down jog

T Medium length easy run

W Warmup jog, **drills**/strides, 20 x 400m @ 74-ish -> 66-ish / 40-45 secs. rest periods, cool-down jog

Th Medium length easy run

F Short to medium length easy run with a few light to medium speed buildups included near the end

Sa RACE

* That's 3 days with full drills and 3 days with reduced drills (including the RACE day) in this 14-day period

Mid-season

Su Medium length easy run

M Medium length easy run with a few light to medium speed buildups included near the end

T Warmup jog, **drills**/strides, 2 x 20 min. @ high-end/tempo pace / 3 min. rest periods, 4-6 light to

medium speed buildups, cool-down jog

W Medium length easy run

Th Medium length easy run with a few light to medium speed buildups included near the end

F Warmup jog, **drills**/strides, 5 x 1,600m @ 4:50 -> sub-4:35 / 2:30 rest periods, cool-down jog

Sa Medium length easy run

Su Warmup jog, **reduced drills**/strides, 45 min. light progression to high-end pace (about 20-25 min. at high-end pace), 3 min. rest, 6 x 15 secs. progressively faster buildups, cool-down jog

M Medium length easy run

T Medium length easy run with a few light to medium speed buildups included near the end

W Warmup jog, **drills**/strides, 4 x 400m @ 70 -> 62 / 1 min. rest periods, 3 min. break after last rep, 4 x 800m @ 2:16 -> 2:08 / 1:30 rest periods, 3 min. break after last rep, 2 x 300m accelerations / 2 min. rest periods, cool-down jog

Th Medium length easy run

F Short to medium length easy run with a few light to medium speed buildups included near the end

Sa RACE (underdistance)

* That's 3 days with full drills and 2 days with reduced drills (including the RACE day) in this 14-day period

<u>Late season</u>

Su Medium length easy run

M Warmup jog, **reduced drills**/strides, 45 min. light progression to high-end pace (about 20-25 min. at high-end pace), 3 min. rest, 6-8 x 100m progressively faster buildups, cool-down jog

T Medium length easy run

W Warmup jog, **drills**/strides, 2 x 2,000m @ 5:50, 5:45 / 3 min. rest between each, 5 min. walk/jog after last rep, 3-4 short strides, 2 x 1,200m @ 3:20, 3:15 / 3 min. rest between each, cool-down jog

Th Medium length easy run

F Warmup jog, **drills**/strides, 2 x 20 min. @ high-end/tempo pace / 3 min. rest periods, 4-6 light to medium speed buildups, cool-down jog

Sa Medium length easy run

Su Medium length easy run with a few light to medium speed buildups included near the end

M Warmup jog, **drills**/strides, 4 x 400m @ 72 -> 64 / 45-50 secs. rest periods, 3 min. break after last rep, 4 short strides, 1 x 1,000m @ 2:38, 4 min. walk/jog, 2 x 300m accelerations / 2 min. rest periods, cool-down jog

T Medium length easy run

W Warmup jog, **reduced drills**/strides, 3 miles light progression to high-end pace, 3 min. rest, 4 x 400m @ 72 -> 66 / 1:30 rest periods, 4 x 200m @ 34 -> 30 / 1:30 rest periods, cool-down jog

Th Medium length easy run

F Short to medium length easy run with a few light to medium speed buildups included near the end

Sa RACE

* That's 3 days with full drills and 3 days with reduced drills (including the RACE day) in this 14-day period

So this guy was usually getting 3 days per week which involved drills, but only 3 days in each full 2-week period used the complete routine. That's only about an hour (including recovery time between sets of drills/strides) out of 10-12 hours of workout time per week (including secondary A.M. runs) for this 90-110 mpw runner. The time spent doing actual drills and strides during the warmup routine (not counting recovery between sets) was probably about 30 minutes per week (note there were more strides following some workouts and on some easy days). That's not a big percentage of the overall mileage, yet regular devotion to the drills provides a thorough and spiced-up warmup, fosters better footstrike/stride mechanics, and maintains those mechanics over time even during periods devoted to more endurance running and less race pace or speed (note how slow some of those 400m and 1k reps were in the early season relative to this guy's 5k best).
marijuologist wrote:

These drills have absolutely no value ...

Don't you know that the value is not in the drills themselves but in how they are included within the overall framework? How can we begin to explain the gestalt to those who examine only the constituents as stand-alones? Now that is a real mode of faulty thinking that has dominated physiologists' attempts to intrude into athletics training for decades.

People who do these things regularly **in conjunction with the other things** become snappier, exhibit improved running economy, experience fewer injuries, feel mentally sharper, and (perhaps most importantly for racing purposes) respond to missteps, jostling and pace changes better than their peers who don't do them. With just the right attention to the right drills, this is a predictable and repeatable result.

Placebo? Not a chance. But even if it was, any medicine that works is good medicine.

If they have any effect at all, these drills will cause skill confusion, ...

Ah! Now you would have a point there except for the fact there aren't enough of them in each warmup routine to reinforce incorrect movements. The inclusion of the post-drills slower-to-faster buildups and

the subsequent workout always rewires running specificity. Given the hundreds of hours per season runners spend making the exact same motion thousands of times per hour, it's actually **preferable** to use a variable motor skill set and slightly different muscular involvement to warm up on occasion. This is an example of what I call the "something has to give" rule. You won't find an athlete with the highest max VO2 and highest running economy, for example. Some characteristics preclude others, perhaps as a protective mechanism. Nor will you maximize every measurable aspect of running fitness simultaneously. Something has to give. Things also eventually have to give if every movement you make is a weight-bearing running movement. So think of warmup drills as "cross training" in that regard - bringing a fresh physical twist and mental perspective.

Involving antagonistic muscles (some with more recruitment, as in heel walks, and some with higher rate coding, as in goose steps) is also helpful in the area of injury prevention via keeping a favorable strength ratio.

Peak recruitment involving peak forces or continuing to muscle failure does create skill confusion - weightlifting, for example. But replication of a few elements of the whole complex movement at sub-peak forces and with brief duration **will not** create skill confusion. Not a chance (gee, that's the second time I said that - QFE, I suppose).

--*

General health through good eating habits should result in much better O2 uptake - and, more importantly, in better performances - than poor health.

Raw fruits and vegetables (or lightly steamed carbohydrate veggies like broccoli, etc.) improve digestion and regularity, keep blood vessels healthy, allow for good transport of metabolites across cells, provide antioxidants, polyphenols, lycopenes and indoles, and give you a high nurtrion-to-calorie ratio, which is improtant for weight stabilization and as a life extension technique.

Foods high in protein and heme iron but low in fat are instrumental in anabolism (tissue building) and oxygen transport. A good example is emu meat. Beef is decent, but isn't quite as good because of the higher fat content, which makes the beef harder to digest and leaves foodstuffs in your body in various stages of digestion instead of having a healthy cycle of absorption/elimination.

Fish - the essential fatty acids are very good for runners in general, leading to better joint and vascular health and faster recovery. If that doesn't promote higher O2 uptake directly, it can indirectly by allowing you to do more work without breakdown.

Simple sugars or high glycemic index foods are usually bad. The exception comes after a very depleting session (such as a taxing long run or a workout in which a strong pace was run for over an hour, not necessarily a continuous run). After these workouts, it's desirable to occasionally take a simple sugar within a few minutes to get an insulin spike, then eat a meal high in complex carbohydrate within an hour after the workout, with plenty of water. This allows more of the carbs to be stored as glycogen. The water is also necessary toward this end. Making a habit of eating sugary foods usually promotes inflammation, however, so avoid them in day-to-day eating.

Some combinations of supplements are touted, but there isn't enough info on them to support a lot of the claims their promoters make. Buffering agents, for example, can often speed up the release of O2 into cells from hemoglobin, but many of the commercially-available buffering agents promote dehyrdation and rapidly exceed bowel tolerance if taken in quantities sufficient to achieve desired results. So

experiment with stuff like this at your own risk.

To state the obvious, healthy foods will be better for your running than unhealthy ones.

--*

train in the only hi-mod-lo protocol in the country. I see people all the time who want to form a serious training group, but they invariably qualify the idea with trying to get the other interested parties to move to (name of THEIR city). You can see the same qualification being presented in this very thread. I'm interested in finding people who REALLY want to be the best - willing to relocate to the most favorable environment and to not merely be part of some "social running" clique. So far, I've only seen evidence that there are about three people in the country who are that dedicated to being their best (or who have the financial independence they THINK they need). So are YOU willing?

Why Flagstaff? Alright, it's at altitude, so why not Boulder or Alamosa or Albuquerque or Gunnison? The answer is that Flagstaff provides the requisite elevation (circa 7,000 ft.) to stimulate a prominent erythropoietin response AND allows for fairly quick access to higher and lower (even close to sea level) elevations. From Flagstaff, you can quickly get to Sedona (4,200 ft.) or Camp Verde (3,200 ft.) for threshold training and to Phoenix (1,000 ft.) for faster running. You MUST run regularly at l-a to maximize the effectiveness of the training. A trial period of a few weeks can be used to determine if you are an altitude responder. If you are a responder, you will never achieve your best performances WITHOUT moving to a h-a site for at least a portion of the year, so forget about staying where you are and asking others to come to you if you want to truly be dedicated to success.

Be prepared to develop a LOT of endurance from the ground up and to perhaps take more time than you think is necessary. This is not a quick fix. In fact, you may very well get SLOWER in the early stages. If you abandon the training for lack of TANGIBLE results after a few months, you are NOT really a serious runner and will not reach your full potential with any group of training partners or at any location (even Kenya, Japan, etc.). Alan Webb, for example, would probably not be a good fit for what I have in mind. This is not to single him out; virtually every runner in the country has the same "I'll try something for several months and if I don't get faster, I'll try something else" attitude. Depending on the individual, that's not always the WORST approach. It might be a healthy attitude (i.e., preserves the joy of the sport) for Alan Webb and for a number of others, but I'm not looking for people with that mindset.

Nor am I looking for people who need external motivation. I've got big news for you: The primary role of a COACH is NOT to motivate someone to run through brick walls. A COACH is someone who knows where the damn DOORS are and can teach the athlete how to find them so there's no need to bash his head against any walls. If you need somebody to fire you up and TELL you to believe in yourself, good luck with all that. You're looking for a motivational speaker, not a RUNNING coach. Just bash your head bloody against those walls, bub. I'm looking for people who LOVE to run and are ALREADY willing to be led through the doors and who will methodically and patiently pass through them while the other suckers are busy getting "psyched up" enough to endure the pain of bashing their brains out IN VAIN.

Now the not-as-good news: If you make this commitment, you will need to find your own sponsorship (if you're at that level already) or will need to have some outside means of income. Not only that, but I (as a professional running coach) expect to be paid a small monthly fee, as well as a 10% cut of any money you might make from races. Criticize if you like, but I believe time and services should not be provided for free. Chumps who give away everything for nothing are unprofessional and don't stick to their principles. I am a professional, not a chump, and I expect compensation. Besides, while free advice is often good advice, there comes a point at which (you know the clichÃ©) "free advice is worth every penny". If you're not willing to make at least a small monetary commitment, you're the kind of person who probably

won't last for the long haul and free advice will eventually just go in one ear and out the other.

Also, it is impractical to have a group which is TOO large. Ten to fifteen runners is probably ideal, so if this seminal idea comes to fruition, we may have to limit the number of participants and start imposing time (or other) standards.

Anyway, that's my take on it. As I mentioned, the training will likely be slower (at first) than you might be accustomed to doing, which will be necessary as you adjust to h-a and cope with varied terrain. You need to be able and willing to reach about 150 miles for your higher weeks. This depends, of course, on individual ability to adapt, but this is a WORLD class training protocol, not a typical American anaerobic interval program, and it is not for the person who falls apart at 70 miles per week.

So mull it over.

--*-*

Of course you know that anybody who has a 2:10:59 PR and advocates no-nonsense, old school, twice daily high mileage training has my utmost respect as a runner and as a dispenser of training wisdom. But I've got to disagree on the altitude issue. There are enough studies that have been carried out on the live high/train low paradigm by now that it's quite conclusive that some people are "responders" (increased erythropoietin hormone) and those people unmistakably exhibit significantly improved performance vs. that of non-responders and vs. that of the live low/train low runners. Of course, these have been SHORT-TERM studies (a few months), but the studies were undertaken in the first place because of the number of altitude-trained or altitude-born runners who were delivering superior performances (and due to anecdotal evidence). It's pretty clear that someone who IS a responder is most likely selling himself short if he has the opportunity and the means to use hi-lo training and chooses NOT to. In fact, two of the three runners that I've had relocate to Flagstaff showed dramatic blood chemistry evidence of responding to the h-a, and their PRs improved in a concomitant fashion. The third suffered from march hemoglobinuria within a few weeks (after too sudden an increase in mileage) and we were unable to determine if he was a responder.

The Epo boost is not the only advantage conferred by living high. The benefits are myriad. It's also advantageous to do some easy running at h-a and to do a fair amount of threshold training (or in the zone barely above the threshold) at moderate elevations. The gains here occur mainly in the areas of improved lactate buffering capacity and increase of oxidative muscle enzymes. Of course, training itself promotes vascular growth, as does hypoxia (strangely, though, running at h-a doesn't seem to foster vascular development any more profoundly than running at l-a does). There are also some PROBLEMS (or I should say "less than optimal scenarios") which can arise from doing ALL training at h-a. So a balance needs to be struck as to time spent living and training at various elevations and as to the effort levels achieved when running at these elevations. I doubt there is a "perfect" way to make use of altitude living and training. The best we can do is maximize the principal positives (the ones which contribute most to improved performance) while minimizing the negatives. Intermittent hypoxic exposure using the tents may prove to be as good an option as anything.

Anyway, there is VERY STRONG evidence that altitude IS beneficial for a majority of endurance athletes. Don't close your eyes to the evidence just because people ran well 20-25 years ago when that evidence wasn't available. Sure, Americans ran better before all the technobabble came on the scene, but that's because our high schoolers for some reason began running less mileage and higher intensity (for the quick fix, I suppose) and were either not good enough (or were too hammered out) to continue pursuing serious running careers or were unprepared to handle a higher training load if they did try to continue. My point is that the technobabble can be useful if you can separate the wheat from the chaff and integrate it within the framework of the tried-and-true principles from the old days.

I, for one, am more than confident that I've made several refinements and IMPROVEMENTS to the basic model that brought Americans success in years past, and have done so without abandoning that model. And I'm pretty sure others around the world have also evolved those old principles into new systems. Sure, it would be great to first get back to the level we were at in the day, but that's not good enough anymore. The game has changed, and not all of it is due to drugs. This is in no way meant as a put-down to any of the old guard, but if we want to compete in the new millennium, we can't be stuck in the old one.
Those lists would be very compelling (inasmuch as the l-a runners are just as fast or faster than the h-a runners) EXCEPT for the fact that all of those h-a runners but one (Meb) have NOT made use of the current hi-lo method. The evidence points to living and training high (hi-hi) conferring at most a TINY advantage vs. living and training low (lo-lo) when racing at sea level. Hi-hi runners DO appear to perform significantly better AT ALTITUDE than lo-lo runners, but hi-lo runners (responders, that is) appear to perform better than both of the other groups at h-a AND at sea level. These studies have been going on since about 1990, and the results are pretty consistent.

Meb reputedly used hi-lo prior to breaking Nenow's mark in 2001 (and he also ran barely under the old mark in 2002). You might call him an outlier, and of course we can't PROVE he wouldn't have run as well WITHOUT hi-lo, but nonetheless HE has the AR, not a lo-lo runner or a hi-hi runner. 27:13.98 is hard to argue with.

While we can't redo Meb's 2001 and 2002 seasons without hi-lo to see what he WOULD have done (and I'm not even sure to what extent he used it), we HAVE tested a SIGNIFICANT number of runners using lo-lo, hi-hi, and hi-lo living/training protocols, and the results are crystal clear in favor of hi-lo, enough so as to confidently eliminate other factors (such as pre-study training, weather conditions during time trials, etc.) from contributing to the greater performance gains exhibited by the hi-lo runners. The hi-lo runners who have been responders and have shown elevated blood markers have ALSO shown improvements in time trials which correspond closely to their degree of response to h-a.

Of the h-a runners other than Meb on those lists, only Kyle Heffner came close to today's version of hi-lo training. He lived at over 8,000 ft. and came to Boulder (5,400 ft.) regularly for tempo running on the roads. He also raced over various distances at sea level. The only things he missed were regular WEEKLY sessions at near sea level. Prior to moving to Colorado, he had never run farther than six miles at 5:00 pace, and he was able to improve to the point of averaging 4:59.6 pace for the marathon in the 1980 OT race. He will tell you that he felt the altitude was a MAJOR contributer to his rise from college journeyman to Olympic status, although his increased mileage, rest time, and nutrition (he was sponsored by Arrowhead Mills) were OBVIOUSLY huge factors, as was having the opportunity to learn about high-level training and racing from the likes of Shorter, et al. He also felt that coming DOWN for faster training and racing enabled him to achieve a rhythm that he could never have found up at 8,000+ ft.

In summary, I say that the people on our all-time lists who would have responded (or did respond) to h-a probably WOULD have run even FASTER using the hi-lo method. Runners who use ONLY hi-hi (this includes those in Alamosa, Gunnison, Colorado Springs, Boulder, and Albuquerque (the last two of which are not really "high")) are getting SOME benefit vs. lo-lo runners, but not as much as that of hi-lo runners. I further contend that more runners were using high mileage, aerobically-oriented training during the 1970s and 1980s, which accounts for the large number of top ten performers (a slight majority, in fact) achieving their marks prior to 1990. All of the 10,000m performers were "strength runners" (BTW, Abdi has a 27:42.83 from 2002, which bounces Pre). On the 5,000m list, only Padilla was a low mileage runner. Even most of the milers had good base mileage and aerobic capacities which enabled them to be very good at X-C. If more of today's runners begin using aerobically-based training AND the hi-lo method (for those who turn out to be responders), I predict many performances which are superior to

those of the 1970s and 1980s.

Plenty of factors go into creating an ideal situation for a given individual, and relocating to h-a might NOT be right for everyone (even for a h-a responder), but I think the results are conclusive enough that the hi-lo option should be given some pretty hefty weight when making a choice on training location. Smart, sound training which follows the proven fundamentals is the number one physical requirement for reaching your potential. Love of running and a confident attitude toward training and racing are the key mental ingredients.

IF you have the opportunity and the inclination to use hi-lo training, I think it should be placed VERY high up on your list of potential physical criteria, because the possible performance gains are far greater than trivial. You can always use a trial period of several weeks to see if hi-lo is for you or not. If its benefits are trumped by other factors or personal preferences, then by all means go with what works for you.

--*-*

The ingredients for making the most out of your talent are consistency, high mileage with a focus on high-end aerobic running, a proper transition to hard track training, a limited amount of VERY HARD training, and an overpowering desire to MAKE yourself into the runner you want to be.

When you DO train intensely (and when you race), you must be willing to REALLY HURT BAD to achieve your goals. I mean go to the sludge at the bottom of the well. However, I've seen numerous elite runners (most from the 1970s) do this kind of hard training and can say with no hesitation that I've also witnessed countless high school nobodys who have trained every bit as hard relative to their own fitness levels as any elite runner I've ever seen. The difference is that the HSers don't HAVE much fitness either because they simply have less natural aerobic capacity or (more often) because they spend MOST of their time doing the hard track training and they ignore the base work and transition work.

The "secret" you're looking for is the high-volume, high-end aerobic base training. Without that, you won't ever reach your personal summit. You may be so gifted that you still turn out awesome compared to most others, but you won't be the BEST you COULD be. For over a decade, Americans wanted dearly to believe that they could skip the foundation work and hammer themselves into greatness. Why? Probably because a quick fix is more alluring. But the experiment resulted in FAILURE. Dramatic, obvious, measurable-by-the-stopwatch FAILURE.

We're doing a bit better during the last few years, but MOST Americans still don't get it. They need to forget the "horses for courses" training LIE and start training like REAL DISTANCE runners. Once they set the base over first months, then years, THEN they can spend more time on the specialized training which they have found by trial and error to benefit their racing most.

Lydiard said, "Miles make champions." Runners aren't physically any different today than they were 40 years ago, so that fundamental principle still applies. Toshihiko Seko's coach, Kyoshi Nakamura, likened correct training to the steady fall of raindrops which slowly forges a hole in a rock. Some days the rain falls harder and some days it doesn't fall at all, but the process cannot be HURRIED. There is the "secret" of training. I once wrote that even a football player can train himself to run 10 balls-out quarters, but still won't be in SHAPE. Being in shape means having the aerobic power to run CONTINUOUSLY for 5 miles or 10 miles at a very high percentage of top speed. Any intense training that can be done WITHOUT that kind of basic fitness can be done AFTER that fitness is acquired - and it can be done MORE EFFECTIVELY.

Well, there's another rant. Pertaining to the PSYCHOLOGICAL characteristics of elites, one trait that's shared by most of the best is that they can stay relaxed and confident going into a race, yet can maintain total focus throughout the race itself. Being able to lock into a "competitive zone" and place winning over ANYTHING else is a hallmark of all champions.

--*

... Being able to withstand quick eccentric loading is vital to a runner, not only for full-speed sprinting, but also for economy. The less time a runner spends in the amortization (plant) phase, the better the runner's economy generally is at that particular speed ...

I should add to that bit that barely exceeding the threshold on aerobically challenging runs is helpful on occasion during the base period. If done correctly, this can give you the opportunity to process lactate (reconvert it to other metabolites) without lowering your blood pH. Slightly exceeding the threshold at the end of a progressive tempo run or performing a workout such as 15-20 x 400 at roughly the pace you could currently run for 3,000 (not the pace you could run for 3,000 when in PR race shape) with relatively short rests (45-50 seconds should do) will provide this stimulus. With sufficient pace work, most runners can eventually run 15-20 x 400 at roughly the pace they could run for an all-out 2,400 at the time, but this overall intensity is neither necessary or wise during a base stage.

--*-*
--*-*-*-*

Spoken like a bloke who was *not running in the 1970s* (in fact, probably not even alive in the 1970s). The serious runners of that era (and the ones in this one who are smart enough to use their methods) know the sole reason for the ensuing decline in performances - no participation issues, no economic factors, not "tonsa" reasons. Only one.

I predict another slight decline in U.S. running within the next 12 years. There was a brief return to aerobically-based training between 1997 and 2004, but more recently - at the high school level in particular - there has been a new infusion of reliance on individual *elements* of training at the expense of mileage, and new championship meets have been created, for which high schoolers hammer and taper, eschewing relaxed aerobic running and ignoring long-term development. Those high schoolers and their immediate successors will be in the peaks of their careers in about 10-12 years. Here we are on message boards talking about using gadgetry to monitor precisely-orchestrated sessions which will fine-tune our running to the nth degree. That's great if you're already an aerobic monster, but all the while, the main goal of acquiring general fitness is being ignored by most people because they don't know how to do it.

There are many posters on this and other message boards that can talk a very good game when it comes to knowing *about* the effects *specific* workout procedures can have on your circulatory system, skeletal muscles, fat/glycogen metabolism, monocarboxylate transport system, wasa wasa wasa. But I've only seen one or two people who know how to put it all together. When I was 13 years old, a classmate of mine learned a lot about Civil War battles and soldiers. He could tell you many little-known facts about the ammunition used, the river boats in service at the time, the uniforms worn, etc. Had you asked him the right questions, he would have seemed by all accounts a Civil War expert - a whiz kid. But someone asked, "What was the war about?" And he *didn't know*! Is that kid you? Do you spend a lot of time looking for answers to running questions in books and medical journals but don't know what running is about?

If you think for one instant that there is *any* special formula by which a "quality over quantity" methodology will bring you to fruition as a runner, that "kid" is you. You have no idea what this sport is

about, and I suggest you learn what is about by *doing* it rather than by researching Ex. Phys. studies, observing runners on treadmills or getting a complete workout schedule from *anyone* who does either for a living. Those resources can *help* you with some specifics, but you will *never* find the total solution there. The answer lies in the trials of miles out on the roads.

Skuj wrote:

The general running population didn't know about Coe training, or Lydiard for that matter.

Let me guess - you have *read* about running in the 1970s but never *lived* it. Having started running in 1968, *daily* running in 1972, and having logged about 78,000 lifetime miles, many of them alongside sub-9:00 HS 2-milers, sub-1:45 800m runners, sub-3:55 milers and 2:10 marathoners, as well as the recreational crowd and every competitive level in between, I'll help get you up to speed on the way things *really* were during the 1970s *and* the 1980s. Heck, I'll even throw in a pitch about the 1990s.

First of all, the "general" running population of the 1970s consisted of *serious* competitive runners of the original "running boom" (which was no doubt influenced heavily by Dr. Ken Cooper's "Aerobics" in 1968 and fueled by Frank Shorter's gold medal in the 1972 Munich marathon). There were also a *few* of the fitness joggers that comprise the lion's share of today's "participation boom." I never met a single person involved with *competitive* running at the time who did not know about Lydiard, his methods, his Olympic athletes, and his influence in the sport from New Zealand to Finland *and to the U.S.* Even most of the joggers knew about him, just as today's joggers know about Runner's World's recommendations on the most comfortable fanny packs and tastiest post-race snacks. Dr. Cooper, Shorter, Jim Ryun and (later) Bill Rodgers were the "household" running names in America at the time, but the general *running* population knew all about Lydiard, and virtually all the literature of the era promoted long periods of relaxed base training with weekly long runs, and what was at the time called "high steady state" running (which would now be called "threshold" running or AT or tempo). People ran the roads as often as they ran X-C and track. Most low-key local road races were vastly more competitive than they are today, and national-class or world-class runners would sometimes show up unannounced for these small races in the bigger cities and would occasionally have their hands full with a *local* guy or two. Running was that competitive among the masses then. I know first hand because I was *in* many such dinky city races with national-class guys (and I once got outsprinted for the win in the last 200m of a half marathon by none other than Tony Sandoval ... when he had one of his worst days!). Even high schoolers and college runners did these road races regularly. High school performances were at an all-time high in 1976. The U.S. won individual and team titles at the world junior X-C championships from 1974-1977 and went 1-2 (Hulst and Hunt) in 1976. College runners were competing against world record holders and Olympians in NCAA meets, some were Olympians themselves and many went on to world-class status.

Enter the 1980s. While the elite runners (who had grown up during the 1970s running boom and understood how to train) were still running sub-28:00 for 10,000m (Nenow, Bickford, Eyestone, Sandoval, etc.) and scads of 2:10-2:15 marathons (and a few 2:08-2:09 times on p-t-p courses), the high school crowd (beginning circa 1979) had moved toward a "faster must be better" mantra. Coe obviously did not *start* this, but his assertions that "modern middle distance running is about speed" (another direct quote), as well as the other quotes mentioned above, fed a virtual cult of misuderstanding followers who praised the Emporer's new clothes of high intensity. The biggest problem was the non-runners in the white lab coats determining (in true "forget what we told you several years ago; *this* time we've *really* got it right" fashion) that max VO2 could be improved to its ceiling by running 35-40 miles per week. The next generation of runners, already overestimating the importance of max VO2 in predicting performance, was happy to hear that they could be back at the arcade playing Asteroids and Pac-Man after a 30-minute track workout. Virtually every piece of literature of the mid-1980s announced that the trend in training

was toward lower mileage and higher intensity. Performances on the depth charts plummeted, first among the high school ranks and then among U.S. elites. Runners who had burned out from high intensity and mediocre performances in youth had little reason to stay in the sport, and the elite ranks thinned.

Then came the 1990s. This decade saw the explosion of growth hormone and recombinant erythropoietin. East Africans began to dominate the sport (not sure if there's any connection to the drugs). Dieter Baumann beat a horde of them in Barcelona to win the 5,000m gold medal, but the long track races would soon become Ethiopia vs. Kenya (and, later, Kenyan defectors), while the middle distances saw more North Africans and a smattering of Euros challenging the mighty Kenyans. Kenyans also began making a laughingstock of American road races. Americans struggled mightily. Steve Spence's WC bronze in the marathon briefly sustained hopes for a comeback, as did Mark Plaatjes (via S. Africa) winning the 1993 WC gold for the U.S. But by the middle of the decade, only Todd Williams and Bob Kennedy were mixing it up with the world's best on the track and in X-C. Admittedly, Kennedy was a low mileage runner in high school and only a moderate mileage runner in college, but he blossomed when he moved to the 100-140 mpw range, running 12:58 twice the following year and briefly leading the Olympic final in Atlanta. Williams also logged up to 120 mpw when he was gamely gutting it out with the Africans in 1992-1995, while Jerry Lawson and David Morris were doing likewise when they popped 2:09 marathon ARs. The *only* world ranked or world listed male Americans of the 1990s were those who did what? That's right - the same training mileage that their predecessors did 10-20 years earlier to become world class themselves. But in the 1970s and early 1980s, there were many more of them.

The decline, which I agree has occurred, cannot be pinned on this training ideology.

See above. You obviously were not involved with the sport in America during both decades. I was involved *alongside the runners themselves* at every level from junior high school to elite, and everyone else who was likewise involved will give you the same answer. Lower mileage during the mid-1980s and beyond was the norm and was the *sole* reason for the decline in performances. This is absolutely unarguable to anyone who was a serious runner during both decades.

And I do think that you exaggerate what that ideology is.

"Think" is the key word there. The ideology is unquestionably one favoring intensity. While the exclusion of volume is not specifically *encouraged*, it is stated very explicitly that such volume is *not required* to produce maximum performances. This line of thinking is simply DFW.

It is NOT drastically less volume for everyone. The Coe quotes have been isolated and takem waaaaay out of context by you and many others.

Re-read those quotes and explain how they can possibly be taken "out of context." *What* "context"? Again, "It eradicates the need for high mileage" and "... long slow distance makes long slow runners." Isolated, maybe. But this is what people heard or read. No grey areas there. No room for interpretation. The message *is* the context and it could not possibly be any more straightforward.
From a physical standpoint, your kick is a function of your raw speed, your ability to accelerate, AND how deeply you've had to rely on anaerobic energy production up to the point in the race that you launch the kick. Bearing that in mind, having a high AEROBIC capacity will give you a greater speed RESERVE (how much of your maximum sustainable oxygen debt you still have to "give away") than many runners who are flat-out faster than you are over 100m or 400m or whatever. So you should primarily train for aerobic endurance. The guy who trains ONLY for the kick shouldn't be close enough to

you to use it, anyway.

--*

As far as speedwork goes, you should ALWAYS be doing a little something about your turnover, even during a base-building phase. I refer to these workouts as "speed maintenance". They provide variety in footstrikes, muscle fiber recruitment, etc., which can not only keep you in touch with some speed, but can also help prevent injury.

Examples of speed maintenance workouts are simple buildups and strides and some form drills. You might try two to three sets of 5-6 buildups of 15-25 secs. WITH THE WIND (if any), jogging back (or jogging an equal distance) between each, and jogging 5-10 min. between sets. The first buildups in each set should be the slowest, but each set can be started slightly faster than the previous one (since you're going to be more warmed up). Every 2-3 weeks, you should tack on a fairly fast 2-7 min. run following the last set of buildups. The purpose of this is to get your heart rate up NEAR its maximum (also close to VO2max) WITHOUT tying up very much. Only run the 2-7 min. thing at about the pace you could run for TWICE the selected distance at first (e.g., run 3 laps at the pace you COULD currently run for 6 laps in a race).

Another speed maintenance session could be 2 sets of 5-6 x 30-35 secs. progressively faster EVEN-SPEED strides. Jog the same distance between each and jog 5-10 min. between sets. These can be run as 200m reps on a track (with the wind, if any) or they can sometimes be run DOWN a very gentle hill (keep the surface soft, perhaps on a golf course) to concentrate on a light, quick turnover. The purpose of emphasizing turnover on occasion is as a prelude to quick accelerations. You can also run some UPHILL reps, but they don't necessarily need to be FAST. Just using the correct form (hips beneath the torso - NOT leaning too far into the hill with the buttocks back) will work the correct muscles for hill running.

At some point near the start of a competitive season, the speed on sessions such as these can be deliberately WORKED a little more. You can also do about 10-12 progressively faster 12-15 secs. uphill repeats, finishing really fast. BUT - you should avoid tying up horribly in any case. Make sure you can hold form. The more you practice relaxation at close to top end speed, the easier it will be for you to recruit the necessary motor units (muscle cells and their connecting neurons) when it's time to kick it in at the end of a race.

Provided you've stayed in touch with your speed in the above fashion during a non-competitive season (or during the early part of a competitive season), and provided you've done some form drills (an entirely separate topic) you can introduce some "creatine phosphate" training. This initially entails a thorough warmup followed by 2 sets of 2-3 x 7-10 secs. all-out (take about a 20m running start before rally blasting the next 7-10 secs. - you don't want to strain anything!), with 30-60 secs. walking rest between reps and 8 min. rest (water break) between sets. After you've done this workout a couple of times (maybe once per week), you can add a third set to the above for one outing only.

Having completed 3 of the above "acceleration" workouts (remember to cover other training bases as well!), you should then proceed to a workout of 3-4 x 150m at 98%-100% effort with 30-60 secs. walking rest between each. Following this session (allow enough time for recovery and to include one or two other hard days), proceed to 3 x 300m at 98%-100% effort with 2-3 min. walking rest periods. The next "kick-specific" workout (about 4-5 days later) should be 2 sets of 2 x 400m at 98%-100% effort with shorter rests (near 1 min.) between reps and full recovery (8-ish min.) between sets. You may need to jog some and add a couple of light strides at the end of the 8 min. rest period in order to prevent straining anything at the start of the second set of 400s. These longer sprints work lactate "clearance" and use the creatine

phosphate stores simultaneously. These two energy systems are precisely the systems which are invoked when you kick at the end of a race.
The *best* way to develop a kick is to *practice* doing it at the end of races. Oh, you have to do all the other "physical" preparation, too; i.e., getting fit endurance-wise, working on your flat-out speed, etc. But even all that won't enable you to produce your best kick. You must *get in the habit* of calling forth everything you have to shift gears and launch the most furious sprint you can deliver. This sprint may be fairly weak - even pathetic - the first few times you attempt it, and it will hurt like Hell during a heat wave, but you must never give up. Giving up is not an option.

It actually requires an enormous mental effort - and I mean a literal simultaneous and cooperative summoning of neurons, not just "desire" - to put forth an *additional* finishing effort when you are feeling maxed out at the end of a race. The "desire" or "not wimping out" aspect of this anguish is what drives you to give everything you have even when you are not rewarded with a pickup in speed. And this may happen a few times; that is, your "kick" may not be any faster than you were running up to that point in the race, despite your utmost effort. But you cannot be discouraged; you must give it everything you've got regardless of the outcome. If you do this, it will not be a Sisyphean effort. The act of will which summons all those motor units at once when you're already laboring must be *practiced*, and it will become more easily repeatable; that is, you *will* get better at it. No matter how bad you're hurting and no matter how pointless or lost the cause seems, *force* yourself to change gears with as smooth a form as you can. Force yourself harder, harder, harder. After a few races, what was torture will start to seem like an old friend. You will recognize it, you will know what to expect and you will know you can handle it. Your form will improve, as well, so the kick feels less like you're flailing and more like you're channelled and focused.

How important is it to keep battling in competition even when your goals seem out of reach? Ask Bouchra Ghezielle. In the WC 1,500m, Ghezielle was stuck on the inside with nowhere to pass and losing to four Russians with 100m to go, with 50m to go, with 10m to go, with 5m to go. Maryam Jamal was coming up on the outside. Ghezielle kept digging and fighting and somehow squeaked past Yelena Soboleva on the inside in the last couple of steps of the race and outleaned both Soboleva and the hard-charging Jamal. For what? Fourth place. Oh, well; still out of the medals, right? Wrong. A DQ to Yuliya Chizhenko, who had finished second, moved Ghezielle up to the bronze medal.

Giving up - settling - is not an option.

--*

This stuff is all reminiscent of Dr. Phil Maffetone's recommendations - very little work done involving anaerobic energy systems (phosphocreatine or glycolysis), with most work done between the "aerobic threshold" (AeT) and "anaerobic trheshold" (AnT).

One thing to remember when considering this approach is that Dr. Maffetone has generally advised triathletes, whose sport features two disciplines requiring little to no impact stress, the body being supported during exercise. In dividing time between disciplines, triathletes normally experience far less eccentric force (in the "loading" phase, where muscles lengthen under tension) and less torque to connective tissue in comparison to full-time runners, who spend virtually all their workout time pounding the ground. Being able to withstand quick eccentric loading is vital to a runner, not only for full-speed sprinting, but also for economy. The less time a runner spends in the amortization (plant) phase, the better the runner's economy generally is at that particular speed.

Although the term AeT is a bit hazy, it's defined by some to be the point at which the active muscles rely more on glycogen than on fatty acids to produce ATP energy. For experienced runners, some weeks spent

running at a pace near or even below the AeT will reset the pH balance, but eventually the runner will experience a glycogen sparing effect and will require a faster pace to elicit the same returns per time spent running. Of course, this is built into the program (if it's done correctly) by virtue of relying on heart rate or perceived exertion and not by using a consciously faster pace to determine day-to-day effort. For beginners, the easy pace should become faster almost by default, as long as training can continue uninterrupted by injury. With years of experience, runners may find the AeT occurs closer to the AnT, which occurs closer to the max VO2. Some of these terms might be loosely defined and the concepts behind them rather nebulous, but all it means is that with vast running experience, it's possible to run closer to top speed and feel relatively easy doing it.

Some people may find a program involving slower running doesn't work for them because they are adopting lazy mechanics. When you run slowly, make sure you consciously maintain a stride frequency that is similar to the one you'd use when running a race of about 40 minutes in duration.

It's also advisable, rather than using nothing above the AnT for weeks or months, to touch on some quick speeds a couple of times per week or to perform some relaxed, low-level plyometric-type drills such as bleacher step-ups, rapid steps (over 200 steps per minute for a few seconds) and skips or bounding. These short strides and drills need not be intense or comprise an extensive portion of a workout. Just a few minutes of them after 15-20 minutes of jogging before continuing with the run (or at the conclusion of a run) twice a week will do.

It's also not a bad idea every couple of weeks to have a run which includes 4-6 reps of 1-3 minutes each at faster than your AnT (with full recovery between reps) once you're warmed up nicely. These segments should not involve tying up. They're just little snippets of running involving a slightly different energy system, recruitment pattern and mental focus.

On the subject of running between AeT and AnT (or between certain heart rates), progressive runs which finish with about 2-3 minutes faster than the AnT are normally superior to strictly-paced "tempo" runs.

Include a little variety, but do not discount the basic approach of taking as long as needed to acquire aerobic endurance. Most runners require a much longer time frame than they get to become adequate aerobically. The "base" periods between cross country and spring track are usually far too short. Instead, five months of aerobic development, from light jogging to strong tempo running, is normally much more effective than the three months or less high school and college runners devote to each preseason. Also, a period of even four years is not "long term" in this sport, so learn to have patience and enjoy the process of running itself rather than judging your success or failure as a runner on races you ran in college. You might need many more years of aerobic development than that, with fewer intense workouts and races, before you see how fast you could really be.

Just something to think about.

--*

Yes, once a desirable pace is found, one that gives a floating, effortless sensation, that feeling should be preserved for 20-40 minutes. Most of the time, the effort should be just far enough below the AnT to leave you itching to pick it up. Then you can let loose for 2-3 minutes at slightly above the AnT. Virtually any pace which requires a pronounced reliance on glycogen as a substrate will elicit improvements if it is repeated with sufficient frequency while still allowing adequate recovery. Lydiard sometimes referred to this as a high steady state, other times calling it "effortless effort." If this pace does feel weightless, a spontaneous or "autopilot" result of a gradual warmup and progresssion in speed, it should be no trouble to exceed the threshold for 2-3 minutes at the end of the run. Doing this will enhance aerobic

development not only by calling on more motor units farther along the spectrum toward "fast twitch," but it will also safely cultivate an ability to use lactate as a fuel source.
Exceeding AeT isn't nearly as perceptible as exceeding AnT, so it can't be described by a feeling, but AeT usually occurs somewhere around 65% of max heart rate (MHR), give or take a bit depending on the experience and current training status of the runner. It can also be estimated by % of "heart rate reserve" or % of max VO2 or by respiratory rate, but long story short, you can't really feel when you've exceeded it during a run.

AnT is also used interchangeably with the terms "lactate threshold" and "ventilatory threshold," although the points by which these terms are defined are not identical. It can likewise be estimated by heart rate or VO2. With experience, you can tell when you've crossed the AnT or even when you are nearing it. Recognizing the onset of the AnT is a skill which is invaluable, as it allows you to optimize your day-to-day training and minimize risk of overtraining.

A proper tempo run basically is a progressive run, but these days, people let pace override relaxation. If it's done right, a progressive run should be completely spontaneous.

--*-*-*-*-*-*-*

You *warm* up your muscles - literally - by increasing blood flow via a routine beginning with light movement and progressing to more vigorous movement. This improves oxygen delivery to the skeletal muscles and the heart, increases muscular mechanical efficiency, promotes sweating (which prevents overheating), speeds up neural impulses, reduces sudden reliance on the phosphocreatine system (allowing aerobic metabolism to dominate), and other benefits.

The reverse process should occur after a period of stressful exercise. Your aim is to *slowly* return the temperature of the muscles to that of pre-exercise. The primary purpose for this is to prevent venous "pooling," allowing removal of recovery-impeding metabolites and hormones from the muscles and the blood. Yes, you are keeping your muscles warmer than their resting state longer than you would if you abruptly stopped all movement. But you are certainly *not increasing* their temperature at this point.

You *cool* down.

--*-*-*-*
There is a good chance your running economy at higher speeds will become *worse* if you do all your faster running on a treadmill. The reason is because more energy is used for *stability* in treadmill running. This results in a longer foot contact time with the belt. If you become extremely comfortable with the mechanics of treadmill running, you will tend to apply the same mechanics (longer ground contact time) to overland running, resulting in a more stability-based support phase, a slower stride rate and less efficient forward propulsion.

On the flip side, if you live in an area that is lacking in hills, having a treadmill can *sometimes* be a benefit. I say "sometimes" because even if you are running uphill, your support time on the belt will still be longer (and your stride rate slower) on the treadmill than it would be running up real hills.

Of course, it all counts as mileage. It is running, after all, and an hour on the mill is better exercise than spending the same hour staring at the idiot box.

But if you ran only on downhills, you could also count that as mileage, yet you would be woefully less prepared for a level-surface race than if you had spent the bulk of your time at race pace on flat terrain.

--*-*-*-*-*-*

---

douche bag daryl wrote:

Please show me empirical evidence of this hypothesis of yours regarding the increase use of stabilizing muscles and the subsequent increase in foot contact time as result of more treadmill running vs. all land running.

It's not my hypothesis. There has been *plenty* of research on the difference in treadmill running vs. overland running. The inescapable conclusion is that support time is *longer* on the mill vs. overland as the speeds increase. One of the first studies to reveal this was done at Penn State in the early 1970s. I'm sure a search engine can lead to some information on it. This study was done with trained cross-country runners who had an adjustment period to get comfortable with treadmill running.

Subsequent research also shows that, as the speeds increase, the support phase is longer, stride frequency is lower, and strides are longer on the mill. There are minor variations due to the different designs of treadmills, but the basic result is the same.

--*-*-*-*-*-*-*

---

douche bag daryl wrote:

I believe I found the article you are referring to being cited in a more recent study on this topic. ... They are basically saying that this increased stance phase/support time was not observed.

Yep, I guessed this sort of thing was coming. There's always research that contradicts or refutes other research. All it does is keep people in the dark. What's really ludicrous is the number of people who say, "Runners today are too caught up in worthless laboratory research," yet when these same people are presented with a viewpoint counter to their own, they fire right back with, "Oh yeah? Then show me the *studies* that *prove* your case." Finally, when such research is actually presented, they retort with, "Yeah, well, that study was flawed. Here's the *real* research."

Newer treadmill models may change the data slightly owing to the efficiency of the belt and the type of

support structure under the belt, so perhaps the stability issues with earlier models are being erased.

What can we say? If you'll read my initial statement, you'll see that I said, "There is a *good chance* your running economy at higher speeds will become worse if you do *all* your faster running on a treadmill." The "good chance" qualifier was not a cop-out; it means exactly what it says. If you want to spend the majority of your time running on a treadmill (including *all* of your race-pace or faster running) and believe your overland running performance (or economy) will improve as a direct result of using the mill, have at it. Good luck with all that, chief. There is a "good chance" your performance will suffer relative to what it might have been had you spent some time running at your target race pace overland. Is that a *guarantee*? No. If you are one of those rare runners whose stride mechanics are unaffected by treadmill running or who can actually *improve* some facets of your mechanics by virtue of a different angle of impact or reduced injury risk (or whatever), more power to you. But I'm not making a blind bet on it.

---

liffiker wrote:

Then there was the research about 20 years ago that compared TM running with overground running among a group of elite runners ... TM running cost 7.1% less energy than overground, ...

This bit is interesting since, although the study conflicts with the earlier one on the issues of stride rate and support time, it still shows that running overland is *more costly*. Why become ingrained in a neuromuscular pattern which results in *less* energy cost without spending a requisite amount of time performing the precise (more costly) activity you will perform in competition?

Long, easy runs during the off-season (as well as slow running to recover from fast efforts in season) will definitely help you become a better miler during the course of your career. But do you want to spend all your time jogging and ignore working at mile race pace? Of course not! Is running on grass easier on the legs than running on concrete? Almost certainly. But if you *never* ran on the road, don't you think the unfamiliar difference in energy transfer would cause some snowballing distress during a marathon race on concrete?

Occasionally running downhill strides can be helpful, but should you train only on courses that are entirely downhill, with no flat or uphill sections? No. If nothing else, you would get an inflated sense of your abilities and when it came time to race on a track or on a road course with uphill sections, you would be in trouble quickly. On the other hand, if you planned on a *serious* approach to the Boston Marathon, you would be wise to *incorporate* more long downhills than usual into your preparation, without sacrificing *general* racing fitness (and of course including some workouts involving *uphills*).

So if you happen to be a runner who transfers identical gait mechanics between the mill and overland without *any* transitional work (and you don't mind running in place for mile after mile), there probably isn't much need to ever hop off that belt until race time. But, as I said, there is a "good chance" your overland stride mechanics and running economy *will* be impaired if you spend too much time on the mill.

--*-*-*-*-*

Don't let the haters discourage you, Steve [Magness, 4:01 HS miler]. They don't understand what it's like to have a purpose and a polestar. Not one of them is or ever has been a determined, committed person, at least not in this sport. If you know what you want to accomplish and you have a focused yet flexible plan, stick with it.

You sound a lot like I was in high school and college in terms of trial and error in your running experience, reading up on and analyzing every piece of information available, and single-minded determination to squeak everything possible out of yourself. I made quite a few mistakes, too, and those were necessary. But I learned early on (as I think you did) what the *real* keys to the sport are, and returning to them (after my numerous stints as a "prodigal son") always brought success and joy back to my own running, as it likewise did for all the others I ran with over the decades.

I can tell you that it *is* possible to overthink or try too hard in terms of getting this training formula absolutely perfect. Running is like cooking in so far as the ingredients are important, but it is the *recipe* - that is, the *combination* of ingredients in correct proportions and with correct *timing* and temperature - that produces the perfect meal. Caviar is great by itself, for example, and so is a banana split and a premium beer. But what would happen if you tossed all those tasty ingredients into a pot in an attempt to create "the perfect meal" out of "the best ingredients" - then left it on "boil" too long??? Your finished product - even with all those individually yummy foods - might taste like a $&%t sandwich. And that's exactly the kind of thing that can often happen with your running when you try to maximize *every* aspect of your fitness *simultaneously*.

Don't get me wrong; ingredients (specific effort levels and training speeds) are important. Even though there is a *continuum* of speeds and associated muscle fiber recruitment and metabolic pathway access, there are definitely *specific* effort levels and speeds that give you more return for your effort in day-to-day training. You already know most of them. The questions for you to answer are "How much of each ingredient?" "When do I add them?" "When do I turn up the heat or turn it back down and for how long?" ... etc.

In terms of the daily running grind, the only difference between 25-30 years ago and today is the *terminology*. Every single one of the training speeds and effort levels that are bandied about now by some new kid who's all excited because he thinks he's discovered a secret novel training speed or skipping and jumping routine was done to *death* several decades ago, and in almost every conceivable combination. If you want to make the most of your forays into exercise science, you will recognize from the outset that all Ex. Phys. will ultimately do is *validate* what you have learned by feel through trial and error and from discussing the sport with other real runners who have tried the same methods. If you don't accept that from the start, enough trial and error *will* drive it home for you eventually.

I might email you to discuss your training. Some collegues of mine have been urging me to do so for some time. I do see some places where you may have gotten overeager in terms of continuing to increase speeds in high school, but don't worry - that stuff can be corrected if you catch it early. And the really serious runners with the attitude necessary to make the *most* of their abilities are the ones that usually

make that mistake, so all you need to do is keep your needle closer to the top of the "upside-down U" rather than letting it drift too far to the "obsessed" side.

--*-*-*-*

The right pace is the fastest one that you could touch on several days in a row and feel good every day (assuming you weren't doing anything more intense within those few days).

Think of a correctly-executed threshold run like you were going surfing - you want to have *fun* with it. Yes, by doing it, you will make improvements (and that's the ultimate goal), but the *enjoyment* should normally outweigh any effort involved. It's a sensation of being carried along at the fastest speed that doesn't cause you to stress yourself any.

To continue the metaphor, just get out in the surf, paddle around gently for awhile, *looking* for a wave and trying to catch it. If you catch one, you'll obviously have to put a minor amount of effort into adjusting yourself to stay upright and on the board. But you should *never* thrash about in *still waters* and waste effort trying to create your own wave. You *should* position yourself such that you're likely to find a wave and hop on it if it comes to you. But if it doesn't, take your board and go home. There will be other days.

When you can regularly *feel* what all that means in the running context, you're getting it.

--*-*-*-*-*-*-*

Not all muscle cells can be categorized conveniently into "Type I" or "Type IIa" or Type IIx." Instead, there seems to be a continuum of muscle fiber types which display many intermediate properties. Training can change some, but not all, of these attributes.

Fundamentally, the limiting factor in a muscle cell's ability to produce forceful contractions is the size of its connecting neuron. There is no known technique by which you can change the size of a motor neuron. There is an invasive technique by which you can re-wire a large neuron to a "slow twitch" fiber and create a fiber with predominantly "fast twitch" properties, but this cannot be accomplished through any form of training.

Training at extremely low intensity will not lower a "fast twitch" (large) motor neuron's synaptic threshold; that muscle fiber will still be able to respond to higher-intensity training and regain the ability to contract forcefully even after months of slow running. The muscle cell will take on some characteristics of intermediate fibers with training, which will spur the need for higher-intensity work to return to top sprint speed, but "innate speed" will remain with the individual until aging factors begin to come into play.

Type II (fast twitch) fibers can take on some characteristics of Type I (slow twitch) fibers, but this seems to be accomplished more readily with high-intensity repetition running rather than with slower running or jogging. Basically, the Type II fibers are not recruited at low intensities, so it is difficult to effect

maximum transformation in those fibers by just jogging. However, they can be depleted or partially depleted of substrate by running slowly for long distances, which will result in an increase of oxidative properties within the cells.

Type I fibers can also assume some qualities of Type II fibers with training, but this result is much harder to accomplish, in part because the Type I fibers are heavily involved with maintaining stability and posture; thus, they will always be recruited for these purposes even during high-intensity exercise, and they will retain most of their innate characteristics.

In young individuals, Type II fibers begin responding very quickly (often within one week) to strength training or pure speed training, so as long as the individual is not exhibiting traits of aging, it will be no problem to regain any speed or strength which may seem to have been "lost" as a result of endurance training.

--*-*-*-*-*-*-*-*-*

I used Stim-O-Stams for a few non-consecutive track seasons back in the 1970s and 1980s. I felt that they did initially help prevent soreness following high intensity workouts but that, if anything, they actually began *undermining* my body's own buffering system during all-out efforts longer than 800 meters. The wheels would come off sooner than usual after that initial onset of impending anaerobic distress occurred. Similar stories from other runners led me to the conclusion that prolonged use of phosphates or bicarbonates is probably a bad idea for long distance runners and perhaps for middle distance runners. They seem to be excellent for explosive events (sprints, jumps, throws), but runners in longer events should only use them to prevent soreness and hasten recovery from an occasional "pure speed" workout. You don't want to artificially buffer acidosis on a regular basis, and you certainly shouldn't *depend* on Stim-O-Stams to improve your race performances.

--*-*-*-*
L = Theoretical LT pace in seconds per mile
F = 5,000m pace in seconds per mile

$L = 1.063(F) + 8.18$

This linear regression formula should be fairly accurate for marks between WR performance and 25 minutes for 5,000m. Make sure you use per mile pace (not per 1,600m pace) when applying the formula. The relationship between LT pace and 5,000m pace is not exactly linear (although it can be closely approximated as such within a range of performances); hence the qualification of its validity for performances faster than about 25:00. Also, this is only a statistical estimate, not a precise indicator (seeing as how the notion of "lactate threshold" is partially dependent on the testing protocol used to measure it, you can't take any formula involving LT as the final word).

Example 1: For the 5,000m WR, we have a per mile pace of 4:03.77 (243.77 seconds). The regression formula yields a theoretical LT pace of 267.3 seconds per mile, or 4:27.3 pace.

Example 2: For a 5,000m pace of 6:00 (360 seconds) per mile, the formula yields L = 390.86 seconds, or around 6:30.9 per mile.

Example 3: For a 5,000m pace of 8:00 (480 seconds) per mile, L = 518.42 (8:38.4 per mile).

The formula actually begins to become less accurate for runners whose 5K times exceed about 25 minutes and is particularly unreliable for those who walk/jog during 5Ks.

--*

Victor Mora wrote:

Don't you think that running some 25-30 seconds per mile slower than 5k pace will make you fight to keep up this pace?

It shouldn't if you gradually approach that pace from the slow side during a run and hold it for 15-25 minutes once you reach it. The earliest sign of labored breathing or labored movement indicates that you have exceeded your "threshold."

The LT is itself a nebulous concept, since there are many GXT protocols which attempt to pinpoint it, each protocol giving the test subject a different warmup phase, a different increase in speed (or treadmill platform incline) at the beginning of each stage of effort and a different time spent at each stage.

Basically, your "threshold" runs should mimic a test protocol by giving you a very gradual warmup period (some protocols, such as the Bruce test, do not do this). You should also learn to recognize when you are *approaching* your threshold so as to stay in the desired zone for the time frame you're seeking. If you do these things correctly, you could run them for a few days in a row before needing a slow run to recover (as long as you aren't doing any high intensity work on alternate days).

--*-*

Had Some Myself wrote:

When you get some seconds faster than LT pace, you'll start producing more lactic acid, and you'll start stimulating max vo2 type adaptations to some extent too. You'll just need to make sure to take these in shorter chunks (6min? 10min?) and take a little bit more rest in between the reps. You could try taking the longer faster recoveries between reps such as Canova recommends in sessions such as 2k reps (in say,

x:00/mile) with 1k rest (in say, x:00 + 40seconds/mile). These types of sessions seem to be great for teaching the body to use and clear lactate.

Of course, it is now known that lactate itself is not the enemy; it is used as a fuel by the heart and skeletal muscles and is also reconverted to glucose in the liver. The H ions which interfere with muscle movement may actually arise from different reactions than the dissociation of lactic acid. However, a sudden inflection in blood lactate accumulation is invariably associated with the ensuing experience of struggling and (ultimately) tying up, making measurement of blood lactate the most reliable objective marker for effort intensity.

An excellent effort intensity for high density repetition running (meaning rest intervals are short relative to the run periods) occurs just above (faster than) the LT and reaches the respiratory compensation point (you feel this when you begin hyperventilating, as though you are "falling hopelessly behind" in your ability to breathe in a stable fashion relative to your effort). To operate effectively in this state of effort, you should not tie up; in fact, you should only experience the first hint of labored muscle movements (a slight tightness or awkwardness in the gait pattern). Normally, the pace for this will be about 8-12 seconds per mile faster than the theoretical LT pace.

Of course, you can run *faster still* and exceed your LT (for example, reps of 400m at 3,000m race pace), and this will provide a slightly different stimulus for improvement, but the idea on the longer bouts at 8-12 seconds per mile faster than LT pace is to spend *more time* on each bout exceeding the LT without experiencing a drop in blood pH. This phenomemon occurs between the LT and the respiratory compensation point, and it provides the opportunity to process or "clear" more lactate without experiencing as many *negative* effects of acidosis. The best format seems to use bouts of 3-20 minutes in length, with recovery periods of roughly (give or take a bit) one-fourth the length of the work bouts, and with about 34-40 minutes of total work done at the desired pace during the session. Most of the recovery period should be jogged in order to keep the circulatory system active and facilitate clearance/reconversion of lactate.

Shorter bouts (3-7 minutes) will likely be at the fast end (12-ish seconds per mile faster than LT pace for most runners between 13:00 and 15:00 for an all-out 5,000m), while longer bouts (up to 20 minutes) may be slower (8-ish seconds per mile faster than LT pace) or may start even slower still and finish at the respiratory compensation point, depending on the purpose of the session.

--*-*-**-*-*-*

Warm up [for a beer mile!] a decent amount by jogging about 20 minutes (between 35 and 15 minutes prior to the start) so your digestive system will be very settled. Then do some strides as you would for any regular race, then run 2 laps at about 3,000m race pace (finishing about 10 minutes before the start of the race). You should aim to have a fairly empty stomach, but take a small amount of some salty bread product, like 5-10 thin stick pretzels, and one small fast food restaurant salt packet immediately after

recovering from the 2 laps at 3,000m race pace (you might have to go number two due to a gastrocolic reflex after eating something, so give yourself time and make sure you're near a loo) and get in a few more short strides about 2-4 minutes before start time to keep your stomach settled and to stay warmed up. Eating something salty and bready will help absorb some of the carbonation of the beers and will reduce the chance of vomiting during the race.

The alcohol of the 4 beers will not affect you at all during the race (it will hit you between 5 and 20 minutes after, and it will probably be less of an alcohol effect than if you just chugged the beers without doing any running); rather, it is the carbonation and sudden addition of lots of fluid to your stomach (coupled with the suppressed ability to ingest the fluid due to running pretty fast) that will cause you to feel bloated and might induce you to puke. This is why practice (first with water or diluted beer, then with more highly carbonated fluids) is important - you can know what to expect and can get accustomed to the feeling of running fairly fast with a full, carbonated feeling in your belly. By lap 3 or 4, you will probably feel uncomfortably bloated, but if you've practiced, you will know exactly what speed you can tolerate without getting a stomach cramp or pulling a Kempainen.

Keep your beers cool but not ice cold. Beer that is too warm is not only illegal for official beer mile purposes; it's also more likely to make you feel sick when you start filling your stomach with it. Conversely, ice cold beer is obviously nearly impossible to drink quickly. You won't just get a brain freeze from it; you might actually pass out from slamming liquid that is too cold, since it will close your esophagus and indirectly hinder your breathing. So make sure your beer is cool but not chilled.

Take a couple of small swigs of cool water (not ice cold, but about the same temperature as your beer) about 1-2 minutes prior to the start. You don't need to get a buzz from beer before the race; the effect you're after is simply taking a very small amount of cool, non-carbonated liquid, which will prepare your mouth and esophagus for the cool beer that you will be drinking. That way, your esophagus won't tighten up.

When the race gets started, slam the first beer as fast as possible (gee, did I mention you should practice this in advance so you can get good at it?) and be right on the starting line when you finish the beer. Throw the can down right as you begin running (not before). Don't cheat on the drinking; some foam left in the can is probably unavoidable, but a significant amount of liquid isn't.

Run the first 50-100 meters of each lap a little slower than you would during a workout of 400m reps and belch out as much of the carbonation as you can during this time, allowing your stomach to settle some. Then cautiously pick it up until about 100m remains in the lap. This gives you some time to deliberately slow down a little during the last straightaway without a lot of anaerobic distress. The tendency is to run hard all the way in on every lap, but don't. This is important, since anaerobic distress will cause you to hyperventilate and prevent you from getting the next beer down quickly. In this event, it's way more about getting the beers down quickly than it is about running fast laps (until the last lap, when it's full blast for the final 300m, after you've belched out the carbonation during the first 100m). Gaining a couple of seconds while running a lap might cost you 10-20 seconds on the subsequent beer.

If you do it right, you should run laps 1-3 at about 2 seconds slower than your all-out mile race pace, with

the last lap fast enough to make the total running time for the 4 laps fairly equal to (or within 5 seconds of) your all-out mile time.

Give yourself about 5-8 seconds to start catching up on your breathing before you begin drinking each beer. You might be tempted to try pouring the beer down immediately, but you will probably lose time if you try this (this is sort of like trying to "bank time" in the first half of a marathon - it doesn't work very well). It's better to not panic, but to stay cool and start drinking when you're ready and can get the beer down quicker. Practice is invaluable to help figure out when you really are ready to start drinking.

When drinking prior to laps 2-4, breathe in through your nose while you are pouring some beer in your mouth and holding it there briefly, then swallow the beer between nose breaths. It sounds easier than it is; it actually takes some practice to perfect this. Once you get it, you'll know how to do it right. If you screw this up and inhale any of the beer, you're done for.

Make sure you use the full "drinking zone" (the exchange zone) while drinking your beers and be right on the start line when you chuck your can and start the next lap. I've seen people forget to use the full drinking zone and they ended up a few steps behind the line when they finished drinking. I've done it myself, too, and while you're concentrating on your drinking, it isn't automatic to remember to get right up to the start line and run the minimum distance. So try to remember if you can.

--*-*-*

Nutrition Expert wrote:

The correct meal plan for a male running 80mpw and seeking to lose bodyfat is as follows:

(meals are four hours apart)

Meal 1
8 egg whites
1 tbsp extra virgin olive oil
1/2 cup steel-cut oats (NOT instant oatmeal)
1 orange

Meal 2
5 oz. chicken breast
1/4 cup walnuts
1 cup raw broccoli
3 cups raw spinach
1 apple

Meal 3
5 oz. grass-fed beef

1/2 avocado
1 tbsp extra virgin olive oil
1 tbsp vinegar (mix with olive oil for salad dressing)
3 cups romaine lettuce
1 tomato
1 bell pepper
1.5 cups blueberries

Meal 4
6 oz. wild salmon
1/8 cup almonds
1/2 cup pumpkin
1 cup raw zuccinni
1 oz. shiitake mushrooms

Meal 5 (if neccessary)
2 oz. oven roasted turkey breast
2 tbsp. ground flaxeed
1 cup mixed berries

Nutritional Supplements:
2.5 grams long-chain omega-3 fatty acids
15000 IU vitamin A
100 IU vitamin E
100 IU vitamin E as natrual mixed tocopherols and tocotrienols
250mg vitamin C
400 IU vitamin D
200mcg selenium
200mg R[+]-Alpha Lipoic Acid
60mg CoQ10

CORRECTION: replace the flaxseed in meal 5 with 1/2 avocado.

Nutrition Expert has some good stuff. It sounds like a meal plan you'd get at a "natural hygiene" retreat. I know that smacks of quackery, and a few of these places are a load of rubbish, but some are very good.

Natural foods are generally better than packaged, all-purpose bars or cans of "just add water or milk" powders. In fact, two good rules of thumb are: 1) If it can spoil, eat it, and 2) The longer the list of ingredients, the worse it is for you!

The avocado, salmon, extra virgin olive oil ("Not until marriage, Popeye!") and Alpha Lipoic acid provide the right kinds of fat (try to avoid the "trans" fatty acids). Fat *consumption* is crucial for proper fat *metabolism*, and the high carb / low fat diet many runners gravitate toward is not fully nutritious. These fatty acids are instrumental in formation of brain neurotransmitters and general well-being. Runners with EDs often enter a vicious cycle of depression, starving (or purging) and binge eating, which *temporarily* increases the testosterone:estrogen ratio (during the starve phase) and serotonin (during the start of a high-carb binge phase) but results in a subsequent crash, precipitating another repetition of the cycle. Healthy

fat intake might go a long way toward avoiding these kinds of problems in the first place.

Brightly-colored fruits (like blueberries, raspberries and strawberries) are very high in antioxidants. Vegetables are high in phytonutrients which always aid in proper digestion. If you want to do this right, make sure your fruits and vegetables are raw. Broccoli and spinach can be lightly steamed, but for higher nutritive value, drink the runoff and swish it around in your mouth to get the digestive enzymes activated! Same idea if you're a health nut who's into drinking lots of fruit juices or vegetable juices - you should "chew" the juice for several seconds instead of gulping it down. Proper digestion starts in the mouth with your saliva; don't skip this stage by putting the juice (or any food) straight into your stomach.

Do not take more than the recommended 200 mcg of Selenium. Higher levels can quickly become toxic and it is easily possible to overdose on this supplement.

You also might want to add some Calcium/Magnesium (particularly females), Zinc (males) and *occasional* liquid Iron (mixed with a fruit or vegetable juice for the Vit C absorption benefit and to nullify the strong taste). Only take the Iron for a week or two, then cycle off it for a couple of weeks. Iron is an oxidant and too much is eventually destructive to cells, but it may be of benefit in the short term, especially if you are about to relocate to high altitude.

Weighing or measuring food portions is good for starters, but YMMV on caloric needs, so let hunger be your guide once you feel like you've arrived at an ideal running weight. Your weight is just a number - do not worry about the number itself. Instead, find the weight that's right for your metabolism and running routine. I like to say that your best running weight is the lightest weight that you can stay *healthy* at, but I've seen a rare few people run *better* by adding a few pounds onto what everyone thought would be perfect. At any rate, eat to live (and to run well); don't live to eat.

I must add to the meal plan given by Nutrition Expert that if you are running *high* mileage or have regular long runs, taking simple sugars immediately after a depleting run is *not* a bad thing. This will raise your insulin for a couple of hours and will better allow you to store complex carbs as glycogen in your recently-depleted muscles. Always take plenty of water following runs (especially following long runs or when doing regular high mileage), and eat a meal which is high in complex carbs within a couple of hours after a depleting run (unless you want to deliberately deplete yourself further, as some runners do from time to time). So take those simple sugars and lots of water within 15 minutes after a long run (dates have the highest sugar content if you want a "natural" food for this, or you can just drink a soda). Then wait about 60-90 minutes and eat a meal high in complex carbs. That should replenish your glycogen follwing a long run. If your mileage is very high, you will need more carbs (and perhaps more calories) than Nutrition Expert has listed for the 80 mpw guy. If you *reduce* your mileage in favor of faster speedwork during a competitive season, you will probably also want to have a gradual shift away from carbs and toward higher dietary *protein*.

--*

Nutrition Expert wrote:

ZUZU: alpha lipoic acid is not a fat! you are thinking of alpha linoleic acid

---

Actually, I meant the Omega-3 fatty acids but just skipped ahead and mindlessly typed in what I was looking at on the screen at the time.

--*-*--*-*-*-*-*

The people that I know who have run with Tergat claim he is not that fast and estimate his flat-out speed when he was in top track shape at about 51 seconds. Of course, he never worked exclusively on the 400m, so nobody knows for sure. Nevertheless, he won an awful lot of major races, broke some world records and ran way under an hour for the half marathon *without* ever having actually run a 50 second 400m at the time.

Whether Tergat *could* break 50 or not, he apparently has never *done* it, yet he was the best cross-country runner in the world, a two-time Olympic silver medalist, a former WR holder on the track and a current WR holder on the road.

The bottom line: Being able to run sub-50 might be helpful, but it isn't necessary in order to win major races.

---**-*-*-*-*

Many readers will think the term "Central Governor" smacks of a contrived, all-purpose agent used to conveniently explain away all manners of as-yet-not-understood phenomena. However, the interplay of human biological processes is not completely comprehended, and the unexplained regulatory mechanism (if there is one) needs to be called *something* until it *is* explained.

Tying up during prolonged anaerobic exercise provides built-in protection against muscle cell damage and other nasty consequences of low pH. It is likely that if Noakes's "Central Governor" exists, it is within some of the more primitive structures of the brain such as the cerebellum and the reticular formation, which help maintain balance and orchestrate positional changes to produce movement. These brain structures are continuously processing information which is influenced by a host of factors. Even the most simple and thoughtless movements, such as tapping a finger on a desk, require a rather complex interaction of the cerebellum, basal ganglia, proprioceptors, etc. Your volitional thought of "tap finger" is all you are aware of, but to summon the precise motor neurons to achieve the task with the least energy cost is a more complex undertaking than meets first glance.

More advanced movement patterns which require more (or larger) motor neurons require a greater *mental*

exertion, and mastery involves continual practice. When you learned to walk, you fell down a lot as your central nervous system could not yet summon the precise motor units in an orchestrated sequence and the muscles in your feet and legs were not yet strong enough to simultaneously bear your weight and balance it on one foot at a time, yet alone propel you forward. But as an adult, walking is practically a thoughtless activity. You think, "I'll go to the mailbox," and you get up and do it without normally wondering how many times you might fall down on the way. Walking is a low-intensity activity for a normal adult, and it requires many motor neurons which are fairly small and are responsible for posture and finer movement patterns. These motor neurons supply slow twitch muscle fibers, as may be found in the soleus muscle (instrumental in standing). Running, particularly sprinting, requires an *enormous* mental act of summoning a vast continuum of motor neurons and muscle fibers which involve not only force, but balance, precision and coordination of movement.

You correctly pointed out a distinction between general conditioning and specialized event preparation. In mentioning hills and sprints as increasing force production, it is also worth noting that *economy* (requirement for less energy expenditure) can also be influenced through the use of hills and a few drills, although I would discourage the use of full-speed sprints during a period of base training until other neuromuscular qualities were acquired. I'll explain the rationale behind that in more detail (and with an analogy or two) if asked, but it goes back to the previous concept that forceful muscular contractions simultaneously require balance and precision of movement in order to minimize energy expenditure. Practicing exaggerated, rapid-fire motions which involve *both* force (neurons with a high threshold for activation) *and* stability (neurons with the lowest threshold for activation) will train the central nervous system and all its complex feedback mechanisms for complete mastery of the task at foot. This results in the minimum energy cost and the most efficient forward propulsion.

Regarding the original topic: It doesn't really matter whether the dissociation of lactic acid is immediately responsible for protons which interfere with muscle movement or if those protons are by-products of reactions further down some chain of events. That is to say that it does not make much difference to your training if high lactate production turns out to be the cause of, a consequence of, or simply concurrent with "tying up." What *does* matter is 1) recognizing that tying up and laboring too often results in inefficient movements, reduced time spent running, feeling stale, and potential cell damage (therefore making many forms of anaerobic training low in cost-effectiveness) and 2) learning to identify physical feedback that signals such laboring is imminent. It so happens that exceeding the lactate threshold *is* a prelude to the onset of struggling (whether it is the *cause* of struggling or not). Since blood lactate measurements are now relatively easy to obtain (and can be correlated with heart rate and, in a more subjective sense, with perceived exertion), why not use the lactate threshold as an objective marker for effort intensity? Someday the entire notion that there is a "lactate threshold" may be debated or even discarded, but *how you feel* during that stage of effort between "in control" and "in trouble" will always serve as an effective training barometer.

--*-*-*-*-*

Antonio Cabral wrote:

Yesterday the training was been like it was and today the training that's the same. The only thing that changes that are physiology knowledge.

Thank you. Somebody needed to say that.

Laboratory testing is too limited in scope to observe (let alone control) the many variables which affect running performance. When an effective method of improving a certain aspect of fitness is discovered, it is the tendency of scientists (or others without extensive real-world running experience) to overemphasize that method, even proclaiming it a newfangled "secret" for success. The *true* secret lies first in patiently and incrementally building general fitness and then in optimal sequencing of more specific sessions to provide the greatest stimulation/adaptation at the lowest cost while maintaining the general fitness as much as possible. All the while, the ability to *compete* in a *race* should be cultivated. Try to find a laboratory study which addresses all *that*!

Exercise scientists routinely "understand the notes but miss the music."

... in between the lactate threshold and and running in trouble to the exhaustion you don't know no useful intensity plateaux that are useful as training formats? I do. If i'm in complete disagreement what Richard Gibbens says (all-out training) I also knows that are effective ways to improve the aerobic condition out of the anaerobic threshold method without get "into trouble".

Oh, yes. I know these formats quite well. I assume you are referring (at least in one of these intensity plateaus) to the isocapnic buffering stage of exercise. There are sessions which target this zone (in both continuous and interval formats) which are extremely cost-effective. The parameters are not completely inflexible, but since the time frame between the LT and the subsequent drop in pH is narrow, some degree of precision should be observed to stay in the most effective state of effort with the least risk of exceeding the correct intensity. Other aspects of fitness and neuromuscular control should also be developed prior to *regular* training in this zone.

None of these indivdual sessions are as complex as the fancy nomenclature sounds (nor are they magic bullets). The real complexity is determining at what points in a season (and how often) to enter into this zone in training, and to blend work in this zone with other sessions to produce the best race performances at the pinnacle of the career. This can never be accomplished through theory or via laboratory testing; it can only be established through personal running experience and by observation and analysis of the evolution of the sport. Personal experience enables you to "get it" - to "hear the music." Observation and analysis of decades of training evolution involving thousands of runners from the mid-packers to the super-elites allows you to identify which of those principles that worked for *you* are also *universal*

principles, which ones apply to athletes with certain identifiable innate characteristics, and which ones have been utilized with success by "outliers."

--*

for *mature* runners, female performances will generally be between 11% and 12.5% slower than equivalent male performances. For 15- to 18-year-old runners, the difference is usually 13% to 14%. For even younger runners, females are generally closer to the males (boys haven't had that testosterone boost yet and girls are usually very light and have narrow hips).

So a 15:00 5K for an adult male would equate to something in the 16:39 to 16:53 range for an adult *-*-female (more like 16:57-17:06 if both were high school age).

--*-*-*-*

Most of the top Kenyans usually wear lightweight or midweight trainers for road or trail runs (even fast runs) and spike up when they do track work. They don't wear racing flats for workouts.

--*
Tergat has been known to sometimes train in the Pegasus sure enough. Some of the other guys wear the Response or even as heavy a shoe as the Asics 2090.

That said, Americans these days are generally rather underdeveloped in the lower legs and feet (maybe because they don't spend as much time barefoot as kids anymore and because they walk around in hard-heeled shoes all the time?), so they ought to do about 20% to 25% of their running in racing flats (a decent amount of their fast stuff and some of their slow stuff). And they should be walking around barefoot when they can and doing some barefoot strides on safe, soft grass a couple of times per week if it's warm enough weather.

But using the midweight trainers is necessary, too (as long as they suit your particular cushion/stability issues), since varying the foot mechanics will provide a sort of stimulation/recovery and will work the legs and feet across a broader neural and muscular spectrum. Rotating shoes to give a different feel can be considered the pure distance runner's version of "cross training."

--*-*-*-*-*

Dedicated runners get hurt for the same reason cars sometimes rattle at previously untested speeds and their engines wear out from being revved constantly. One mis-step or exposure to a virus can do more damage to the runner who is already pushing the envelope than it may do to the recreational dabbler.

"Only those who risk going too far can possibly find out how far they can go." - T.S. Eliot

Serious runners are operating in a delicate state on the edge of a physical precipice. In fact, as T.S. Eliot put it, in order to *find* their limits, they must try to push past them. If that results in a problem, they are constantly returning to the same limits with new strategies for breaking through. They don't even ask

whether, after a journey of years, they should settle in a comfortable valley when they know the city of gold they truly seek is just beyond that next mountain - if they can only find a way to climb it.

In order to be *your* best, you must become the type of athlete who is willing to return to face *your* limits, never settling. Pay no heed to the people who are too chicken to take risks. So what if they're faster than you with less work? There are many people in all walks of life who go farther than others with less work or even in spite of hindering themselves. Their work ethic (or lack of it) isn't the causative agent in their success. They're doing *you* a disservice by leading you to believe (or even telling you outright) that you, too, can be your best without total dedication and old-school hard work. If you caught the CEO of your company snorting coke in the executive washroom, would you then believe that it's the reason for his success and that you should do likewise in order to climb the ladder?

--*-*-*-*

Brief forays into high mileage are actually good for a developing teenage runner. OTOH, staying high all the time will often produce the best results at the high school level, but this may come at a small expense later in life.

This isn't to discourage a high schooler from going high on occasion. 120 miles in a single week (barring injury) is almost certainly going to help a teenager who is already accustomed to 17-mile days in shorter blocks (2-5 days) or who has done a 105-mile week in the past.

High school runners are generally light and recover quickly (and boys have a surplus of testosterone at that age, which makes it easier to handle a heavy workload), so it might feel easy for awhile to keep the big mileage weeks rolling. But it's best for future development to have a short excursion into high mileage, followed by a very low segment, then a return to normal mileage levels.

What are good "normal" levels for a high school Senior? Probably around 70-75 per week for boys and 55-60 for girls (provided this level has been attained safely during previous seasons).

It also depends on what the goals are. Many runners have no aspiration to compete in college or beyond in more than a recreational capacity. For these runners, maxing out in high school might not be that bad, and being part of a state (or national) championship team would unquestionably be the highlight of most people's careers. Schools like York and The Woodlands come to mind as schools with deep, rich traditions of championships. These guys do a lot of miles, which might cost a little for the future. But if you were an average high school runner with less-than-stellar talent and no aspirations for world records, wouldn't you want to make the elite seven at York and be a part of a coveted championship?

And guess what.

Maybe that "average" high school guy will go farther with what he thought was modest talent as a result of his early success, disciplined habits, and the inspiration gained from his state championship than he would have gone by settling for mediocrity.

Surely there are African runners who do too much too early in life (or do it too hard), just as there are

Westerners who meet the same fate. We never hear about them. But, in general, the serious runners who bank the big miles are the ones who will shine when the final results are in. To prepare for high mileage, push the boundaries out with short blocks of a few high days, then gradually progress to high weeks, then to high months. The high school years are not too soon to begin this process.

--*-*-*-*-*-*

Be sure to cover all your bases beginning many months in advance of important competitions, and sensibly increase your workload from season to season (or modify it as necessary) as you mature and learn about your adaptability.

This is an incomplete list, but some useful moderate/hard road or track sessions for the 800m include the following:

For aerobic endurance

* Continuous running of 20-35 minutes at a pleasantly challenging aerobic pace with the final 2-3 minutes picked up into the "hard" effort zone (the "threshold" work is usually preceded by 15-20 minutes of slower running to warm up to the quicker pace)

* 3 x 8 minutes (or 2 x 12 minutes) at a stronger, more focused aerobic pace (slightly above the threshold, with very strong - but not labored - breathing, and no tying up) with 2-3 minutes easy jogging between reps (sometimes followed by a short volume of faster work such as 4-6 x 10-30 seconds fast strides)

For oxygen uptake

* 15-20 x 200m at 3-5 seconds slower than 800m race pace with 100m jog in the same time between reps (**Ex**: 1:50 man runs about 30-32 seconds per 200m and jogs about 30-32 seconds per 100m)

* 12-16 x 400m at 10-12 seconds slower than 800m race pace with 45 seconds rest periods (**Ex**: 1:50 man runs about 65-67 per 400m)

Event-specific anaerobic work

* 1 x 600m at 800m race pace, do not stop but go immediately into 600m jog in 4:30, 2 x 300m at the same pace or faster with 300m jogs (no stopping) in 2:15 after each rep, 2-4 x 150m at the same pace or faster with 150m jogs (no stopping) in 60-70 seconds between reps (**Ex**: 1:50 man runs 1:22 for 600m, 39-41 for 300m reps and 19-20 for 150m reps)

* 500m at 800m race pace, 2 minutes rest, 300m at same pace, 5 minutes walk/jog, 500m at same pace, 2 minutes rest, 200m all-out (**Ex**: 1:50 man runs 1:08, 41, 1:08, 24-25?)

* 3 x 200m at 800m race pace with 2 minutes rest between reps, 5 minutes walk/jog after last rep, 2-3 sets of (300m at 800m race pace, 1 minute rest, 200m at 400m race pace) with 5 minutes walk/jog between sets (**Ex**: 1:50 man runs 27 for 200m warmup reps, 41 for 300m reps and 24-ish for 200m reps)

* 4 x 400m at 800m race pace or slightly faster with 3-4 minutes rest between reps (**Ex**: 1:50 man runs 53-55 per 400m)

Faster speed work

* 6 x 10 seconds accelerations (each one slightly faster so the last 2 finish at top speed), 15-20 seconds recovery between reps (after decelerating to a complete stop), 2 minutes rest after last rep, 1 x 150m all-out, 5 minutes walk/jog, 4 x 10 seconds medium speed accelerations, 15-20 seconds recovery between reps

* 6 x 10 seconds accelerations (each slightly faster), walk or slow jog back to start for recovery, 2 minutes rest after last rep, 1 x 150m all-out, 2 minutes rest, 1 x 300m at 800m race pace, 2 minutes rest, 1 x 300m all-out, 5 minutes walk/jog, 4 x 10 seconds medium speed accelerations (**Ex**: 1:50 man runs 17-ish for 150m, 41 for first 300m and 35-37? for second 300m)

* 350m-300m-250m-200m each all-out with 400m walk between reps (**Ex**: 1:50 man runs 24-25 200m pace on each rep)

Precede each fast session with a warmup jog of 12-20 minutes (plus some short warmup strides if not included in the session) and follow each with a jog of 10-15 minutes. Very light static stretching is optional prior to the fast portion of a session and is often helpful following the post-workout jog.

Use the very high-intensity sessions sparingly lest they become counterproductive. High-speed work during the last 9-10 days prior to the most important competitions should consist of mostly short strides.

Taken as individual components, these workouts mean little (again, this is a somewhat incomplete list of necessary aspects of fitness). It is consistent improvement of general fitness (principally aerobic power and running economy) that ultimately contributes most to performance. Also, introducing each stage of effort intensity into the seasonal routine at the proper point, how you string the sessions together, and how you manage your recovery through easy running (or rest) and diet/hydration will have a great bearing on the effectiveness of your preparation.

Aficionados will recognize the pace session of 1 x 600, 2 x 300, 2-4 x 150 and the speed session of 350-300-250-200 (or variants of these) as being publicized by the Soviets as training for their women in the early 1970s. Their most notable athlete of tht era was Olympic champion and multiple WR holder Tatiana Kazankina. The Soviet system as it stood was quite intense; of course, many people suspected rampant drug use by the communist regime, which would better enable athletes to perform high-intensity work more frequently. Nonetheless, these two sessions can be useful if adequate general fitness is acquired first, if lighter transitional workouts are used as preparation for the intense ones, if enough recovery is allowed between sessions, and if all work is managed so as to achieve a synergistic effect.

There are also some nice pre-season and early season sessions involving progressively advanced drills, as well as some effective hill sessions. But we'll leave those for another time.

--*

Regarding drills:

You really need to *see* drills being performed and have *hands-on instruction* in order to learn how to do them correctly, since there are some subtleties in breathing, foot contact and orchestration of movement which are important for correct execution. Proper execution of drills is vital to achieving the neural recruitments necessary for maximum improvement. I can list some good drills, but they will merely be names unless you know how to perform them and know how and when to incorporate them into a complete running program.

Start with simple drills involving light impact to begin developing some low-level muscular strength and joint dynamics and to wire in the neural patterns which will facilitate more advanced drills to come. These simple drills include bleacher steps (stepping onto and down from a bleacher or 20"-high plyometrics box), high knees, fast feet, lunges, crossover steps, and skipping.

In order for drills to be of any use, they must be transferable; that is, they must replicate the act of running or of certain interactive phases of running. They should also involve the components of strength, exaggerated motion, and rapid movement (in more scientific terminology, recruitment and rate coding - see below). Although each drill only needs to incorporate one or two of these components, the most advanced ones will incorporate all three at once and will be the most effective. The advanced ones will also present an injury risk if done incorrectly or without prior preparation, so do not pass over the simplest drills.

As the simple drills become easier to perform, more repetitions can be added, then these drills can eventually be phased out in favor of drills which involve more permutations of strength/exaggerated motion/rapid movement. One of the first alterations is to "combine" high knees and fast feet by performing rapid high knees. Bleacher steps and lunges can be phased out in favor of slow to medium-speed hill repetitions to build strength through recruitment of more motor units and to prepare for faster hill drills to come. Crossover steps can be continued during this time.

Faster hill repetitions of 10-12 seconds in duration can be brought in at a later stage. These should include a runup of a few seconds prior to the 10-12 seconds on the hill. Once *full-speed* reps are introduced, recovery between reps should be about one minute, allowing about 80% recovery of the ATP-Phosphocreatine system. Partial recovery enables continuation of the exercise with no loss of motor coordination while the continual stress to the system effects an increase in its capacity.

More advanced drills include hill sprints of 10-12 seconds with an exaggerated vertical motion (more height or lift on the toe-off) and hopping on one foot uphill for up to 12 seconds at a time.

It is always best to report what works first, then look for the reason why it works. It is the tendency of

many theorists to first report why something is bound to work, being baffled if it doesn't, and stubbornly continuing to seek validation for their delusory premise in typical Fred Flintstone "cram the square peg in the round hole" fashion. Anyway, these drills are helpful - they do work - but only if done in the correct balance with other preparation. The probable basis for their effectiveness is as follows:

Power and speed are increased by *recruitment* (activating more motor units) and *rate coding* (increasing the frequency of movements).

Absolute strength (which involves greater recruitment) provides the framework for *explosive* strength or "speed strength" (which involves both greater recruitment and increased frequency). For running, the best method for gaining absolute strength is to spend time running in hills (at first done at relaxed speeds) to develop the mechanical properties necessary for explosive strength, which is then improved through drills which replicate running motions or interactive transitional phases of running motions.

Reducing ground contact time seems to be the principal ingredient that explosive strength training contributes to improving running economy. This type of training does *not* require an increase in maximum *force* in the muscles being trained, as improvements are due to neural adaptations and not muscle hypertrophy.

Performing near-sprints up short hills while using an exaggerated vertical component (i.e., "springing" with a little added height on each stride) is one of the best workouts for improving explosive strength, which in turn can improve running economy. The hills should be steep enough to activate a sufficient number of motor units to affect absolute power and to allow an "eccentric" pre-stretch of the ankle, but should not be so steep that the pre-stretch is a long, slow one. It has been demonstrated that the *faster* a muscle is stretched eccentrically, the greater the force will be on the following concentric contraction (Bosco, et al 1980). Such hill work should be performed for short durations (10-12 seconds on each uphill) and should be curtailed before muscular fatigue occurs (this is also true of other drills), as fatigue reduces the elasticity of movements and increases injury risk.

One foot hops up very short hills are also useful for improving "speed strength." This is a very advanced drill inasmuch as the potential for injury is high unless some simpler introductory drills are used for a number of weeks prior to introducing these one foot hops.

Do not neglect level-surface speedwork. If you seek to improve your 800m performance, you must do a requisite amount of work on the track, since running on a flat track activates motor units in a different pattern than that required for running uphill.

--*-*-*

I did some cursory stat gathering on this subject about 20 years ago and fit a linear model to the HS-to-college improvement graph to come up with some expected improvement rates. Mile and 2M times are in yards or converted to yards from metric marks. The 10,000m times are not based on actual college stats but are "equivalent" performances for the corresponding 5,000m times. In real life, most runners will be out of college before they perform as well at 10,000m as they have at 5,000m, probably due to continuing improvements in running economy and more opportunities to contest the distance.

Mile (HS) ... Mile (College)

4:05.0 ... 3:58.7
4:10.0 ... 4:02.9
4:15.0 ... 4:07.1
4:20.0 ... 4:11.3
4:25.0 ... 4:15.5
4:30.0 ... 4:19.9

2M (HS) ... 5k (College) ... ~10k

8:50.0 ... 13:37.3 ... 28:29.7
9:00.0 ... 13:52.5 ... 29:02.6
9:10.0 ... 14:07.7 ... 29:35.5
9:20.0 ... 14:22.9 ... 30:08.4
9:30.0 ... 14:38.1 ... 30:41.3
9:40.0 ... 14:53.3 ... 31:14.2

--*-*-*-*-*-*-**-*

As long as the effort parameters are correct, your 20 x 200m workout should be a *staple* session for 800m runners everywhere.

To get the effort parameters correct, try the workout with the 200m reps run at about 2 seconds slower than your current mile race pace. This will likely seem too slow to be challenging, so you can increase the speeds to your mile race pace in the middle of the session. The effort by the middle of the workout should involve hyperventilation and a slight laboring feeling (maybe a little onset of "burn") during the last 30-50 meters of each rep, but should not involve actually tying up. Aim to run at least 15 reps and possibly 20. You are finished when you cannot continue the speed on the 200m segments without tying up, so try to work your way down after about 5 opening reps toward the speed that you think you can handle for 15 more reps.

The recovery should be jogged. Staying *active* during the recovery interval ensures that the muscles do not tighten and that your blood does not pool (you should stay above 65% of your HRR for this). Ever-increasing quantities of lactate produced during the session are better processed as fuel or reconverted to pyruvate in the heart if the circulatory system remains active and the muscles stay in motion.

If you were to use Veronique Billat's criteria, you would be jogging 100m between each of the 200m reps in the same time it took to run the 200m. But you are to become an athlete who is not *restricted* by external criteria; rather, you will know your body and you will know the purpose of the session. You will therefore *begin* with some reasonable guidelines but will *learn* to find the correct recovery pace and duration by intuition. You will also avoid asking yourself, "What could I run for race distance X based on

workout Y?" This is not an indicator session, so it doesn't matter how fast it is, only that you got the correct training. You should improve your times for this session as you get fitter during the season, but you should not force the workout just so you can have a better average in your logbook and convince yourself you're faster. Therefore, do not repeat this session every week. Wait until your fitness and sharpness improves to the point that the times on this will be faster *without* your having to try any harder than before.

Once you learn and apply the correct methodology, you will discover that you do not require a lot of training at faster than race speeds.

--*-*-*-*-*

The recovery intervals should be of a duration and jogging speed so that - beginning about halfway to two thirds of the way through the session - you should still feel "in the hole" a bit when starting each rep. But the speed on the 200m segments should be *manageable*; that is, you should be locked in mentally and physically so that resuming the correct pace should occur without a noticeable increase in concentration or physical distress. Each rep may become a little more demanding about 5-10 meters further from the finish than the previous rep was, but it should only require a *slight* increase in effort or concentration to counter the rising fatigue. Moreover, the increase in effort should be *linear*; if it *suddenly* becomes a bear to maintain the pace, that should indicate that you are done with the 200m reps at that speed. You might add one additional rep (perhaps only 150m) at a *noticeably* faster speed to top off the session. This will utilize a different recruitment pattern and slightly different energy sources, so it shouldn't feel any worse than another rep at your previous speed would. In fact, it might feel better to run a really fast one. But don't go overboard and run several fast reps just because that one felt super; one is enough to serve the desired purpose.

The lactate isn't what causes the "burn" of exercise. That comes from Hydrogen ions competing with Calcium ions for binding sites which are responsible for allowing muscle movement. Lactic acid does dissociate into lactate and H+ ions, but some research

http://www.sportsci.org/jour/0102/rar.htm

indicates that the resulting H+ ions may actually be taken up in other reactions and therefore are *not* the culprits responsible for the experience of "tying up."

--*-*-*-*-*

Work your way up to some 15-mile *days* - perhaps several in a row - first. This doesn't have to be seven days in a row. Keep the remainder of your mileage at a somewhat lower level, steady but manageable. Perhaps this will mean a regular 50-70 mpw routine with the occasional 3-5 days of 15 miles per day inserted every few weeks. As you get older, longer periods of high mileage can be incorporated.

People cite examples of a runner here or a runner there in order to make an attempt at "proving" a point. However, when *hundreds* of U.S. runners of many different performance levels are scrutinized, the stats

are overwhelmingly indisputable: High mileage in high school results in far better performances in high school and somewhat better performances at the peak of a career. But moderate *regular* mileage (50-70 mpw) in high school supplemented with *sporadic exposure* to high mileage (15+ mile days) during that time, *followed by* regular high mileage in adulthood, results in the *best* overall career performances.

The *specifics* of how you go about *getting* that exposure to high mileage depend on how well you handle it from a structural/recovery standpoint. Nobody can tell you that; you will have to figure it out.

--*-*-*-*-*

Which era was more successful and produced more elite performances for United States runners?

1) Early 1970s through mid-1980s

2) Mid-1980s through mid-1990s

Care to guess which of the methodologies under scrutiny here the U.S. more closely followed in each of these eras? Of course, it wouldn't be a guess; you know the answer. Now if you'll just connect the dots, ...

If you have eyes in your head and a brain in your skull, there can be no question - literally - the question should never even be asked. If you have ever actually *run* yourself, you'll know the truth from a personal standpoint.

Someone posted some Horwill $h!+ and it was followed by a post saying "maybe if I was on EPO."

Want to take a stab at how accurate that is at the highest levels of the sport?

People like Horwill and Coe set back Western running 20 years. It took the advent of internet message boards and mailing lists to bring the truth about training straight from the runners of the 1970s to the aspiring runners of the present day. That has undone much of what was destroyed by low- to moderate-mileage "running" in those bleak years. American performances (not including the marathon) have now surpassed those of years past (although world rankings have not, since the game has changed due to blood-boosting drugs and due to an enormous influx of talent from North African and East African countries).

High school is where it all starts. The number of sub-4:10 miles and sub-9:00 2-miles among HSers shot up very quickly between 1996 and 2001, almost reaching mid-1970s levels during the next few years (actually surpassing the 1970s depth lists in the mile). If you'd like to try to argue that the internet has made it easier for high schoolers to know how fast everyone is running and where the best competition will be, thus raising the bar (this is a common attribution among T&F fans), go ahead. All that means is that the HSers of the 1970s were even *better* depth-wise, since they had no internet and they had to run their performances without the benefit of knowing how they stacked up against the rest of the country. Ergo, something they were doing (read: more running) was what made them so good, not the internet.

Lydiard was virtually the only way to go, Shorter was big, Rodgers was big, Viren was big. Runner's World catered to serious athletes and not to the recreational "finish a marathon even if it takes 7 hours" crowd. The articles and pamphlets published by RW were informative and contained Lydiard-style training that promoted long, relaxed, enjoyable running as a prelude to "high steady state" training and (later) sharpening. Nothing fancy. Not much numerical data. The Gardner-Purdy computerized schedules were state of the art for determing training speeds. Today there is an overload of information and terminology, some of it useful, most of it horse crap. Somehow, the runners in the 1970s and early 1980s found those key training zones by feel and through patient trial and error. And they ran fast.

In fact, high schoolers in the 1970s *did* know about the big meets such as Golden West, Arcadia, etc. Word got around what the top performances in the country were. There *were* such things as newspapers and telephones, you know. And track meets *did* have announcers then. People in the late 1980s and early 1990s *all* knew about those meets and the Kinney (now Foot Locker) X-C championships, too. But did knowing about those meets and who would be there help those 80s and 90s guys run any faster? No, no and double no. They were over 10 seconds slower at every point of the 3,200m/2M depth charts than runners in the mid-1970s had been. Why? You guessed it correctly again! They had been led to believe they could run just as well or better by piddling around at 30-60 miles per week, doing some sprints and O2 uptake stuff, lifting weights and generally jumping up and down like a bunch of gymnasts.

We tried that approach, people. It failed miserably. Do not let it happen again, m'kay?

--*-*---*-*-*-*-*

Where did I mention David Martin? I said, "People like Horwill and Coe ..." This also includes physiologists who drew hasty conclusions from Gary Dudley's 1982 research involving rats running at various percentages of max VO2. I didn't even mention whether I referred to Peter Coe or Seb Coe. So in fairness, just to clear up any confusion about where runners *everywhere* think *both* of them stand, try these on for size:

"Training at 3K pace is golden. It eradicates the need for high mileage." - Peter Coe

"I have never run more than seven miles in one run. I believe long slow distance makes long slow runners." - Seb Coe

Whether or not those quotes encapsulate the *actual* Coe methodology, the *message* they sent is what was received (and there is *no* way of misinterpreting it) by the general running population. And that message, wherever it is taken to heart, is absolutely the worst message an aspiring runner could possibly hear.

--*-*-*-*-*

My chart has 59:50 for 10M equivalent to 2:50:59 for the marathon.

That assumes you're equally good at the two distances, the course severity is identical for the two efforts, and weather is consistent and conducive to good performances.

While the marathon is over 2.5 times as far, your 10M performance is usually a better relative predictor of marathon performance than a 400m time would be in predicting a 1,000m time. But the way energy is doled out in the marathon is still quite a bit different than it is for a 10M race. You will probably be hyperventilating and forcing the pace for well over half of a 10M race if you are running your best race, since anaerobic metabolism contributes greatly to the effort. Not so in the marathon. Oxygen uptake is directly related to caloric expenditure and reflects the substrate (stored fuel) being used. If you are hyperventilating halfway through a marathon, you are rapidly squandering your glycogen and are destined to be in survival shuffle mode with several miles still remaining.

Most people are severely underprepared for delivering their best effort in the marathon and think that because the early pace feels easy that it will remain easy for the full distance. But if you are really prepared for the marathon (or have a naturally efficient stride and naturally high economy at your goal pace), you can definitely run in the low 2:50s with a recent sub-hour 10M performance.

--*-*-*-*-*

The function used there assumes possible values of t1 = 0 and t2 = 0 for any two race distances. This would never correlate with actual data. When using real-world performances to derive a regression formula, you are almost always bound to have a positive intercept value, especially if the regression model is linear. For our purposes (comparing the relative strength of race times), a linear model is as accurate as a non-linear one within the range of data we're investigating. A linear formula begins to deteriorate for performances slower than the low 6:00s for the mile, low 13:00s for 2 miles, mid-21:00s for 5,000m and for performances at other distances near that ability level. This may be because fewer runners at this level are highly trained aerobically. Performances faster than world records have not yet been achieved, so we have no data to go from beyond that end of the model.

Here are my conversions for the preceding 5,000m marks, including predicted equivalent performances for the mile and the 2,400m. Note that this model shows the 10,000m WR is currently the "best" mark, with the 5,000m WR extremely close. The vaunted 3,000m mark is actually a little behind (equating to 7:55.94 for 2M), as is the 1,500m record (equating to 3:42.49 for one mile). The depth of 5,000m marks at the elite level has improved relative to the depth of marks for other distances over the last few years, so the chart may need a slight revision, making predicted equivalent performances for the 5,000m probably about 0.5 to 1.5 seconds faster. This would bring predicted performances for the shorter distances more in line with the *actual* performances. After all, the world records themselves (not some formula-based chart!) represent the *real* truth of human achievement.

Excuse any problems with the formatting.

Mile	2,400m	2M	5,000m	10,000m
3:41.30	5:45.48	7:53.65	12:37.35(WR)	26:18.04
3:47.3	5:55.2	8:07.2	13:00.0	27:07.3

3:55.3 6:08.2 8:25.3 13:30.0 28:12.6
4:03.3 6:21.1 8:43.3 14:00.0 29:17.9
4:11.3 6:34.0 9:01.3 14:30.0 30:23.1
4:19.2 6:46.9 9:19.4 15:00.0 31:28.4
4:27.2 6:59.9 9:37.4 15:30.0 32:33.7
4:35.2 7:12.8 9:55.4 16:00.0 33:38.9
4:43.2 7:25.7 10:13.5 16:30.0 34:44.2

--*-*-*-*-*-*

Rather than think of "lactate tolerance" and "lactate buffering," think of running at moderate to high intensities as "dealing with lactate." This basically means processing it as a fuel source at a fast enough rate to forestall the lowering of either muscle pH or blood pH.

The presence of lactate (the negative ion) actually may not be **directly** linked to lowering pH, since the associated protons (the positive ions) are apparently taken up in another reaction before they can interfere with muscle movement. But let's not throw the baby out with the bath water - blood lactate **is** still an excellent **barometer** for ensuing distress and lowered pH.

There are a number of ways your body can combat a lowering pH; the prinicipal method is via bicarbonates and phosphates present in the blood. There are also ways you can deal with lactate. Lactate can be reconverted to glucose in the liver (gluconeogenesis) or it can be used as fuel by the heart (reconverting to pyruvate via dehydrogenase enzymes). It can also be transported **out of** certain skeletal muscle fibers and **into** other skeletal muscle fibers for use as fuel. The monocarboxlylate transport (MCT) proteins are instrumental in this process, specifically the MCT-1 and MCT-4 "isoforms," whose expressions are increased via certain types of training and associated recovery stages. Expression of these isoforms during training is also dramatically increased by supplementation with testosterone **and by thyroid hormone**.

Two basic types of workouts which affect expression of the MCT-1 and MCT-4 isoforms are:

1) "Crest-load" running at an effort intensity slightly above (stronger than) the "ventilatory threshold" but not exceeding the "respiratory compensation point." ***Note that since lactate can be processed, the "lactate threshold" may be blurred in many runners; i.e., blood lactate may rise more suddenly at a certain effort intensity or it may continue to rise gradually without having an easily definable point of inflection. Ergo, the term "lactate threshold" seems to be falling out of favor, but "ventilatory threshold" remains very definable and measurable.*** When operating at this effort level, you basically want to hold steady at as close to the respiratory compensation point as possible without surpassing it for more than two minutes at a time and if it **is** exceeded, the effort should remain constant and manageable at a strong pace rather than spiraling quickly into a state of discomfort.

What's happening at this effort intensity? You're experiencing levels of lactate which **barely** exceed what you would normally consider to be within your "steady state" of effort, but you are operating at this intensity for a brief enough time (or are managing the pace well enough) to avoid a lowered blood pH, which would be associated with difficult, labored movements. This affords you the opportunity to generate a strong stimulus for incresing expression of MCT proteins, which assist in processing lactate. If you stop the moderately hard running before you get in trouble, take a short rest period, then resume the effort for repeated segments, you can accumulate more time at the strong pace than you would be able to

do in a continuous run at the same pace without excessive laboring. This leaves you with an **overall** effort intensity (the session taken as a whole) which is similar to that of a continuous run of the same duration at about 8-12 seconds per mile slower. The state of effort between the ventilatory threshold and the RCP is also called the "isocapnic stage" of exercise - a stage in which blood lactate levels rise in a **non-linear** fashion but pH is **not** lowering because the effort is curtailed before the blood's buffering systems become overwhelmed by the infusion of positive ions.

Ideally, you'd accumulate 25-35 minutes of running at this kind of pace (about 8-12 seconds per mile faster than your theoretical "threshold" or "maximum steady state" pace) in a session, broken into segments of anywhere from 8 to 15 minutes and with rest periods between segments which are about 2-3 minutes long. Normally, this pace is one which you could run for 39-45 minutes in a race, but you can also run a tad slower and do 4 x 10 minutes on, 2 minutes off or 2 x 20 minutes on, 3 minutes off. Or you can go a little quicker and reduce the segment lengths to 3 minutes with a recovery of 30-60 seconds. Go by feel. Do the first 10 minutes of running (out of a total of 25-35 minutes) a little easier, then find a strong, steady groove during the middle of the session. Start each segment when you feel ready to go again, but keep the pace such that the rests can remain **short** relative to the run periods. Finish faster if desired, but do not race it.

2) Flooding the muscles with lactate. This involves a short but highly intense workout - something like 2 x 400 at 3-4 seconds faster than 800 race pace with a 1 minute rest period. Not many reps at all, but the warmup needs to be very thorough, so there will be a decent amount of fast strides prior to the 2 x 400, and you may wind up getting about a mile of stuff at a fast pace if you count all those strides. There isn't much explanation necessary for this one; you just go for it and tie up. This should provide a stimulus for increased expression of the MCT-4 isoform in the Type II fibers (or whatever they call those things these days), making it a good session for 800 runners or maybe milers who lean toward the speed side, but distance runners don't normally need anything quite that intense in conjunction with higher orthopedic stress loads, other workouts being sufficient to mesh with their metabolic needs and cover this base of MCT-4 expression.

To discuss where these workouts fit into a schedule could easily become a tome. The schedule is infinitely more important than the individual workouts. Properly balanced, the whole can become much greater than the combined weight of the individual parts.
Where science can help us is by finding physical indicators that correlate with those intuitive "feelings" about running. Without a guide to how you should feel and what general pace you should run on certain days, it might take you years of trial and error to find the most cost-effective zones for training. Or you might never get it. As an example, most people do "tempo" runs incorrectly, either progressing to a decent pace too quickly or just jumping right into their pace without progressing at all or running too long at too fast a pace too often for best results. How can the guys in the white lab coats help us find the right feeling?

Well, it turns out that most runners, even many experienced ones, can't discern what kind of effort level represents their true "threshold," a safe effort for regular use, one which is so cost-effective that it basically "cheats" the overtraining gods by virtue of skirting the edge so finely - even crossing it in such brief stints - that the runner gets most of the benefits of fast-paced running with few of the risks. Some runners may literally feel that all running is too easy unless they're forcing things, or they may feel like even a "slow" pace is a bit of an effort. Or they may be somewhere in between, but still without a definable feeling of what "on the brink" running is. So how can they really know what's too slow or too fast?

Along come the exercise scientists to find a few measurable physical processes which occur in conjunction with that "maximum steady state" or "on the brink" feeling reported by the runners who are in

tune with that feeling, even providing points of definition for the effort level. Subsequently, some number values (imperfect as they may be) can be assigned to the true "threshold." The pertinent data, such as blood lactate and respiratory exchange ratio, can then be correlated reasonably well with other standards, such as percentage of 5k or 10k or half marathon or marathon race pace, or with heart rate, to provide a more "field-suitable" set of numbers for everyday use. Of course, these numbers still aren't infallable. Since heart rates are affected by more stressors than perceived exertion is, they are more variable in actual practice, and therefore less reliable, but they can be used in a "general neighborhood" fashion. The same is true of pace as a workout parameter. Jumping right into a predetermined pace on a "tempo" run is usually less effective than progressing to the right feeling, but a "lower limit" starting pace (just like a "neighborhood" heart rate) can often guide you to that feeling. If nothing else, regular failure to come close to the pace you should be able to sustain (or, conversely, running without difficulty at a quick "steady state" pace but racing poorly) can be a sign that something is amiss and that you might need to back off for awhile or you might need more work in a different area of fitness.

Realize that laboratory science (not counting the roads, tracks and trails as one big laboratory) can never replace the trial and error of thousands and thousands of runners when it comes to finding the best duration for "threshold" running and (more importantly) how frequently it can be repeated and how it blends in best with the other running you do. But exercise science can attach quantifiable measurements to those effective training zones runners have come to know.

To illustrate the limits of exercise science in truly understanding the big picture of running, consider this: Even if you do know the right feeling for repeatable, cost-effective training, it's often easy to go overboard, thinking that you might as well go ahead and hammer it really, really hard while it feels good, so as not to "waste the super feeling," so to speak. If you're in great shape and are at the ideal weight and are eating and sleeping right and recovering well in the short term, hammering it pretty often might work for awhile but, alas, there are no perfect bodies. Something has to give, and (like Icarus flying a little too close to the Sun) your awesome fitness can definitely override your structural (and, eventually, your metabolic) limits. You will never get it right if you can't learn from your mistakes and the mistakes of your predecessors. Exercise science can be an aid when it comes to some specifics, but it's those mistakes and successes of your predecessors that will prove vastly more valuable to you than anything exercise science can provide.

--*

In a previous post, I mentioned MCT proteins and their association with "above threshold" running. Those concepts only reflect what people currently think is a major contributing factor to producing energy during moderately high-intensity exercise. But guess what, Chief Two Dogs Humping ... I was running in that exact zone several decades ago, long before there was a name for it. Other runners were as well, and the collective experiences of these runners has already done far more to refine the use of this zone in a broader training scheme than exercise science will ever do. And if, a hundred years from now, exercise scientists "finally understand what's really happening" (like they always seem to be doing) and propose "new, innovative" workouts to attack these "previously undiscovered energy systems," you can bet every red cent you've ever had that runners have already done those workouts enough times to figure out how to incorporate them into a schedule (if they need to be done at all).

As long as you are operating in a steady state of effort - i.e., have not exceeded your ventilatory threshold - each 1% of incline will normally affect you by about 9.2 seconds per mile over land for moderate inclines (4% to 8%). This translates to about 1.74 seconds for each 10 feet of elevation increase, regardless of the horizontal distance covered.

Some runners have muscular or joint properites that allow them to have more efficient uphill (or downhill) gait mechanics than other runners (or have specifically trained for hill running), so take the above figures as an average range. The figures also change once you shift to different energy sources or stride patterns, and the cumulative effect of hill running also adds an additional toll, as does the shift to different muscle groups as the inclines become even steeper than 8%, so the slowdown rate does not appear to be linear for the steeper grades. For a workout of 10 x 400 meters at a "hard but not all-out" effort, an 8% grade would probably affect the times on average by 18 seconds.

Grades of over 14% are impractical and almost detrimental to stride mechanics and running economy for the average runner. You might as well do one-legged squats. Of course, squats (and wall sits) during the early stages of the preseason can be helpful in minimizing the inhibitory effects of the Golgi tendon organs (which prevent excessive muscle movement that might override and damage connective tissue), but if the goal of a workout is to orchestrate recruitment and rate coding into the act of economical running, the degree of knee, hip and ankle bend you will experience on very steep grades (leading to prolonged time for holding muscle contractions) renders these steep hills ineffective for regular use. When you hear of runners doing fast reps on grades of 15% or higher (including the "ramps" of 10-15 seconds up extremely steep grades), assume the reported grades are exaggerated. Some of those hills (i.e., 20% grade or higher) would be pretty much unrunnable, even for a few seconds.

Steep downhill running can also be detrimental to running economy in the short term, since the high eccentric load can lead to muscle microtears which tend to place excess burden on less-affected muscle fibers as the affected ones heal over a period of 4-7 days. Therefore, most runners would play it safe to avoid workouts involving hard, pounding downhills for 5-7 days prior to important competitions.

***

Does intensity matter for capillary development?

At some level it does, since you require a stronger stimulus to see improvements as you get fitter and significant capillarization won't continue to occur without more time spent at faster speeds, inducing more prolonged hypoxia within the Type I fibers and providing greater activation of the Type II fibers. However, during initial stages of fitness building or following a peaking stage (i.e., during base training), running at moderate intensities (somewhere between a normal recovery day pace and a decent "threshold" pace for most runners) for sufficient duration extends capillaries equally around both Type I and Type II muscle fibers even if it's predominantly the Type I units that are actually recruited. This could possibly be due to the fact that expression of vascular endothelial growth factor (VEGF) messenger RNA occurs both within and between muscle fibers following endurance exercise.

If I run, and I run long, is there any "bonus" for going faster than whatever feels "easy" that day?

Yes and no. A possible "no" in the sense that if you need an easy day and a faster pace would just run you into the ground, grinding it out for the sake of development in some other area (capillarization, etc.) makes the negatives outweigh the positives. But if you feel fine, there are

quite a few positives associated with picking up the pace to near marathon pace during the last fourth to last half of a long run.

Also, is there any pace too slow (in the sense of it would take 50 times as long for the same developments)?

Yes. Capillary development will be minimal to nonexistent if you never operate at any stronger an effort level than about 45% of max VO2. For most competitive runners, this means a pace of roughly 60% of 5k race pace, or in the neighborhood of 3 minutes per mile slower than 5k race pace. This isn't to say that running really slowly on occasion doesn't have some benefits; it's just that the benefits at these super-slow speeds don't extend to capillary development.

--*

The Japanese tend to "jog" a lot, I'm talking 8:00/mile pace for a 2:06:57 marathoner (Inubushi).

Yes, and Morceli used to do some easy ambling at 9-10 minutes per mile. Shorter said he couldn't find many people who could run fast enough for him to work out with on hard days and also couldn't find enough people who would run as slow as he did on easy days. Willis once remarked that he hadn't seen college teams that ran as slow as he likes to run on recovery days either. There are plenty of other examples.

Of course the Japanese do long tempos and such, but those 2-3 sessions are not going to make a 2:06:57 marathoner.

However, those runners neither sprang forth from the womb able to do 30k at 4:50 pace nor decided one day that they'd jump into running and schedule a few of these long, fast runs during their first season. They had to work up to that level over many years with thousands of hours of running at all manners of speeds, and the cumulative stimulus of all this created the performances they ultimately produce.

Could you explain the success of runners that use a long slow distance approach, or run most of their mileage slower than 60% of 5k race pace? What other factors are involved that enables these runners to succeed with this type of training?

The slow running can be helpful, just not in the area of capillarization. As mentioned, the sum total of tens of thousands of miles created all the physical and mental components of success, including the wisdom to find the proper balance between fiery determination, patience and prudence in training and in racing. Most of these runners have already reached their physical

limits in many of the measurable physiological facets of running performance before they reach their peak performances, yet they continue to improve in more subtle areas, such as efficient mobilization and sequencing of motor recruitment.

Those extremely slow runs can be very useful for regeneration by keeping connective tissue healthy, providing weight maintenance and promoting running economy through a tremendous amount of repetition in an utterly relaxed state. Even thought the speed seems useless (and would be largely ineffective if this was only speed used), as supplementary running, the sheer act of step after step on autopilot while in no metabolic distress fosters extreme efficiency in the neurons and muscle fibers responsible for fine motor control. Runners who already have a substantial high mileage background have also trained well beyond the point of experiencing a glycogen sparing effect in their long runs; therefore, they may need this easy jogging to provide a fat-burning stimulus to help stabilize weight at an ideal level for running.

In addition, if you're doing a decent number of regular hard workouts during a certain stage of a season, you should run your recovery runs as easy as you need to. While easy doesn't necessarily mean really, really slow, if this is what it takes to recover sometimes, so be it. The time for significant capillary development is probably past by that stage of a season, anyway, so recovery from hard efforts (with maybe a little maintenance of the vascular component as an afterthought) is the name of the game at that time.

--*

Are there actual studies on humans that actually measured capillary growth NOT occurring below 45% of Max VO2?

There was at least one in the early 1980s using human subjects. Admittedly, these were already active subjects and the sample size was small (as is the norm for many of these larks). But the conclusion was that capillary development did not take place at 45% of max VO2 and it is therefore prudent to keep exercise intensity from becoming too low to effect change in this area.

There have been other studies within the last decade using groups of rats running for various durations and intensities. But rat muscle fiber composition differs markedly in homogeneity from that of the corresponding muscle groups in humans and rat recruitment patterns are altogether different, often involving Type II fibers where Type I fibers are recruited at the same relative intensity in humans. Interested runners should therefore be skeptical of any sweeping conclusions about the effects of various intensities and durations of exercise on human fiber types if the test subjects are rats.

So walking wouldn't develop capillaries at all?

Perhaps it would in completely sedentary subjects who had never undertaken any exercise regime, but that doesn't really apply to any competitive runners that I'm aware of, so I've never thought it was worth looking into.

--*-*-*-*

Higher-intensity running is actually more conducive to mitochondrial proliferation than low-intensity running is. The main benefit to FT units arising from longer, slower runs is the fact that some glycogen depletion occurs in adjacent fibers whether they are actually recruited during the run or not, which stimulates enzyme production within all the fibers, ST and FT alike, and creates more efficient meshing of glycogen synthesis with other metabolic systems such as lipid breakdown.

For a better long run protocol, one which actually recruits more of the larger (but still oxidative) fibers along the spectrum, sometimes pick up the pace to around probable marathon pace for most of the last third to last half of the run, with a slightly faster last mile or two than that. This will count as a moderately hard effort day due to impact stress and possibly some fuel depletion, so adjust the remainder of the weekly schedule accordingly. Eventually, you'll need to do this (a faster pace for some of the long run) in any event due to glycogen sparing, which puts a damper on the stimulus for aerobic enzyme activity. Maybe alternate long run protocols, with one being a true long run at an easy pace throughout and the next one being 75% to 80% of that length (15 to 16 miles if your longest run is 20) but using the strongly-paced last half.

--*
Owen Anderson would rubber stamp the 8 x 30 seconds plan were it not for the fact that each rep would be farther than 20 meters.

Actually, doing 6 to 10 buildups of about 15 seconds each during the last couple of miles of a regular easy-paced long run is another good way to recruit additional motor units after the smaller, fine-control (ST) units have done enough work to start getting fatigued. Use a buildup format on these and not a sudden change in pace or range of motion which might precipitate an injury after 90 or more minutes of easy running. Start with a pretty slow rep and touch on a little faster speeds with each successive buildup until a speed around 1,500 race pace is reached for a few seconds during the last few reps. Concentrate on staying smooth, tall and relaxed and using a deliberately quicker stride frequency and shorter ground contact time than was used during the bulk of the long run itself.

--*-*-*-*-*

[this is from the cool running forums, not letsrun]

Cool Runner posted 02-24-2001 02:09 AM

The pace on "Yasso" 800s does typically fall somewhere between the optimal critical training zones. The

efficacy of the Yasso 800s vis-a-vis other workouts will depend in part on your own recent running background (read: mileage) and on your basic abilities (i.e., do you have more talent for middle distances or are you a natural long distance runner?). As a general rule, though, Yasso 800s are slightly too fast relative to the pace which brings you to your lactate threshold (LT), and they are too slow relative to the pace which elicits your VO2max. If you run closer to your LT pace or closer to your VO2max pace, you will get a more cost-effective workout, provided you spend enough time at pace AND provided you control the lactate accumulation during the workout.

In case you didn't know, a decent estimate of your LT pace is that which you could run for a one hour race (using an EVEN pacing strategy, of course). A decent estimate of your VO2max pace is that which you could run for a 10 minute race. Of course, this ASSUMES you are already trained well enough to run pretty hard for an hour and that you're capable of really hammering it balls-out for 10 min.

In practice, you will usually exceed your LT (and will subsequently begin breathing noticeably harder or faster) after 18-22 min. at your LT pace. In Ex. Phys. parlance, the point of hyperventilation is called the Respiratory Compensation Point. Even though your blood lactate levels begin to rise faster at this point (actually, BEFORE this point), you can still maintain the pace for the full hour (give or take a bit) by relying more and more on anaerobic glycolysis (energy production) as the race progresses. Anyway, it turns out that 20-ish min. at LT pace provides optimal stimulus for improvement if you are running CONTINUOUSLY at that speed, and 34-42 min. at or just below (slower than) LT pace provides optimal stimulus for improvement if very short REST PERIODS are incorporated. All this has been determined and refined by trial-and-error, not by theory, so you can rely on it.

At VO2max pace, 15-20 min. spent at or very near pace delivers the best results. It takes between 3 and 4 min. to achieve VO2max from a dead start if you're running evenly at this speed, but you can attain VO2max repeatedly during the middle and latter stages of a workout of repetitions as short as 1-2 min. if you orchestrate the rest periods correctly. Ideal rest periods for VO2max workouts are slightly shorter than the length of the previous run period (e.g., 2:00 at VO2max pace, 1:45 walk or 2:00 jog, repeat). If you rest longer than you run on this sort of workout, you'll actually accumulate MORE blood lactate (that's bad). This has to do with the phenomenon known as "venous pooling", which undermines the ability of the heart, liver, kidneys, and non-working skeletal muscles to take up the blood lactate and re-metabolize it. So bear that in mind - too much rest is counterproductive when doing a VO2max workout.

Anyway, the repetition running I'd recommend in lieu of Yasso 800s includes the following workouts.

LT workouts:

1.) 12 x 3 min. at your estimated LT pace, with 30-60 secs. rest periods between each (just start the next rep when you're ready, and as you get fitter, you'll get closer to 30 secs. rests). This workout is MOST effective if you select a pace which will allow you to run the FASTEST reps at the END of the workout without undue struggling (it should feel like a good, strong rhythm run that you'd do on the road if you felt good).

2.) 15-20 x 1 min. STARTING at your estimated LT pace (on the first 1-3 reps), slightly FASTER during the middle of the workout (get into a good rhythm here), and progressively faster still on the last 2-3 reps, with 20-30 secs. rest periods. Since those rests are so short, you'd better select a starting speed that doesn't get you in trouble early on, or you'll make the workout too anaerobic and it won't be as effective.

VO2max workouts:

3.) 6 x 3 min. at your estimated VO2max pace, with just under 3 min. rest periods (some or all of this can

be jogged).

4.) 12-15 x 1 min. STARTING at VO2max pace, slightly faster in the middle of the workout, progressively faster still over the last 2-3 reps, with 55-60 secs. rest periods.

5.) 5 x 5-6 min. at about 95% of your VO2max speed (about 15-20 secs. per mile SLOWER than VO2max pace), with roughly 3 min. rest periods between each (very easy jog on most of this rest period).

Give those a try. Obviously, you've got to be reasonably fit be-FORE doing sessions such as these, AND you must cover all the other bases in your training (recovery runs, long runs, tempo runs, a few short races here and there, etc.). This is just GENERIC information and it DOESN'T tell you how to fit the workouts into an overall program. You'll have to be smart about that. If you do want to do the Yasso 800s, try doing them with rest periods of about HALF of the run periods rather than EQUAL to the run periods.

Train hard and smart, but above all, enjoy.

--*
[this is from an article on John Kellogg's time coaching at a private school in Texas, found on Kevin Beck's website]

The longest long runs for our teams (out of season) were 2 hours and 5 minutes, which was 17-18 miles for the most experienced runners (the ones who had built up to that over time and demonstrated that they could handle it). There were two guys who actually went farther than that in training a couple of times (one had a high of 20 and the other had a 20 and a 21) and one other guy did a marathon out of season, but those were the only ones who ever did more than 2:05:00 in a run. The in-season "regular" long runs (for maintenance) were 90-95 min., or 12-13 miles for the oldest, most experienced guys.

Speeds which were faster than "easy" were of four basic varieties: threshold (and sub-threshold) pace, VO2max pace, "speed maintenance", and lactate tolerance.

We used speed maintenance (buildups or even-speed strides of 35 seconds or less, or form drills or hills) year-round. You may have read of Dr. Maffetone's idea of "Maximum Aerobic Function" training, in which all the base training is done at no faster than threshold pace (or heart rate "deflection point"). This is the general idea in our base training - EXCEPT that MAF training is more geared toward triathletes (particularly the non-running disciplines). In running, some degree of alactic fast-twitch fiber recruitment is necessary 1-2 times per week for best results. The need for variety to develop the joint strength and mobility is greater in running than in cycling or swimming. The impact stress can nearly double when switching from jogging to hard running, and the range of motion of some joints can increase by about 35%, so it is vital to prepare the body incrementally to handle these faster speeds BEFORE introducing race-specific running into the training routine. Also, complete lack of variety in rhythm overburdens tendons and ligaments. Furthermore, many male runners notice a loss of vigor when doing lots of volume. The inclusion of speed maintenance stimulates the adrenals and seems to maintain higher androgen levels, so that runners feel sharper and more eager to train (important when doing lots of volume). During the regular seasons, speed maintenance could actually become speed IMPROVEMENT by use of 12-15 seconds runs in which the middle 8-10 seconds were "bursts". Again, this was ALACTIC.

The sub-threshold and threshold workouts comprised the bulk of the "hard" running. It's important to teach young runners to work WITH their bodies and NOT AGAINST them. Tying up and fighting the clock on distances longer than 3 or 4 minutes is counterproductive (except in races, of course). We

usually spent from 25 to 35 minutes at threshold speeds once or twice per week (non-consecutive days), either in the form of continuous running or repeats with extremely short rests, so that the feeling of a continuous run was achieved. We also did occasional 45-60 min. runs (out of season) at a sub-threshold pace in order to provide greater stimulus for aerobic improvement.

VO2max running mainly used repeats of 2-4 min. in length, with equal rest to run ratios (or slightly less rest), and a total time spent at pace of 15-20 min. There were also the occasional 12-15 x 400 at a slightly faster pace and stuff like 5 x 1,600 at a fractionally slower pace with 3 min. rest periods. These trained the same systems (stroke volume and respiratory muscles) at different rhythms. A 400-1,000 meters trial (90%-95% effort) at the very end of a speed maintenance workout was done about every 3 weeks during the off season just to maintain a small middle distance component and to keep stroke volume fairly high without any real tying up.

Most of the lactate tolerance workouts involved distances between 45 seconds and 2 minutes, with no more than 4,000 meters of overall distance and rest periods between 1.4 and 2 times the previous run periods. Reps of 45-65 seconds would sometimes be done on hills. We would also use a short sequence of workouts with only 2-3 reps of 200-500 meters per workout (at 98% to 100% effort) designed to drastically improve ability to both fortify creatine phosphate stores and handle muscle lactate. It is now known that such sudden flooding of the muscles with lactate induces protein-mediated clearance. Extreme care must be taken with teenage runners, since the CNS gets stressed too much with regular anaerobic tolerance work like this. We probably only did about 6-8 truly intense anaerobic workouts during an entire Fall season and again in the Spring season (none in the pre-seasons).

The "runners" in the second half of the 16 years I mentioned actually did "train" 6-7 days per week, not 3-4. They ran very hard on 3 days per week (sometimes 4). The weight lifting was also highly anaerobic and was so non-transferable to running mechanics that it reinforced the WRONG movements! Their training would have been excellent "basic conditioning" work for a DECATHLETE, but (with painful clarity) had no bearing on competitive distance running. Alas, training to run a decent 1,500 at the end of a decathlon has NOTHING to do with training to run your BEST 1,500 (or longer).

The 60-65 mile weeks were average IN-SEASON mileage levels for the older guys. The main thrust of progressive periodization is limited periods of "pushing the boundaries out" with higher and higher mileages during the off-seasons. We stair-stepped the weekly volume with a high followed by a low (paying attention to individuals who needed more recovery), and often used the same scheme in the competitive season (without increasing the high weeks). As runners mature, the mileage in the "high block" periods gets even higher AND the lengths of those periods increase. By the mid- to late 20s, a male runner can often have an entire base period of 10-12 weeks at 140-150 miles per week.

Two-a-day workouts were also introduced incrementally, starting with one per week for 2-3 weeks, then building up to 3 or 4 per week (with some lower weeks having only 0-2 doubles), depending on age and experience. Occasional days completely off were also an important part of the training, particularly with younger runners or beginners, but the fewer of those as runners mature, the better.

The down side at the school was the parents and athletic department administrators not understanding what distance running is all about. Not that they were (all) MORONS or had BAD intentions or DIDN'T want to succeed; it's just that they were not runners and simply "didn't get it". Think of it this way: If only one person in 1,000 ever learned so much as basic arithmetic, it would probably be pretty easy for a scam artist to walk into a school and pass himself off as a math teacher without having to worry too much about some real math guy stumbling into one of his classes and exposing the fraud. Even if that DID happen, it would be the phony's word against that of the real deal. Suppose also that the charlatan allowed the

students to play cards and eat ice cream cones during class and said it was "part of the learning process", then gave them advance copies of his own tests complete with useless non-problems and (mostly wrong) answers. Memorize the bogus answers, write them down on the test paper, and get an "A". Woo-Hoo! The students would WANT to be "taught" by this clown! They'd have a blast, get some false sense of self-accomplishment and an "A" to pad their GPA, but they wouldn't learn any math and nobody would know the difference until one of them later came across a real math class taught by one of those one-in-a-thousand guys. By then, that poor student would be so poorly grounded in math that he'd be hopelessly lost and would probably ARGUE with the teacher that "we learned it a DIFFERENT way". Same deal with running. That school (and the entire country for about 15 years) has been duped into believing there is more than one path in this sport. There isn't.

Grades? Almost every kid in the school did at least one extracurricular activity (the school was big on that), so people were often short on time and sleep whether they played a sport or not. The X-C guys had by far the best grades of anybody in athletics, and were among the top students overall. Injuries? We did have a few, but no more than they had in the following 8 years and far fewer than occurred in football. The season-ending injuries (such as stress fractures) were few in number (probably about 6 or 7 during the entire 8 years), and in every single case, they happened to the guys who came into school with no Summer running (after they were told repeatedly that if they DIDN'T run in the Summer, they would be risking INJURY in the Fall - now, whose fault was THAT?). Funny how, in football, the parents acknowledge that a damaged knee requiring surgery is all just "a risk of the game", but if a kid is asked to RUN during the Summer, doesn't do it, and then gets an overuse injury in the Fall, it's because the X-C coach is a psycho for forcing the kids to run some insane distance of more than a mile a day! Even Joe Newton, after 20 Illinois State X-C titles at York, admits that perhaps the toughest challenge for him was to convince the PARENTS and ADMINISTRATORS how much running it takes to be a champion in this sport. And of course there are always plenty of candy-@$$ed doctors (non-runners, all of them - imagine that!) who will back up a skeptical parent's claim that "running is bad for a kid's health". We who know the truth face an uphill battle even AFTER we have already PROVEN how to win.

I've used probably FIFTY different handles on Internet forums and mailing lists over the last few years, but I like "TG&P Oz" the best. In the movie, Oz spoke through a huge, smoking visage with a booming voice which invoked abject terror in those who didn't know who he really was. "SILENCE!", he screamed, as if to say, "I am superhuman and I am IN CHARGE HERE!" Once they found out he was a mere human (seemingly like any other), at first they felt cheated. Who was this little man behind the curtain to tell them what to do? Why had he sent them on that perilous mission to get that broomstick (saying that they MUST do it to get what they wanted) only to tell them the broomstick itself was worthless? He seemed to be a complete fake! But once unveiled, his words never rang truer. He DID have the answers after all! He only used pomposity and arrogance as a crutch for leadership because he NEEDED to inspire AWE in them. The travelers never would have gone after that broomstick if they hadn't believed in Oz's POWER to magically grant them what they wanted. But getting the broomstick was not a mere test to "earn" any rewards at all. It was self-discovery. In the end, they found out that they each had the very thing they sought all along. That first trip down the Yellow Brick Road to the Emerald City wasn't enough to show them what they already possessed. It took that last journey into darkness (with the chips really on the table) and back out again for them to find their brains, heart, courage, and home (sense of belonging and being dear enough to others that they would risk their hides). There WAS no omnipotent entity who could ever bestow these qualities on them as GIFTS (which is what they all originally WANTED to happen). The working together to discover their inner qualities was the REAL "Wonderful Wizard". The little man only had the PLAN to GUIDE them toward that discovery. And a wise one it was!

I am arrogant and one million percent unapologetic about what it takes to be the best in this sport (progressively higher mileage is a huge part of that). Why do I pose as "Oz"? Because I know which mission to assign to help runners discover their potential. But I can't give them any results through magical powers; I'm just a human like the little carnival man from Kansas. I can only guide them. THEY have to DO it. It's neither easy nor free. Many walk away from the Emerald City and remain searching for whatever, lost "over the rainbow" somewhere because they're afraid of what that arrogant, artificially amplified voice is telling them to do. Listen, take that step to get started on the road to self-discovery, and use the brains, heart AND courage (together) that you already have. Then you can find your way home.

--*

[quoted in a thread in 2005 titled "TINMAN BASHES WEJO'S COACH." Apparently JK was replying to an article by Antonio Cabral on Rui Silva. This may be from the lost posts of the old message board]

"Should be required reading for all aspiring American milers

If I can reprint excerpts from that article without violating copyright laws, I'd like to make some comments on Silva's training in a series of posts. There are a number of elements of the training that stand out as EXCELLENT once you're familiar with them on a personal level. Without actually experiencing them and witnessing them, these secrets remain hidden, lost in the jumble of workout times and terminology. Once you've lived such training and uncovered the principles that separate mindless hard running from intelligent and purposeful running, you'll know what to look for; that is, what the real keys to the training are.

"People began to think that we could do better than we had done because of the nature of the Portugese (sic) people and our willingness to train hard."

As they found out, determination to run balls-to-the-wall was not getting the job done. It never will be enough. That's not what it's all about. Part of the sport demands that attitude and effort, of course, but continual training with this mindset will NOT make you fit, even for 1,500-3,000.

"We use (sic) to do only interval training and a low overall volume of work. However, we saw that others were doing things very differently. We can safely say that Lydiard greatly influenced Portuguese coaches through the introduction of his ideas centered around marathon training and a large overall volume of work."

Amen, brother! Remember, these are 1,500m guys we're talking about - the kind of runners with a gift for (and enjoyment of running FAST for a few minutes at a time. Most of them are NOT natural long distance runners who relish the prospect of a fairly long continuous run (or 30 minutes of long intervals) at or below the "threshold" (AT). If you read the article in its entirety, you'll see the patience demonstrated by Silva (and the other athletes and trainers) to develop over a period of years using the same basic program structure. This is common to every successful distance running program and is something that should be taken to heart by all American middle distance runners from jr. high to post-collegiate levels.

"We then began to progressively increase the volume of our training until we were performing a high overall volume of continuous runs at relatively high intensities. Much of this work would now be considered AT training. We also continued with regular short and long repetition sessions. After making these changes success came rapidly."

Ditto on the above comments about higher mileage. Another lesson learned was that continuous runs are only a piece of the puzzle. Also necessary are repetition workouts at varying speeds but always emphasizing running within oneself as opposed to testing the limits every time a stopwatch is started. In some of Silva's workouts (shown later in the article), it's obvious that he's running FASTER than the classic "one hour run pace" concept of AT, but he's still orchestrating the speed and the rests so as to remain BELOW the spike in lactate accumulation. Staying relaxed at a VARIETY of speeds is absolutely necessary. Merely using "half marathon pace" as threshold training all the time is not sufficient.

"The major lesson was that we need good volumes of easy/base training as well as the intervals that we had been performing in the 60's. More recently we have come to understand that simply performing hard and easy sessions is not the complete answer either. We have developed the concept of training at threshold levels for much of our specific work."

Again, this goes back to the concept of staying at the threshold of lactate accumulation even when running middle distance pace. Care must be taken to use correct periodization when staying in touch with faster speeds throughout the year, but it can be done with DISCIPLINE on the part of the runner. Of course, periodization is a JD-type term which has actually found its way into Jogger's Globe, but it's an important concept nonetheless. See? Jogger's Globe isn't ALL bad. Anyway, a runner must learn how to stay right at (or just below) the limit of the comfort level and must be disciplined enough to refrain from hammering workouts. Check it out - nearly all of Silva's repetition sessions employ the concept of starting cautiously, finding the groove in the middle, and finishing faster. This is extremely important and very rarely used in America, where competition with teammates (and the stopwatch) from the outset of a workout is the norm.

Resistance workouts

Let's skip ahead in the article to a topic which is widely debated - resistance training. There are a FEW exceptional circumstances, of course, but the following quote pretty much summarizes what SHOULD be the extent of "supplementary training" for MOST middle distance (and, of course, long distance) runners.

"(Silva) does flexibility work, but no plyometrics or weight training. The only strength work he does are (sic) repetitions on hills. Sometimes he runs steps as a form of strength training. His coach was a fan of the Lydiard methods which helps explain his preference for using hills. It can be said that the vast majority of Portugese runners and coaches do not believe in the need for strength training. They think that sufficient strength is gained through resistance running such as hill work."

Keep reading that until it permeates the stubbornness-brain barrier. The only circumstances under which you (assuming you're a RUNNER) should be lifting weights are 1.) you are woefully weak to the point of it (your weakness) actually contributing to poor mechanics or increasing your risk of injury and/or 2.)

you're past your peak years (somewhere in your 30s or older), in which case, you probably need to lift in order to promote fat burning in a variety of muscle groups post-exercise. Even scenario 1 can usually be prevented or ameliorated by use of simple "body weight" calisthenics and form drills. BTW, hill running IS weightlifting (added resistance training), and chances are it's the only weightlifting you'll need. Running steps also develops knee integrity with minimal risk of overuse to the Achilles tendons, but this drill does not stand alone. Actual hill work is necessary for maximum benefit.

You're not BENCHING anything out on the course or on the track. Why would you perform that exercise with weights when it's invariably anaerobic (even with light weights and high reps) and reinforces discomfort and incorrect movement patterns? A LITTLE weight work on OCCASION is not bad, but I get so exasperated when I see distance runners on these "weight training programs" which are designed to "build up their upper bodies" and make "all-around athletes" out of them. Those guys are dumber than a box of rocks! They might as well eliminate 30% of their running to practice juggling cats!

Spend YOUR time RUNNING - or at least use your "weight room time" (if you have any at all) to do drills which carry directly over to running movements. Yeah, I know drills are TECHnically plyos (which the Portuguese claim to avoid), but CORRECT drills transfer easily to the running motion and should be included at some point, preferably early in a running career, and should be maintained from time to time during the early stages of preseasons.

Misc.

Re: bone density-

Doing kicking drills in a swimming pool (stuff like flutter kicks, leg crossovers, etc.) will also build bone density a little by virtue of "torquing" the muscle attachments to the bones. I like this because there's no impact stress involved and there's very little chance of straining a leg muscle in the way you could with squats.

Re: stretching -

I'd imagine the Portuguese runners do static stretches and work some knots out of their muscles at the same time. Ballistic stretching sucks - UNLESS you've done something to warm up your muscles AND thoroughly stretched statically before doing the ballistic stretches.

Re: "body weight" exercises -

Pushups, pullups, dips, ab rollers, etc. are preferable to lifting barbells or dumbbells. These things involve a wider variety of "core" muscles, thereby burning fat in more muscle groups post-exercise. This is important for Masters runners, who tend to have more trouble maintaining the weight they carried (or didn't carry) 20 years earlier. Again, I'd never recommend non-running-related stuff like this for runners in their prime years unless they were pathetically weak. But ... I do "Jack LaLanne"-type exercises 2-3 times per week these days myself (2-3 sets of 25-35 pushups, 2-3 sets of 15-20 pullups, 2-3 sets of 20-25 dips, 1 set of 35-50 situps or 20-25 ab rollers), but that's because I'm only running a half-@$$ed amount

(40-60 mpw). If I could do 120 mpw without getting hurt (cartilage problems from eating too much sugar), I probably wouldn't need to do more than a set or two each of the calisthenics every 7-10 days to stabilize my weight/body fat. If you're going to do these things at all, it's better to start them right after a competitive phase (when you're not doing any real anaerobic running) and hit them pretty hard for a few weeks (but not to the point of "bulking up"). Then you'll be able to do them less often (as "maintenance") later in a training cycle (as you begin getting more serious about running faster) without having them be very anaerobic. Do them slowly. They'll be less anaerobic and you'll get more out of them.

Re: protein/diet -

Masters should probably eat a higher percentage of protein for tissue repair purposes, but the main thing is avoiding "empty" calories (Mr. Pot talking to Mr. Kettle here). Eat lower-calorie, higher-nutrient foods (if you can identify them and find them). This partly depends on mileage. Higher mileage requires a higher intake of carbs. And nope, a 45-year-old can't eat like a 20-year-old anymore and expect to have the same physique - running volume notwithstanding!

Re: other Masters principles -

You should be sure to include short, progressively faster strides a few times per week as you age. You'll get EXTREMELY uncomfortable at faster speeds (and actually can't even attain those speeds) if you don't stay in touch with them year-round. You should also do some one-shot time trials (about 95%-98% effort; not necessarily all-out) of 2-8 minutes in length every couple of weeks (at the tail end of a workout of strides) to push your heart rate up near its maximum. This maintains a fairly high stroke volume (important for keeping your VO2max up there). Stretching post-run is also very important. Loss of range of motion in the hip flexors alone can cost a few seconds per mile, and reduced flexibility is quite common among Masters runners who don't stretch religiously.

If you're running less than 45 minutes per day on average, you'll probably get best results by spreading mileage increases more uniformly over the course of several days (as opposed to merely bumping up the long run and keeping everything else low). If you're already over about 45 minutes per day average, you're good to go on inching up the long runs. They really start becoming effective once they get close to 2 hours in duration, especially if you can get comfortable with a gradual pace pickup over the last few miles. Stay under control - more at a slightly challenging aerobic effort - and avoid really struggling.

Post-run recovery is aided by doing a thorough, relaxing stretch, then taking some simple sugars within a few minutes. This will raise your insulin levels, which allows you to store the maximum amount of carbs as muscle glycogen if you eat shortly after that. You need to eat a meal which is high in more complex carbs within an hour after taking the simple sugars. If you wait longer than 2 hours total after a long run to eat those complex carbs, you've missed your best window for replenishing your glycogen.

Some light activity the day after a long run also speeds up recovery. If your legs are shot, you can try tooling around for 30-ish minutes in a swimming pool or doing some light spinning on a bike with low resistance. Of course, actual running on a soft surface is preferable, but people often need to build up to the point where they can run comfortably the day after a long, depleting workout.

An ice bath (the "David Blaine therapy") might be a bit over the top, but many runners swear by dipping their legs in cold water immediately following a long run. It's a bit of a shock the first few times, but you eventually adjust to it.

Back to Silva's training

To continue with excerpts from the Portuguese training:

"With regards to AT training, Rui performs a large amount for the 800/1500/3000 events. ... This AT training is not scheduled in advance, but it comes naturally if he feels that he is sufficiently recovered to do it. This is the typical Portuguese way to do it. However more advanced Portuguese coaches have begun to schedule AT work as a specific session. This does not always involve a continuous run, but can also take the form of long repetitions."

This is the way it SHOULD be done. Some of the training at the AT is unplanned (usually on continuous runs or on longer repetitions), but some is deliberately fit in with general pace guidelines depending on current fitness (not so much on goal times). Both continuous AT running AND long repeats are necessary. If only continuous runs were used, there would be no variety in rhythm and motor unit recruitment.

Notice in the article itself that Silva did some of his long repeats on grass without as much regard for TIMES; instead, the training was effort-based. Also notice that the speeds on the reps were almost always INCREASED as the workout progressed. In fact, the first reps were under control enough on some sessions that the last rep was run WAY faster. This means that Silva was NOT TESTING himself on each rep. Instead, he was TRAINING.

The workouts such as 4 x 2,000 and 4-5 x 1,500 were usually done off a 3 minute rest interval and were run at about 93%-96% of predicted VO2max pace (63 400 pace or slightly faster), with the last rep substantially faster than the others. This is right in line with information from the (still down) Paragon site, in which we advocate 20-25 minutes of running (in 5-ish minutes segments) at 95% of current VO2max pace with rest periods of 50%-60% of the run periods. Silva also used 6 x 1,000 right at 63 per 400 average, with 3 minutes recoveries, again in line with our recommendations of 2-3 minutes on/3 minutes off at VO2max pace, using 15-20 minutes of total time at pace.

The main points to be made are 1.) this is NOT all-out running (being substantially slower than 1,500 race pace and still a good deal slower than 3,000 race pace), yet it still has a very beneficial training effect, and 2.) the only REALLY FAST rep is the last one, meaning that a spike in lactate accumulation never occurred until the end of the workout. Compare this objectively with the way YOUR high school or college team typically runs/ran workouts of medium/long repetitions. There is a vastly different approach in HS and college, with the emphasis being on running EVERY rep at a predetermined (and very challenging) time which was written on a sheet of paper.

Sufficient warmup

Another couple of paragraphs from the Silva article:

"As Rui has gained in maturity and experience, the tendency has been to increase the number of

repetitions while decreasing the recovery interval. It may be surprising that he never performs these long repetition sessions with a recovery period of less than 3 minutes. However, the first priority on these long sessions is the pace achieved, with the length of the recovery period being of secondary importance. Sometimes he allows almost complete recovery between repetitions. This session is always performed following an easy 30 minute warm up run, and is followed with a 15 minute warm down run.
He usually performs 3-5 fast strides over 100m before starting the repetitions. It is interesting that a 1500m runner such as Rui performs these long 1000 - 3000m repetitions regularly throughout the year. However, this work has been fundamental in developing his overall fitness. I believe that it is this endurance work which allows him to be strong enough to produce such a good kick at the end of fast races."

Since the rest periods are equal to or nearly equal to the run periods, this differs from classic AT training (running at "1 hour race pace") and actually works primarily on oxygen uptake. But the concept of avoiding a spike in lactate accumulation still applies to "VO2max" training.

Notice the fairly long warmup periods prior to repetition running. These are no doubt started at an EXTREMELY SLOW pace and all systems are allowed to achieve a sort of equilibrium before the actual workout is started. Also notice the 100m STRIDES at the end of the warmup. While warming up is a pretty obvious concept for most runners, it can safely be said that Americans tend to rush their warmups and are not REALLY ready to start their interval workouts or fast continuous runs. They therefore tend to get a little in the hole anaerobically early in the workout.

Ever notice how some of your best continuous runs start out as planned EASY runs? Ever notice how you feel way better and are able to run very fast at a much more relaxed effort with everything "clicking" if you do a long warmup and some MODERATE speed stuff before hitting the really quick stuff? Try it out. Do a 30 minute warmup, starting at almost WALKING pace, gradually letting the speed increase itself with no additional effort on your part, and getting REALLY comfortable running. Then do a few progressively faster strides, THEN try some intervals. Start those cautiously and squeeze them down as you go. You'll probably feel pretty light and loose. Concentrate on STAYING smooth and relaxed and resting just enough so that you feel ready to go again. Even if these repeats are not as FAST as you normally run them, you will likely get more out of them than you would if you tied up on most of them."

--*-*-*-*

Repeats with short rests are usually recommended to allow you to just barely exceed your lactate threshold (LT).

A little background: When you first experience a non-linear increase in lactate as a result of increased running intensity (or prolonged running which necessitates recruitment of FT fibers), the lactate entering the blood stream is buffered by the bicarbonate system. This increases CO2 production *without* a fall in blood pH. This stage of exercise is known as the "isocapnic buffering" period. At some point as the intensity continues to increase (or moderate intensity is prolonged), lactate production exceeds the buffering capacity of the system, leading to a *fall* in blood pH. This results in an additional drive to breathe, which marks your "respiratory compensation point" (RCP). In practice, this means you begin

hyperventilating and start to get a tight, straining feeling.

The isocapnic buffering zone, therefore, occurs "between" the LT and the RCP and is a highly effective training zone which is also fairly safe for many "hard" workouts, since blood pH is not being lowered during this time. This is a *very thin* window of effort intensity and the time frame between the LT and the RCP is very short. Consequently, you need to spend some months improving (and learning to recognize) your maximum steady state (just *below* your LT) before focusing on training in this nebulous area between comfortable and uncomfortable.

Care must be taken to avoid passing the RCP during this type of training, since this would be an indicator that your blood pH is being lowered. Particularly competitive runners tend to turn such workouts into harder efforts than they need to be. What you want is a pleasantly challenging or *slightly* uncomfortable feeling which is just short of that onset of hyperventilation. Some experimentation might be needed to get it just right.

Arthur Lydiard discovered that controlled time trials of three to six miles at efforts which reached just above (faster than) the LT were beneficial. These types of runs, if properly done, will have you working in the isocapnic buffering zone for a brief time. So will Kenyan-style "progression" runs. But you can train most effectively in this region by using repeats which feature very short rest periods relative to the run periods (a.k.a. "high density" repeats).

Examples of high density repeats include 10-15 x 3 minutes with 30-60 seconds recovery (just take enough rest so that you're ready to go again and achieve that same barely uncomfortable feeling by the end of the next rep, but pace yourself so you only need about 30 or so seconds between reps) or 5 x 7 minutes with around 2 minutes recovery (walk/jog) or 3 x 15 minutes with 3 minutes recovery (mostly jogging).

Dr. David Martin also recommends 2 x 20 minutes with a mile at a brisk jog between bouts. These longer bouts (15-20 minutes) are almost continuous runs in their own right and, in fact, spending around 20 minutes hovering right at the LT will take you to your RCP by the end of the run and will provide a fairly good stimulus for improvement (or at least maintenance) without having to do a second 20 minute bout.

The effect of training in the isocapnic buffering zone is enhanced if the training sessions are done at a slight altitude (between 3,000 ft. and 4,500 ft. is ideal). These sessions are best preceded by an acclimatization period at a somewhat higher altitude (7,000 ft. to 9,000 ft.), which will result in increased production of erythropoietin hormone (and, subsequently, red blood cells) in about 60% of the population (about 40% are "non-responders"). A very short trial period at altitude can determine if you are a non-responder.

Recent literature (such as a RRN article several years back) has proposed that interval training at just below or just above the LT is preferable to continuous running. Real world trial and error, however, says that *both* continuous running and repetition running in this zone are needed for best results. Arthur Lydiard advocated relaxed but fast running (which turns out to be fractionally below the LT) as the kind of base work that can be repeated several days per week. This safe aerobic pressure might be called

"repeatable maximum steady state". The sessions just above the LT (in the isocapnic buffering zone) fall into the same general category of "threshold training". Since lactate is being buffered for a short time when you first exceed your LT, it's safe to train in this zone as long as you don't spend enough time there to allow the lactate accumulation to override your buffering system and cause your blood pH to fall. High density repeats are slightly more effective for this "above the LT" training than continuous running is.

Workouts which exceed the LT (even if the RCP is not reached) should be considered "hard" outings and should in most cases be bookended by easy runs. Although it can be done on rare occasions, it's not a good policy to make a habit of running at a near maximum steady state the day before or after a "hard" workout. Nor is it wise to run in the "no man's land" between easy and high steady state. Very easy (at or below 60% of maximum heart rate) should be the rule on recovery days.

A hypoxic enviroment creates a somewhat more ischemic condition in the body, which causes more lactate to be produced during exercise. As long as the runner stays within the "compensatory zone" and does not surpass the RCP, this provides further stimulus for improvement in the buffering system without the potential detriments of a reduction in blood pH. The range of 3,000 ft. to 4,500 ft. appears to be best for threshold training since running speeds which are within a few percent of sea level threshold pace can be maintained.

Also, the athlete is more sensitive to reaching the threshold at altitude, which makes it easier to perceptually control the effort and keep it within the compensatory zone.

It's important to have an initial acclimatization period of easier running at higher altitudes prior to doing threshold training at medium altitudes; otherwise, blood lactate levels will rise too quickly when the LT is reached, forcing the runner to either run too hard to achieve the correct purpose of the workout or to abandon the workout before an optimal amount of time is spent in the desired zone. In other words, altitude training should be approached by the unacclimated person in the same way sea level training should be approached by the novice runner: start from the very bottom rung of the ladder and gradually work your way up.

--*-*-*

I take it you are referring to the "Haldane effect" here. This is where oxygen displaces CO2 from hemoglobin in proportion to its partial pressure. This normally results in lower production of lactic acid during maximal work at high altitude when runners are fully acclimated (the so-called "lactate paradox").

The *primary* effect of decreased blood oxygen content at altitude (in regard to lactate production) is that it precipitates an increase in *epinephrine* secretion. It is most likely this increased epinephrine secretion (rather than inhibition of oxidative metabolism) which results in greater lactate production. But all this is getting to the limit of my knowledge of physiology. All you really have to know is that with acclimatization, blood lactate during exercise *decreases*.

It is extremely difficult to address *all* the potential benefits (and pitfalls) of altitude living/training.

There's not only the issue of red cell production and characteristics to consider, but also vascular development, enzymatic activity (both aerobic and anaerobic), mitochondrial biogenesis, changes in plasma volume, diffusion capacity in the lungs, increase in mobilization of free fatty acids (which spares muscle glycogen), changes in muscle fiber size, and a *host* of other factors.

To further muddle the overall picture, most rigorous, controlled studies examine only a few factors at once and are therefore of limited scope. What is needed is to experiment with these restricted findings to see if they blend favorably in the greater context of long-term training and living arrangements. It is myopic, for example, to believe that raising VO2max is the Holy Grail of training and that 35 miles per week is a sufficient total mileage. That, in a way, is analogous to quaffing a soft drink, getting a quick energy burst, and concluding that simple sugars and caffeine are the "nutrients" that matter most in meeting day-to-day energy requirements. Quick fix, yes. Optimal in the long haul, no.

In short, when deciding on a sound living/training scheme for runners moving to higher altitudes, there are potential plusses and minuses to weigh. There are positive effects of *exposure* to hypoxia, potential negative effects of *prolonged* exposure to hypoxia (or to *severe* hypoxia), positive effects and potential negative effects of *training* in hypoxic conditions, and positive effects of training at *sea level*. Most of the negatives revolve around *hard* training at higher altitudes. Without addressing those specifically, here are some of the principle positives:

Positive effects of exposure to hypoxia include the possible erythropoietin response (within the first 48 hours) and subsequent red cell production, and accelerated vascular development (especially during the acclimatization period).

Positive effects of easy base training at high altitude include an increase in mitochondrial enzyme activity and peripheral oxygen utilization, and enhanced pulmonary circulation due to greater pulmonary demand.

Positive effects of doing faster training at sea level include retaining neuromuscular coordination and optimal selection of muscle fibers, reaching the highest possible oxygen uptake during maximal or near-maximal efforts, and attaining a suitably fast speed for any given workload.

There are also benefits to doing long, easy runs in *hills*, which comprise much of the usual terrain at high altitude locations. Running uphill produces greater systolic pressure, which places more demand on the left ventricle, and running on both long uphills and long downhills (common terrain at high altitude) increases aerobic enzyme activity in the quads.

Also, moving to altitude to train is usually accompanied by a single-minded focus on running more miles and taking a serious, long-term approach.

The bottom line with altitude training is that we must formulate a balanced living/training protocol which maximizes the positives and minimizes the negatives. Owing to the multifactorial nature of the problem, as well as variation in the responses of individual athletes to altitude and to training in general, a mathematical model cannot be precisely constructed using decision variables and constraints. Instead, we have to create the best "eyeball estimate" of an optimal program that we can, and we must be able to

adjust it in favor of individual athlete response if necessary.

Taking all factors into consideration, the rudimentary formula that emerges for sensible altitude living/training seems to involve living at 7,000 ft. to 9,000 ft., with occasional excursions of 12+ hours per day (on two successive days) to elevations between 9,000 ft, and 12,000 ft., doing easy base running at 7,000 ft. to 9,000 ft., doing some running near the LT (or barely above) at 3,000 ft. to 4,500 ft., doing some additional running (including longer runs) near the LT at close to sea level, and performing faster tempo runs, "VO2max" training, and anaerobic interval training at close to sea level. Occasional training stints of 7 to 10 days at near sea level also afford the opportunity to achieve normal sea level running speeds and absolute work rates for a continuous time period, and the subsequent return to 7,000+ ft. often creates an additional boost in erythropoietin for high altitude responders.

--*-*

And welcome to the 21st century.

Look, nobody who knows anything is suggesting that we abandon the proven principles that brought Boston Billy and his peers so much success. We *know* that those principles include lots and lots of miles (with a suitable portion of those miles being *fast* ones).

That said, taking the "just go out and run" approach is similar to a baseball manager or pitching coach telling the guy on the mound to "just mix up your pitches and get all the hitters out". Naturally the pitcher would want to develop the basic physical skills necessary to have an effective repertoire of pitches, but don't you think better use could be made of that repertoire if the manager, coaches, and players knew the tendencies of the hitters they were about to face and applied that knowledge? Maybe the guy at bat tends to have trouble with high, tight fastballs. Maybe the next guy in the lineup tends to chase breaking balls low and away. How do you select your pitches or position your fielders if there are runners on first and third, the batter's a lefty, there's one out, your opponents like to use the hit-and-run, a power hitter with 10 homers in his last 4 games is on deck, blah-blah-blah? Sure, you could choose to ignore the finer points of the game, citing the fact that the 1927 Yankees just "went out and played ball" without going overboard with all that silly "batter tendencies" nonsense. Meanwhile, a rival team with equal physical talent and determination might choose to *study* their opponents and play the odds and, while the outcome of any individual at-bat would not be predictable, that rival team would patiently and methodically rise to the top of the heap over the course of a full season of play.

Whether you want to accept it or not, there are advantages to understanding how and why the body responds to different stimuli (altitude, training procedures, etc.). It *is* possible to integrate this understanding into our training and fine-tune it *without* having to abandon the tried-and-true principles that runners like Bill Rodgers used to become great. Don't be daunted by science. It *can* go hand-in-hand with experience.

--*-*

During exercise, the smallest motor neurons (the ones with the lowest threshold for synaptic activation) are recruited first, as long as there is sufficient force produced to sustain the exercise. These small motor neurons innervate ST muscle fibers, while larger neurons innervate FT fibers. It follows that there is a definite hierarchy of fiber utilization during exercise, which depends on the intensity (not so much the duration) of the exercise.

So it *does* matter how fast or slow you're running as to how many FT units are recruited.

So do ST fibers fatigue during long runs, thereby necessitating more and more FT fiber recruitment? Yes, they do, but it's not as much the duration of the run that determines fiber recruitment as it is the *pace*. Why should you feature a lot of relaxed running when developing an endurance base, then? One reason is because, if you're like most runners, you will wind up producing a modicum of lactic acid if you run at a pace sufficient to mobilize your FT fibers. This will be detrimental over time and will hinder your fitness development and ability to run just below your anaerobic threshold for very long.

Your policy on most runs should be to keep lactate production as low as possible at any given time in the run. Run more gently and run longer, allowing yourself time to warm up very gradually and feel as though you're firing on all cylinders. Then you can work a little closer to your AT. As you get fitter, your "relaxed" pace will become faster without any additional effort on your part, and you will mobilize FT fibers without producing nearly as much lactate as you once did. This training will improve the ability of *both* ST and FT fiber types to cope with exercise stress by stimulating you to develop more mitochondria and surrounding capillaries.

--*-*-*-*

Some combinations of effort level and duration are more cost-effective for building general fitness than others, whether or not the speed involved happens to line up with any race pace. The zone just below (slower than) the ventilatory threshold is the most cost-effective for regular continuous running. The zone near the respiratory compensation point is the most cost-effective for long repeats (3-15 minutes) with rest periods each about one-fourth of the previous run period. The zone near max VO2 (about 95%-97% of max HR) is best for medium length repeats (2-4 minutes) with rest periods each about 60%-90% of the previous run period and with about 15-20 minutes of total time accumulated at the necessary speed (which usually results in about 10-12 minutes accumulated at the desired HR). This protocol is the most cost-effective for increasing stroke volume and for mitochondrial biogenesis.

As target events near, some sessions can be orchestrated to address metabolic pathways/energy systems **and** involve race pace. Still other sessions can work on race pace and **don't have to address any specific energy system**. Becoming familiar with meting out effort at race pace (and what to expect in terms of feeling at various points in the event) is at least as important at this stage of the year as raising the stroke volume or maintaining the "threshold." Preparing for various race tactics can't be completely ignored

either.

By and large, though, addressing energy systems in a cost-effective and repeatable fashion is far more important for basic fitness. Touching on a wide range of paces througout the entire year, albeit with greatly reduced intensity during the non-competitive seasons, is also desirable.

--*-*-*

You can agonize over all the theoretical reasons why easy runs are a waste of time or don't contribute to making you faster, but in actual application, easy runs are very beneficial and have a place in making you faster. Theory also once said there couldn't be a mammal that lays eggs, has a rubbery snout shaped like a duck's bill, webbed feet and venomous spurs, but real world actuality always trumps theory.

If it feels too easy, run more. But make sure you maintain a decent stride rate. If your stride rate becomes too slow by habit, you will have a hard time getting to the top of your game and you will have a point in saying that type of running is largely fruitless.

--*-*-*-*

---

jtupper [Jack Daniels, famous running coach and physiologist] wrote:

I think between 5:12 and 5:24 would be the range -- more in the 5:24 category at current fitness and I calculate 5:12 is threshold pace for a 31:00 10k ...

That's very much in line with what I've observed. I have a regression formula that predicts a 31:00 runner will reach the respiratory compensation point after 20 minutes at 5:11.5 per mile pace (5:21.0 pace for a 32:00 runner). Of course, this means running at "threshold" pace would entail approaching the listed pace from the slow side.

But I'm not going to tell you to run an exact pace. In short, just run as you feel and try to find the fastest pace that seems floating and weightless if possible. This should be a default rhythm that puts you on the edge of having to concentrate after about 20 minutes of running it. Note that "concentrate" doesn't mean "struggle." You should be able to run maybe 40 minutes at the chosen pace before you start to experience the kind of labored, maxed-out-at-this-pace feeling you'd get in a long-ish race of 20k or thereabouts. Alternatively, you can run a bit slower and go significantly longer than 20 minutes before you even reach your respiratory compensation point, perhaps picking up the pace near the end to provide some stimulus for improvement at the faster pace. That's a good plan for a "tempo" run of 5 miles or longer. Going "x minutes at y pace" before exceeding the RCP is just a contrived formula based on average values, and no one should be a **slave** to it, although it is pretty accurate if the workout conditions are identical to the treadmill test conditions when the RCP was found.

... but don't try to train as if a 31-min 10k runner already.

Amen to that. If you're currently in 32:00 shape (or slower), your default rhythm at "threshold" pace will certainly be below (slower than) the same pace/effort ratio you will have should you improve your best time to 31:00. But you can still **touch** on 31:00 pace in **some** of your workouts without hypertraining for your current level. That's one thing repetition running (or interval training or what have you) is useful for.

--*-*-*-*-*

Most people are thinking too much. Experience the flow first-hand and you'll understand it.

For the lion's share of "tempo" running, malmo has it sussed. KudzuRunner also has it. It's the kind of running you can find yourself drifting into on a regular daily run simply because it feels so good - provided you have the wherewithall to recognize when enough is enough at that pace and have the discipline to end the run before you start pushing.

The "6-8 miles at half marathon pace" stuff also does serve a purpose (lactate clearance), but these are actually long time trials and are nearly race-level efforts (in a workout atmosphere, they could **be** race efforts), so they ought to be restricted to one every 2-3 weeks.

That "half marathon pace equals threshold pace" rule of thumb came about by fitting a regression equation to values for running velocity and lactate threshold using graded exercise testing. I've calculated this myself with a number of runners and determined that **ventilatory threshold** corresponded to the extrapolated pace the average runner could sustain for 1:03:47. Ventilatory threshold is easier to gauge since it has a more precise definition than "lactate threshold," which is difficult to measure because it's a sketchy concept in the first place. Of course, measuring the pace at which ventilatory threshold occurs still depends on the test protocol; furthermore, no test protocol of less than 30 minutes on treadmill will really tell anybody how long that particular pace can be sustained in a real race on pavement. So it's all guesswork in the end and you might as well go by feel instead of looking for a specific formula.

The "tempo runs are 20 minutes long" concept apparently stems from the fact that most runners seem to reach the respiratory compensation point after around 20 minutes at whatever their particular "threshold pace" is. The respiratory compensation point is significant because it's basically a good marker for when the struggling has started. Again, assigning a precise value to "threshold pace" is iffy and largely depends on duplicating the atmospheric conditions, GXT protocol and pre-test rest state present during the laboratory test. For "tempo" runs, you might as well just do the damn things by feel. Notice, however, that virtually all of these GXTs start at a crawl and allow runners to somewhat stabilize systematic functions at each stage (basically, they get to warm up gradually); hence, the "graded" modifier in "graded exercise test." That's one thing you should remember whether or not you're going to use a pace chart to find your tempo pace. Don't simply run the regression equation-generated pace from the get-go. Just let the pace

happen most of the time. The fitter you are, the more sensitive you'll usually be about **where** the floating stops and the pushing begins, and experience will give you a better handle on how much **orthopedic** (impact) stress is just right for each day, so you can continue building yourself up rather than tearing yourself down without realizing it until it's too late.

If you learn how to tell where the true "tempo" pace stops and the "pushing yourself" pace begins, you'll be able to touch on this pace regularly and will become a pretty good judge of how much duration is just right for each day that you do touch on this pace. Note that the duration can vary - it doesn't have to be 20 minutes - and the pace itself will vary depending on weather, increases in fitness over time, recovery state, and so on.

On a true tempo run, you're just going with the flow. You can push it at the end (or anywhere in there) if you want to, but experience will teach you how to be smart about how often to push it and what to do in the ensuing days to ensure you keep building rather than breaking.

***--*-*-*-*

These [the aerobic, anaerobic, and lactate thresholds] are all just ways to objectively measure a state of effort or measure the contribution of various substrates (stored fuels) or energy pathways. State of effort can also be sensed subjectively. If you want to rely on a physiological marker for "tempo" running, the nearest one to optimal is the respiratory compensation point. Basically, when you're hyperventilating, the work demand is "driving" the ventilation up quickly rather than the ventilation being constant or rising slowly and uniformly subject to your conscious control. By the time you're hyperventilating, you're no longer in "tempo" mode.

Experiencing that crossover from weightless flying to effortful pushing can eventually help you sense the rhythm that will keep you from crossing over. Then you only need to trust it is smart to stay on the safe side most of the time and have the willpower to hold back when you need to, which is sometimes hard to do when you're in great shape and feeling really good all the time. It isn't bad to let it rip sometimes, but doing it too often can backfire before you become aware of it.

The guys who say "just run, baby" have almost put it best. A good "tempo" run should be something you do without trying to do it.

At some point if you just keep running at the same intensity all the time, you will not stress and overload the system to improve whatever aspect you are looking to do.

Ergo, the need for periodization and a workable recipe, which includes not only ingredients but doses and timing. You must know which stock to choose, when to boil, when to simmer and when to cool, when and how much of each ingredient to add, when to stir, when to congeal and when (and with what

compliments) to serve the finished dish. These are things laboratories cannot test. Analysis of each ingredient can be interesting and may have a few implications from time to time, but the total experience of running is discovered not in any number of short-term studies or in any "schedule of the issue," but from many seasons spent on the roads, the trails, the hills, the fields and the tracks.

A version of the Yerkes-Dodson law applies in running; i.e., continual stress levels that are either too low or too high result in poor performances from both a physical and psychological standpoint. You may choose to insert some race pace work into your running throughout the year, but you cannot maintain peak fitness very long, let alone continue to apply increasing stress in any number of areas and hope to receive continual benefits, so you will be wise to vary the amount of attention given to race pace work. Otherwise, something has to give lest physical stress overloads and mental freshness deteriorates. This is why periodization is paramount to integrate maximum function of endurance with speed and to coincide peak physical preparation with peak enthusiasm.

--*-*-*-*

Yes, it turned out he [George “malmo” Malley] did have a fair share of talent, but it took a certain level of commitment and work and a certain time frame before the underlying ability was manifested. Most people have more talent than they think they have. Unfortunately, they also think they're working hard (or intelligently) at it when they really aren't. And some work hard for awhile but don't stick with it long enough for their true ability to come to the surface. Hence, the saying "The harder I worked, the more talented I became." There are hundreds of potential sub-8:30 steeplers and sub-60 20k runners out there who simply aren't producing it because they either don't know how or they settle for less or they give up too soon.

--*

The athlete with the max VO2 of 78 wasn't born with that value. It's more likely his hard work raised it to that level from the 60 he once had, which would make him equal to the other runner had he not worked to raise it. Of course, if those two runners have been working equally hard and have equal determination to perform their best in competition, the one with the higher test values probably - not definitely - has the advantage at this point in time. Or maybe, just maybe, the one with the lower value at present will require more time for his hard work to take effect. Running economy can continue to improve after many years of consistent work, and some athletes continue a steady rate of improvement in performances while the high school and college stars level off or fade away. There are a lot of those "60"s out there who could one day be "78"s but aren't doing what it takes long enough to find out.

So malmo's point stands: he was 41st on the high school 2 mile list for his senior year, yet how many runners ahead of him on that list ever ran 8:21 for the steeple or 1:01 for the half marathon? He was working hard in high school, probably harder than several of the sub-9:00 guys that year, but he was slower to reach his real potential. Some runners would have given up on working any harder or would have consigned themselves to staying 41st among their peers, but he kept plugging away at it and finally popped some elite performances. Several guys reading this might be 9:10 high school 2 milers. They need to know that just because a guy runs 8:45 and 10 more break 9:00 their senior year, they should stay

determined and focused on making the most they can of their abilities and they could very well find their consistent daily grind leapfrogs them past most of the runners who were ahead in high school. Of course, there's no guarantee of that. It's more likely the fastest guys will stay near the top, but one of those 9:10 guys could be a future American Record holder who is still making steady deposits and will make the big withdrawals when it counts most later. And that guy won't find out by not continuing to work for it. Wasn't Dan Lincoln a 4:17 high school miler? Steve Scott?

--*-*

No, I didn't miss that point. I'm just making a different one. Even if everyone did ultimately rise to their genetic ceiling through the right combination of hard work, rest, nutrition, etc., some people would do it sooner and others later. We think of the "talented" people as the ones who do it sooner or with less initial work, but the truth is that you may have that kind of potential and will never realize it without a couple of hours per day of methodical work, day after day after day for many years. Conversely, the chances you will ever reach your potential without that kind of work are very slim.

--*-*

"Tempo" refers to pace or cadence.

"Steady state" refers to metabolic indicators and to sensation of effort.

A run which is done at a basically constant pace and with a generally consistent (or with only a slowly increasing) effort (or heart rate or respiratory rate, etc.) can be classified as both a tempo run and a steady state effort.

By strict definition, "tempo" refers to rhythm or rate and comes from "tempus," meaning "time." So most people envision a tempo run as falling within strictly scripted parameters, perhaps at a certain pace (like "one hour race pace") or heart rate (like 87% of maximum). But malmo is referring to a more spontaneous rhythm that your body will naturally slot into once you're warmed up and when the running is easy. Lydiard always called this a "high steady state" of effort, or "effortless effort." This is the kind of thing you could touch on nearly every day if you didn't plan in advance on doing it, as long as you're recovering fine. It's still pretty easy effort-wise, even though it's at the fast end of easy.

You shouldn't run 25-40 minutes at "one hour race pace" all the time, but you can do it twice a week with no problem if you recover between efforts, or you can touch on that same feeling for 5-15 minutes at the end of an "easy" run more often than twice a week. Notice the word "feeling" as opposed to "pace" there. When you put a stopwatch on a tempo run so that pace is the goal, it should be approached as a real workout - a hard day - but you can feel really good at that same pace on some easy runs and not only get away with running that pace for a short time, but benefit from it.

Of course, the "high steady state" pace itself will be different from day to day depending on weather alone, not to mention other recent running you've done or how well you've hydrated or allergies or jet lag

or whatever; hence, the importance of knowing that "tempo effort" just as well as you know when you're thirsty. You also have to be in tune with your own recovery abilities. This will prevent you from being prodigal with your effort when you feel really good.

Getting in tune with the feel of a true "high steady state" is one of the signs you're arriving as a runner.

As far as those long runs go, you ought to be running what for you is "high mileage" before relying on the long run as a staple. If you're already accustomed to a routine of regular high mileage, the long run with a slight increase in pace during the last half is one of the best tools in the shed. But you do have to be doing the other things right first. Relying on the long run as your lone Ace in the hole means you'll have to hope to catch another Ace on the board.

--*-*

The best indicator [for 10k performance] is some sort of controlled time trial of about 6,000-7,000 meters. If you can run on goal pace (3:12 per k) until 1,000 to go and can roll under 3:00 for the last k in a 6k or maybe 3:05 at the end of a 7k, you should be money at a 3:12 average pace in the race, given similar course and weather conditions. People can have different recovery needs from time trials like that, so the trick is to do it near enough to the race to still be a reliable indicator but not so close that it only serves to make you tired for the race if you push too hard on it. Some people could run great 5 days after a 7k time trial and others would be cooked from a 6k time trial 7 days out.

Workouts you do near 10k race pace one week out won't really improve any aspect of aerobic fitness for the race. Those improvements take about 9-14 days to kick in post-workout, so a super hard, fitness-improving hard workout, like a bunch of 1,000s or half that many 2,000s, ought to be scheduled about a week and a half to two weeks out. Some people need a fairly hard effort only a few days before a goal race, but there aren't improvements from that so much as the effort maintains carbohydrate metabolism, plasticity in the vascular system, neural control, etc. Those people may feel flat or bloated or uncoordinated if they don't do something reasonably hard close to the race to get the heart, lungs and legs working just long enough to feel like they're still in sync a few days later. Other people run their best with their last "hard" day over a week out, with just a few strides for coordination in the last week. Some can - and need to - keep their regular mileage near peak all the way up to race day. Some have a gradual mileage reduction plan during the last few weeks. Still others run best with several days completely off before the race. You have to experiment with that stuff, along with water and food intake in the last few days, to get it right. Even then, tapering isn't 100% predictable.

--*-*-*-*-*-*

Some from column A and some from column B. Even if proper fluid/electrolyte balance is maintained, the combination of heat and strong running can divert blood flow away from the digestive system, triggering an unsettled, nauseous state. When gastric emptying is that slow, thirst isn't fully quenched, so the tendency is to gulp extra fluids, which can often make the problem worse. Finding the proper balance

of water and electrolytes, taking the right volume and temperature of fluid at each stage of the race, and keeping the body as cool as possible by regularly dousing with cool water (especially over the top of the head) can reduce nausea during hot weather races. As usual, it's better to experiment during training runs if possible instead of waiting until race day to try something out for the first time.

--*-*-*-*

To optimally work any given "system," you need to spend a certain amount of time at the requisite pace, which somewhat precludes **fully** working all of those "systems" in the same workout. But you can certainly **touch** on several different speeds/systems in the same session. If your main aim is to run a somewhat aerobically challenging pace, you probably want to limit the amount of time you're spending at speeds which would lower the blood pH. You can **briefly** lower the **muscle** pH near the very end with a positive result (this can even be done at the end of a continuous "progression" run), but getting a strong aerobic effort **and** an intense, tying-up effort in the same workout isn't usually as productive as waiting for another day to do the intensity.

You might say a hard continuous pace followed by some really intense work better simulates a real race, but just because you **can** do something (i.e., simulate a race) doesn't necessarily mean you **should** do it, at least not very often. Most workouts should leave you feeling like you could do more and do it faster without any form breakdown or other altering of smooth stride mechanics.

An example of a session that involves a strong aerobic effort and some work at a variety of faster speeds might look like:

Progressive warmup of 12-20 minutes
Drills optional
4-8 short strides of 10-15 seconds
12-15 minutes progressing from a comfortably fast aerobic pace (about 1:30 per mile slower than current mile race pace) to a stronger pace (about 1 minute per mile slower than mile race pace for the final 3-5 minutes)
2-3 minutes recovery (walk/jog)
Repeat 12-15 minutes as above, finishing a little faster but keeping it pleasantly challenging
2-3 minutes recovery
2-3 short strides to familiarize with the pace for the upcoming 1,000s
3 x 1,000 (or 3 minutes) at roughly current 5,000 race pace (maybe 30 seconds per mile slower than mile race pace?), with 2 minute recovery periods between each segment
4 x 200 (or 30 seconds) cutting down from mile race pace to 800 race pace, with 1:30 recovery periods between each rep
(1 x 400 at slightly faster than mile race pace or something like 3 x 300 "accelerations" with 2 minute recovery periods could be substituted for the 200s)
12-20 minutes jog
Calisthenics/weights optional

So a 4:12 miler might start the aerobic segments at 5:40 something per mile for a few minutes and finish the first rep in the 5:10-5:15 range for a few minutes and close the second rep with about a 2:30 half mile

or even a 5:00 mile if that wasn't a struggling effort (those speeds might even feel too easy for a 4:12 miler who was a good longer distance runner, and the pace could be adjusted accordingly to get the right feel). Then the 1,000s would be run at about 2:55 to 3:00 each, with the last one being the fastest. The 200s would be done at roughly 32-30-30-28 (or 1 x 400 at 60-ish or a few 300s with 18-16-14 for the 100s).

The bulk of the workout is in the longer stuff, so there isn't a huge need to run up to 5 x 1,000. The overall energy requirement of the 3 x 1,000 plus the stuff at mile race pace or faster should be akin to adding a third 12-15 minute segment at least as fast as the second segment was. The faster pace will require more immediate focus and will elicit a different feel, but the effort should be commensurate with the distances involved and should not be excessive.

This is a good generic late preseason workout involving roughly 70-90 minutes of running and can be used as a medium-intensity maintenance session at any time, even during the middle of a non-competition phase, although the absolute speeds involved (such as "current mile race pace") will almost certainly be quite a bit slower that far removed from competition.

--*-*-*-*-*

EPICLULZ wrote:
I'm mainly asking if training like this for EVERY workout would be better than your standard split of 1 R workout, 1 I workout, and 1 T workout.

Not for every workout. There are times you want to get a certain number of minutes at a given effort intensity in order to create a viable stimulus for improvement. All the factors involved in performing effective workouts vs. hypertraining, whether they be substrate utilization, orthopedic stress, changes in muscle or blood pH or secretion of pro-inflammatory cytokines, restrict the amount of time you can spend at each particular exercise intensity and certainly limit the ability to spend an optimal amount of time training at **all** exercise intensities in the same workout. To run enough reps of 1,000 meters to effect the maximum positive change to the particular combination of energy systems which contribute to running at 5,000 race pace would eat into the workout time that needs to be devoted to training at 800 or mile race pace to deliver the optimal stimulus for those systems.

Most medium-intensity or hard workouts can involve some **short** speedwork before and possibly after the meat of the session. Just make sure you aren't putting **so much** variey into each and every workout that it detracts from the main purpose of the session or forces you to go overboard in terms of added stressors just to spend the optimal duration at the principal pace. If you were working to achieve a high stroke volume and to enhance expression of MCT proteins (among other effects associated with traditional "VO2max" workouts), you'd want to spend 15-20 minutes at about 3,000 race pace (with a workable combination of run durations and corresponding recovery intervals). This in itself would be of such high intensity that adding a 20 minute "tempo run" or 6-8 x 400 at mile race pace **on top** of it would do more

harm than good (if you could even accomplish it).

Touching on several different speeds/efforts in a workout is fine sometimes, but **some** workouts should be devoted to spending the optimum amount of time to improve **specific** physical systems peculiar to certain race distances, and piling additional work on top of that is either unfeasible or counterproductive because of excessive stress.

--*-*--*-*-*

It looks like malmo got it. If you're doing 45 miles a week and think slogging out a weekly 20 miler will make up for not doing 90-100, you might as well stop at 12 and spend the the other hour peeling potatoes.

Maybe, maybe, maybe if you want to half-ass a marathon and for whatever reason can't or won't do more than 45 miles a week, then sure, you probably need to work up to a 20 or two in there somewhere just to prepare you in the short term for what you'll be in for. But at 45 per week, you haven't acquired the physical characteristics to benefit any more from a regular 20 than from a regular 12-13. It's like eating one stick of celery 6 days a week and deciding you need a giant vat of spaghetti and meatballs on Sunday because you think calories equal nutrition.

Long running probably won't activate the fast twitch unless you pick up the pace near the end. But long runs do make your body "search for energy," as you put it. By accessing glycogen in all the fibers, including the fast twitch, you create oxidative adaptations and glycogen storage capacity in the fast twitch fibers without having to actually activate them for movement. That has to do with why 20 mile runs aren't a lot more use than 13 mile runs for the 45 mile per week runner but they will be for the 100 mile per week runner. As you adapt more to regular depletion through higher daily mileage, you'll experience a "glycogen sparing" phenomenon, requiring longer runs or a faster pace throughout to achieve the same stimulus. You also access liver glycogen during long runs, but liver glycogen primarily provides glucose for brain function, while skeletal muscle glycogen is accessed for muscle movement.

--*-*-*

Just from eyeballing it, I'd bet tons more kids went around barefoot in the 1960s and 1970s. They probably had a more powerful toe-off and were less injury-prone by the time they became runners. They might have needed that foot and ankle strength, though, because running shoes were pretty low tech at the time, they wore out quickly, and they had almost no variety in weight, sole thickness and motion control.

I'd also bet the average kid was in better aerobic shape and had better coordination before starting organized sports.

Fast foods and simple sugars are more prevalent these days, which means the general population probably isn't as healthy. Serious runners might be, but it's probably a little more likely they let good eating habits slide now vs. then.

Footwear has changed and there are practically no dirt or cinder tracks left, factors which have to have

some bearing (who knows if it's for better or for worse?) on stride mechanics and possibly running longevity.

--*-*-*-*

Roccer wrote:

I've been running for 10 years now, and the more I think I know about my training, the more I realize that I don't know how to get it done. I can read all the books and training logs and message board guru treatises on how to be fast, but in the end I still catch myself trying to do everything at once and getting nowhere. I know that to get where I want to be, it will take time and consistent effort, but it is so easy to give up on the bigger goals and settle for smaller ones that don't require as much of a commitment.

This illustrates a very important principle: When laying groundwork, don't fall into the trap of adhering to a rigid schedule. General conditioning should be more loosely structured and should be given as many months as necessary. You cannot cover all your bases at once and you cannot get in your best shape in a few short months punctutated by numerous races, most of which are intended to be low-key but which invariably assume immediate importance.

You must come to enjoy the process itself, not only the end results. I like the saying "Training is your wife; racing is your mistress." You live to run for its own sake and presevere through both the good and bad spells, occasionally going off for an exciting fling with competition, but you always return to your day-to-day routine. As bland as it may seem to non-runners, and sometimes even to the most dedicated runners, this routine, and your commitment to it, provides a steadier source of joy than the racing results ever could.

This was a huge characteristic of the runners of the 1960s and 1970s. They had races as goals, but their main goal was to get better at running so they could better enjoy the act of it. This was the underlying purpose of and commitment behind nearly every day's run, and it was never forgotten due to the fact they ran because it was who they were, not only because it was something they could do well. The focus now (at least among younger runners - the pros might be another story) is more on the immediate results, and growing as a runner is just something which is assumed should happen. This isn't a physical difference, of course; it's more one of attitude, but in the old days, even high school runners lived the runner's life and harbored the same runner's spirit that the elites had. Perhaps this grew out of those long play sessions nearly every kid enjoyed back then. They played and ran free, stopped when they got tired, then started playing or running some more until they got better at running without doing a single pressure-packed or goal-oriented "workout." As they matured to adulthood, running remained a love and not so much a job.

--*-*-*-*-*

D1runner? wrote:
6x200 in 27 secs to 28 secs
2 to 3 mins rest

There isn't anything wrong with that as a preseason workout to be done once every week or two. I know two sub-1:45 runners who used to do stuff exactly like this as medium speed turnover work when starting back into preseason stuff after taking some down time and when working on their fundamental endurance fitness. Their speed would get faster though - down to about 24-25 for the 200s once they got ready to start really hard workouts.

As a staple workout for the competitive season, you're right - it probably won't prepare you to run your best race unless you're about a 2:04 guy hoping to crack 2:00. If this is the hardest and fastest stuff you do, you'd probably run just as fast for the 800 by playing basketball during your workout time.

--*-*-*

Yep. Many aspiring runners need to do a lot less reading and nitpicking over ever-changing terminology and do a lot more running. That's how they'll get the fundamentals figured out.

"Lactate threshold" may or may not refer to a precisely measurable instant or quantity of lactate produced, but if you can dial into your own "maximum steady state," that fastest speed which feels spontaneous and weightless and which is the effort level which "lactate threshold" attempts to pinpoint, you know all you need to know about that aspect of developing fitness.

BTW, blood lactate measurements are still an extremely good objective method for identifying this effort level, which is undeniably a significant effort level from a cost/benefit standpoint, but subjective methods are more viable (less expensive and non-invasive) on a workaday basis. You could correlate lactate values with heart rate and use a pulse meter to control your workout pace or race execution, but developing a consistent and reliable RPE will serve you better anyway, since weather and terrain may factor into the picture and cause lactate values and heart rate to fluctuate during the workout or race.

For "VO2 max" work, the race pace of many commonly contested track distances (those requiring 7 to 13 minutes to complete) will fill the bill. That's a broad enough spectrum of speeds to provide plenty of variety in workouts if you want it. Getting familiar with your target race pace is always a good idea in any event ("event" meaning both "circumstance" and "race distance").

--*-*--*-**-*

Whether or not there is a precise LT, a runner can certainly tell the difference between relaxed and pushing. With practice, you can physically sense the point at which you exceed your maximum steady state. If you're in good shape, you can sometimes feel that division of effort intensity to within a second per mile of pace change. Learning that feeling is more important than relying on lactate measurements, although some people seem to have trouble feeling it as a distinct moment, so using lactate values or pulse rate can still be useful if a particular state of effort is desired.

Lactate is like an anemometer inasmuch as it is an indicator. A wind gauge itself doesn't blow things around. The wind does. And you can tell by standing in the open whether it's calm or windy without having to look at the vane. But the gauge can let you know from an indoor location pretty much what to expect when you step outside. In the same way, lactate doesn't directly cause struggling or tying up, but measuring it can give a good idea of how close a runner is to a laboring state or tying up.

--*-*-*-*

The most important things in 800-3,000 are finishing place and finishing time.

"Lactate threshold" may not be recognizable as a precise instant (unless you want to use the arbitrary 4 mmol value to define it), but other terms which use physiological measurements to indicate the same (or nearly the same) state of effort do have precise definitions and can be pinpointed.

"Lactate tolerance" should probably be renamed "H+ buffering" to stay in step with current ideas about the role of lactate in exercise.

"Lactate clearance" may still be apropos under the current line of thinking.

"VO2 max" only tells you how much oxygen you are capable of consuming to perform work; it doesn't tell you how fast you can run. There is a general relationship between VO2 max and performance in endurance sports, but VO2 max can't predict performance with enough accuracy to say "this is what we need to work on."

--*-*-*-*-*-*

You're doing both at the same time anyway. Any race pace can be expressed as some percentage of VO2 max pace, which is itself an estimated figure arrived at by extrapolating outside the range of collected data.

If you want to work on your goal race pace, do repeats near that speed, rest just long enough until you're ready to go again, and call it a day when you can sense doing more wouldn't be any better, maybe adding a few faster 200s or something at the end to become accustomed to finishing quicker and to activate different muscle fibers and a different energy system.

Once you have a huge running background, your body becomes sensitive to all these things anyway, as well as sensing how this type of workout fits in an overall schedule. So by fine-tuning your own

perceptive abilities, you won't always need to exactly follow a written workout plan at x% of y pace with z rest to get the effect you want.

--*-*

In addition, consuming oxygen isn't the only means of producing energy for muscle movement. An athlete can have a relatively low max VO2 and can process lactate very well. If running economy is evaluated by measuring VO2, the results won't necessarily show **why** the runner is using less O2 at any given speed. It could be due to a short amortization phase (an efficient "stretch shortening cycle") or due to rapid stride cadence or due to a high ability to use lactate as a fuel or due to some combination of those factors. Runners can therefore use their "engines" in different ways.

--*

Evaluation of the lactic acid produced and the oxygen saved by anaerobic glycolysis indicates an energy equivalent of approximately 220 calories per gram of lactate formed. You can do the math to determine how that relates to the caloric demand of aerobic energy production. The respiratory exchange ratio usually gives an idea of the percentages of the substrates being used at any given time, but this is somewhat based on estimation, since not all the work is being accomplished via O2 consumption. Some of these figures might not be exact, and only an invasive method would shed better light on it.

Anthropometry doesn't show many significant structural correlations to running economy, so it's more likely the principal musculoskeletal or neural contributions to economy are more along the lines of reducing the dissipation of energy between the eccentric and concentric phases of muscle movement, from the activation threshold of the Golgi tendon organs, and from sychronization of firing rates of motor neurons.

--*--**-*-*

You usually want to be warmed up well but still fresh enough to retain good form and be able to stay relaxed. Relaxation and proper execution are important, so be physically and mentally sharp when you do drills. This means you'd normally do drills **after** a progressive warmup of slower-to-faster jogging and **before** the main portion of a workout. If you're going to do a hard running workout following the drills, add a few more short strides following the drills to readjust to a range of motion and recruitment pattern specific to running and to establish a probable starting pace.

Don't do drills when completely fatigued from hard track work which causes you to tie up or immediately following an easy run which keeps you at a restricted pace and limited range of motion for a long time (unless you do a few progressively faster short strides after the easy running and feel good doing them).

An exception to the "early in the workout" rule can be made in the event you're doing a workout consisting of several sets of short strides. In this case, explosive drills (but not static, strength-focused drills) can be added prior to the final set of strides. Some degree of additional concentration will be

required to perform the drills following so much prior running, but if you haven't tied up or experienced form breakdown, you should benefit from the added concentration requirement, since this will force you to summon a wide spectrum of motor neurons.

The stage of training should also dictate which drills you emphasize. The resistance-oriented drills which target absolute strength and minimizing the inhibitory effects of the Golgi tendon organs should be stressed during the preseason and should gradually be phased out in favor of explosive drills which target reducing the "electromechanical delay" and improving neural coordination. Addressing static strength first provides a more suitable framework for the "speed-strength" to come later, since rapid movements can only be as explosive as overall joint integrity will allow.

--*-*-*

Of course you shouldn't focus on drills to the extent they become a replacement for running. Running is the best exercise for getting better at running. In fact, short sprints (up and down hills and on level surfaces) can effect almost every change the explosive drills can effect; moreover, sprints are vastly more running-specific. You should include short sprints at times. But drills can be a helpful part of a dynamic warmup routine. They require different recruitment patterns and distribution of impact, so (if properly applied) they provide refreshing changes to normal forces to the legs while still allowing you to warm up and get in some exercise that can train you to reduce the time you spend in your plant phase.

In addition, the different combination of neurons activated and the variety of forces encountered can be helpful in injury prevention; for example, if you suffer a misstep while fatigued, you may be better able to withstand the unfamiliar stress or immediately and subconsciously correct for it mid-step. Summoning new recruitment patterns can also manifest itself in races which feature sudden pace changes. Faced with sudden physical stress when already fatigued, it's often difficult to make good decisions (or enact them if you do decide to make them), so the introduction of a variable set of neural patterns to your protocol can be of benefit (unless the time spent on it eats into your acquisition of basic running fitness, of course).

I'd say running drills are at least as important as stretching and calisthenics. You shouldn't expect to become a better runner by stretching alone, but you shouldn't completely avoid it. Likewise, pushups, pullups, ab work and other upper body exercises won't make you a good runner by themselves (otherwise, gymnasts could hop straight off the pommel horse and be good distance runners), but people who are muscularly weak normally have less vigor, stability/balance, posture and basic health than athletes with reasonable muscular fitness, so you don't want to be a grade A weakling. Flexibility and upper body muscular strength should be afterthoughts for runners, but they shouldn't be **non**-thoughts. Neither should drills.

--*-*-*

If you're doing really intense stuff some days, definitely go as slow as you want on the other days, but make a point of keeping a decent stride cadence even when you're jogging so you don't start to adopt a longer plant phase, which is uneconomical.

If you are not adding any hard workouts to the mix but are just building general fitness, try to find a default, repeatable pace which provides some stimulus but which you can run nearly every day while feeling somewhat tired most of the time from doing it so much but without actually going over the edge (this could take some trial and error, but start out on the easy side of things). If you're a sub-14:00 5k runner, doing an hour (or probably even 2 hours) at 8:00 mile pace every single day in the off season probably won't give you a new catalyst for improvement in any area. Either your default pace will have to get faster naturally or you'll have to do some sort of regular "workout" to provide a spark.

If you're extremely experienced, you can also use that default pace at the end of an easy day even when you are doing hard workouts, as long as the pace just happens because you feel really good, not because you consciously try to hit a certain pace. This is risky if you don't have a good handle on when to back off, because you may be like Icarus and fly high for several weeks of this and not realize at the time that you're just foolishly taunting the running gods and that you'll be paying the price shortly.

---*-*-*-*-*

Dilutional pseudoanemia, footstrike hemolysis (a.k.a. march hemoglobinuria) and heme iron deficiency have been mentioned, but intestinal bleeding due to thin or easily irritated digestive tissue, coupled with mechanical friction to the intestines from repetitive pounding or torso twisting (and oxidative stress from intense training), can sometimes contribute to severe anemia in runners.

Other stressors, such as insufficient sleep, pressure from schoolwork, vitamin deficiencies, frequent travel, reduced hours of daylight, etc. can trigger high cortisol, temporary reduction in testosterone (or other hormones) or neurotransmitters, or other subtle factors which contribute to poor mineral absorption or hemoglobin production, allowing incipient anemia to spiral out of control, especially when exacerbated by hard training. Vitamin B deficiency has been associated with low hematocrit, but lack of vitamin D brought on by long periods without sunlight (as in Northern winters or rainy seasons in traditionally cloudy areas) is being investigated as a possible contributor to anemia in athletes. Runners should habitually eat healthy foods, including some animal protein, and supplement with multivitamins. Establishing baseline blood values for regular reference is also advisable in cases of past history of anemia.

-

--*-*

Bongo players have also suffered from hemoglobinuria, which seems to indicate erythrocytes were ruptured in the hands and fingers. The common term "march hemoglobinuria" arose from armies whose soldiers were experiencing crushed red cells being passed through the urine. It was postulated that day after day of marching was responsible, although a bland diet and other stresses of army life could no

doubt contribute to the problem. If diet is a factor, perhaps cannabis is in part responsible for the phenomenon in the bongo players. If so, Maynard G Krebs had to have been chronically anemic.

--*-*

There are two simple workouts totally devoted to 200s that can be helpful for middle distance runners who gravitate toward shorter rather than longer distances. Both of these should be done with the good old "date pace now, goal pace later" mentality as the season progresses. In other terms, this can be thought of as "general conditioning" early in the year, with attention more to feel and less to absolute pace (just getting in some "going through the motions" introductory work), then morphing the effort toward "spec work" (race specificity) as the competitive season gets underway.

You should be doing **short** (10-15 seconds) buildups or even-speed strides on a couple of days each week even during the deadest time of the year in order to retain neuromuscular coordination for decent speeds and to keep your plant phase time short so you don't slip into lazy mechanics. This will make anything involving middle distance speeds much easier to transition to when required.

1) 15-25 x 200 mostly 1-2 seconds per 200 slower than current all-out 1,600/mile pace (starting slower and getting faster as you go), with a 100 jog in the same time between 200s.

If you can run around 4:16 for 1,600 at present (32 pace per 200), you'd probably do the bulk of these 200s in the 33-34 range, going straight into a 100 jog in 33-34 between each 200. If you're at 4:40 for 1,600, the pace would obviously slow down to the 36-37 range. If you don't have any idea what your current mile pace is, feeling should definitely trump pace. The first couple of times this is done, just "take a safety" by running all but the last couple of 200s deliberately on the easier side (and possibly doing fewer reps if you still feel too stressed), then adjust the speeds on subsequent workouts to find a strong effort. Try to jog at an even speed during the 100 recoveries. If the pace for the 200s seems too easy, they can either be run faster and nearer the minimum number of reps (15) can be used or the recovery jog can be slightly faster and up to 25 reps can be run, depending on the desired purpose.

2) 5-6 x 200 at about the pace you would currently run the first 200 of an 800 race with active (walk/jog) recoveries of 2-3 minutes between reps.

If you can currently run 1:52 for 800 (28 pace per 200), you'd probably start your race with a 200 in the 26 range, as it's hard to run your best 800 with even splits or negative splits (though it is sometimes seen, it's rare). If you're in 2:12 shape for 800 (33 pace), you'd probably start off with a 31 or so. This pace you'd open an 800 with is a good general neighborhood for these quicker 200s, which should be approached as 800 spec work (almost a blow-off day in terms of the overall amount of work you feel you've accomplisehd when it's over) and not as full-bore, high-intensity speedwork. As with the other workout, be on the safe side the first time or two you do this one. As you (hopefully) get faster for the 800 during the season, the involved speeds for these 200s will become near-sprints, so the overall effort required for the workout will no longer be as light.

--*-*-*

A time in the mid-44s for 8 miles would normally be an all-out race for a 10:00 2 miler. You probably don't want to run 44-flat as a "tempo" run in a "workout."

A 10:00 2 mile would also correspond to a theoretical "threshold" pace of about 5:42 per mile. Running 20-25 minutes at that pace would be a good stimulus, but a full 8 miles at that pace is still going to put you basically in race mode and negatively affect recovery if you're trying to hold down a typical weekly workout and race schedule.

Assuming the entire 8 miles is to be run at a decent clip, I'd suggest starting off at around 6:15, 6:05 and 6:00 for the first 3 miles, then try to stay steady around 5:55 until the last mile. In the last mile, you might knock off a 5:30-something if it still feels good, with half miles around 2:55 and 2:40 or thereabouts. Your overall average pace for the 8 miles will end up at about 5:57 per mile, which is about 5% slower than you'd probably race the distance.

That's assuming you're just as good at 8 miles as you are at 2 miles (capable of about 44:30 in a race) and that you have been running enough to be comfortable recovering from a day of 11-12 miles (assuming some warmup and cool-down is included). If you're a high mileage, long distance type of runner, that should pose no problem. If you struggle as the distances get longer, I'd say bag the idea of timing the 8 miles at all and just run most of it comfortably with a few quicker miles near the end or instead try a "tempo" run of about 20-25 minutes at 5:40-5:45 pace.

--*-*-*

Of course, in biomechanics (in contrast to finance), the amortization phase is the period between the eccentric loading (lengthening of the muscle while under tension, as in lowering the bar during bicep curls) and the concentric stage (contraction of the muscle to provide acceleration in the opposite direction). The amortization phase features displacement of the active joint, after which the muscle is concentrically activated sufficiently to resist the displacement. Only then can positive acceleration (movement in the desired direction) occur.

The interval during which the concentric muscle tension is initiated is also called the "electromechanical delay." A prolonged electromechanical delay results in detachment of the muscle filaments, which in turn reduces the ability to access the stored elastic energy in the muscle.

Coupling of eccentric and concentric actions increases force output, since the muscle has the opportunity to store more energy and become fully activated. Moreover, a **faster** eccentric loading phase and a **decreased** amortization time result in a more explosive concentric phase.

The aim of drills in improving running economy (using less energy to sustain a given work output) is threefold:

1) Increase the potential of the "myotatic reflex," which is the mechanism by which a muscle reflexively

contracts with a force commensurate with the degree of pre-stretching occurring in the spindles. Traditional alternate-leg bounding or one-legged bounding are good for this. Double-legged depth jumps (using boxes) are somewhat less effective for runners since stabilization of movement is allocated to both legs at once, but they accomplish the same basic purpose.

2.) Minimize the inhibitory effects of the "Golgi tendon organ," which prevents excessive muscular force which could damage the involved joint or connective tissues. Slower movements which involve both eccentric and concentric actions and which feature added resistance (such as lunges steps or one-legged squats) are good for this.

3.) Increase neuromuscular coordination by training motor units to act optimally in concert. Downhill running (@ 2% grade) at top **relaxed** speed is good for this.

--*-*-*

The main benefit of drills is development of a more efficient stretch-shortening cycle, resulting in a quicker amortization phase. Almost all of this is neurological and little to none of it involves muscle hypertrophy.

Correct use of drills should therefore target reducing the dissipation of energy between the eccentric and concentric phases of muscle movement. This should improve the sychronization of firing rates of motor neurons.

Short sprints accomplish most of the same aims. Strike a balance between use of uphill sprints (work up to 8%-12% grade over time) for recruitment (power), level-surface sprints for event-specific work and downhill (@ 2% grade) for rate coding (rapid stride cadence).

--*-*-*-*

Seems like you could use "intervals" for everything but cover all the other bases by doing 3 x 5,000 at a tempo pace with real short rest or sometimes 8 x 400 fast or other times 5 x 2,000 a little stronger than the pace you'd use on something like a 5 mile tempo.

Also, what's long? You could still run fairly long in one workout nearly every day and claim you never did long runs since x miles was your regular daily distance.

If it had to be the same exact workout repeated every time it was supposed to be a strong, hard effort, I'd use something like this:

*****

15-20 minutes warmup with 4-6 short strides of 10-15 seconds

2-4 minutes rest

2 sets of 30 meters rapid high knees

2 sets of 80 meters long, high skips

2-3 minutes rest

4 x 200 at 5k pace, then 3k pace, then 1,500 pace, then 800 pace, using about 1:30 to 2:00 between reps

3-4 minutes active rest (mostly walking with some jogging in the middle to stay loose) after the last rep

3 x 2,400 at 15k pace, then 10k pace, then 8k pace, using 2-3 minutes between reps

3-4 minutes active rest after the last rep

2 x 800 at 5k pace, then 3k pace, using 2 minutes between reps

3 minutes active rest after the last rep

1 x 300 starting at medium speed and accelerating the whole way to a very fast finish

3-4 minutes rest

15 minutes jog

Light stretch

*****

It's a total of about 11 miles of running with just over 10k of strong or fast pace. You could do that every third day with easy running in between and maybe a few short strides at the end of the easy run the day before the workout. If you want to emphasize anaerobic work, go fairly light on the 3 x 2,400 and really rip at least the second (and maybe both) of the 2 x 800 reps and the 1 x 300.

If you do that, you can avoid tempo runs in workouts but cheat by doing some road races where you start slower and finish faster, so they do the same thing as tempo runs only you count them as races.

--*-*-**-*-*-*

How much emphasis you'd want to place on specifics somewhat depends on age and experience, and variety can sometimes result in sacrificing consistency. But as a general rule, you want to run as much as

you can while touching on that "fast end of the comfort zone" as often as you can while being able to sustain the routine for a few months. As mentioned, age and experience are important, if only to find out where your limits are. You might feel good for a few weeks and have the effort suddenly catch up with you without changing a thing. Only running experience can determine that for you, so make this a journey of years and do some exploration.

Not only do you want to avoid falling apart during the summer; you also want to be able to safely increase the speeds without dropping your mileage much at all during the competitive season to follow. A smooth transition to faster workouts and competition is facilitated by maintaining a near-race pace stride frequency even on easy runs, by varying the terrain sometimes, by staying in touch with short strides a couple of times a week and by hitting the "tempo" feel when it grabs you.

By "cv" do you mean the old "critical velocity" term of the 1960s exercise scientists and biologists? Gad, that could have any number of meanings, but it historically has meant the slowest speed that would eventually elicit max oxygen uptake. A rather loose definition, though the term might have been assigned a new meaning. In any case, if you're going to do organized medium-length reps in lieu of a spontaneous "tempo" run in the summer, the general idea should be to briefly exceed your "tempo" pace by 10-15 seconds per mile but take a rest period before you reach your respiratory compensation point (hyperventilating). Rest until you're recovered enough to achieve the same feel again for the next rep, and don't be tied down to a specific pace or distance for each rep in the summer. Let the feeling dictate the pace, duration and rest interval.

--*-*-*-*

Of course it [the LT] exists as a zone. Pinpointing it as a precise value of blood lactate concentration is iffy.

It's kind of like identifying the "blue" region of the visible spectrum. Obviously it exists, but where does "blue" precisely occur - at a wavelength of 450 nanometers or 475 nm or 500 nm? It just depends on which shade of blue you want to label "exactly blue." As far as we're concerned, agreeing on an exact wavelength or shade to call "blue" ought to take a back seat to being able to recognize the basic color of blue from its neighbors, green and violet. Same deal in running. A runner should be able to recognize by effort when he's entering the basic zone in which the "threshold" somewhere lies.

If a guy said the color blue didn't exist, we'd know right away he was either totally blind or unable to distinguish blue from any other color. And when we see a wall painted with a color in the blue region of the spectrum, we don't think, "Oh, look at that 495-nanogram-wavelength wall over there!" We just call it blue without really thinking about what kind of quantitative definition "blue" ought to have. Being able to recognize the color of the wall in the first place is the idea. Knowing off the top of the head what wavelength of light is being reflected off it doesn't change the look of it one bit.

Since shorter wavelengths are more penetrative than longer ones, blue is a more intense color than green, but isn't as intense as violet. Ultraviolet or shorter wavelengths are potentially damaging to human cells. Carrying that analogy over to running, the entire "aerobic spectrum" is like the visible spectrum, which is comprised of wavelengths from about 400 nanometers (violet) to 700+ nm (red). Jogging might be

somewhere in the "red" end, while extremely high-intensity aerobic work (near max VO2, which also requires a significant anaerobic contribution if sustained) is at the other end, near ultraviolet. The "comfortably fast" aerobic efforts lie in the green and blue regions, with the "threshold zone" somewhere in the blue. It doesn't matter what exact wavelength it occurs at, but it does matter that you can recognize a basic shade of blue when you see it. As a runner, you'd like to be able to tell when you're crossing from the softer green zone into the strong blue zone and you should learn how it feels when you get into the more intense violet zone so you can figure out what shade of blue is the right one for you to look at more often without "damaging your eyes." Precisely identifying a wavelength value for "blue" is just mentally punching the clown.

--*-*-*

The greater force requirement involved during uphill running will necessarily enlist more of the larger motor neurons (which innervate the Type II fibers). Changing the entire nature of a muscle fiber through training is unlikely; a more likely result is that many of the muscle fibers will acquire some (but not all) of the properties of their Type I counterparts if they are subjected to sport-specific stimuli of sufficient duration.

I wouldn't be as concerned with what is happening at the cellular level. Even if you understood **every physical process** that occurs when we run at X pace for Y minutes (and no one does as yet), you still wouldn't be able to maximize all of those variables at once. Something has to yield; hence, there must be balance. There are times to run slowly, times to run with medium and steady effort, times to run fast, times to run long, times to run uphills or downhills, times to run on the road, trails, grass or track, and seasons and times of life to emphasize some of those aspects over the other aspects. This is far more an **art** than a **science**, and as a runner, it is far more important that you know **what** works than knowing **why** it (theoretically) works; otherwise, you will be swamped by trying to micromanage your running as a slave to often incompatible or contradictory "scientific" principles which **cannot** be applied all at once. Runners, not laboratory scientists, develop the art, and the best vantage point for viewing the paths you might follow is the one you will have if you stand on the shoulders of your running predecessors.

To illustrate that there are more processes at work than the acquisition of Type I fiber properties by Type II fibers, consider just **two** of many effects wrought by doing sustained uphill running:

Since uphill running, even at slow to medium speeds, necessitates more gross motor unit mobilization than level-surface running at the same speeds, and since it involves nearly all of the same recruitment patterns, it is ideal for use as "absolute strength" work within a running context. Absolute strength in a sport-specific context has the effect of overcoming the tendency of the "Golgi tendon organs" to inhibit the movement of joints which are under high stress. This general resistance training will provide the framework for more "explosive strength" work to be done at a later stage. Explosive work (within the same sport-specific context) has as one of its principal effects an increase in efficiency of the "stretch-

shortening cycle," which in running is a major contributor to reducing the energy cost per footstrike.

Additionally, since muscle contractions are held longer during uphill running, the intramuscular pressure - and, by extension, the vascular resistance - is greater, which places more demand on the heart as well as on the prime mover muscles.

While there is also less impact stress per footfall during uphill running vis-a-vis level-surface running, those sustained muscle contractions also provide potential drawbacks to long uphill running, to the tune of prolonged time spent in the plant phase as a result of requiring longer to bend and unbend the knee and ankle joints on the hill. This shouldn't pose a problem unless you spend a majority of your running time in hills, but it's something to be mindful of. You don't want to rely exclusively on uphill finishes to long runs when a simple progression of pace on flat terrain will also accomplish many of your aims, targeting the muscle recruitment patterns used in level-surface running (and involving Type II units specific to that activity).

--*-*-*-*--*-*-*

[Re: If Tim Noakes' "Central Governor" Model is Correct AND there is NO Lactate Threshold, HOW should this effect my training?]

Similar question: If the Sun and all the stars aren't really revolving about a stationary Earth, why did the ancients rely on the motions of the Sun and stars (relative to the Earth) to help them with agriculture?

Answer: Their conceptual **model** wasn't entirely accurate, but their **results** were exactly the same as they would have been with today's model, since practical (and amazingly accurate) calculations for timekeeping and for the cycles of seasons - based on many generations of real-world observation, mind you - were the guidelines they followed. Their limited (or total lack of) understanding of the mechanics of the solar system and of the universe in general didn't render the measurements which affected their lives any less accurate.

As with farming, it's practicality that takes center stage in running. Finding a single physical process which pinpoints the exact "threshold" may be an exercise in futitily, but that doesn't matter in the workaday world of running. Whether or not there is a distinct LT, lactate levels **do** rise with increasing exercise intensity, and correctly executed "tempo" runs will improve your ability to process that lactate for use in energy production, reduce the negative effects of the associated positive ions (or **whatever** the fudge it is that creates fatigue), accumulate more time in a steady state of unbroken rhythm and harmony, and provide a host of other benefits that you will only come to learn and appreciate when you do enough running.

So if Noakes wants to call some hitherto unidentified exercise gremlin "Central Governor," let him. They might have thought it was strictly a lactate accumulation issue in Ye Olde Days (ah, I shall slay the evil lactate monster - I call him "Lactor"), but it doesn't change the effectiveness of "threshold" running (or the way you should approach it or how often you should use it) one iota.

They might have called the Earth the center of everything and the Sun a "god" a few thousand years ago, while today they see gravity as a property of how matter acts on space, which produces all those celestial motions we see. But none of those motions are changed by our (still limited) understanding of what is behind them. The ancients could have believed the Sun to be a huge flaming booger that got flicked off the end of the finger of some giant nosepicking nerd, who was lurking beneath the horizon of the flat Earth, to blaze a slow path across the sky every new day, and that theory wouldn't have made their tedious calculations of its motions (and the practical application to farming techniques) any less accurate or effective.

--*-*-*-*-*-*-*-*-*

Richard_ wrote:

Perhaps the most surprising fact to emerge from the research was that elites do very little tempo paced training.

WTF????? Whose backasswards conclusion was that and what fly-by-night definition of "tempo running" were they using? Ever done any **running** with sub-elite or elite Kenyans? For the vast majority of them, about 40% of their total volume is tempo running - proper tempo running, that is, in contrast with following strict numbers pulled from Penguin Planet magazine's latest pace chart. "Tempo" is not defined by pace; it is a state of being which is not so much "done" as it is "experienced" as a free-spirited, go-with-the-flow sensation. A tempo run pace isn't decided on; it just happens. And how do you know when you've passed it, when you've exceeded your "threshold"? In much the same way as raising a gram of liquid water from zero degrees to 100 degrees demands an energy requirement of one calorie per degree temperature increase, but overcoming the surface tension and changing from the liquid to gaseous state once the 100-degree mark is reached requires an additional whopping 540 calories per gram, exceeding the "tempo" state requires an inordinate amount of effort relative to reaching it in the first place.

The problem with "billions of man-miles of accumulated experience" ...

How can there **possibly** be a **problem** with that?

It's accumulated experience - often at a Darwin Award-winning cost - that taught people certain plants or mushrooms were inedible. If we had to rely exclusively on theory instead, we might guess brightly-

colored foods like strawberries or carrots are poisonous precisely because of their aposematic (warning) coloration, so we should play it safe and stick to bland-colored foods like Amanita phalloides (a.k.a. the "Death Cap" mushroom).

Speaking of warning colors and ignorant, stubborn scientists, native Americans living in the desert Southwest knew for ages that Black Widow spider bites could produce much more severe symptoms than the bites of other indigenous spiders, so they were wary of these spiders and checked their clothes and bedding for them as a matter of habit. Yet many university-trained arachnologists and other wildlife "experts" insisted as late as the 1940s that there was no reason to believe these spiders were any more venomous than other spiders. Experience trumps theory, folks.

Sadly, exercise physiologists without enough real-world experience all too often prescribe for runners a training diet laced with poison.

--*-*-*-*-*-*-*-*

Runningart2004 wrote:

Tempo Runs work for a very simple and uncomplicated reason:

1. You are running hard for an extended period of time.

Most spontaneous tempo runs shouldn't be "hard," at least not for very long. One of the main benefits of these on-the-fly tempo runs is that they can be simultaneously fast and relatively effort-free. Let's not lose sight of the fact that the goal of improving running performances isn't to run **hard**; it's to run **fast**. Running at your limit obviously **involves** running hard, but making **improvements** in your ability to efficiently convert stored energy to forward velocity (a.k.a. running economy) is normally maximized by cultivating the ability to relax and maintain effort-saving movements while running fast. Properly **relaxed** "tempo" running, while it can be done at many different **speeds** and still remain below a "threshold" of distress (speed and duration of effort being generally inversely related in this equation), affords the opportunity to accumulate more time in an economical state than if the effort produced distress, either orthopedically or metabolically. And **more time spent** means a **broader stimulus for adaptation**, as long as (and particularly if) the same state of effort can be reproduced frequently without those orthopedic or metabolic breakdowns resulting.

Some of the adaptations that occur in this sport, particularly in relation to running economy, are either entirely neurological or are intimately tied to neurological signals during effort. For example, in a sustained effort, invoking the fewest motor units (and, normally, those with the lowest threshold for activation) which can accomplish the job is the most effective m.o. and will result in the least squandered energy, the least orthopedic stress, and the most time amassed at that pace. Optimal stride frequency for sustained running varies slightly between individuals based on skeletal structure, muscle fiber

composition, muscle mass distribution, etc., but as a general rule (and up to a point normally between 180 and 185 steps per minute for most competitive runners), a faster stride cadence with a lower power generation is more economical at a given steady pace, due to the minimization of vertical oscillation (which is not only wasteful as a result of prolonged "hang time," but often creates unnecessary shock on impact during the plant phase), due to reducing the time spent bending and unbending joints within the plant phase, and due to the involvement of more motor units which can contribute to fine motor control (which also minimizes wobbling and contributes to more stable footstrikes). Correct **relaxed** tempo running gives you the chance to habitually ingrain and reinforce efficient stride patterns and motor unit recruitment for durations sufficient to produce noticeable adaptations. Struggling and fighting the pace not only hinders the efficient selection of motor units; it reduces the amount of time spent at pace, prolongs recovery time, and effectively dampens the stimulus for adaptation.

Tempo Runs, and likewise Lydiardesque "Time Trials" seek to make you run at a hard level for an extended period of time just as you would during a race.

Those time trials are what most people think of as tempo runs and what you mean by "running hard for an extended period of time" - the effort is more focused on a certain pace and you're consciously pushing a bit more (and perhaps for a little longer) rather than enjoying the ride for most of the run. Even in these harder efforts, the duration (and peak intensity) of the hard running should be managed so relaxation can be preserved as much as possible as the different energy pathways (such as the lactate system) begin to come more into play as the pace quickens.

--*-*-*-*-*

The actual training and competing has nothing to do with your physiology-speak.

Pretty much sums it up.

From "Good Will Hunting" comes this dialogue which does a good job of illustrating the stark distinction between hearing about or reading a mere summary of something and being totally immersed in the reality of it:

"So, if I asked you about art, you'd probably give me the skinny on every art book ever written. Michelangelo. You know a lot about him - life's work, political aspirations, him and the Pope, sexual orientation, the whole works, right? But I bet you can't tell me what it smells like in the Sistine Chapel. You've never actually stood there and looked up at that beautiful ceiling, seen that.

If I ask you about women, you'll probably give me a syllabus of your personal favorites. You may have even been laid a few times. But you can't tell me what it feels like to wake up next to a woman and feel truly happy.

You're a tough kid. And I ask you about war, you'd probably throw Shakespeare at me, right? 'Once more unto the breach, dear friends ...' But you've never been near one. You've never held your best friend's head in your lap and watched him gasp his last breath, looking to you for help.

I ask you about love, you'll probably quote me a sonnet. But you've never looked at a woman and been totally vulnerable, known someone that could level you with her eyes, feeling like God put an angel on Earth just for you ... who could rescue you from the depths of hell. And you wouldn't know what it's like to be her angel, to have that love for her, be there forever. Through anything. Through cancer. And you wouldn't know about sleeping sitting up in a hospital room for two months, holding her hand, because the doctors could see in your eyes that the terms 'visiting hours' don't apply to you. You don't know about real loss. 'Cause that only occurs when you love something more than you love yourself. I doubt you've ever dared to love anybody that much.

I look at you. I don't see an intelligent, confident man. I see a cocky, scared sh*tless kid. But you're a genius, Will. No one denies that. No one could possibly understand the depths of you. But you presume to know everything about me because you saw a painting of mine. You ripped my f***ing life apart. You're an orphan, right? Do you think I know the first thing about how hard your life has been? How you feel? Who you are? Because I read Oliver Twist? Does that encapsulate you? Personally, I don't give a sh*t about all that. Because you know what? I can't learn anything from you I can't read in some f***ing book. Unless you want to talk about you - who you are. Then I'm fascinated. I'm in. But you don't want to do that, do you, sport? You're terrified of what you might say."

Well, there you have it. There are those who watch from the sidelines and talk theory, and there are those who **do** and gain the truly pragmatic understanding. Many exercise scientists presume to know running because they "saw a painting" or two. But unless they've been through the running equivalent of those experiences described above, they don't know sh*t about building a running career from the ground up. That's not to say observing and gathering marginally-related data (as exercise science does in relation to day-to-day running) **never** has useful applications in real life. Some practical **nuances** can come out of exercise science, but using it as your basic template is like watching every episode of "Kung Fu" in order to learn how to protect yourself against armed attackers. There might be a couple of practical nuances in that show, as well, but those are only things that you'd recognize as practical if you already knew the basic principles of dealing with the reality of violence, and none of those nuances will turn a wimp into a fighter. Getting in some David Carradine stance and making a few flowery circular motions with your fingers and hands will only get you killed when two or three crowbar-wielding five-time felons on angel dust charge at you in a dead-end alley. In the same vein, you can concoct some very good stand-alone workouts from exercise theory, but nuances **aren't** what make the runner.

--*-*-*-*-*-*-*-*

Ugali, Miss Molly! This thread is still alive? The whole "discussion" makes me think of a bunch of monkeys throwing feces at each other.

Richard_ wrote:

Tempo training is accepted to be an effective training method.

Can it be? I think you're ... **correct** ... on that one!

The physiological explanation (lactate threshold) for tempo training is now known to be inaccurate.

No new physiological explanation has been offered as a replacement.

BRAAAAACK!!!!! Awwwww. And you were doing so well up to that point. There is a threshold, although it's more of a "yellow zone" than a precise line. The reason you can't pinpoint it exactly is because your definition of it is somewhat dependent on the protocol used to find it, which is in turn tied to the rate at which pace (or incline) increases. Ergo, the threshold may be passed through quicker with some protocols than with others. Certain athletes who process lactate as fuel extremely well may also have a broader "yellow zone" and be able to spend more time in it before crossing into the "red zone." Some of that ability may be fiber-dependent and/or related to stride mechanics and/or related to an as-of-yet unknown mechanism, so looking for a Holy Grail "catchall" explanation for this phenomenon (or most others related to exercise) is like playing darts blindfolded. You don't even know if you're facing the target.

Calling this zone the **lactate** threshold could possibly be seen as a misnomer inasmuch as lactate itself is now viewed as not causing fatigue (not that the negative ion ever was viewed as responsible for fatigue). However, lactate levels do rise during increasing (or prolonged) moderate to high exercise intensity and as such can be used very effectively as a **barometer** or measuring stick for ensuing distress or fatigue.

This brings us to the the "replacement explanation." Since lactate levels rise with increasing exercise intensity, and since lactate is used as fuel, this chain of events **increases** the logic behind using tempo running to stimulate adaptations. A lollipop to the clever lad that figures out why.

Effectiveness of tempo running is also related to the amount of time spent in a steady state of effort, which most assuredly can be found on the roads and trails and tracks even if it can't be isolated to your satisfaction in the laboratory. The stressors and associated adaptations perhaps have one or more skeletal

muscular components, but they also include some myocardial components, pulmonary components, neurological components, etc. Moreover, the true effectiveness stems from the fact that all of these systems are working together in unison during sustained effort.

No changes in tempo training have been suggested.

Read just a liiiitle bit closer. I've often advocated segments of "crest-load" running at the very end of the "yellow zone" and briefly dipping into the "red zone" during the end of some of the latter segments. This would be stuff like 3-5 x 7-12 minutes on / 2-3 minutes off, with a total of about 35 minutes (give or take a few) spent at the speeds leading to those states of effort. This isn't a **new** training method either (people were already doing this in one form or another when I started running back in the early 1970s), but it's an **underemployed** training method. It can also be tricky (just like continuous tempo running) to get the effort just right for regular use. In light of the idea that lactate appears (for the moment) to be our friend and has no hidden plans to sabotage us, it makes sense to do some sustained running while producing (and therefore using) medium amounts of lactate.

--*-*

Aw, nuts. I forgot the most important part:

In light of the fact that correctly incorporating tempo and crest-load running produces fitter, stronger runners with better performances (regardless of what other changes are or aren't taking place), it makes even **more** sense to use that type of running.

--*-*-*-*-*-*-*-*

Here's one [indicator workout] from circa 1974 out of the U.S.S.R. It's accurate for 1,500.

400 at 1,500 goal pace, 40 seconds recovery, 800 at same pace, 1:20 recovery, 300 at same pace or faster, 4 minutes walk/jog, repeat 400-800-300.

5 x 1,000 with recoveries of 2 minutes is usually a reliable indicator for 3,000 race pace.

5 x 1,600 with recoveries of 2:30 reasonably predicts 5,000 race pace.

If these are to be true indicators, you should be going to the well to maintain the pace by the end of them, which by default makes them hard enough that you might as well just run the race or do a time trial over the race distance instead, but there are some advantages to indicator workouts:

1) They give you some idea of what to expect if you're far enough removed from racing that you don't have any clue how the pace will feel after the first few laps (but before you do anything as hard as this stuff, you should have been doing some moderately hard running already and should have a vague idea

what kind of pace you can run)
2) If you're in over your head at the chosen pace, you can still salvage a workout by changing it up in the middle (start doing shorter reps at the same pace or whatever) and say to yourself, "it's just a workout, no big deal, at least I learned something" instead of having the wheels come off in devastating fashion during a race, struggling home or DNFing and still not knowing what kind of time you would have run if you had run smart
3) Workouts can let you spend more time at race pace (for example, 5 x 1k instead of 1 x 3k), which may help you get in better shape down the road in some ways that a race wouldn't do, as long as you're smart about recovery following your hard workouts
4) Races don't always play out at an ideal pace and it's often hard to run at your own rhythm while the rest of the field might be doing something different, but you can always be your own pacemaker (or have workout partners help out) and run the speed you want from the start in a workout

--*-*-*-*-*-*-*

Stronger and/or more efficient respiratory muscles can better control thoracic pressure, which does have a bearing on venous blood flow and therefore on efficient gas exchange during continuous exercise. When you are highly fit, you can become sensitive to changes in thoracic pressure either while running or at rest. The carotid sinus baroreceptors ("baro-" meaning "pressure" as in "barometer") are particularly sensitive in a fit endurance athlete, allowing the athlete to willfully lower the heart rate or induce temporary respiratory arrhythmia (skipping beats) using breathing techniques.

Respiratory muscles may be relatively inefficient for a number of structural reasons, including the configuration of the rib cage, some degree of ischemia, or faulty running posture, the latter of which could be brought on by mild scoliosis, small leg length discrepancies or any number of minor (and therefore unknown) structural irregularities.

As far as doing something about it, you might need to practice diaphragmatic breathing while running or relax as much as possible while running so the respiratory muscles and interspaces will be correctly aligned. Or you might need some of that stuff they call "core strength" these days in order to improve your posture and stability, which will also improve alignment and, by extension, the mechanical function of the intercostal muscles. Or you might not be covering all your bases in terms of workout speeds. Certain workout formats seem to elicit the greatest involvement of the muscles responsible for maximum respiration (they have other benefits, as well), but how often you do them depends on your running history, both lifetime and recent.

--*-*-*-*-*-*-*

In my view, the number one concern in most races should be to race the **people** and if you run fast in the process, that's a bonus. At the same time, you don't fully progress as a runner unless you're willing and

able to get as fast as you can get in absolute terms. Obviously, those two goals aren't always accomplished in the **same** race. A **few** races are specifically set up in a time trial format so people can chase qualifying marks or records, but most races should be run with the goal of beating people.

We've all probably known many college runners - and indeed entire college **teams** - who sought out only those time trial races during the non-championship weeks of a track season. When the championships rolled around, even though they had by far the best performances in their conferences, they were totally incapable of running well in hot or rainy or windy conditions or if the pace was slow or screwy. They were in great shape for getting hoovered along at a fast, even pace in perfect weather, but they simply couldn't operate outside that comfort zone. On the flip side, more of those people qualified for the biggest meets, sometimes making All-American, while the people who paddled them at the conference meet never did anything beyond that level since they couldn't run a fast enough pace when it was required.

The best runners are ready to win any kind of race in any kind of conditions because they can run a fast absolute pace **and** they're constantly concerned with beating anything their competitors can throw at them **and** they aren't daunted by lousy weather. By definition, that's why they get the title of "best." At the world level, the **best** 5,000 runners can run 61 pace the whole way if that's what's called for, and they're also able to throw down a 1:56 800 for laps 9 and 10 or run 51 for the last lap to win if the opening pace dawdles.

A strong competitive fire as evidenced by high finishes in important races **and** superb fitness as evidenced by fast PRs ... the ultimate runner has both.

--*-*-*-*-*-*

[from the Renato Canova thread]

Wasting bandwidth - a general career training outline

Here are the fundamentals of our training approach. We use this same basic outline throughout an ENTIRE CAREER from about age 15 forward, with mileages steadily increasing toward the maximum as a runner demonstrates the ability to tolerate the load and benefit from it (this is BASIC training). We aim for two peaks per year. This policy is more conducive to long term development than is trying to peak three times in a year, as is often done in college (and sometimes in high school). We don't ALWAYS follow a 7-day pattern, either, but since most runners are often constrained by external demands (school, etc.), it's useful to acquire the ability to function well within a 7-day schedule. This is used for ALL track events from 1,500m through 10,000m, with adjustments made along the way as a runner shows a tendency to improve from a particular balance of workout types (this is the ART of training). Just as Lydiard's elite runners trained on the same basic plan until it was the time of the year for them to move toward their specialties, the aim of EVERY runner who races at middle and long distances should be to acquire a high level of aerobic fitness and to handle steadily increasing training loads (read: mileage).

We set the paces for timed workouts based on recent time trials or races (also depends on if there is an important race within a few days or whether the week's mileage is planned as high or low, etc.). In any case, we'll almost ALWAYS start SLOWER than the intended average and work into a speed which keeps lactate levels under complete control until the final 2-3 minutes of running. The PACE may be FASTER than the "laboratory GXT definition" of LT pace as "approximately one hour race pace", but the lactate levels THEMSELVES are what we are concerned with, NOT necessarily the PACE. For example, a runner who is in CURRENT shape for a 15:00 for 5,000m may have a theoretical LT pace of 5:15-5:20 per mile and might on one day perform 10 x 3 min. on/30-60 secs. off (so-called "high density") at an average of 5:15 mile pace for the 3 min. runs. Then on a DIFFERENT threshold workout, the same runner might do 3 x 8 min. on/5 min. off (lower density) at an average pace of 4:55 per mile (covering roughly 6.5 laps in each 8 min. bout if done on a track). Or the workout might consist of 20 x 400 in around 75, with 20-25 secs. rest periods - another high density session but run at a different pace than the first high density session. The point is to work at VARIOUS speeds but to stay on the comfortable side of tying up, only feeling like you're really "ripping it" during the last 2-3 minutes of the entire workout - and even THEN not rigging, but getting a "fast flying" feeling - working but not straining. You must train your body to operate under CONTROL while recruiting different muscle fibers, with various ranges of motion, and at different power outputs, thereby stimulating some systems while recovering others. High density repeats use predominantly slow twitch fibers and can be repeated fairly often in lieu of continuous runs. Lower density repeats allow you to spend significant time at or below your LT while running FASTER and are complementary to the high density sessions.

4-8 WEEKS EARLY PRESEASON:

This phase is loosely structured, with the emphasis on rebuilding mileage and on running by feel while covering some of the necessary bases.

2-4 days per week - Progression runs (no pace parameters yet - start slow, gradually and spontaneously increase speed to the high end of aerobic effort and stay there from 30-65 min., with a faster finish if feeling strong)
1-2 days per week - Sets of buildups or strides (ex.: 2-3 sets of 5-6 x 15-40 secs., jogging equal distance between reps and jogging 5-10 min. between sets - always do buildups, strides, and drills WITH the wind, if any) + drills and/or hills on occasion + 2-8 min. @ 90% effort (following last set of strides) every 2 weeks
1 day every 2 weeks - Long easy run (getting longer each time, last 1-3 miles gradually faster if feeling good)
Phase in doubles 1-2 times per week for 2 weeks, 3-4 times per week for 2 weeks, 4-6 times per week after that

4 WEEKS LATE PRESEASON:

Here we get more structured toward Mondays and Wednesdays being faster days and Saturdays being long run days (schedule shifted if needed based on whenever the long run is most convenient). The basic outline below totals 65-80 miles for a week at MINIMUM (depending on average training pace) and

totals 125-150 miles at MAXIMUM (depending on pace).

Sun. A.M. 0-35 min. very easy ("shake-out" or "super-O2" pace) / P.M. 30-95 min. easy (normal comfortable pace)

Mon. A.M. 35-50 min. very easy / P.M. Progression run (spending 30-65 min. at a high end of aerobic effort) OR Tempo run with 20-25 min at LT effort OR High Density LT repeats (ex.: 8-15 x 3-4 min with 30-60 secs. rest periods)

Tue. A.M. 35-50 min. very easy / P.M. 35-95 min. easy

Wed. A.M. 35-50 min. very easy / P.M. Progression run (spending 30-65 min. at a high end of aerobic effort) OR High Density LT repeats (ex.: 15-25 x 60-90 secs. with 20-25 secs. rest periods) OR Sets of strides OR Lower Density short LT repeats (ex.: 12-20 x 45-90 secs. at roughly current controlled 3,000m Time Trial pace with nearly equal rest-to-run ratios)

Thu. A.M. 35-50 min. very easy / P.M. 35-95 min. easy

Fri. A.M. 0-35 min. very easy / P.M. 35-65 min. easy with 4-10 strides near the end

Sat. 125-155 min. easy with last 10-20 min. gradually faster if feeling good OR 95-125 min. with last 30-60 min. picked up to a strong high-end pace OR A.M. 30-35 min. very easy / P.M. Long warmup (25-35 min.), CONTROLLED (deliberately slow start) Time Trial of 3,000m-8,000m - designed to determine critical training speeds and make adjustments (60-65 min. total)

4 WEEKS EARLY COMPETITIVE SEASON (assuming Saturday RACE):

From this point on, runners who specialize at 1,500m will gradually gravitate toward the lower (or moderate) outlined mileage levels and will place slightly less emphasis on threshold work, favoring repeats more often than continuous runs and moving toward Lactate Tolerance training slightly sooner than the longer distance runners. Races during the early season are usually overdistance for 1,500m-3,000m runners, underdistance for 5,000m-10,000 runners (unless a time is needed as a qualifier).

Sun. A.M. 0-35 min. very easy / P.M. 30-95 min. easy (normal comfortable pace)
Mon. A.M. 35-50 min. very easy / P.M. Progression run (spending 30-65 min. at a high end of aerobic effort) OR Tempo run with 20-30 min at LT effort OR High Density LT repeats (ex.: 8-15 x 3-4 min with 30-60 secs. rest periods or 15-25 x 60-90 secs. with 20-25 secs. rest periods) OR Sets of strides (if long RACE previous Saturday)

Tue. A.M. 35-50 min. very easy / P.M. 35-95 min. easy
Wed. A.M. 35-50 min. very easy / P.M. Lower Density short LT repeats (ex.: 12-20 x 45-90 secs. at roughly current 5,000m race pace with nearly equal rest-to-run ratios) OR VO2max training (ex.: 6-8 x 2-3 min. at slightly slower than current 3,000m race pace)
Thu. A.M. 35-50 min. very easy / P.M. 35-95 min. easy
Fri. A.M. 0-35 min. very easy / P.M. 35-65 min. easy with 4-10 strides near the end
Sat. 95-125 min. with last 30-60 min. picked up to a strong high-end pace OR (rarely) 125-155 min. easy with last 10-20 min. gradually faster if feeling good OR RACE of 3,000m-5,000m (10,000m only if needed for qualifier)

4 WEEKS MID-SEASON (assuming Saturday RACE):

The 1,500m runners still spend more time on the faster workouts than longer distance runners, occasionally staying in touch with their LT training. Races are usually underdistance or specialty distance for all runners (unless a time is needed as a qualifier).

Sun. A.M. 0-35 min. very easy / P.M. 30-95 min. easy (normal comfortable pace)

Mon. A.M. 35-50 min. very easy / P.M. Sets of strides OR Tempo run with 20-30 min at LT effort OR High Density LT repeats (ex.: 8-15 x 3-4 min with 30-60 secs. rest periods or 15-25 x 60-90 secs. with 20-25 secs. rest periods) OR Lower Density long LT repeats (ex.: 4-5 x 4-5 min. at roughly current 5,000m race pace with 3-4 min. rest periods or 3 x 8 min. at roughly 10 secs./mile slower than current 5,000m race pace with 3-5 min. rest periods)

Tue. A.M. 35-50 min. very easy / P.M. 35-95 min. easy

Wed. A.M. 35-50 min. very easy / P.M. Lower Density short LT repeats (ex.: 12-20 x 45-90 secs. at roughly current 5,000m race pace with nearly equal rest-to-run ratios) OR VO2max training (ex.: 6-10 x 2-3 min. at slightly slower than current 3,000m race pace with equal rest-to-run ratios) OR Creatine Phosphate training (ex.: 2 sets of 2-3 x 7-10 secs. @ 98%-100% effort with 60 secs. walk between each and 8 min. walk between sets) OR Lactate Tolerance training (ex.: 8-10 x 45-65 secs. at slightly faster than current 1,500m/mile race pace with rest periods of about 1.5 times the run periods) OR Lactate Clearance training (ex.: 2-3 x 30-40 secs. at 95%-100% effort with 3-4 min. rest periods)

Thu. A.M. 35-50 min. very easy / P.M. 35-95 min. easy

Fri. A.M. 0-35 min. very easy / P.M. 35-65 min. easy with 4-10 strides near the end

Sat. RACE of 800m-1,500m (1,500m-5,000m specialists) or 1,500m-5,000m (10,000m specialists) OR 95-125 min. with last 10-20 min. gradually faster if feeling good

4 WEEKS LATE SEASON (assuming Saturday RACE):

Time to peak out. Lactate Clearance training is often done by all runners during this stage (if there are not too many races scheduled during the season), but only if regular speed maintenance (buildups and strides) and some Creatine Phosphate training has been used first.

Sun. A.M. 0-35 min. very easy / P.M. 30-65 min. easy (normal comfortable pace)

Mon. A.M. 35-50 min. very easy / P.M. Sets of strides OR High Density LT repeats (ex.: 3-4 min. reps with 30-60 secs. rest periods) OR Creatine Phosphate training (ex.: 3-4 x 20 secs. @ 98%-100% effort with 60 secs. walk between each)

Tue. A.M. 35-50 min. very easy / P.M. 35-65 min. easy

Wed. A.M. 35-50 min. very easy / P.M. VO2max training (ex.: 6-10 x 2-3 min. at slightly slower than current 3,000m race pace with equal rest-to-run ratios or 12-15 x 1 min. at slightly faster than current 3,000m race pace with nearly equal rest-to-run ratios) OR Lactate Tolerance training (ex.: 8-10 x 45-65 secs. at slightly faster than current 1,500m/mile race pace with rest periods of about 1.5 times the run periods) OR Lactate Clearance training (ex.: 2-3 x 1 min. at 95%-100% effort with 4-5 min. rest periods) OR Taper Session (ex.: 2 x 2 min. + 2 x 1 min. + 4 x 30 secs., each set of 2 having first rep medium speed and second rep fast with rest periods of about 1.5 times the previous run periods and the set of 4 all starting at medium speed and getting progressively faster)

Thu. A.M. 35-50 min. very easy / P.M. 35-65 min. easy

Fri. A.M. 0-35 min. very easy / P.M. 35-65 min. easy with 4-10 strides near the end

Sat. RACE of 400m-1,500m (1,500m specialists) or 800m-5,000m (5,000m specialists) or 1,500m-10,000m (10,000m specialists) OR 95-125 min. with last 10-20 min. gradually faster if feeling good

Oh, yes, don't forget the most important criterion of all: LOVE running!

--*-*-*-*-*-*-*-*-*-*-*-*

Quoted in a Canova thread:

A substantial portion of preseason high mileage running (roughly between 15% and 40%, depending on your age and experience) needs to be done at just below your "maximum steady state" of effort, as this pace uses more glycogen as fuel (as opposed to fat, which is accessed more during slower jogging), and sufficient use of glycogen as the primary substrate allows for the greatest improvement of oxidative properties within the muscle cells.

These "high-end" aerobic workouts should at some point become the staple "fast" sessions of any serious runner's preseason training. They contribute to running success more than any other type of workout, since the cost/benefit ratio is favorable at a pace which is fairly quick yet still relaxed enough to eliminate tension.

The general idea on a high-end aerobic run is to find the fastest pace at which you can run without feeling as though you're having to fight to sustain the pace. You should start at your usual easy run pace and let your breathing and perceived effort stabilize before attempting any increase in pace. As the run progresses, lock in to the pace which will train you yet force a slower runner to strain. In layman's terms, this means "relax and train a runner, kill a jogger". The pace should always be manageable; that is, you should be well in control of the speed rather than forcing yourself to maintain it. Once you sense that struggling is about 10 minutes away if you keep the pace you're running, it is time to wind up for the finish of the high-end portion of the run. You should then squeeze the pace down to a gradually faster speed for only about 2-3 minutes. At this point, you may find yourself flying, but you should still feel as though you are floating rather than straining. Because you will only be spending 2-3 minutes at the faster speed (above your lactate threshold), you will not accumulate enough time at this effort level to go into a predominantly anaerobic state. This is important. You should always finish a high-end workout feeling strong - almost energized from the sensation of running right on the edge of pushing it.

The most prudent approach is to work with your body rather than against it, watching for the signs that tell you that you are about to go too hard, as opposed to struggling and fighting yourself and undermining the effectiveness of your workouts

--*-*-*-*-*-*

Quoted in the “140 miles a week” thread

A case study provided by John Kellogg (Weldon and Robert's coach): “On Bruce Hyde- A High Mileage Miler”
February 2005

There is a point at which you optimally build fitness; if you go beyond that point very often, you begin

giving some of it away. Your ideal frequency of threshold running (as well as your ideal mileage) simply depends on how often you can do it comfortably without needing a very slow recovery day (or series of recovery days). But it should also be regulated according to a few general rules:
1) Your age/running experience
2) Time of year (base training or competitive season)
3) Your long-term goals or lack thereof (also influenced by age)

I'll use Bruce Hyde as a case study, since he's followed things pretty much according to plan since his last season of high school.

During off-season training, Bruce would run at a "high-end" of aerobic effort only about twice per week when he was younger. On other days, he would either run very slowly the whole time or would add some short strides for mechanical efficiency. At first, he would (like most runners) go too hard, either testing himself as if to find out if he was any faster than he was a few days before or simply getting carried away and wanting to hammer it too often. As he became more experienced, he finally found the feeling you're supposed to find. It took some discipline on his part (and some constant prodding) to keep him from going too fast at times and giving too much away, but he finally embraced the high-end pace as the correct one for proper development. With maturity, he was able to progress to the point where he was hitting that high-end pace more often during his base phases. He still only does so about 4 times per week at most, and he only goes there 1-2 times per week during the competitive season when higher intensity is added (running very easy on in-between days so as to make this routine as safe as possible and repeatable for years).

Bruce took the 2003-2004 school year off academically and was able to get 5 months of pure base training which was uninterrupted by the normal college routine (this is a detrimental routine of tapering for a bunch of mostly meaningless races 3 seasons per year, running those races, recovering from those races - or staying run down - and never allowing complete development to take place). His mileage went way up from his previous levels (average of 106 per week for one 10-week period, highest of 125) and he was able to focus on threshold running as the staple of his preparation. In fact, he was getting ready for a marathon that he later decided to skip. At one point, he ran a 22-miler with 18 miles of that at an average pace of 5:20 per mile (several of those miles were hillier than anything on his target marathon course). From a training perspective, this aerobic development and this alone is what made him a better 1,500m runner. All his race-specific "workouts" were the same as they had been in previous years (although faster with the improved fundamental conditioning), so the specificity had next to nothing to do with improved performances - it was only the mileage and the consistency of threshold running over a period of months that made the difference.

You might know how the story played out after that: Bruce went on to run 8:03 for 3,000m in his first race the following season, a huge breakthrough into national class territory for him. He backed that up with a 4:02 mile, another big PR, and showed he could race with more seasoned runners when he used a 26.9 last 200m to place 4th in the USATF indoor 1,500m with another PR of 3:42.44 (equal to about a 4:00.25 mile). He sat out the outdoor season, again developing more aerobic endurance (up to a 142-mile week, with a few others in the high 120s), and returned to school for cross-country, winning the HEPS crown, the Northeast Regional title, and All-American honors at NCAAs.

Although Bruce Hyde is obviously a talented runner and not everyone can make themselves as fast in absolute terms as he is, that's an example of the personal improvement anyone can achieve with steadily increasing mileage and more consistent high-end running. Of course, everyone is different, so you have to experiment to find the right mileage and the right amount of threshold running for your current tolerance, body weight, and state of development. But these are universal principles - they work across the board. If you keep safely and steadily trying to push the boundaries out as the years go by, you may have some inevitable setbacks during the discovery process, but you'll find what's right and you'll continue to make an overall improvement for years to come.

Interesting story: Bruce had blood lactate measurements taken during a test about a year ago, and the physiologist was going on and on about how runners he tests are never able to accurately ascertain their true LT. They always think they're running with less distress than the measurements really indicate; i.e., they've passed their LT long before they feel like they have. But Bruce was just as adamant that his coaches (Rojo and me) had ingrained in him that same truth - that true maximum steady state is a more relaxed and controlled effort than runners realize and that they all pay lip service to the concept of LT but to a man they lack discipline and they go too fast. The physiologist had heard that story before and insisted that every runner with any head knowledge of LT thinks the same thing yet they always get too carried away with the pace and misjudge the effort. Well, Bruce proved him wrong. His true LT turned out to be precisely where he felt it was. The physiologist was impressed and remarked that, in his experience, no one had ever nailed it by feel. Here, finally, was someone who not only knew about "maximum steady state," but actually had an internal dialogue which was sensitive enough to put it into practice.

That's the kind of self-government you're looking for during threshold running. You want to find a pace you could theoretically hit for a portion of a run several days in a row before you need a complete recovery day or two. Trial and error (and factor analysis) indicates that actually hitting that high-end pace more than 3 times per week will expedite your fitness at a small cost to long-term development (also dependent upon how much higher-intensity work is being done). The take-home message in this is that if you're a newcomer to the sport or if you're younger than your prime racing years (25-35 years old for most long distance runners), you will be better served (at least from a statistical standpoint - obviously not everyone responds in exactly the same manner) by including more easy running in your base training regimen. If you are an older, experienced runner who is in (or past) your prime, you may be better served by running at a maximum steady state more often (4-6 times per week). If you're a high school or college runner who wants high school or college glory but doesn't plan to go a whole lot farther in the sport after those years, you'll also probably be better off running at a high-end pace several days per week, as long as you've done enough preparatory running to be ready for it.

--*-*-*-*-*-*-*

There aren't any magic workouts [for the 1500m], but if you're already at a high level of general fitness, these two should give you a good bit of stimulus at race pace or slightly faster without being too taxing.

Workout 1:

12-20 min. warmup jog
Some light dynamic drills (if you've been doing them all pre-season) to help warm up a little more (these also help with running economy if they're done for months)
4-6 short (10-15 secs.) buildups (each one a little faster than the previous)
4 x 200 starting about 4 secs. slower than 1,500 goal pace and cutting each one down by about 2 secs. so the last one is about 2 secs. faster than goal pace, with 60-90 secs. between reps (the first 2-3 reps are still part of the warmup process, also helping to establish pace familiarity for the bulk of the workout to come, with the last rep or two starting to segue into a real effort as part of the workout proper)
3 min. break after the last rep
3 x 600 starting at current 1,500 pace and cutting each one down by 2-3 secs. so the last rep is 2-4 secs. faster than race pace, with 2:30 rest after each rep (if you're at 4:00 for 1,500, the 600s would be run in 1:38, 1:35-1:36, 1:32-1:34; you can use less rest if this is too easy, but it isn't necessary, as this isn't supposed to be killer workout or an indicator workout, just a decent stimulus at race pace or a little faster)
Follow the last 2:30 rest period with 4 x 200 cut-downs in a similar fashion to the beginning set of 200s, with the last rep blowing the pipes out a little more if you feel good
15 min. cool-down jog
Light stretching

Workout 2:

12-20 min. warmup jog
Light dynamic drills
6-8 short buildups (a couple of extra ones this time since you're not doing any 200 cut-downs before the main part of the workout)
3 sets of (3 x 400 / 1 min. walk/jog between reps) / 3 min. walk/jog between sets (do the first set at current 1,500 pace or maybe a second faster (the 4:00 guy would run 63-64), then run each successive set about one second faster than the previous set; this isn't an indicator workout either, since if it was all-out, you could probably run all 9 reps right at 1,500 pace using only equal rest-to-run periods (about a minute) without taking 3 min. between sets, but (like Workout 1) it isn't supposed to be a 100% all-out, balls-to-the-wall effort)
15 min. cool-down jog
Light stretching

Again, these aren't the hardest possible workouts. But workouts should only rarely be the kind that are harder than the races themselves (and they sure can be). You normally want to be really fit in general terms, then just touch on your race pace or goal pace enough to finish the workout strongly and recover enough to feel fresh within 2-3 days before you add another stimulus (this doesn't have to be the same stimulus; it might be a tempo effort or some short speed work or something else different than race pace, or it might be a race). In any event, you don't want race pace to feel incredibly labored as a result of overdoing a single workout or from repeating these race-pace workouts too frequently. Unless it's done in lieu of a race (in the middle of a 2-3 week period with no races), a race-pace workout should usually be pretty challenging but not so tough that you can't believe you actually finished it.

--*

This should have said "3 x 600 starting at about 2 secs. slower than current 1,500 pace and cutting each one down by 2-3 secs. ..."

--*-*-*-*-*-*

It's [the success of Alberto Salazar's athletes] mostly the use of hypoxic chambers. They've figured out to adjust to a specific range of simulated altitude for a minimum duration per day (it must be at least 12 hours, not the 7-9 that most people get when they sleep in a chamber). This almost always results in a one-second-per-lap improvement if done correctly. Some people say it must be drugs, but these improvements can definitely be made without PEDs if the altitude simulation is orchestrated properly.

They aren't the only ones to have figured this out. Furthermore, a good recipe of hi-lo training at an actual high-altitude site can result in even greater improvements than they're currently getting, although it takes longer to see the benefits.

As far as the actual running itself, Al Sal does have them practice how to sprint and reduce foot contact time, which a lot of others don't do properly. Most of the day-to-day stuff is the same as what everyone else is doing these days, so it's nothing secret. Over 90% of it is their use of hypoxic chambers. The remainder comes down to a ton of perks and resources, though they do have to exactly know how to make use of those resources, at which Al Sal must be doing a good job.

--*-*-*

One of the purposes of breaking up a total volume of running into reps with rest periods is to get as much stimulus (and practice) as possible at a particular pace before getting into trouble.

Doing 20 laps in 68 seconds each with 45 seconds intervals (traditionally, "interval" refers to the break between bouts, not the bouts themselves) is generally easier than doing 10 laps in 68 seconds each with no rest periods between the laps. The heart, lungs and skeletal muscles get a more robust stimulus from the larger volume of work than it does from the shorter continuous run, and with less chance of lowering muscle pH or blood pH. The higher number of reps is also better for promoting a sense of rhythm - hence, the reference above to "practice."

Doing 10 reps at a faster pace (presumably with slightly longer rest periods) increases the chance of lowered pH, which can be a useful training tool in moderation but is easy to overdo. Speeds near 3k race pace tend to better promote mitochondrial biogenesis than speeds at 5k race pace. The faster pace also obviously invokes different muscle fibers and provides some variety in mechanics and impact stress distribution.

To summarize:

20 laps at 5k pace =

* More profound stimulus to the heart, lungs and skeletal muscles
* Normally less sudden reduction (and less end reduction) in pH
* Easier to find the correct tempo and control it
* Familiarity with running 5k pace

10 laps at 3k pace or faster =

* More stimulus for mitochondrial proliferation
* Variety in 1) fiber recruitment, 2) range of motion in muscles/connective tissue, 3) torque and associated impact distribution stress
* Familiarity with running the faster pace

There are plenty of other benefits and drawbacks to using a variety of speeds for interval training (some of which obviously overlap), but above are just a few of the differences between those particular paces.

--*

J.O. wrote:
Pretentious nonsense.

Oh, sorry. My bad. Here, let me rephrase that for you:

When you run really, really hard, like if you were chasing a big, shiny choo-choo, you suck in a lot of air. In that air is something called "oxygen." That's pronounced OKS-uh-jenn, by the way, but don't worry about that. In your muscles are tiny little thingies where the "oxygen" combines with other stuff to make the "energy" you need to chase the choo-choo. The rate at which this happens depends on how fast you're running, and there's a limit to how quickly you can use the oxygen. Your body is cool, though, because if you go quick enough to have to use a whole lot of the oxygen stuff at a really fast rate, your body ends up making more of the little thingies so it gets better at using the oxygen to help you go-go-go! Yay!

It turns out that when you chase the choo-choo fast enough to use the oxygen stuff at the quickest rate your body can use it - at the limit of the process - your body responds by making **even more** of the little thingies than it would if you didn't run as fast, like if you were chasing Skippy, your pet beagle.

Better?

Now, I think it goes without saying that when you work out, it means bugger-all what happens to your mitochondria if you don't get better at running, right? So you cooould (insert "rolleyes" smilie) simply ignore the "bollocks" about the mitochondria and just focus on the "variety in training" and "familiarity with different speeds" when you work out. But the original question implied there were different benefits that occur when running more reps slower vs. fewer reps faster. And while mitochondrial biogenesis does take place across the spectrum of running speeds, running at max VO2 is **more effective** for developing mitchondria than running with a lower VO2 is. That seems to be part of the answer to the original question. Hey, if you don't like that part, just skip over it.

Of course, if research has come to light that refutes what I said about max VO2 and mitochondrial biogenesis, you cooould (insert "facepalm" smilie) have the courtesy to point it out without charging out of the gate with "BOLLOCKS." To that, I'd probably say, "Hmmmm. I never heard that before. I guess that means today's scientists are more thorough than those of yesteryear, meaning today's version of the truth must be the final one after all."

--*

---

malmo wrote:
Also, lowering blood pH is a training tool?

Taken to mean "running 10 x 400 fast enough to lower pH can be a useful training tool." (See, people? To eliminate confusion, grammar and sentence structure do matter, and since it was a long post, I rushed it.)

Human athletic performance is a coordinated ballet of electrical and chemical signals to the muscles and the energy processing demands by those muscles and the removal and recycling of byproducts from those reactions.

And this doesn't sound as esoteric and pretentious as mentioning mitochondria (nothing more than one of those energy processors)? No offense, but ... bordering on pot calling kettle there, maybe?

Groundskeeper Willie wrote:
so 20 x 400 would be done at what pace?

If you get fit enough - especially if you get good at doing that workout for it's own sake (don't laugh; too many people do this) - you could run 20 x 400 at **faster** than 3k race pace with less than a minute rest between reps. If you really killed it, you might even be able to run them all at the pace you'd run for an all-out 2,400. Then again, just because you **can** do something doesn't necessarily mean you **should**.

Yes, as malmo says, 10 x 400 is better suited for mile pace rather than 3k pace.

--*

Antonio & malmo - Easy there! I assure you that all of us would agree on virtually all things running-related. I am cut from the same mold as you, a product of the 1960s and 1970s old-school, "no shortcuts," "learn both from your predecessors and by trial and error" way of doing things. I have run on a daily basis with a number of the people malmo ran with at AW. I've seen all the trends, all the fads, all the "research" this sport has has to offer, tried them all, observed thousands of others try them all, rejected the crap and held onto the practical nuts and bolts. I consider anyone **not** cut from that same mold as a recreational dabbler and (if **they** start yapping about mitochondria) nothing more than an armchair quarterback.

In short, I believe we are on the same team here.

But because I mentioned the word "mitochondria," you made assumptions. I'll give you a mulligan on that one, but I would have thought people with your experience would be able to (as Jacob Bernoulli said about a mathematical solution sent to him anonymously by Issac Newton) "recognize the lion by his paw."

Regarding this "rebuttal" on exercise intensity boosting mitochondria, it's not necessary, but put one up if you've got one. I haven't seen anything that contradicts Dudley's 1982 findings. Quite the contrary; recent studies (within the last 2 years) still cite Dudley with the end purpose of getting fatasses to adopt high-intensity interval training (HIT) and stop giving the "no time to exercise" excuse. Then again, I don't spend too much time surfing around looking for such crap, because I don't want or need to "know as much about mitochondria" as "J.O." thinks I don't.

I will say this - increased size and number of mitochondria in **all** of your oxidative fibers (as you get from working at max VO2) is a **positive** adaptation from working out at those speeds.

The 20 x 400 at 5k pace was a random and hypothetical set of parameters used to create a distinction with another random, but faster, pace - 10 x 400 at 3k pace. I wasn't **recommending** those particular speeds to be used for those workouts. You can run 20 x 400 at that pace or you can run them at 3k pace or faster depending on where you are in a season or where the workout fits into your immediate plans. Duh.

--*

malmo wrote:

It has nothing to do with a principle of physiology being wrong, or out of date. It was your sciolistic attempt at assigning a singular cellular response to athletic training, and attributing that as the reason for a specific kind of workout.

Oh no no no. That wasn't the intent. First, to clear up the non sequitur here, I can mention one and only one cellular response to training if I want to and it **doesn't** follow that I see that as the only such response from said training or that it was a "sciolistic attempt" at anything. The fact somebody might **read** it that way doesn't **make** it that way.

Now, **if** fizzy-o-malogical responses were the only reasons for doing a certain workout (and people who do approach it from that angle are missing some of the point), there is unquestionably a whole long list of itty bitty cellular responses that occur at 3k pace which aren't as pronounced at 5k pace (even if you run longer at 5k pace), and - although practically insignificant as stand-alones - the sum of those tiny benefits does carry some weight. If it sounded sciolistic, maybe it's because I only included **one** of those small benefits. What I am supposed to do? List them all? I didn't have time and I didn't feel like typing anything else at the time anyway. I'm pretty sure nobody knows them all anyway, but if I had listed a dozen more of those little cellular responses, would that make the info less sciolistic? ... or more sciolistic because there was more fizzy-o-crap? Maybe if I added this: "None of these changes is overly significant in itself, but taken together, they confer a slightly different overall benefit than you'd get from running at a slower pace." Something tells me that would **still** be more than pedantic enough for "J.O.," who came off as snooping around for something to be contentious about. Maybe if I listed **none** of the cellular responses ... naaah. See my third sentence above. I can mention one if I want to.

In any event, I never did attribute the mitochondrial boost as "the" reason for that workout (IIRC, I mentioned 2 or 3 other benefits to be had). Actually, it's not even "a" reason somebody should **choose** to do 10 x 400 instead of 20 x 400. It's just one small effect bestowed by having done the work. The **other things I mentioned**, specifically the variety and the familiarity with another pace, are better as **reasons** for doing different workouts from time to time.

--*

---

intervals with no control as an universal procedure to adoptg or for the neophyte runner, i bet that he starts in faster pace than he woukd finish and i bet that on the day of the run he would do the same, no manage pace aquisition, he will start like a rabbit and will finish like a turtle.

I've seen people who **require** cones placed every 50m and a timer that emits a loud noise when the runner should be at each cone ... and some of these runners need to use this setup for **years** before they get any sense of rhythm. Other people seem to set their inner clocks very early in their careers.

To copy some training approach with the argument that we have seen someone do it and gets lots of success, but copy with no critera or some coach undertand is what gets my sarcasm.

Yes, there are many things that some people never see about the inner workings of a successful runner's (or group's) training, not the least important of which is how these runners arrived at their current ability to "train by feel." That is a growth process that normally goes hand-in-hand with improving fitness. Yet many inexperienced people will attempt to adopt some of the successful runner's principles and be improperly prepared (both physically and in understanding) to apply them.

Ralph Waldo Emerson said this: "The man who grasps principles can successfully select his own methods. The man who tries methods, ignoring principles, is sure to have trouble."

Too many people try the methods, sometimes equating them with the principles, but more often failing to recognize how much experience is required to truly **understand** the principles enough to successfully apply them to a variety of situations or methods.

--*

J.O. wrote:

We don't do faster sessions to increase Mitochondrial biogenesis in fast oxidative fibers, we do them because we will be racing at those paces and we need to improve our ability to last longer at that intensity.

Great. Now read the bold & italic parts this time:

T*** wrote:**

20 laps at 5k pace =

* More profound stimulus to the heart, lungs and skeletal muscles
* Normally less sudden reduction (and less end reduction) in pH
* Easier to find the correct tempo and control it
* ***--- Familiarity with running 5k pace ---***

10 laps at 3k pace or faster =

* More stimulus for mitochondrial proliferation
* Variety in 1) fiber recruitment, 2) range of motion in muscles/connective tissue, 3) torque and associated impact distribution stress
* ***--- Familiarity with running the faster pace ---***

There are ***plenty of other benefits and drawbacks*** to using a variety of speeds for interval training (some of which obviously overlap), but above are ***just a few*** of the differences between those particular paces.

"Differences between those particular paces" does **not** mean "We do these sessions **because** ..." You read that, but I never said that.

Stick to known provable principles, and don't make stuff up.

This is the assertion **as I wrote it**: "Speeds near 3k race pace tend to better promote mitochondrial biogenesis than speeds at 5k race pace." So is this incorrect as a general principle? This conclusion (per Dudley's et al. 1982 findings and recommendations for practical use) is still cited and reaffirmed in medical journals today (Ross & Leveritt, Laursen & Jenkins, Kubekeli et al., Burgomaster et al., Gibala et al.) and is put into practical use (e.g., Wingate-based training - obviously only a small part of the picture for serious runners) precisely because of the reason I gave.

Is the general principle incorrect? Anyone? I admit I don't spend too much time investigating crap like this, but I do a cursory search every few years just to see if some of these principles are considered out of date - precisely so I can make statements without being called out - and this doesn't seem at first glance to be out of date.

--*

---

checkered cab wrote:
Would you provide details about this study?

That list of names was a list from memory of studies by several researchers/authors, most of whom I believe only invoke the **general** principle of high-intensity interval training (HIT or HIIT) promoting mitochondrial biogenesis but do not make any distinction between the **rate** of mitochondrial biogenesis following training at faster speeds vs. slower speeds.

Here is the original report from Gary Dudley, et al. (this team used rats as test subjects):

http://jap.physiology.org/content/53/4/844.full.pdf+html

From Martin Gibala at McMaster University in Toronto:

http://www.iahsaa.org/Sports_Medicine_Wellness/Performance/GSSI-High_Intensity_Interval_Training.pdf

Here is another one regarding HIT - co-authored by Gibala:

http://jp.physoc.org/content/588/6/1011.full

More general info about HIT promoting mitochondrial biogensis:

http://jap.physiology.org/content/98/6/1983

Here's some info on the old Wingate test:

http://www.sport-fitness-advisor.com/wingate-test.html

So-called Wingate-based training protocols may deviate from the standard 30-second bouts in the original Wingate test, but they're characterized by short-duration, near-maximum efforts. Somewhere back in this adulterated thread was mention of 10 x 400. Coincidentally, Martin Gibala has recommended 10 bouts of 1 minute at near-maximum intensity with 1-minute rest intervals as a practical HIT protocol.

Of course, serious runners had better not rely solely on HIT. In part, it was misapplication of findings just like these (i.e., shortcut seeking) that characterized the dismal state of USA running in the 1990s. The HIT protocols are recommended as a reasonably effective and time-saving alternative to prolonged cardio work for relatively **untrained** people who "don't have time to work out" but are interested in getting some **basic** fitness.

--*

---

malmo wrote:

The first citation on rats doesn't address the topic.

Some researchers think it does. I couldn't remember the link at first, but I've located the paper which I consulted before making that statement in my initial post:

http://www.google.com/url?sa=t&source=web&cd=2&ved=0CBsQFjAB&url=http%3A%2F%2Fwww.thefreelibrary.com%2FSkeletal%2Bmuscle%2Bbenefits%2Bof%2Bendurance%2Btraining%253A%2Bmit

ochondrial...-a0213319995&ei=B3oqTbCpHZefnweYiM3gAQ&usg=AFQjCNEckoRnc-8_19k7g-DlovVpTA098w&sig2=baZl4DhIXvq9X6Jxbcxwnw

Here is a specific quote concerning the topic:

"In addition, exercise intensity interacts with the exercise duration. Dudley et al. (8) have shown that **greater increases in mitochondrial content occur within oxidative muscle fibers with higher intensity, shorter duration training sessions**."

I assume that the issue in this thread surrounds whether "greater" means "greater relative to any possible amount of lower intensity work." For example, would 10 x 400 at mile race pace confer a greater stimulus for mitochondrial adaptations than 20 x 400 at 3k pace would? And what if you ran 50 x 400 at 3k pace, assuming you could? Would 10 x 400 at mile pace still be better for mitochondrial biogenesis? That, I assume, is what's under discussion. When you factor in the issue of **specificity**, I have asserted that the faster pace **does** have a different effect by promoting mitochondrial adaptations in the different fibers which must be recruited.

And ... voila! These sections of the report address this intertwined topic of adaptations occurring in accordance with specificity of the work done and muscle fibers involved:

"Mitochondrial adaptations which occur within skeletal muscle fibers in response to endurance training are **specific to the muscle fibers recruited during the training**."

... and ...

"... when applying the principle of specificity, the bulk of your training should **simulate the event in which you plan to participate.** This will train the muscle groups required for the event."

To continue:

"... understand that the **intensity** and duration of training sessions along with the length of the training program all have influences on the **magnitude** of these adaptations."

This was good enough for me. I certainly didn't misread these quotes and don't tell me I misinterpreted them. Concerning the first one, yes, a certain intensity **and** a different duration can confer the **same** overall effects ... but the specificity isn't equal, which is one reason (which I mentioned) for using a variety of speeds. The only possible points of dispute that are left are 1) the findings still apply only to

rats (but the authors make practical suggestions for humans, so they must believe otherwise) and 2) this information is (within the last couple of years) outdated or is flat-out incorrect, in which case, blame **these authors** for their own shoddy interpretation of a 1982 study. I only referenced it. Don't blame the messenger.

And I **still** don't see any published work or even a general consensus disputing the notion contained in these quotes. In addition, I have said that I'm **open to correction** if such dispute does exist.

Gyah! Do we have to have our ducks in a straighter row than **this** before we can post on a topic?

--*

malmo wrote:

T***, nothing about those studies says directly, **--- nor implies anything ---**, about the difference between 10x400 and 20x400 paces on an intracellular level.

Huh???

Given:

1) All miblurps are squeezoids.
2) Effect "Zed" occurs with squeezoids.

Therefore:

Effect "Zed" occurs with miblurps.

Given:

1) All sessions of 10 x 400 at mile race pace are higher intensity, shorter duration training sessions than are sessions of 20 x 400 at 3k race pace.

2)

"... greater increases in mitochondrial content occur within oxidative muscle fibers with higher intensity, shorter duration training sessions."

Therefore:

Greater increases in mitochondrial content occur within oxidative muscle fibers with sessions of 10 x 400 at mile race pace than with sessions of 20 x 400 at 3k race pace. Q.E.D.

Whether 2) is true or false is still the issue. If we take the quote from the paper as is, not only **can** we draw the conclusion I gave; that conclusion is **imperative**. If 2) is false, blame the **authors** because my conclusion from their information is de rigeur.

I'm not the only one to make that conclusion.

Over 15 years ago, I had a former national champion long distance runner who is also an exercise physiologist by profession tell me that he believed Dudley's findings implied higher intensity workouts **for human runners** were better for inducing mitochondrial adaptations than lower intensity workouts were. When pressed as to whether a high-rep, moderate-speed workout could have the same **overall** intensity as a high-speed, low-rep workout, he clarified that by higher intensity, he meant faster speed - up to and perhaps exceeding speeds which elicit max VO2. Ten years later (2003), another multi-time All-American runner and physiologist by training also said this was generally-accepted information. Whether it is **actually** true or is just one of those up-in-the-air non-conclusions that people hold onto until it's finally debunked ... I don't know for sure. But by no stretch am I being "pretentious" in stating something many intelligent, experienced and trustworthy professionals have also believed. Again, don't shoot the messenger.

---

malmo wrote:
The sciolistic walkabout in the wilderness adds nothing to the topic, so far.

At this point, **that** is definitely true.

--*

---

malmo wrote:
Using your logic trail you could say that 6 x 400 at 800m pace produces even HIGHER cellular responses, when in fact, you don't know unless it is ob severed.

Well, the authors didn't place any qualifying limits on their own statement. My conclusion follows directly from what they wrote. According to **their** generic statement, it actually follows that 5 x 100 at 300m race pace would be a better stimulus for mitochondrial adaptations than either 20 fairly fast 400s or 10 even faster 400s.

Now **that** is something I do **not** believe to be true, partly as a consequence of both intuition and experience, but also because it's considered a no-no to make predictions or inferences outside of the range of observed data, and the highest intensity used in Dudley's original study represented 116% of the speed at which max VO2 was reached. We do have to make a leap to human runners (which the authors themselves took the liberty of doing), but the given parameters of Dudley's study are going to include reps at mile race pace for humans. I believe a few of the later researchers did try to justify use of all-out sprint repetitions in their HIT protocols by taking Dudley's findings a bit too far.

Longer training activity results in larger more mitochondria. So does shorter interval sessions. HELLO TO 1950. You don't train for the 800 by running focusing on long training session and you don't train for the marathon by focusing on short intense sessions.

Hence the mention of specificity, which (as you said) is what most of this is about. I did read all of paragraph 2 and wasn't just reading what I wanted to read. **Because** of the diminishing returns of many benefits as exercise durations are increased beyond certain points, occasional inclusion of shorter, faster work is useful. **Of course** it's not all about mitochondria and we don't "focus" on mitochondria **at all** when we run. HIT probably does a lot more for mechanics and economy than it does in promoting mitochondrial growth anyway.

... saying that you are running 10x400 or 20x400 **--- for ---** different cellular responses is off focus ...

Ah, but that's misreading my original post. The initial question inquired about the **benefits** of workouts, not our reasons for choosing those workouts. One of many benefits we get from doing fast reps is mitochondrial biogenesis. But we don't do a workout with the specific **intent** of creating more and bigger mitochondria. We do the workout because our own experience and that of thousands of other runners leads us to believe now is the right time to include this workout in our routine in order to give ourselves a good chance of getting excellent future results. **That** is "why" we do it - what we do it "for" (there - it turns out at the end of the day we're on the same team after all). But that wasn't the wording of the original question. It asked specifically for some benefits conferred by doing different workouts. Not all benefits; some benefits. I listed some. Increased mitochondrial content in a variety of muscle fibers is one of those benefits.

PS - I wasn't being condescending with the logic example. I just couldn't resist using some made-up words like miblurps and squeezoids.

--*

J.O. wrote:

Worrying about the best way to maximize mitochondrial mass is silly.

That's exactly right. See, I do get where you're coming from here. I really do. I've seen plenty of people blather to support an agenda-related stance that frankly has very little (or even counterproductive) practical use. I just don't get the need for the original "football hooligan reacting to a questionable call" impersonation. When the subject has come up (quite infrequently, mind you), the prevailing view among the people I've chatted with - people who were long-time serious runners first and exercise scientists second - is (and I quote one of them) "For mitochondrial development, intensity is preferable to duration." If it's bullshitology, so be it. I'm just relaying what I've learned from others I have no reason to doubt. Don't. Shoot. The. Messenger.

Bullshitology, BTW, is pronounced with a medium stress on the first syllable and a heavier stress on the third.

But I see where you're coming from. People suggest practical applications for fizzyology at the expense of the basics all the time. In the end, mitochondria have no bearing on **why** someone would do 10 x 400 as opposed to 20 x 400. For the record, as much as this thread smacks of an article straight out of Peak Performance, I did **not** mention any principle for the purpose of **application**. I never advocated **selecting** one workout over the other because of anything to do with mitochondria.

There are barmy types who stubbornly harp on some isolated finding in a decades-old or obscure study (regardless of its truth or falsehood) to justify some laughable, cockamamie training concept that's already been put under real-world trial time and again and has rightly been rejected. For example, Richard Gibbens likes to cite this same 1982 Dudley report in his "Power Running" manifesto. Not to single him out for ridicule, but he's posted as Richard_ on this forum in the past, so he's fair game. Guys like that not only can't see the forest for the trees; they incessantly try to nurture the only birch tree in the forest and don't notice that rest of the forest is comprised of Douglas-firs.

But I'm not cut from that mold. As I said, at the end of the day, I believe we're on the same team. I'm not using fizzyocrap with the intent of **advocating** anything here, and I take as dim a view of that nonsense as anyone ever has, because 1) a theoretical approach **doesn't work** in the real world and 2) it wouldn't qualify as the primary justification for doing something even if it did work.

The bottom line is that we do workouts to improve our race results. Are we getting fitter and faster and are we moving up the pecking order? I previously mentioned the notion of doing workouts with the right timing. The concept of "now is the right time" for including a workout is quite important. Even if it's executed to perfection, if it's included at a very inappropriate time, something might not turn out as well as it could. Everybody pretty much knows what kind of pace, how many reps, and how much recovery between reps make for good guidelines to follow for these **individual** workouts. Hence, in threads about workouts, you'll get the same responses from many people concerning pace, rest intervals and number of

reps. What is very hard to communicate is how to formulate the overall game plan, since that depends on too many things - age, experience, the type of athlete someone is (fiber composition, etc. do play a role in this), psychological makeup (this might include something like whether a guy is a workout king or steps it up to a different level on race day), what kind of workouts were done during the last 12, 8, 4, 2 weeks, susceptibility to injury, and so on. People who rely on "scientific training" aren't going to grasp **any** of this.

I think you would also use your knowledge better for coaching purposes, if you were equally skeptical of certain areas of dogma in the field of sports science.

Up until about a decade ago, I was as gung ho about that prospect as anyone has ever been about any subject. Unfortunately, the spirit of the sport that was so prevalent in the 1970s was missing among the vast majority of would-be runners. I came to realize that it was **unhealthy** to "want it more than the athletes." Other runners from the 1970s and early 1980s shared the frustration and suggested I should give up on the USA and move to Mexico, where the runners of the time were committed in both thought and in action. This idea that it's bad for the sanity to want it more than your runners is a notion that I've also heard Jack Daniels and Mick Byrne express (perhaps with different words).

In some ways, guiding somebody along a career trail can be rewarding. Even after 100 journeys, it never gets old to say, "Another 50 yards ahead, you should be coming to a gnarly old oak tree. You can either go left there or can go straight ahead. Going left takes longer and some people find it a little less scenic, but it's not as rocky. It's up to you, but based on how you handled that rocky patch a few miles ago and the fact that you like to take your time and not care about the view, I think going left will work out better for you."

But my thoughts on what a runner's long-term goals should be have generally been much more demanding and far-reaching than the willingness I've seen in these runners. Additionally, no one ever knows how far along that trail they will get during their career, and I see far fewer runners now who will do it for the enjoyment of the journey itself; rather, they seem entitled to the guarantee they will reach a specific destination. Alas, this is too frustrating to deal with for a perfectionist and a purist runner like I am. It's downright unhealthy, in fact.

So we can agree about one thing - let's start over and forget about mitochondria. Look where it's gotten us.

--*

J.O. wrote:

... they way we develop this as kids is how we should continue to develop at any age.

Of course runners rely on both stride length and stride frequency, and each runner may favor one over the other for any given speed when compared to the average runner at that speed. It could be that the best distance runners in any given era will be faster than those in previous eras by virtue of being able to transfer greater power into increased stride length as opposed to increasing stride frequency. Kenenisa Bekele seems to have longer strides and lower stride frequency at a steady tempo than some of the other elites have.

Either way, runners who favor force (longer strides) at pace X are going to be using that natural trait whenever they train at pace X anyway, so there probably isn't a need for a lot of supplementary work designed to maintain their force or to consciously improve it. Nor is their any need to go overboard with exercises intended to make that runner slot into some predetermined "ideal" stride frequency. It would be square-peg-in-round-hole silly to waste valuable training time making a long-legged runner adopt a stride rate of 185 steps per minute just because most of the 5'5" elites of the era were doing it. I can't recall the stride frequencies of Jack Bacheler or Peter Maher, but theirs can't have been as high as those of Josiah Thugwane or Juma Ikangaa. In the same vein, if it happens that one of the 5'5" guys is more force-reliant (longer strides) than average, that guy is probably going to run best with that stride pattern, especially if those mechanics were arrived at through plenty of running at a young age.

Force-reliant runners seem to do better when they play to their strengths by regularly touching on that aspect of stride mechanics. But **because** they're force-reliant, they're doing that anyway whenever they train at or near the speeds of their preferred race distances. So resistance training, calisthenics or plyos above and beyond the cursory "supplemental" amounts might not have as profound an impact as some runners wish it would. Race-pace training goes a long way toward covering that base. Doing fairly short buildups which reach top speed for about 3 seconds (like sprinters do when they do short trials using speed gates) also helps for running-specific force production / stride length.

--*-*-*-*-*-*-*

If you aren't experienced enough to find the right pace by feel, you can't calculate it with only a 3,200 time.

You just want the fastest pace that feels like it's doing itself without a hint of distress and without a noticeable point of effort increase on your part. If you really aren't experienced enough to nail it down on the fly, odds are you'll go too fast in an attempt to hit some per-mile pace you've decided is the bare minimum acceptable speed. The "LT" is hard to pinpoint even in a lab (many people claim a single point of inflection doesn't even exist), so you won't know when you've reached your precise "threshold" during a run. But you can absolutely learn to recognize when you've entered the "foyer" of the House of Pain. This discovery process is mostly up to you.

Basically, you can't "calculate" an exact LT pace. You can get in the ballpark, but the "pace du jour" will vary depending on how far you're running that day, what the weather's like, how well rested/fueled up/hydrated you've been recently, what other workouts you've been doing, und so weiter

--*

---

dhdhdhhdh wrote:

Just saying "run by feel" without some starting point (formula) is NOT helpful to me as a beginner.

Here you go, then.

T = "Threshold Pace" per mile in seconds
A = 3,200 time in seconds
B = 5k time in seconds
C = 10k time in seconds

Now you have to do the number plugging, but ...

T = (0.5728 x A) - 2.6
T = (0.2982 x B) + 60.6
T = (0.1575 x C) + 18.5

I gave the regression equation with a function rule rather than using tabular form (aka a chart) because it takes up less space and formats better.

That 10:08 3,200 gives a "T" of round about 5:46 mile pace. Better long distance runners might have a faster "threshold" pace than these equations predict, partly from nature and partly from immediate nurture. Relative to runners who do better at shorter or middle distances, the long distance specialists will also probably be more sensitive to where their yellow light pace is. Again, that comes somewhat from running habits and somewhat from having muscle fibers more suited to fine control and capable of holding a strong pace more efficiently and for a longer time. See how there's no precise predictor for threshold pace? But this should get you in the ballpark. Until you find the actual feel for a "tempo" run, the "T" pace above should be regarded as the speed limit. Don't go any faster until you figure out whether that pace is too easy or too hard. Then you can play around and be more spontaneous without using a watch, as in a "progression" run.

To assist in gauging the desired feel, try this as a "tempo" workout:

Warm up well, including a few short strides
Run 2 minutes at 10k race pace (if you don't know what that is, you can approximate it by figuring out "C" from "T" using the last equation above)
Walk/jog for 2-3 minutes
Run 20 minutes at 20 seconds per mile slower than the "T" pace you calculated above

Walk/jog for 3 minutes
Run 12 minutes at the "T" pace you calculated above
Walk/jog for 3 minutes
Run 4-8 progressively faster, relaxed, smooth buildups of 15 seconds each, with 3[0]-45 seconds jogging in between each one
Do a cool-down jog

If that adds up to too much running for a beginner, go for 12 minutes instead of 20 minutes for the first segment and go 8 minutes instead of 12 on the second rep.

It gets easier to find the right effort as you get fitter, more experienced and stabilized at the ideal weight. Then you'll have a better handle on how to feel on continuous runs of various lengths. Pace can take a back seat if desired or can be the main focus if desired.

--*-*-*-*-*

If the goal is to run as fast as possible in a time trial type of effort [over 800m], the best races statistically are run with each 200 about 3% slower than the 200 before it.

For a 2:00 race, running exactly 3% slower for each successive 200 would work out to splits of 28.68, 29.54 (58.22 at 400), 30.43 and 31.35 (61.78 second lap). So it's nearly 0.9 slower for each 200 at that level of racing. Obviously it's astronomically unlikely to run ***precisely*** 3% slower on each 200 (to the 1/100 of a second), and even if you could, you normally have to contend with wind or avoiding other runners. Furthermore, if you run these kinds of splits against competition of your same basic level, you're also guaranteed to pass a lot of people in the last 100 (most people slow down by 2 seconds or more in the last 200), so some running wide or weaving through the crowd might be in store for you. But a 3% slowdown for each 200 (or reasonably close to that, depending on weather and pack dynamics) is a pretty good estimate of ideal 800 pacing for most runners.

FWIW, if the current world record was run with a 3% slowdown on each 200, the splits would be 24.14, 24.87 (49.01), 25.62 (1:14.63) and 26.38 (1:41.01).

To sum up, if sub-2:00 is the goal, I'd shoot for a low 28 and barely under 58 and see what happens. If it's a bunched-up field, you usually only have one "move" in an 800. Don't waste it early. If it's a strung-out, time trial sort of race, you ideally have ***no*** moves - the whole thing is just a barely-controlled near-sprint that has a very gradual natural slowdown after the opening 200.

--*

Yeah. So just try it with an opening lap of 57-58. Once you get rolling down that first backstretch, how will you know if it's going to be a 57-58? You probably won't until you see/hear the split. It usually takes practice to get the 800 just right, to get a sense for how it's supposed to feel at various points in the race in order to have a good chance of holding on for a decent finish. Even with practice and racing experience, that last 100-150 is always a little dicey, and even if you're feeling great with 300 to go, you can never be 100% sure what you'll have in the tank half a lap later. So don't be afraid to race these things and maybe

screw it up a few times. That's pretty much the only way to get better at them and figure out how you run them best.

--*

t's only marginally on topic, but this stuff should probably be addressed:

---

ventolin^3 wrote:

from purely physics point of view, even-pace is most efficient, but small differences in splits make virtually no difference, so you are better off ignoring any particular ordained strategy & running the way you like

---

The second part (running the way you like) definitely should be taken into account a lot of the time, but the bit about pure physics and even pace really only applies to some theoretical machine that could draw from its various energy sources at an even rate throughout and would never have to allot any additional energy to accelerating at the start. Of course, a body isn't that type of machine. Its energy pathways don't always operate at a constant rate; nor do they interact at a constant rate. When running at a reasonable 800m speed, in the act of accelerating to speed off the starting line - and when running at race pace (even a second or two per 400 ***slower*** than 800 pace) - the lion's share of contribution from anaerobic pathways (phosphocreatine and glycolysis) occurs pretty early in the race. The overall energy distribution is 55% to 65% via aerobic metabolism (closer to 55% for a race of shorter duration - i.e., 1:41 as opposed to 2:30) and 35% to 45% anaerobic, with the contribution from aerobic metabolism rising continually throughout the event. The best strategy with the kind of speeds involved in the 800 is to recognize the need for ***some*** sense of pacing, but to get a faster-than-average-pace start and make the most use of the anaerobic pathways early, while they're delivering their peak contribution to the effort. Get the ball rolling, so to speak. In this way, you can almost cop a "free" second or two versus trying to run at a perfectly even pace. Are there some runners that might be the exceptions to this "rule"? Yeah, sure, maybe. Those are probably the guys who aren't too fast at 400 and ***can't*** run the opening lap very much ahead of pace without being maxed out early and tying up like a big dog.

So it even makes sense in ***theory*** to try for a slight positive split in a PR attempt at 800. Of course, new measurement techniques will arise and there will probably be future research that calls into question or even refutes outright the findings of all that research that was done between 1994 and 2006, which primarily used the accumulated oxygen deficit method and measurements of changes in muscle substrates to assess the contribution of the different energy systems during various events. But at the end of the day, you know what? Theory is buggar-all. Actual performances paint a better picture than small-sample lab research ever could. Sure, a number of championship 800m races have been won with even or negative splits, but - despite all the attempts to tinker around with record-setting 2-lap strategies over the decades - only the tiniest number of career-best times are achieved this way. If records continue to fall, some people might conjecture that there will be a tendency toward even splits. But I'm guessing that ideal splits will still be positive (though perhaps slightly less positive). Why? Because if 800m runners as a whole get

faster, it stands to reason that more of the pool of 800 specialists will also be faster at 400, allowing the vast majority of them just as much wiggle room between top-end 400 speed and average 2-lap pace as people have now. They'll still be getting out ahead of average pace without having it be ***too*** fast. Will there be exceptions to that - people who run their best evenly or possibly with negative splits? Yes, but there always have a been a scant few.

Coach 432 wrote:

Your body starts aerobic, then switches to anaerobic when, because of the intensity, the aerobic system can't catch up. By 600m, you are primarily using your anaerobic system, thus you are experiencing lactic acid (the by-product of anaerobic respiration).

Your body starts almost exclusively anaerobically and - while energy-supplying processes overlap and interact - it takes time for the aerobic energy production to reach its maximal contribution, but when it does, it dominates. In an event as brief as the 800, peak contribution from anaerobic energy pathways occurs rather early in the effort and continues to decline throughout, while contribution from aerobic metabolism rises, although VO2max is not reached in such a short time.

New research suggests that it is the hydrogen ions produced during anaerobic respiration that actually screws up the nerves in the muscles and causes you to slow down.

On a geologic time scale - i.e., by comparison to when the Burgess Shale was deposited - yes, that research is brand-spanking-new.

--*

---

ventolin^3 wrote:

not all of it will be used in going out in a 800 as no one is blasting the initial 100m at full speed - you may use part of it in the 1st lap

---

No duh, you're not supposed to deplete ***all*** of your PCr in the first 100 of an 800. Re-read above - some attention must be given to pacing. You may have some PCr in reserve, but you use ***most*** of it in the first 100 even if you start slightly conservatively, and it isn't resynthesized during the next < 2 minutes in the

midst of 800m race intensity. Take optimal advantage of the readily-available energy systems while they're able to deliver their peak contribution ***and*** while coordination and acuity are highest.

---

i saw kip run that zurich race live on tv ... he went thru in 48.3 ... he held on to smash the wr by 1/2s with his 1'41.24

Well, diddle my doodle. Another positive-split world record. Never would have seen that coming.

Bottom line, the most important concept when looking for "a leg to stand on" is this: Studies, schmudies, theory, schmeory. ***Look at how the athletes run their fastest races***. Thousands upon thousands of them spanning several generations have attacked this puppy from all sorts of angles in an effort to get it right through the most revealing and applicable method in all of science - real-world trial and error. By-and-large, what are we seeing them do when they run career best 800m times? Who wants to field that slow roller?

--*

Oh, brother (palm face). HWGA, HWGA, HWGA - prattling on about our own small-sample test results, trying to fit them to our personal models of what we wish was true, and demanding "proof" in the form of other pseudobabbling, mental-masturbatory research if something doesn't support our view. I do it too. But you miss ***the principal point*** (see below), which provides proof concerning the original topic.

---

ventolin^3 wrote:

you are stating generalities

What's wrong with that? It's a generality that people tie up somewhere near the finish of an 800. You'd like to know if it's at 689 meters or at 742 meters, but the thing we know is true is that they tie up. Not knowing exactly where and when doesn't make the general observation any less factual.

In that vein, I don't know the figure for what percentage of PCr is exhausted in the first 87.932 meters of the 800 (or are you insisting the value for the first full 100 is the important value?). But I do know that Paul Gastin (who has contributed to research on the accumulated oxygen deficit method for measuring contributions of different energy systems to exercise) and colleagues have found that the contribution of the ATP-PCr system is negligible (and remains negligible) after the first 20 seconds in supra-maximal 90-second all-out efforts and after the first 25 seconds in constant-intensity exercise at 110% of VO2max (the latter test often lasting over 3 minutes). I can't imagine there is significant regeneration of PCr (if any at all) during an all-out 2-minute event like the 800, especially with the associated low muscle pH. Yes,

"negligible" and "significant" are more of those irritating generalities, but Chuck U. Farley sez: "Who Cares? Contribution from phosphocreatine after the first 25 seconds of a hard 800 ain't squat."

That's the best I can offer at the moment. Finding sources might take time I don't have this weekend. The articles might require subscription anyway.

---

what has that got to do with the physics aspect ???

It doesn't matter, as you should soon see when we arrive at ***the principal point***.

We post this crap on here and we can often all be "right" as far as presenting data and citing sources, except that when we try to interpret the data, we're making assumptions and conjectures.

F'rinstance, the stuff I posted about the contributions of various energy systems and the time frames involved is correct (as far as we currently know). The part you alluded to about how phosphocreatine can resynthesize with enough available oxygen is ***also*** correct (although it won't resynthesize during an effort where muscle contractions are forceful enough to create ischemia and reduce available O2, but blah, blah, blah). What is a ***guess*** - not SWAG, mind you, but a very reasonable guess based on actual data - is that people normally positive split their best 800s in part because it's advantageous from an energy distribution standpoint to get the ball rolling early when 800m velocities are involved. Yes, it's partly a guess - theory, you might even say - but let me repeat ***the principal point***, since it seems some people aren't getting it ... (wait for it) ...

THEORY IS BUGGAR-ALL.

What is ***not*** a guess is that an overwhelming majority of serious competitors have historically run their fastest 800s with positive splits. Nor is it a guess what the average slowdown on the second lap is (or, for that matter, on each successive 200, since enough splits are available to figure out that tidbit as well). As is the case 100% of the time, when I type something about real-world application, that's the way it is. Not because I say so (although that will be good enough for you, if you have any sense), but because that's the way it already was. I just gathered the data and ***then*** said so.

Oh, wait - I think I hear that verse again. Come on! You all know the words! ...

THEORY IS BUGGAR-ALL.

So here's what I'm going to suggest to any butt harlequins, glute jesters, rump fools or ass clowns who honestly cling to the imbecilic fantasy that most 800m runners would run better if they'd only employ even splits or some "perfect formula" based on iron-clad rationale using fizzix ...

Let's gather a couple of hundred career-best 800m times from the really deep all-time list at tilastopja.org,

ferret out the ones that have intermediate splits available (might take some digging) and see what we get, m'kay? I say we get the astonishing surprise (cough, sarcasm) that most of those performances were done with positive splits. So hang on ... what's the matter with those incompetent, self-sabotaging might-have-beens? Didn't they know they were just spinning their wheels by getting out ahead of the pace they'd average? Surely after dozens of 800m races (or perhaps more than 100) during a career (not to mention watching hundreds or thousands of other competitors and trying to learn from those races as well as their own), they would have by chance run (or seen) a couple of "perfect" races where they hit upon the "lawz o' fizzix," avoided those unprofitable positive splits, and figured out even or negative was the way to go. Amirite?

(subliminal message follows)

THEORY IS BUGGAR-ALL.

Know what else I'm willing to bet on? The average slowdown of 3% for each successive 200 (within 0.2%). And just why am I sooo confident that will be the case? That's right! You get a gold star! It's because I ***cheated*** and already crunched hundreds of these numbers over the years and they always turn out the same! Did it with high school and college runners as well as internationals, too. You just don't wanna take that bet (or any other one) against me, Chief Spread Eagle. Why, that would be like calling my all-in wager, me showing A-K of spades, watching Q-J-10 of spades hit the flop and ***insisting*** you be allowed to keep betting additional cash on your own worthless hand. That's pretty much what people do around this place, though, and it all amounts to bringing a ... well, nothing ... to a gunfight. Yeah, you already know the answer to this one. Everyone knows it. Most people run their fastest 800s with positive splits. If you've hung around track meets for even 5 seasons, you can eyeball this bad boy without having to go to any deep lists for validation, and it turns out your eyeball is right. If you only watch 800s on TV or video, you might see more championship rounds and finals which go out slower than a rabbitted record attempt, skewing your perception on how optimal ***fast*** 800s are normally run.

--*-*-*-*-*-*

HRE wrote:
More miles done by more people.

Yep. Back then [in the 70s], there were a lot more roadies - many times more - who focused on longer distances and raced on the roads at least as much as they did on the track. The culture was different to the extent that the second- and third-tier types were every bit as serious about training and racing as the elites were. It seems like these days, if there isn't a guarantee of making a decent living as a pro, not as many people pursue serious marathoning, so the middle and lower tiers have dwindled in size.

As far as the training went, it was a lot of miles which included doubles 5 to 7 days per week. All the serious marathoners I knew, from the sub-2:10 guys to the guys in the high 2:20s and even a few of the slower ones, were regularly running between 100 and 130 per week - something like 5-6 in the A.M., 10-

13 P.M. on most days. Some did even more. The bread-and-butter hard workouts were fairly long (usually around an hour, sometimes longer) runs at marathon goal pace or faster. Ten to twelve miles at a good strong pace was a staple.

--*-*-*-*-*-*

[workouts to do 72hrs before a mile race]

Totally Unimportant Race -

Go ahead and run something hard 3 days prior and let the race itself (and the pre-race strides) serve as a reduced volume of additional pace work. Something like:

* 400 at mile "date pace" (current pace or your best estimate of it), 30 seconds walk, 800 at the same pace, 1 minute walk, 200 at 800 "date pace," 4 minutes walk/jog, 2 x 400 at mile "goal pace" with 1 minute walk/jog after each rep, 200 at 800 "goal pace"

(So if you can run 1:56 and 4:20 at the moment and realistically hope to run 1:52 and 4:12, try to hit 65-2:10-29 for the first set and 63-63-28 on the second set)

OR

* 4 x 400 at current mile pace with 1 minute walk/jog between reps, 3 minutes walk/jog after 4th rep, repeat 4 x 400 with the same protocol (3 minutes off after the 4th rep), 2 x 400 at 1-4 seconds faster than current mile pace with 1 minute walk between reps

Regular Mid-Season Race -

* 4 x 200 starting at current mile pace and cutting down to 800 pace with 1 minute rest between reps, 3 minutes walk/jog after 4th rep, 4 x 400 at mile pace with 1:30 walk/jog after each rep, repeat 4 x 200 as per the initial protocol

OR

* Just use that old Villanova staple that malmo cited - 6 x 400 at goal pace with a lap jog between reps - since it's almost identical in intensity to the workout directly above ... guys like Mark Belger, Eamonn Coghlan, Don Paige and Sydney Maree did this nearly every week for a few months a year (of course, they had high enough general fitness that they could easily step up in distance from their bread-and-butter events), so you can't really go wrong with it - unless you hammer the reps too fast!

Extremely Important Race -

Do your last really hard, tying-up, knee-grabbing goal pace workout about 12 days prior to the important race (absolutely no closer to it than 10 days away) but 3 days away, use something like:

* 5 x 150 starting at mile pace and cutting down to 800 pace with 60-90 seconds between reps, 5 minute jog after 5th rep, repeat 5 x 150

Don't fall into the trap of treating every race as being so important that you always use this taper workout 3 days before it. You'll eventually lose fitness for sustaining your race speeds unless you're doing mid-week races.

--*

---

6 x 400 at goal pace with a lap jog between reps

My bad. The cited workout was at 800 pace, which you probably should reserve for one of those midweek workouts before a pretty unimportant race - unless you've been doing a similar workout every week for awhile like the 'Nova guys were doing.

That one's actually really tough. For a midweek workout before a mid-season mile race you want to be rested enough to do well in, I'd just go with 6 x 400 at no faster than 4 seconds (per 400) quicker than current mile pace with a lap jog between reps. If you're in 4:20 shape, that means you can run them as fast as 61, which will still be a medium to hard effort even with a full lap jog for your R. It's not a ton of stimulus, but this assumes you're doing enough other fitness-oriented stuff often enough that you can get away with only touching on a reduced volume of race pace during some weeks. Save the 6 x 400 at 800 pace for your "harder" days. A lot of people find it's actually quite difficult to complete 6 400s at 800 pace.

I believe the staple 'Nova mile pace workout was **10** x 400 with a **200** jog between reps. That one's nearly identical to that workout I gave above (4 x 400 + 4 x 400 + 2 x 400 a little faster).

--*

Oh yeah, all of it assumes you've done a progressive amount of touching on these speeds in the weeks leading up to full-fledged "workouts." You also need to remember that workouts at mile race pace really only make you more race-worthy within your established fitness level. By themselves, they don't allow you to dramatically "change fitness levels." Only steady mileage and proper progressive tempo running at the right pace (not forcing it all the time), with some regular inclusion of short strides (maybe some drills) for variety and snappiness and the occasional "hard" overdistance efforts - **and then focusing more on the regular race pace stuff** - will give you a quantum leap in fitness and performance.

As an example of copying workouts and misusing them, I know of one university track program that changed coaches back in the 1980s and the new guy tried to use those regular Villanova track workouts to the letter. Week after week, it was 10 400s here, 6 400s there. But the new guy only focused on the track workouts and not on baseline fitness. As a result, almost every guy on the team was close to a personal

best very early in the indoor season but was either hypertrained (crashed and burned) or injured by the start of the outdoor season. Very few ever ran as fast in their entire time there as they did in their first season, and those who had been on the team prior to the new coach's arrival also got worse. Most of them were piss poor cross-country runners and they battled each year to stay out of the cellar in their conference, whereas they had had a decent team (always in the upper half of the conference) before. Even many of the middle distance runners in the previous regime were okay at cross, but the new middle distance groups averaged, gee, it had to be nearly two minutes slower on 8k/5M courses.

The take-away message is that mile pace workouts by themselves don't make the miler. Of course, 100 miles a week all year with a bunch of tempos and practically no mile pace work won't get you as good at the mile as you could be, either. It's more intertwined than that. These "mile workouts" you see in this thread (or anywhere else) have to be taken in context.

--*-*-*-*-*-*-*

[foods to help out with depression]
Number one: Cut out simple sugars. They play havoc with serotonin levels. Replace that stuff with raw fruits and vegetables to assist digestion.

Eat the protein portion of a meal first.
Chew your food more thoroughly.
Avoid icy cold water. Drink it cool but not chilled.
Get more essential fatty acids.

--*

Python wrote:
Do you mean refined sugars?

Yes, refined sugars.
Chances are, the longer the list of ingredients, the worse it is for you.

Corollary: If it can spoil, eat it (before it spoils, of course). If it cannot spoil, do not eat it.

I'm a hypocrite myself when it comes to this, so do as I say, not as I do.

--*-*-*-*-*

Block training is markedly more effective in low-impact or no-impact endurance sports (cycling, swimming, etc.) and even then should be postponed until late enough in the career that the athlete's training volume has reached the point where the risks outweigh the returns in economy and traditional periodization no longer confers the dramatic effect it once did.

If you did choose to do it, normally you'd do 2 x 20 minutes at or slightly below the theoretical or observed AnT as a session each day for several days, take a few days of very easy exercise or even complete rest, then go for another several days of the 2 x 20 minutes gigs. For your hypothetical 2-week

stint, you'd probably do 5 days of the 2 x 20 things, take 4 super-easy days, then 5 more days of the 2 x 20s.

Extremely mature runners who have been in the sport a long time and have a huge lifetime base or runners who are naturally economical at speeds close to the AnT are liable to benefit from this as a new stimulus after other stimuli have run their course, whereas less-developed runners who try it stand to risk not developing fully or to risk injury or hypertraining. Orthopedic stress and metabolic stress are intertwined enough that when a high energy demand is placed on a runner (especially a beginning or intermediate one), mechanical difficulty is likely to ensue - and vice versa.

Runners do benefit by touching on the same stimuli in smaller doses (maybe 15-20 minutes near the end of a run, rather than 40 minutes per day at that effort) through use of progressive runs, which can be done several days in a row. Again, the more experienced or naturally economical runners are the ones who get away with doing more of this running more frequently (and benefit from it more) than novices or less-talented runners.

--*-*-*

If these are going to be full-speed sprints [uphill], use sets of 5 to 6 reps with 30-60 seconds between reps within a set and 8 minutes between sets. That will time things so you partially exhaust the phosphocreatine system a little more on each rep and allow it to replenish almost fully during the 8 minutes between sets. This recovery assists in developing a more efficient stretch-shortening cycle, which is the goal of repeatedly doing these sessions. Work your way up from 1-2 sets at first to a maximum of 5 sets 6-10 weeks down the road.

If the reps are more relaxed, perhaps with each set starting at a medium speed and getting gradually faster on each rep, with only the last 1-2 reps in each set a full speed, you can get some benefit with up to 5 sets of 10 reps.

Be sure to stay as smooth and relaxed as possible and focus on popping off the ground quickly rather than fighting the hill so much that you feel like you're sinking into it due to a prolonged plant phase.

--*-*-*-*-*

Every Monday of my freshman outdoor track season, the distance runners did 20 x 400 in 68 with 45 seconds rest. Every Wednesday, we did (read: were supposed to do) 6 x 1,000 in 2:45 with 4-5 minutes between the reps. Oh yeah, every morning, we'd do a 5 miler which was supposed to be relaxing but which we'd end up running at a decent speed because some dumbass freshman (alright, it was me) would start half stepping everybody else. Durrr!

The Monday one wasn't always that bad, but it was normally harder than it was supposed to be for most of us. Only about half the guys didn't struggle with it. The Wednesday thing might have been a good effort for a 14:00-ish 5k guy. Trouble was, we only had two guys whose were faster than 14:30, and this

workout absolutely killed everybody else. I ran 14:57 that year and the best I averaged on this was 2:47. Hardly anybody hit 2:45 for more than 3 or 4 reps. Well, maybe the coaches thought it's D1 track and field, so either suck it up and hang and hope you've got what it takes or just forget about being competitive. Who knows?

Whatever. Those workouts are ones top level college runners can do without tearing themselves down, so that's not the dumb part. Here's the dumb bit:

Between those fairly tough to killer workouts, we were normally on our own and, as you'd expect, we'd take it easy peazy lemon squeezy. But one Tuesday - O one fine Tuesday - the head coach decided to take a break from watching the sprinters and give the distance runners a little more attention. Our straight-from-the-horse's-mouth instructions for our easy run following our morning 5 miler were ... "Today I want you to do a relaxing 15 mile run with the first 10 miles at a nice, comfortable pace - about 5:30 pace ..." We started laughing here. "... about 5:30 pace, and then I want the 11th mile in 4:30 ..." BAHHH-HaHaHaHaHa! April Fools! No, wait, it wasn't even April. Uh-oh, Spaghetti-Os. "... and then I want the last 4 miles back at a nice, comfortable pace - about 5:30 pace."

So there you have your recovery day between grab-the-knees-and-suck-air workouts - a 20 mile day with 14 miles at 5:30 pace and a 4:30 tossed in there. I heard Craig Virgin did stuff like this between hard days sometimes, but last I checked, we didn't have any sub-27:30 guys on our team; in fact, our fastest guy was 29:30 and most of us were around 30:30 to 31:00 on a good day. I guess if there wasn't a Craig Virgin within each of us, waiting to be challenged with Craig Virgin workouts before it could break free, we just weren't cut out for college running.

--*-*-*-*-*-*-

If your doing 1,000s [for a VO2max workout], use 6 reps with 2-3 minutes active recovery periods (walk/jog) at somewhere between your CURRENT race pace (not goal pace) and about 6 seconds faster per 1,000 than that. If you're in 16:40 shape, the reps would be in the 3:14-3:20 range. That gives a total of just under 20 minutes of running at what should average 1% to 2% faster than you can currently run for 5,000.

Doing bulky (long reps) workouts like this at what is a hard pace at the time can ultimately sap you if they're done for months, so if you aren't even within 30 seconds of your all-time 5,000 best, it might be better to hold off on doing full-fledged "hard" reps that are as long as 1,000 meters each until you get comfortable doing fairly short reps at near your goal pace. This process can begin 3-4 months prior to the time you want to be in peak shape. For example, following a medium effort "tempo" run (which you were smart enough to stop while you still felt good), you could do a few short strides and tack on 4 x 400 at around 80 (maybe 75 on the last one) with nearly full recovery, so there's no struggling. A couple of months down the road, this might gradually morph into doing more 400s with shorter recovery intervals. Eventually, the entire workout could be 15 x 400 with less than a minute rest between reps - "tempo by quarters" so to speak. Note that it's become 6,000 meters worth of work, just like the 1,000s will be a little

later, but the reps are still short enough that you should be in no distress if you keep at least 2/3 of them around 5,000 PR pace (the last few maybe 2% to 5% faster) and don't go overboard trying to crank out the fastest possible average. Realize that tons of runners CAN bang out 15-20 quarters at faster than current 3,000 race pace (that's 3,000, not 5,000) with short rests, but just because you CAN do something doesn't always mean that you SHOULD. Doing them at 5,000 pace (or barely faster for a few) should leave you feeling like it might be too easy if anything. If you can do that and still feel like you're recovering quickly and are on the way up rather than fighting your body, you're ready for the extension to longer reps.

Following a hard 6 x 1,000 workout, go ahead and take two really easy days - maybe even three - if you need them. If you find it increasingly common to be in the hole after two consecutive easy days, you probably HAVE been running too much hard stuff for too long.

--*-*

Like I said, the full-fledged "hard" stuff can only be done for so long before it gets risky.

You CAN do a few short-length reps at goal race pace from time to time all year long. That would be 4-6 150s at 1,500 pace or a short to medium number of reps of 300-400 at 5,000 pace or 2-3 sets of 5 buildups of 15 seconds each culminating in 800 pace or faster for the last 1-3 reps in each set. Plenty of recovery on everything.

Just keep in touch with this stuff for fun and variety and let it gradually segue into "workouts" by September. Even by the end of August, when you might be doing more of it in a workout, it should feel like a "strong but not hammering pace" that is stopped while it still feels good. Use full recovery early, somewhat less later as basic fitness improves and as long as you're still holding back.

Everything you do for a few months is for the purpose of forming and strengthen the building blocks you will need later and then establishing the basic routine they will be structured in so that you be prepared to accumulate an ideal amount of time at your RACE PACE when the time is right. Race pace is what it's all about, and you can touch on it all the time, but before you can handle a HIGH amount of work (relative to the event) at that pace, your conditioning in many separate aspects should be well-founded and gradually integrated in combination before all the aspects are put to a demanding test at the same time.

--*-*-*-*-*-*-*-*-*-*-*

Strides are normally somewhere around 10-25 seconds in length with the majority of a rep at even speed (as opposed to building up speed for a large portion of it) and should usually be between 1,500 pace and 5,000 pace during the off-season, with faster ones added more regularly as a season progresses. They are used for:

1) Warmup / range of motion prior to sustained medium-speed to fast efforts.

2) During general conditioning (i.e., base training), to help build mechanical soundness with low levels of distress, thereby maintaining and reinforcing efficient movements.

3) Activating muscle fibers further along the spectrum toward "fast twitch" after other fibers have been fatigued from a medium to strong aerobic effort - again with efficient movements and relatively low levels of distress.

4) Briefly re-activating muscles (and the circulatory system) following short to medium-length workouts of somewhat high intensity in order to take up lactate - once again with high efficiency and relatively low levels of distress.

Since this question concerns strides following a workout, we'll assume "workout" means a medium day or a hard day, so we're talking about principles 3 and 4 above.

Examples of principle 3 are:

A) (5k/10k specialist) 65 minutes progression run, 3-5 minutes walk/jog AND THEN a short set of light form/ROM drills PLUS 6-10 strides starting at about 5,000 race pace and culminating with a few closer to 1,500 race pace.

B) (1,500 specialist) Warmup which includes some strides (following principle 1 above), 12 minutes at 80% of 1,500 race pace, 2 minutes jog, 8 minutes at 82% race pace, 3 minutes jog, 4 minutes at 88% race pace, 5 minutes walk/jog AND THEN 2 sets of light form/ROM drills PLUS 6-10 strides starting at about 3,000 race pace and culminating with a few closer to 800 race pace.

In each case, since the effort was a strong aerobic one with everything done at slower than specialty race pace, the next aim is to spend a brief amount of time at or near race pace while the initial energy systems are somewhat fatigued but to curtail each stride (as well as the cumulative overall effort of the strides) before efficiency is sacrificed. This enables you to call up the "fast twitch" fibers while in a state of physical AND MENTAL fatigue. Since the aerobic aspect of the workout (along with overall weekly workload) created a small depletion of glycogen in slow twitch AND fast twitch fibers, recruiting the FT fibers while they are in this state provides additional stimulus for development of aerobic properties of the fibers. Workouts like these make it easier to segue into doing more work at race pace later on without undue strain.

An example of principle 4 is:

Warmup which includes drills and short strides (invoking principle 1 above), 3 x 600 at current 1,500 pace with 2:00-2:30 recovery periods, 5 minutes jog after the last rep AND THEN 6-10 strides of 10-15 seconds each (slower to faster) which culminate with a few strides at around 800 race pace. If you're already fully inured to workouts at 1,500 pace, you can probably do 5 or 6 600s at that pace, so 3 reps isn't all that much. But there are sometimes reasons you want to curtail the session. Maybe it's early in the season and you want to avoid overkill, or maybe there's an important race in a few days and you decide to do less than usual to rest up a bit extra. Doing a set of strides after your HR has returned to near resting level will help take up a bit of the lactate incurred during the reps AND will provide additional time spent at the same basic pace without causing laboring or tying up. Counting the warmup strides, the 3 x 600 and the following strides, you're getting 3,000 meters or more at race pace - enough to make a dent in race

pace efficiency without undue struggle, and a good precursor to adding more long reps at pace later in the season.

Following a FULL workout of high intensity (e.g., 5-6 x 600 @ 1,500 pace), doing additional strides might not be as helpful, since the efficiency is more likely to be sacrificed after "the tank has been emptied," so to speak. The maximum amount of work at race pace has already been accomplished by this point, and doing more would be overkill. To take up lactate following this hard workout, it's probably better to do about 2-3 minutes at somewhere near a "threshold" pace in the middle of a 15-minute post-workout jog. This is the type of thing you'd do during a tough "training through" stretch of work where no super-important race was upcoming.

Doing strides on easy days during a phase of hard workouts isn't as good as using the recovery days solely for regenerative running. That is, on a hard-easy-hard 3-day stretch, the easy day should be completely easy. You might feel a little flat on the second hard day after a total jog day, but cumulative fatigue is sometimes part of the training that's necessary for a compensation effect. If you want to come into a hard day (or race) with extra freshness, have TWO (or maybe more) easy days prior to the hard day and then you can do anywhere from 4 to 10 short strides at the end of the last easy day to wake yourself up a bit and feel a little sharper and looser for the hard workout (or race) on the next day. This is a pattern you need to test early on - even during lower-intensity portions of a season - to see how it works for you. Adjust it if necessary until you find what works best.

Strides build and maintain efficiency. Strides following strong efforts are precursors to spending enough time at race pace to develop not only efficiency, but economy. Economy is developed by accumulating time at race pace, but the energy systems involved must be active for periods which are long enough that your effort equals that which occurs between 1/4 and 3/4 of the way through your race distance. Strides alone won't develop running economy to any significance. In order to do that, you must invoke mid-race energy systems and effort levels and spend sustained time there. But doing short strides in a fatigued state CAN begin to develop oxidative properties in the muscle fibers recruited during races, and obviously touches on glycolytic pathways as well. Finishing a strong aerobic effort off with some short and fast (but mostly efficient) stuff also trains the mind.

--*-*-*-*-*-*-*-*-*-*

For the best mile indicator workouts, keep the rest periods much shorter and run at least the total race distance within a set before taking a longer break, and at least twice the race distance (i.e., 2+ miles worth of work) in the entire workout. Obviously, you wouldn't do twice the race distance (20k worth of stuff at 10k pace) in a pace workout focused on the 10k, but for 1,500/mile purposes, 3,200 to 4,000 meters of race pace or near race pace is pretty standard.

To use the 12 x 300 example, break it into only 2 sets of 6 (that's 1,800 meters per set - just over a mile) and take recoveries which are no longer than the run periods (maybe 45 seconds in this case). Then take that break of 4 minutes of walking/jogging between sets of 6.

I've always liked 2 sets of 8 x 300 with 45 seconds between reps and 4 minutes between sets, but not so much as an indicator workout as a fitness builder and as an indoctrination to goal pace. Might do that one

once every 5-6 weeks. This can be started off at CURRENT mile pace for the entire first set plus part of the second set, with the last few reps in the second set cutting down to seasonal GOAL pace or slightly faster. So let's say you can run 4:12 at the start of the indoor season and you hope to run 4:05 in a couple of months. In this scenario, you'd run 47 for all but the last 3-4 reps and would do those in under 46, with the last one hopefully about 44. If a mid-season race is a 4:08, then the next time this workout is done, it's time to run in the low 46s for the early reps and still do the faster ones near the end.

So rather than trying to use workouts with long rest periods to predict a race time, do workouts which are based more on what you already know your current fitness is. From there, get an idea of what a realistic goal is and spend ever-increasing amounts of workout time at that speed during your "race pace" workouts as the season progresses. Workouts that build fitness and which reinforce current race pace or goal race pace can be good indicators, but the rest periods must generally be kept short to get a clear picture.

--*-*-*-*-*-*-*-*-*-*

The threshold exists, but it's more of an effort-based concept than it is lactate-related. What was once thought to be an inflection point in lactate accumulation/clearance is now known to be more of a "foyer" than a "threshold." In other words, the precise inflection point either isn't measurable or doesn't exist at all.

But don't worry about that idea. That's not what threshold running is about. It's about feel and repeatability. You should be able to hit a "threshold" pace or "tempo" pace spontaneously on a regular run that isn't scheduled as a "tempo" day and you should be able to achieve the same pace several times a week and still feel like you don't need to count those days as hard days. It's like that's almost a default "once you get going at a good clip" pace and that you're on the way up fitness-wise - both metabolically and structurally - the more you run at that pace.

The reason that sort of pace is so effective isn't totally understood, but in the simplest of terms, it stands to reason that it's better than plodding and it's also better than struggling. The faster you can run easily and the more frequently you can repeat such a pace with a low effort-to-speed ratio, the better.

To shed some light on how "threshold" running benefits runners who specialize in races that involve faster speeds than that type of pace, it behooves us to look at two intertwined concepts - 1) Running economy at race pace and 2) Convergence of speed and endurance. This might seem long-winded, but bear with it because this is how running works in the real world.

Running economy refers to the energy requirement for running at a given speed. The less energy needed to run at pace X, the better the economy is at pace X. The energy cost can be measured in calories, oxygen uptake (formulaically related to caloric expenditure), amount of lactate produced (statistically related to caloric expenditure) or a few other measuring sticks, some invasive, others non-invasive. The concept of running economy can also be extended to figuring the energy cost of covering a certain **distance** at a given speed. So what does all that crap mean? Basically, your goal is to become more cost-efficient at running at your target pace. Good things happen when you can run fast without squandering energy. There are a number of ways that you can improve economy at goal pace, but the main way is to

get to the point where you can spend more and more training time actually running at that pace while operating in as relaxed a zone as possible and avoiding labored movements. The rub is that spending a great deal of time at a "racing" pace eventually becomes pretty hard on the body either from a mechanical stress standpoint or from a tying-up and struggling standpoint. So you need to have some fundamental building blocks in place which provide variety in stress and also allow you to preserve relaxation and efficiency as you segue into race-pace running. Hold onto that idea.

Convergence refers to training in such a way as to develop overdistance endurance and underdistance speed concurrently, starting with **slower speeds** for the bulk of distance work and **shorter distances** for the lion's share of the faster work, all the while progressively working toward centralizing on race pace from both ends of the spectrum and spending more time at race pace as the competitive phase of a season approaches. Short speed (and some isometric and plyometric drills) provides a general base for running economy at a wide variety of speeds. For the physi-geeks, this is primarily accomplished by reducing Golgi tendon organ (GTO) inhibition and by improving the efficiency of the myotatic reflex. All this reduces the amount of time spent in the plant phase and allows the running muscles themselves to produce greater force and power more quickly and with less inhibition. Plyos alone won't improve running economy for middle distances or long distances, nor will short bursts at faster than race pace - you have to spend time at your target speeds to significantly affect economy at those speeds - but (as stated) such training tools can be considered building blocks which facilitate and enhance future work. Faster speeds also normally involve greater stride frequency, which tends to foster forward propulsion and minimize vertical oscillation. The stride frequency issue is one reason why "threshold" running eventually becomes superior to "jogging" for improvement of running economy. At first, however, slower speeds (easier efforts) promote running economy through sheer repetition since more time can be accumulated in a relaxed state and since connective tissue is strengthened and small motor neurons responsible for stability and fine motor control are recruited for long periods of time without loss of efficiency due to labored movements.

The more time you can amass at a given pace without suffering structural breakdown (injury) or excessive metabolic distress (often a source of injury as well, due to straining in a fatigued state), the more economical you will become at that pace. Repetition and relaxation are the keys. This is a basic rationale behind interval training. The degree of distress can be better managed during interval training than in an all-out race; hence, more distance than the race distance itself can often be covered at race pace in a single session. But this amount of work is more safely and easily accomplished after a gradual period of convergence from the slower and faster ends of the pace spectrum, where relaxation can be nurtured over time. Without relaxation during the buildup of overdistance, you're too chronically stale to get as much out of the underdistance speedwork. It all dovetails.

Why is "threshold" running preferable to slightly slower running? Partly because of stride frequency (and associated reduction in vertical oscillation and increased drive) and because of the balance of glycogen and fat used as fuel as the pace gets faster. And there's more. But it **was** pretty long-winded already.

--*-*

Lactater wrote:

Sw******: Thanks for your lengthy response, if you have any wind left, I'd be very happy to read the 'And there's more..'

Wow, did I really type all that crap above? I was a bit drunk. The gist of it is that tempo runs and science (as people are thinking of it in the context of this discussion) haven't got a whole lot to do with each other. Not that they're completely disjoint, but running is all-inclusive and exercise science is restrictive in scope by comparison. In progressing through a season or even a career, the whole can be greater than the sum of the parts. Exercise science as it's employed today only examines the parts; moreover, it only treats training protocols as short clips of a lengthy film, and it's easy to forget that there's a **plot** to the film. To switch metaphors midstream (looks like I just **mixed** metaphors with that "midstream" quip), it's sometimes easy to lose sight of the forest for the trees.

The "and there's more" bit just means that it isn't only about tempo running. It's the process of fitness as a whole, as well as when and where tempo runs fit in. The pace, duration and frequency of tempo runs will change as a runner progresses through a career, and those parameters also depend on the physiology/psychology and event preference of the runner.

---

over-tempo pace in itself does not have some magical turning point where things go bad, from a training benefit point of view, other than the usual things that go bad if you go too fast, too often, or too soon?

Pretty much. Something's got to give at some point. General fitness with a gradual buildup of overall workload should precede specific fitness at a high workload. Converging on race pace from both ends of the pace spectrum, beginning with low-stress sessions which emphasize relaxation and high repetition, provides variety and lays the foundation for being able to handle more work at race pace later on. And remember, spending more time at a pace (or slightly on either side of it) creates economy at that pace and improves race execution. That's pretty much the purpose of general fitness - to be able to accomplish more work at race pace.

--*-*-*-*-*-*-*-*

I wouldn't recommend scheduling more than 2 runs longer than half the distance at goal MP or faster in the last 2 months leading up to a marathon (and probably none before that, since the fitness to hold the pace might not be there yet and getting in that kind of shape that soon might induce an early peak), with the last long MP run being 16-18 miles at 100% to 101% of goal pace about 3.5 to 4 weeks out, with mileage still being pretty high to ensure this run isn't done with a taper. During those last 2 months, you could have 2 or 3 additional singles of 18-22 miles that are fairly easy (about 80% of MP) for at least the first half of the run, with the option to progress in the last 5-6 miles toward MP or slightly quicker for 2-4

miles at the end.

Some people might run a relaxed but steady overdistance run (45k) or do 35k at close to MP every now and then, but that normally doesn't benefit the rank-and-file marathoner as much as simply getting a high and balanced overall training load.

--*-*-*-*-*-*-*-*-*-*

It's summer. Just take as much recovery as you need [during a 4x1600m workout] in order to feel ready to do the next rep at the same speed without struggling. It doesn't have to be very fast or challenging, either. Think of doing repeats in the summer as no more than breaking up the monotony of continuous runs and for getting familiar with the protocol of repeats. So they really don't need to be done much faster than a comfortably fast, feel-good continuous run. The fastest you really need in the summer for "longer" reps is around a "crest load" pace - the kind of pace you could currently run for about 40 minutes if you did a race of that duration. Repeats of longer than 3 minutes don't need to be any faster than that in the off season, but you do need about 25 minutes or more of time spent at that pace in a single session in order to get anything out of it. If you want a faster-paced structured summer workout (other than short strides or Fartlek), do about 3k to 4k worth of 400s or 600s at current 3k race pace and take as much rest as you need between reps on those as well.

--*-*-*-*-*-*-*-*-*-*-*-*

You can achieve VO2max during a flat-out 800 or you can achieve it near the end of an evenly-paced race that takes around 40 minutes to complete.

I wouldn't fret over finding an exact pace to call your vVO2max. Per jtupper's definition, it's probably somewhere close to 3k race pace and faster than 5k race pace, so use those figures as guidelines. Just run about 6k worth of reps of 600 to 1,000 meters each at 3k to 5k race pace and keep the rest periods the shortest they can be before you're ready to go again without tying up. You'll train all the "physical systems" you need to train by doing that, and - of equal importance - you'll become "economical" and attuned to race pace if you spend enough time at it without fighting your body and having forced, labored movements.

--*-*-*-*-*-*-*-*-*

A super-slow long run might be refreshing and regenerative both physically and mentally, and it can help novice marathoners with a lot of general beginner's fitness issues, including fat burning (and getting psychologically comfortable with long distances), but it isn't very likely to help an already experienced marathoner use fat more efficiently.

Probably because runners have often found an initial improvement from doing long runs at easy paces, there used to be a widespread notion that further use of these long, super-easy runs would continue to produce the same effects even in already fit runners. One of those effects was erroneously believed to be along the lines of fat burning - i.e., since the pace is so slow, it must be using fat metabolism, so that was

conjectured to translate into more efficient fat burning at marathon pace. But it turns out that's not the case for the advanced marathoner.

It's a mistake to think that by giving yourself the exact stimuli you were weaned on that you'll continue to adapt beyond what those stimuli can provide.

It's like if you want to be a math whiz - you have to begin with learning numbers and counting and basic arithmetic like everybody else. But you can't expect to keep learning if you do nothing but continue practicing homework problems out of your arithmetic textbooks while your classmates move on to algebra, then trig, then calculus, linear algebra, multivariable calculus, group theory, differential equations, topology, etc. Those classmates don't lose their ability to do basic arithmetic, but the time devoted to it can now take a back seat because it's established like bedrock. And they can still use the same study habits and learning **principles** they always did. But they're progressing and stimulating their minds with new material while you resign yourself to stagnating in comfort at the elementary school level.

In running, as you get fitter and faster and the seconds get harder to shave off, most of the overarching **principles** can stay the same, but the specific and practical **application** needs to **evolve** to stimulate your current physiology.

--*-*-*-*-*-*-*-*-*-*-*-*

Balance and moderation probably ARE good principles for general health and longevity. Continual pounding and hammering at a moderate to high level can bring about future problems. But some people prefer to be excellent at one specific thing, and moderation won't get the job done there. Single-minded determination and pushing the limits (sometimes beyond the limits) - those are a couple of the hallmarks of distance runners. Something has to give. Will it be future health (an uncertainty anyway) or will it be becoming the best possible runner while the door is open? For the runner, the love of excelling in that one endeavor overrides the potential risks. Plenty of runners would keep piling up the miles and hammering the pace on a lot of it even if they knew without doubt it would chop a decade off their lives. Why? Because a life in the here and now without doing what we've come to love and feel every day that we're wired to do, a life without achieving as much as possible, a life having to ask what might have been ... that life isn't worth living for some people.

Even knowing all along there were prices to pay in the present and other prices to pay later, I chose running long distances because the results (as well as the process itself) were so enjoyable and because both the addiction and the goals made even the most dreaded workouts and those days of "boy, running can really be a drag" or "I do NOT want to get up for this run" worth getting through.

Note to author: Better endurance for the general day-to-day living of the masses CAN be achieved in a short time (and with less overall stress than with hours of aerobic exercise) by using the "Wingate" protocols, but serious, top-end running is another story. That is a cat you CANNOT skin without a LOT of low-level and high-level aerobic running, plus a decent portion of that HIIT when it's the right time for it. And remember, the "serious running" cat - not the "general fitness with overall balance" cat - is the feline that a lot of us absolutely love skinning.

--*-*-*-*-*-*-*-*-*-*-*-*

You [to a poster who was a “workout hero” who couldn’t race well] might not be adequately warmed up for races.

This is a purely physical proposition which might have little or no bearing on the problem if you're just a basket case, but it can't hurt to try it out.

If your race is 3k or longer (but not as long as a marathon), do a standard warmup jog followed by about 8 progressively faster strides of 10-15 seconds each (if you do drills, add them in prior to the strides). Then run 2 minutes starting at about the pace you'd run for 8k in a race and finishing at about 3k pace for the final 30 seconds or thereabouts. You should have around a minute in the middle at 5k pace. Time your warmup routine so you are fully rested from all the short strides and so you start the 2-minute segment about 10 minutes prior to the start of your race. That gives you several minutes to recover from the 2 minutes at a strong pace plus enough time to add in a few more short strides in the couple of minutes before the start. If possible, experiment with this protocol prior to "tempo" workouts or workouts involving long reps like miles or 2k reps instead of springing it on yourself for the first time on race day. You might find that 2 minutes at 10k pace does the trick and that going any faster just makes you feel like you've gone too hard too close to the race itself. So tinker around with the basic template of this concept in a few workouts.

The first **continuous** couple of minutes of a workout which involves these speeds (3k through 10k paces) is a sufficient duration to activate your oxygen delivery system long enough to arrive at a somewhat stable O2 consumption rate. Prior to that, you're relying a little more on "quick energy" systems that tend to put you in the hole a little. When you're doing repeats, the first couple of recovery periods help get you out of the hole and you start feeling a lot smoother, with your breathing and stride rate in sync and with your effort much more perceptible and manageable. In a **race**, you don't have the luxury of a recovery period following the access of quick energy systems, and some people tend to **stay** in the hole, struggling a little more throughout the race than they do after those first couple of reps in a workout. Other people's "engines" do work in such a way as to get the O2 delivery "caught up" to meet their energy needs, and they can avoid staying too deeply mired in the hole too early in the race.

If your event is shorter than 3k, try following normal **short** warmup strides (these are usually less than 15 seconds each) with 6 strides of 25 seconds each at 1,500/mile pace, with almost full recovery between reps. Again, leave several minutes between the last of these strides and the start of the race or workout so you feel fully warmed up and fresh rather than unrecovered and not ready to go. Alternatively, you could use the 2-minute segment above plus several more strides of 10-15 seconds each, making sure the short strides are at basically the pace you'll run in the race itself.

As a memorable example of this "thorough warmup for a mile race" in action, in the summer of 1974, I saw Len Hilton (1972 Olympian at 5k) show up at a rinky-dink all-comers meet in a podunk town with a

water tower and a Dairy Queen as the main attractions. Some decent runners from a nearby larger city were there, but I knew most of them and figured no one in this meet could run 4:20 for a mile on the torn-up black top track if there was a werewolf chasing them at 4:21 pace. Now I was just a spectator for this mile, so I got a good look at Hilton warming up. I knew the name and the accomplishments of Len Hilton but didn't know that was him, even though he was wearing a Pacific Coast Club singlet. I thought it was just some "Fred" trying to impress.

Well, this "Fred" finished jogging and did a few 50s on the infield, then went to the track and began running 220y reps about 20 minutes before the start of the mile race. Started off with a 29. Did another one, then another, then another. He was jogging the half lap in between in about 1:30 give or take. Then he ran a 28, then another, then another. Then came a 27. That was 8 x 220y in 29 or faster. He looked pretty good, but I wondered why this guy was doing a workout (this qualifying as a real workout for me at the time) right before a race. Then after a few minutes, the guys began lining up, they got set, and the gun went off. "Fred" took out at what appeared to be roughly the same pace he was running on the 220s. Sure enough, he hit the 440 in 60. I wondered what he was smoking. After 2 laps in 2:00 and no signs of slowing down through the next backstretch, I began finally taking him seriously, saying out loud, "Who **IS** this guy???" 3:01 at 1,320y. The next guy was 75y back, then another few seconds more to a pack of 4, but that was of no interest. "Fred" was **still** holding pace. My jaw was on the ground. With half a lap to go, he even seemed to pick it up just a tad. At the finish - 4:00.5 hand time. On a poor quality black top track with no rabbit and no company for a single step of the way. 2nd place was a full straight behind. I had just witnessed something surreal and totally unexpected.

Anyway, try the more thorough warmup and get that "first 1-2 reps crappy feeling" out of the way prior to a race like you do in workouts. It might help. Being a workout king could stem from lots of things, some of them already mentioned here, but if you're good in workouts, it can't hurt to try out the notion of warming up for a race in the same fashion that gets you feeling strong mid-workout.

--*-*-*-*-*-*-*-*-*-*-*-*-*-*

---

malmo wrote:

Coaching has nothing to do with "workouts". Coaching is all about motivating and provoking athletes to above and beyond what they had ever imagined before.

This makes the assumption that the athletes will follow sound principles or will come to discover them on their own after being inspired to greatness. Individual workouts don't have to be EXACT if they use sound principles, so in that context (and that one alone), "workouts" don't matter.

But people can be inspired AND be led down a path to destruction by well-meaning but clueless wannabe coaches that do have a place giving motivational speeches in some context but should never, ever be concocting and assigning workouts.

If physical principles don't matter since they are trumped by motivation and belief, then I could stroll straight out of an inspirational lecture on the power of belief, fill two pots with water and summon all of my newfound motivation and mental imagery to compel the water in one pot to boil and make the other water freeze. Now, I think in the absence of physical catalysts, this is what people would call a miracle. And I'm not saying miracles haven't happened and couldn't happen this time ... but wouldn't my chances of success be infinitely better if I lit a roaring fire under one of the pots of water and put the other in a freezer?

See, the physical catalysts DO matter and achieving one's goal by following the proper physical principles is much more likely than if the proper principles aren't used. The correct "workout" for boiling water is the fire. Put the pot of water on the fire and it makes NO DIFFERENCE what you believe - the water will boil. Put the water in the freezer and believe with all your heart and mind, but it will never boil. In fact, it will have the EXACT OPPOSITE result of the one you believe so strongly will come to be.

Of course, athletic achievements aren't solely the result of mathematical training algorithms devoid of human spirit. Nobody's saying the dream, the inspiration, the desire and the courage don't affect the outcome - either of an individual race or of the day-to-day work toward that race and others. But it should be the coach's job to know good physical training principles from wacky ones and be able to guide athletes toward their own grasp of those sound principles - AT LEAST as much as his job is to motivate. Any coach who truly cares should want to motivate athletes to follow a path that gives a high probability of success rather than one that is more likely to lead to disappointment.

--*-*-*-*-*

Sw*****, get over yourself.

Saying that is exactly like a railbird telling a guy who just flopped a royal flush to **not** call 4 all-in bets.

So there aren't "proper" principles? Like sleeping enough? Recovering adequately from hard efforts? Then why not race a 5,000 every day of the track season on no sleep? Actually, by providing these sample workouts that have been staples for decades because they're tried and remain true, you're illustrating embedded principles as you type. Let's have a look at Jumbo's stuff again and see if it is sans principles ...

Every week from January to June. How would you define this schedule? Proper or not?
10 x 400
6 x 400

What's left out there - perhaps forgotten or perhaps for convenience - is what happens be-**fore** January, what the pace is for these 400s, what the recovery intervals are, what's done in between these workouts, and even if there **are** days during the week that involve something **other** than repeat 400s. Now you and I know the 10 reps are done at 1,500/mile race pace (not 600 race pace, mind you) with a 200m jog for recovery and the 6 reps are done at a faster pace - round about 800 pace - with a lap jog between. We also

know they aren't done on back-to-back days and we also know there is **some** element of recovery from using those energy systems on the in-between days. There might be an "easy" run that finishes at a decent clip in there if somebody's feeling frisky, but there isn't a scheduled workout of 10 x 1,000 at some unrealistic 5,000 goal pace between the workouts of 400s. As runners, if we **didn't** know this, we'd **assume** it. Why? Because we are so aware of the principle of stress/recovery that we hardly have to think of it as a principle to consciously follow or to include in our season-long plan. We think of it as plain old common sense that 10 x 400 on / 200 off would be done at closer to 1,500/mile race pace and **not** at 600 race pace, and that we wouldn't do 25 x 400 at mile pace. Embedded by default in the workout is a battle-tested and well-honed staple that 10 reps of 1 minute on / 1 minute off at mile race pace has historically been hard, stimulating, once-a-week-repeatable work but **not** overkill for a miler. We also know that if we have a beginning miler with a best of 5:00 (and a best 800 of 2:15), we would be doing that runner a disservice if on the second week of track practice, we said, "Every 400 in the set of 10 that isn't under 65 doesn't count, and when you do the set of 6 tomorrow - that's right, we're doing it the day after the 10 x 400 - those had better all be in sub-60. And the next day is an all-out 2-mile gut check."

Now that's just absurd, huh? Right now, you're thinking, "You've flipped your pancake, Fenwick. I'm not talking about **that** level of idiocy when I say the term 'proper principles' is a misnomer."

But I **am** talking about that. It's the reason I clicked on the thread. In fact, it's purpose of the thread. And guess what. There really are morons out there who run people into the ground and rob them of any chance they might have of finding joy and success in the sport. I've seen dozens them. I mean literally dozens - 36 I think it was (well, more than 24 anyway). And ruining the athletes isn't for lack of motivating them to aim higher than they thought possible. It's because "proper" principles **do** exist, they **do** matter and these wannabe coaches not only fail to use them; they do so much in stark contrast to plain old common sense that it's pitiful.

As fate would have it, I know of a college team that until recently actually used those very workouts of 10 x 400 every Monday and 6 x 400 every Wednesday. They sucked ass. Many of them regressed from their high school times. A few ran pretty well in time trial types of races at the very end of the season when they had done practically no running for a week or more, but none that I can recall ever ran well in a championship meet. Why? Because even though the fastest guy on the team was a 4:08 miler as a sophomore, and most were 4:15-4:20 types when they came in as freshmen, they all tried to run 60 pace for the 10 x 400 and 56 pace on the 6 x 400 from the very first attempt. There was always a pre-workout pep talk about aiming high and having Buster Mottram-sized nads. The big thing was really gearing up mentally and then getting out there and sticking their di ... errr, necks ... in it and **making** things happen. Brute-forcing their way to 4:00 miles. Well, it sure made them tough and fearless, but it didn't make them any faster or better racers as seniors than they were as freshmen.

These were the very same workouts Don Paige and Sydney Maree did, but with incorrect adherence to principles - proving not that workouts don't matter, but that workouts done without attention to principles are a recipe for inferior results. It turns out the pace Paige and Maree hit on those 10 x 400 and 6 x 400 workouts was in general the **right** pace (i.e., close enough for day-to-day purposes) for them to be able to repeat week after week and still benefit from. It would be the **wrong** pace for Oprah Winfrey. It would also be the wrong pace for most journeyman collegians. It might even be just enough outside the right pace for a 3:58 miler - a likely All-American - that it would result in hypertraining and staleness. The principle here is that those workouts were of such a duration, intensity and frequency that they provided the necessary stimulus for improvement for people who did the requisite work pre-January, who found the right pace to allow the sessions to be repeatable, and who recovered enough on the in-between days to come into each hard day fatigued enough to benefit from the cumulative load but also ready to rock and roll on that day's effort. The same workouts were disastrous for the team that did not adhere to those principles unless a few of the runners got them nearly right by luck. Make no mistake, if you toss a lot of

eggs, a few will be resilient enough to stay unbroken, so some runners nail the principles by luck and never know why it all worked, but the principles do exist and those who learn how to apply them to their own physical and mental strengths will go farther.

Workouts don't matter.

In saying this, you're **still** assuming common sense principles will be followed. If workouts didn't matter, then I could reach my full potential by having some scrotumhead stand on the infield with a clipboard and a stopwatch and yell at me, "Hey, Fenwick! Look sharp! You want that gold medal? Then you know the drill - Yep, a 5,000 all-out today just like every other day. We're going to keep at this until you break the world record. After that, strap that sack of rocks on your back and then it's 3 times up and down that half-mile hill on your left foot and 3 times on your right foot just like you've done every day for the last 2 months! And oh yeah - trust your fitness, Fenwick!"

Training is a accumulation of a bunch of different incremental pieces.

Aha! You just invoked a principle. "Accumulation of a bunch of different incremental pieces" is a fundamental, overarching tenet of seasonal and career structure. More specific principles (effort-based ones in these examples) include "run to the barn" and "feel your Kung Fu" and dozens of other tidbits of advice you yourself urge people to ascribe to. BTW, principles do not have to be unwavering. In fact, variability **is** a principle, and one we shouldn't do without.

Whether or not Coach Blow prescribes 6 x 1600 one day are some sort of ladder, or a tempo run, or hills, or just 10x400 and/or 6x400 every week for months doesn't matter.

By gum, look at the workouts you just wrote. For some reason, you didn't list 25 x 1,600. Nor did you list 4 x 1,200 at mile PR pace with 2-minute recovery intervals. The latter workout is one I saw a high school football coach tell the distance runners to do on the **first** day of a track season (in fact, it was a set pace that was **faster** than a few of the runners' mile PRs). You're forgetting - or may be unaware of - the darkest side of buffoonery in "coaching." Since the kind of principles I'm talking about are so bedrock to you, you see them not as made-up, "magic" principles, but as common sense that you take for granted, ideas only a drooling fool would fail to heed. News Flash: There are plenty of Coach Blows who prescribe individual workouts **and** whole seasons of workouts that butcher common sense, like the basic principle of stress/recovery or the principle of working with your body and not against it on long tempo runs. Forget about the accumulation of those incremental pieces. Forget about finding the right effort and going with the flow on a run. Those concepts don't even exist for these beef-brained no-pain-no-gain types.

--*-*-*-*-*-*-*-*-*-*-*

So how come when the leaders broke away early [in the 2012 OT Marathon] and it was clear the winner was coming from that group, they just let them go?

Because they COULDN'T run that pace without feeling like they were in half marathon mode.

When you make some or all of these mistakes often enough, you'll learn:

***** I know x:xx is my half marathon pace and I know it's been suicidal for me every other time I've tried this, but THIS time, I'm going to get up there and WILL myself to come within 5 seconds per mile of that effort sensation as long as I can in the marathon.

***** The adrenaline and thrill of running with the leaders and the drafting effect will automatically be worth around 10 seconds per mile and will last long enough that by the time it wears off, I'll be close enough to realizing my goal that I can simply tell myself, "You can't lose it now."

***** It's a GIVEN that I can start out a whole lot faster than any of my workouts indicate - faster than I thought possible, in fact - and I'll be able to hold it simply because "it's race day" - and that changes everything.

Sure, people surprise themselves sometimes by getting up there and not dying, but even then, the veterans can sense early on that the pace isn't suicidal. If anything, marathoners - even the really experienced ones - want to meet their "dream race" goals, get a little too ambitious trying to stay on that pace, and overshoot what should actually be their ideal early pace by a few seconds per mile. It feels like they're taking a small chance, but through halfway or even 30k, it's still feeling doable or hopefully doable. Then they positive split by 2 or 3 minutes. And that's not a blowup; it's a normal marathon - the result of trying just a tiny bit extra in the early and middle miles to keep the "best possible realistic goal time" alive only to have it slip away and then having to hang tough to limit the damage to only a 2-3 minute positive split. But this sort of thing happens with a starting pace that's only about THREE TO FIVE seconds per mile faster than what the runner is ready for. Really experienced and disciplined marathoners know "marathon mode" and ambition gives them the sense that 3 (maybe 5) seconds per mile too fast is still in that mode, but you'd better believe they can feel the distinct, insane difference in effort when the pace is TEN seconds per mile too fast. Their bodies tell them - nay, FORCE them - "Don't go there."
--*-*-*-*-*-*-*-*-*-*-*-*-*

(10k time in seconds) ~ (2.1727 x (5k time in seconds)) - 67.04.

That's the linear regression formula based on thousands of real world performances from the world record level to the 18:00 5k / 38:00 10k level. Beyond the high end of that range, the linear relationship might break down and 10k times might be a bit slower than predicted since there are so many "participant" 5k runners who haven't prepared for 10ks. For competitive runners, this formula has been extremely reliable for decades, even many years ago accurately predicting equivalent marks for performances that hadn't yet been run but have since.

Note that regression formulas like this aren't meant to predict what **individual** runners will do in different events; instead, they are useful for a sample set of runners which is large enough to approach a normal distribution.

So ...

15:00 5k ~ 31:28.4 10k

32:00 10k ~ 15:14.5 5k

Other marks:

12:37.35 WR ~ 26:18.45
13:00 ~ 27:07.7
14:00 ~ 29:18.0
16:00 ~ 33:38.8
17:00 ~ 35:49.1
18:00 ~ 37:59.5

--*-*-*-*-*-*-*-*-*-*-*

****

****

Appendix A: JK Speaks

[“JK Speaks” was an intermittent column John Kellogg wrote during the early days of LetsRun.com. Most of these are still available but are often “orphaned” pages with no links to them. They are reproduced here.]

****

Four Principles To Correct Training For Elites

by John Kellogg

This piece centers on the cornerstones of any sound career-long running program, which include progressively higher mileage, periodization, and extremely limiting the amount of hard interval training, particularly in youth. Right from the start, let's make one thing clear: the training fundamentals outlined here do not stem from any sort of "philosophy." Other terms which do not apply here are "opinion", "theory" and "belief." Instead, the word "approach" is the appropriate one. See, "philosophy" smacks of the armchair musings of some non-runner who has a degree in physiology and sets out to prove his little training theory by using serious distance runners in the same disposable fashion that B.F. Skinner used rats!

There are as many scatterbrained theories on training as there are on the JFK assassination and "the mark of the beast." But serious runners don't need theories; they need what has been proven in the real world. Here's the truth: It is not possible to reach ultimate potential without first establishing enough of a lifetime base to make your training count when you become physically mature. Most Americans do not understand this; they try to get a quick fix in this sport, and it simply doesn't work. A runner absolutely must obtain the ability to train at 120-150 (or more) miles per week by the peak of the career in order to reach fruition. There are no exceptions to this. To generalize as much as possible, a proper training approach relies on four principles that are not widely used in the United States:

1.) Long-term development. It takes years for runners to attain their capacities. Most Americans employ a "fast food" training scheme, particularly in junior high and high school. They run hard intervals on the track, which gives them an alluring quick fix, yet the long-term results are without exception mediocre at best. Every time you race, you're drawing not only off of training you did a few weeks ago or even months ago, but also off of running or other activity that you did many years ago! The nature of that activity must be predominately aerobic for best future results in running.

2.) High mileage. This is the missing ingredient in American distance running. An emphasis on low to moderate mileage during the 1980s and most of the 1990s is the sole reason for our failure to produce the number of elite runners that we had during the 1970s and early 1980s. Those guys "back in the day" ran high mileage, and - surprise of surprises - the only U.S. runners who have

been among the world's elite during the last decade are also high mileage runners! Our program aims to develop runners from youth to the point where they can train effectively and consistently at 120-150 miles per week by the time they reach physical maturity. Anything less than that is a cop-out and is inferior to the training used by elites around the world. Again, this is a long-term approach. There are no quick fixes to doing this correctly. It may take many years to reach the point of being able to run three weeks out of every four at 120-150 miles per week and also be able to add an ample amount of faster-paced running in there. It will pay off enormously if done correctly, but several years of only moderately good performances might have to be faithfully endured in order to get to the highest possible level. Probably 99 out of 100 Americans lack this kind of patience and perseverance, and those runners will most likely never fulfill their promise.

3.) Less hard track training. We do far less of the stressful anaerobic interval training than anybody else in America. The bulk of our harder training is comprised of what's commonly called "threshold" or "high steady state" running. The idea in this is to work with your body rather than against it, watching for the yellow warning light that says you're about to go too hard, as opposed to sailing through a red light, struggling and fighting yourself, and undermining the effectiveness of the workout. We also do what is called "alactic" speed work; i.e., short buildups, strides or speedy running of less than 35 seconds at a time. We also develop and maintain joint integrity and muscular strength through occasional form drills such as quick steps and hill bounding.

4.) Periodization. This refers to shifting training emphasis at various times, between each off-season and competitive season, and also over the course of an entire career. There are times to run slow, times to run long, times to run a fast relaxed pace, times to gut it up and push a hard continuous pace, times to do tough anaerobic training, speedwork, etc. You have to know when and how much of each to use. Tailoring this training to suit each individual's strengths is best learned through a long association with each runner, but the principles themselves pretty much apply to everybody.

****

****

JK Speaks: Total Quality Management - Boosting The Economy

by: John Kellogg, AKA JK
September 10, 2007 (JK's birthday)

(**Part 1** in a series on Running Economy)

Running economy is a measure of the energy expended by a runner to maintain a given speed and is generally indicated by the amount of oxygen consumed (i.e., the oxygen cost required) to run at a given velocity; in more general terms, the ability to translate energy into performance.

When the effort is stabilized at a steady VO_2 (oxygen uptake), the aerobic component of the energy demand can be found by measuring the VO_2. The lower the VO_2 for a steady state pace, the less energy used; hence, the better the running economy of the runner at that speed or pace. For example, if Thomas has a VO_2 of 52 ml/kg/min at 6:00 per mile pace (10 mph) and Frank consumes only 47 ml/kg/min at the same pace, Frank has the better economy for that pace. Measurements of economy are taken at speeds below the runner's ventilatory threshold, due to the fact that a pace above the ventilatory threshold does not have a steady VO_2. Runners with very large VO_2 capacities may consume more oxygen for any given sub-threshold speed, but their running economy may or may not be relatively worse when compared to other runners.

Energy can be lost through chemical conversion of substrate (stored fuel), wasted movement, or other factors. **Efficiency** is the percentage of chemical energy converted to mechanical work, while **running economy**refers to energy expenditure vs. velocity (which is not a direct measure of total work). Therefore, mechanical work accomplished and running economy are not necessarily synonymous; if the mechanical work is not translated into forward propulsion (velocity), and energy is squandered, running economy is lower. This may be due to vertical oscillation or excessive knee or ankle flexion (among other wasteful motions), causing a great deal of work to be done with a possibly low VO_2, but not a very fast pace to be sustained at that VO_2.

Comparisons of running economy between athletes may be done using the measured VO_2 at a given pace divided by the runner's maximal VO_2 to derive a relative VO_2 or % VO_2max at which the runner is performing. For example, if the VO_2max of the above runners are 75 and 70 ml/kg/min, respectively, Thomas is running at 69.3% VO_2max (52/75 x 100%) at 6:00 per mile pace, while Frank is running at 67.1% VO_2max (47/70 x 100%) at the same pace. Frank still has the better running economy at 6:00 pace in both absolute and relative terms.

Economy can also be expressed in VO_2 required to cover a certain distance in a certain time. If an athlete covers one kilometer in 3 minutes and maintains a VO_2 of 60 ml/kg/min in doing so, the running economy exhibited during that segment of the test could be expressed as 3 x 60 = 180 ml/kg/km.

Since glycogen supplies more energy than fatty acids per unit of O_2 consumed, it is the preferred energy substrate for aerobically-demanding workloads. Since 5 kilocalories of glycogen substrate are utilized for each liter of O_2 consumed, the actual glycogen requirement for a given pace can be estimated. Figuring in the contribution of fatty acids or amino acids would be more problematical, requiring the respiratory exchange ratio to determine the percentages of carbohydrate and fat which are being used as substrate. Nonetheless, bearing in mind that there is a ceiling of roughly 2,000 available kilocalories of skeletal muscle glycogen which can be accessed to produced energy, knowledge of the oxygen uptake (and, by extension, the glycogen requirement) at a steady pace can assist in determining a prudent pace for longer events in which glycogen depletion may be an issue.

Energy requirements can theoretically be estimated at efforts requiring a high anaerobic demand. In measuring lactic acid produced and O_2 saved by glycolysis, energy expenditure is roughly 220 calories per gram of lactate formed. Accurately measuring this would be an invasive process,

however, and is impractical, so running economy is conventionally determined by measuring oxygen consumption at speeds below the ventilatory threshold, where the VO_2 remains steady long enough to attain accurate and meaningful measurements.

In evaluating treadmill vs. overland running economy, gait patterns are somewhat different, so if measurements are to be taken on treadmills, the test subjects should spend about a week running on the belt prior to taking any measurements of economy. Apparent changes in economy could occur as a result of establishing familiarity with the treadmill and adjusting stride mechanics during the testing period.

Runners who exhibit predominantly slow twitch characteristics generally have better running economy at speeds below the ventilatory threshold. Not surprisingly, running economy (as measured by oxygen uptake) is more important in longer distances (and is a better performance predictor for those distances) than it is for shorter distances. Also, the amount of time spent at a given speed, as long as the effort is not so frequently intense as to invoke wasted motion or tension, has a great bearing on running economy at that particular speed. Elite middle distance runners have exhibited extremely high economy at 4:20 per mile or faster (although the VO_2 is not steady very long at that pace), while marathon runners exhibit excellent economy at 5:00 to 6:00 per mile, but each group's economy becomes worse relative to the other group when running at the other's preferred pace. This, of course, is borne out in race performances as well as in measurements of economy.

Determining all the interacting physiological factors which affect running economy, as well as how to improve economy at various speeds, is a tricky proposition. We might as well simply ask, "What makes someone a good runner?" The good news is that running economy can often continue to improve with running experience even if other standard markers such as maximum heart rate, maximal oxygen uptake, pure 100 meter speed, et cetera are not improving or are even declining.

Part 2 *will examine some of those trainable physiological characteristics that influence running economy.*

****

****

Total Quality Management - Boosting The Economy

by: John Kellogg, AKA JK
September 18, 2007

(**Part 2** in a series, Part 1 can be found here)

As stated previously, running economy can continue to improve with running experience even if other physical indicators associated with performance have stagnated or are in decline. Some of this improvement may be a result of learning how to balance stress and recovery in daily life as

well as in running, but some improvement is a result of repetition of the activity, which cultivates minimized tension and preserves energy through efficient movement.

To understand why repetition assists in developing efficient movements, it is helpful to note the properties of the muscles involved with precise motor control. Smaller neurons, which innervate the muscle fibers responsible for fine motor skills, such as balance and stability, are of the slow twitch variety, meaning they have a low threshold for synaptic activation and generate lower force output than their fast twitch counterparts. The associated muscle cells also generally have a high mitochondrial density. Such motor units initially respond best to training stimuli consisting of low-intensity, high-repetition activities, but higher-intensity aerobic exercise is normally required at later stages of development for further mitochondrial proliferation.

For a given running velocity below the ventilatory threshold, higher stride frequency with lower power generation recruits more of the Type I (slow twitch) motor units and results in increased running economy, partly because more of the muscles which contribute to stability and control are contributing to the cause, partly because vertical oscillation and orthopedic stress are kept to a minimum, and partly because the Type I fibers (even those contributing to gross motor movements) are highly oxidative, so ATP energy production per unit of substrate is maximized.

Extremely high repetition in as relaxed a state as possible cultivates a subconscious sense of position and balance through continual involvement of the motor units which control fine movements. Therefore, practice of low-intensity and high repetition is fundamental tenet of many skill sports. In martial arts, for example, it is important to learn to do a movement *correctly* and with minimized tension *before* doing it with a combination of precision, full speed and full power. Attaining such precision of movement while separately developing explosive power *before* combining the two characteristics is what allows a martial artist to kick an apple off the tip of a sword while blindfolded. A master might say of this feat, "It is not 'done;' it is 'experienced.'"

The same can be true in running. A large volume of easy running with a reasonably quick stride frequency (one which promotes smooth, alert, snappy stride mechanics rather than lazy, sloppy mechanics) is invaluable to improve precise motor control at that particular cadence, channeling movements toward maximized efficiency. Note that the prime movers are not the only muscles which affect running economy. High repetition also trains muscles responsible for respiration, posture, arm carriage, et cetera to become more efficient at performing their duties. This will fine tune the effortless - almost floating - state that experienced runners can zone into when in shape. This sense of weightless euphoria in which endorphins are plentiful and effort is negligible is a state in which the pace seems to carry the runner, not vice versa. As the default fitness level improves over time, a faster pace can be employed more often to further the mitochondrial development and improve synchronization of movements in the motor units which are involved in making imperceptible corrections in balance at the faster pace.

Part 3 *will look at the mechanics of the plant phase of running and how this transitional stage of movement affects running economy. Later installments will deal with methods of training to improve economy.*

[as far as I can tell, part three in this series was never completed]

****

****

Maximizing Oxygen Uptake

By John Kellogg, aka JK
March 30, 2004

Terminology

In order for you to produce energy aerobically, your working muscles must *consume* oxygen. Oxygen uptake (also known as VO_2, which stands for "ventilation of oxygen") is a measure of how much oxygen your body is consuming at any given time. It is usually expressed in milliliters (or sometimes in liters) of oxygen consumed per minute of exercise. The "V" in VO_2 is often written with a dot over it to represent this "minute ventilation." There is an upper limit to how much oxygen your body can consume. Results from research studies involving twins show that maximal oxygen consumption is 40%-50% genetically determined. However, prolonged training elicits improvements in maximal oxygen uptake which can range between 10% and 30%. These gains are directly related to hypertrophy of the left ventricle, increased capillarization, more efficient oxygen extraction from the blood, and a host of other factors.

Maximal oxygen uptake is customarily referred to as VO_2max. VO_2max can be expressed in either *absolute* terms (usually milliliters of oxygen consumed per minute) or in *relative* terms (milliliters of oxygen consumed per minute *per kilogram of body mass*) to compare values between individuals.

The average adult male has a VO_2max which is roughly 20%-25% higher than that of the average adult female. This is primarily because men have a higher hemoglobin concentration and because men have more muscle and less fat (muscle being a more metabolically active tissue).

Average VO_2max values (in ml/kg/min) are 32-36 for adult females and 39-44 for adult males, depending on the testing protocol which is being used. Elite endurance athletes may record values of 70-83 (females) and 80-94 (males). A high VO_2max is *generally* an advantage for a distance runner, although it is no guarantee of elite potential. Runners are often significantly outperformed by others with lower VO_2max measurements.

Exercise scientists normally take measurements of an individual's VO_2max using a maximum effort running test on a treadmill. When following most testing protocols, which begin at slow speeds and have the subject increase the intensity at regular intervals (a format known as a

"graded exercise test," or GXT), there is a *speed* associated with working at VO_2max, a speed commonly known as velocity at VO_2max (vVO_2max), a term coined by Dr. Jack Daniels. Of course, this value varies from runner to runner, but it is normally the pace which a well-trained runner could sustain for roughly *eleven minutes* in an all-out, evenly-paced effort.

Values for both VO_2max and vVO_2max are somewhat dependent on the testing protocol used to measure them (this is also true of values for "lactate threshold" and "lactate threshold velocity"). Using a steeper grade on the treadmill platform during a GXT, for example, results in higher VO_2max readings due to activation of greater muscle mass and additional torque.

Laboratory findings

Groundbreaking research on the effects of training at VO_2max was conducted in 1982 by Gary Dudley, et al. at State University of New York at Syracuse. Dudley induced rats to run once per day, five days per week, at intensities ranging from 40% of VO_2max to 100% of VO_2max and for various durations (the faster-running rats completed the shortest work bouts) and examined how these durations and intensities affected mitochondrial enzyme activity across the spectrum of muscle fiber types. His findings contrasted somewhat with conclusions from prior work (Holloszy and Booth, 1976) inasmuch as 10-minute bouts at 100% of VO_2max were much more influential in mitochondrial production than were longer work bouts (up to 90 minutes) at slower speeds.

Dudley's 1982 research is often cited to bolster the argument that running at VO_2max *eliminates* the need for running longer distances at slower speeds in order to maximize aerobic development. The practical fruits of this myopic and spurious reasoning were harvested in the United States during the latter years of the 1980s and the first half of the 1990s, as high mileage training fell out of favor and hard track work - sans aerobic base - became the norm. During this time, U.S. distance running performances declined significantly. The truth is that *both* high-volume, low- to moderate-intensity training *and* skillfully integrated low-volume, high-intensity training are necessary to completely prepare for any event in which oxygen transport and oxygen consumption contribute to energy production.

Dudley, et al. did demonstrate that from a mitochondrial standpoint, higher intensity *is* generally preferable to duration. However, running performance is ultimately more complex - a gestalt that depends on the interaction of a myriad of factors, a few of which may not yet be identified (or may indeed not be identifiable at all).

Moreover, the use of *rats* as test subjects presents a number of problems when attempting to draw conclusions for the human athlete. Rats are often used for laboratory experiments due to their low cost, small space requirements, short time span of generations, large litters, and the fact that they are easy to handle - reasons which have *nothing* to do with any physiological similarity to humans. The training and study of laboratory rats for no more than a few *months* also depicts a mere *snapshot* of a complete running career, so any conclusions drawn only serve to shed light on a short-term piece or two of a long-term puzzle.

The metabolism of a rat is much faster than that of a human, as is evidenced by resting and peak heart rates. A trained rat has a resting heart rate of nearly 300 beats per minute and a maximum HR of roughly 600 bpm. Furthermore, the metabolism is often along different routes in the body. Additionally, rats run on *four legs* and adopt a *horizontal* body position, factors which reduce orthopedic stress relative to the stress incurred by a human runner. Decreased orthopedic stress results in lower metabolic cost, enabling the rat to recover from an intense effort more quickly. The bottom line is that one day recovery for a rat is in no way comparable to the same recovery time for a human. This raises the question of *how often* the human runner should work at the intensity required to improve oxygen uptake.

Trial and error indicates that - for mature, experienced athletes - running at or near vVO_2max once to twice per week (ideally, from the late preseason until the middle of the competitive season) will provide a firm stimulus for improvement while allowing adequate recovery. Younger runners (below high school age) or beginners should use high intensity training more sparingly. Note that most *races* (especially high school cross-country races or track events of 3,000m - 5,000m) elicit VO_2max (and obviously require a large anaerobic component) and therefore must be counted as oxygen uptake training.

Importance of regular speed maintenance

To develop muscle contractile properties, promote relaxation and develop familiarity with faster speeds, it is important to incorporate some *short* buildups or strides (usually between 15 and 35 seconds in duration) once or twice per week during the preseason before introducing more challenging VO_2max sessions. A total of 10-15 strides (often divided into 2-3 sets of five strides each, with 5-10 minutes of jogging between sets) will adequately serve as speed maintenance. Form drills can be included within such a workout if desired. A few strides can also be performed before and after the occasional "high end" aerobic outing. Run *with the wind* (if any) and take sufficient recovery so as to remain *comfortable* and in complete control on these short strides. The variety this provides will break the monotony of your usual slower-paced, higher mileage running in the preseason, and it may also help prevent injury. Once you are comfortable running these *short* distances at mile race pace or faster, which should in no way be lactate-intensive, you should have no trouble running longer distances at vVO_2max (with recovery periods equal to or slightly shorter than the run periods) when the competitive season arrives.

Every 2-3 weeks during the preseason, it is good practice to perform a reduced-intensity "time trial" of 2-7 minutes in duration to achieve near-maximum stroke volume and as a lead-in to traditional sessions later in the season. This yields best results if incorporated following sets of strides, as the strides serve as a thorough warmup. Run at roughly the speed you could *currently* maintain for *twice* the distance if running all-out. Running at this speed will elevate the heart rate to roughly 92%-95% of maximum, somewhat above the HR achieved with traditional "tempo" or "threshold" running. Keeping a small, moderate-intensity middle-distance component in your base training allows you to dovetail nicely with the less intense running which comprises most of your base work, as your "high end" aerobic pace may feel more comfortable with the occasional inclusion of the faster efforts.

You can *occasionally* use moderate- to high-volume sessions with bouts as long as one minute

each during the preseason (e.g., 10-20 x 1 minute "on" / 1-2 minutes "off"), but avoid any tying up, struggling or form breakdown. The feeling achieved should mimic that of a comfortable "fartlek" outing or a strong tempo run, not that of an intense mid-season track session.

Orthodox methods of oxygen uptake training

When doing full-fledged in-season work at vVO_2max, your aim should be to create a session which can blend in favorably with other sessions and races and which allows you to accumulate enough time to provide a viable stimulus for improvement without overdoing it.

Avoiding overkill basically means *minimizing* the *negative* effects of acidosis, so that your movements remain efficient, muscle groups are recruited in harmonious concert, and *aerobic* energy production dominates your efforts as long as possible. This is best achieved if you orchestrate the rest intervals between bouts so as to allow adequate recovery while also keeping the circulatory system active, thus reducing the possibility of "venous pooling" and allowing for some lactate to be reconverted to other metabolites by the heart and skeletal muscles. It is also desirable to avoid excessive impact or torque stress (these factors can depend on hills or turns of the road or track).

As mentioned, vVO_2max is approximately the speed a well-trained runner could maintain for a race which lasted 11 minutes. A couple of formulas used to estimate this pace relative to common race distances are:

- vVO_2max (per 400m (in seconds)) = 0.1171 x (3,200m time (in seconds)) + 5.22
- vVO_2max (per 400m (in seconds)) = 0.07 x (5,000m time (in seconds)) + 7.32

These equations, though not *perfect*, show that a runner with a recent 3,200 time of 9:13 (553 seconds) has a theoretical vVO_2max of 70 seconds per 400. A time of 14:55 for 5,000 (895 seconds) also yields a theoretical vVO_2max of 70 seconds per 400.

Trial and error reveals that prudent use of training at this effort intensity involves repeats of two to four minutes each at vVO_2max, with rest periods slightly shorter than the run periods, and with about 15-20 minutes total time spent at pace. Some sample sessions which have been commonly used are:

- 8-10 x 2 minutes "on" (averaging vVO_2max) / 1:30-1:45 "off" (active recovery period)
- 6 x 3 minutes on / 2:00-2:30 off
- 4-5 x 4 minutes on / 3:00-3:30 off

A runner with a best recent 5,000 performance of 14:55 would have a theoretical vVO_2max of 70 seconds per 400 and could use 8-10 x 700 averaging 2:02 *or* 6 x 1,000 averaging around 2:55 *or* 4-5 x 1,300 or 1,400 at about 3:48 (1,300) or 4:05 (1,400). The longer work bouts (near 4 minutes) will obviously be the most demanding and should probably be avoided as mid-week training if a very important competition is imminent. Running *longer* than 4-ish minutes at vVO_2max tends to require too great an anaerobic component to be any more useful for aerobic development. Commonly used "mile repeats" should deliberately be run at a slightly slower pace

unless the session is being used as some sort of mental-toughness-promoting, "make it or break it" workout in lieu of a race.

Workouts such as these should generally be used during the beginning or middle of a competitive season. The rationale behind this is that they are liable to promote premature peaking if used in the preseason; moreover, such sessions may be somewhat too taxing to afford sufficient recovery prior to championship events in the latter stages of a competitive season.

These workouts will be quite challenging after 15-20 minutes accumulated at the desired pace, but your lactate levels will hopefully stay somewhat under control, so that you will not be at the mercy of tying up and resorting to flailing, struggling movements (or even slowing down while increasing your effort). For maximum effectiveness, you should pace yourself so that you can run the last few reps in a VO_2max session slightly *faster* than you ran the early reps.

Minor shifts in emphasis

Shorter work bouts (e.g., 12-16 x 60-90 seconds) at a slightly faster pace (about 5% faster than vVO_2max) also have a marginal influence on oxygen uptake, as long as the recovery periods are short enough to keep the heart rate elevated sufficiently. The speed used for these short reps is approximately that which you could hold for *six minutes* in an all-out effort. Physiologist Veronique Billat suggests jogging between reps for an equal duration and at exactly *half* the speed used for the work bouts themselves. For example, our hypothetical 14:55 runner (whose vVO_2max is 70 seconds per 400) could run 12-16 x 400 at about 5% faster (66-67) with a 200 jog in 66-67 between 400s.

Longer bouts (e.g., 5 x 5-6 minutes) at a somewhat slower pace (roughly 5% slower than vVO_2max) and with relatively shorter rest periods (2-3 minutes) will also train the same systems with a slightly different emphasis. Mile repeats (even if they are run faster than 5:00 each) should usually be executed at this approximate effort level for maximum profitability. You can accumulate nearly 30 minutes at this more sedate pace with relatively low risk of excessive acidosis. The runner whose vVO_2max is 70 seconds per 400 might choose to perform 5 x 1,600 at 4:54 each (5% slower than vVO_2max) with recovery intervals consisting of 2-3 minutes of light jogging. If this pace provides little challenge, the recovery period could be reduced or the work bouts could be extended to nearly 6:00 in duration.

It is best to *vary* the distances used from session to session so as to provide variety in muscle fiber recruitment, to reduce boredom and to prevent obsessive comparison of times from previous workouts. Finding an *ideal* blend of workouts is part of the "art" of training (which should always complement the "science" of training) and may require a few seasons of experimentation to determine what works best for you.

Should the recovery periods during VO_2max workouts be spent standing? Walking? Jogging? Some combination of these?

This depends in part on the length of the recovery periods, which depends in turn on the length of the work bouts. Standing rests are almost *never* productive. Jogging during the rest periods is

usually preferable, as this keeps the muscles warm and the circulatory system active (which allows for greater re-uptake of blood lactate), but short reps may be more intense (faster), requiring a more passive recovery (all walking or some walking and some jogging) to keep *muscle* lactate at manageable levels. This is particularly true the first time a session involving a pace faster than vVO_2max is attempted. As lactate metabolism improves during the season, the entire recovery period can be spent jogging (per Veronique Billat's recommendations) even during these faster sessions.

Should the distances or durations of the work bouts vary during a session or should they remain fairly constant?

Although there are some exceptions (see below re: taper workouts and sessions for young runners), it is *normally* best to keep the run distances (or durations) constant within the workout (i.e., use all 800s or use all 4-minute runs rather than using "ladders" or "step-downs") and use fairly uniform rest periods. This trains you to monitor effort better and to mount rising fatigue with additional effort in a more *linear* fashion.

The ups and downs of hill work

Hill training is excellent for improving maximal oxygen uptake because both high heart rate *and* high systolic pressure (the multiplication of these factors, with the result usually divided by 1,000, is known as the "rate-pressure product") are achieved, and these components stimulate left ventricular hypertrophy and vascular development.

Obviously, some introductory hill work (slower speeds or gentler inclines or fewer reps) is desirable as a lead-in to more stressful hill sessions involving longer work bouts or faster speeds. Once you have developed some measure of structural integrity for hill running, sessions such as the following can complement your normal flat track VO_2max workouts:

- Run 2-3 minutes *up* a 4%-6% grade (use an effort intensity equal to running at vVO_2max on a flat surface), jog slowly for one-half to two-thirds of the distance down the hill, run at a strong pace *down* the remaining portion of the hill (not so fast as to *jar* yourself, but fast enough to become somewhat uncomfortable), then jog for about 60-90 seconds on a flat section at the bottom of the hill. Repeat for a total of 5-6 uphills (2-3 minutes each) and 5-6 shorter downhills (about 1 minute each).

- If a *faster pace* is desired, try to set up a square course which features a hill of 6%-8% grade and just over 300 meters in length and also has another hill of similar length but not as steep (3%-4% grade) about 150-200 meters away. Run *up* the steeper hill at an effort which simulates 1,500m/mile race pace (of course, the *speed* will be slower while running uphill), jog at the "top" of the square over to the more gentle hill (about 60-90 seconds) and run *down* it at about 800m race pace, then jog over to the base of the steeper hill and repeat for a total of 5-6 uphills and 5-6 downhills. The overall intensity of the session should be comparable to a track workout consisting of 10-12 x 300m at slightly slower than 800m race pace.

Running uphill for 2-3 minutes at a time at moderate to high intensity (near VO_2max) will likely provide a greater improvement in the ability of your left ventricle to pump blood to your working

muscles than will running with the same effort over level ground or downhill, even though you can run much faster with comparable effort on a level surface. When running uphill, muscle contractions are held longer, meaning the intramuscular pressure and vascular resistance are greater. Since it is harder for the heart to pump blood into muscles which are in a contracted state, the systolic pressure will rise well over 200 mmHg (with a rate-pressure product of over 40) during prolonged, high-intensity uphill running. This creates a high myocardial oxygen demand and provides a strong catalyst for ventricular hypertrophy.

On the other hand, you should not *exclusively* rely on hill work for your oxygen uptake training. The stride rate, toe-off mechanics, fiber recruitment, and the manner in which muscles act in concert are obviously different when running *faster* over a *level surface* than when running with the same effort intensity (albeit slower) uphill. Therefore, since most of your races will probably be contested on flat or predominantly flat surfaces, you also need to train to become fast and efficient at level-surface running.

There is, then, a *trade-off* between the greater muscle mass activation and greater myocardial oxygen uptake (MVO_2) while running uphill and the faster absolute speed attained while running on flat surfaces or on downhills. When faster speedwork is needed in training (during the mid-season or late season), hill work should usually be eschewed in favor of track work. This will reduce the likelihood of Achilles tendon trouble which may result from attempting very fast-paced running up hills.

Twists on standard sessions

There are numerous reasons for runners to occasionally choose to attain *variable speeds* within a session. Some of these objectives include becoming accustomed to a *fast start* before settling into a racing rhythm, practicing pace pickups (surges) *between* segments at race pace, working on *finishing* fast after being fatigued from race-pace bouts, reducing the volume within a workout for the purpose of "tapering," and achieving various ranges of motion so as to feel "snappier" for an upcoming race. If you desire to change speed within a workout, and if working on *oxygen uptake* is one of the goals, you should aim to spend at least ten minutes near vVO_2max (in bouts of 2-4 minutes each) *and* include several short reps at *faster* speeds before and after the oxygen uptake work in order for the session to be productive. Examples of variable-speed sessions are:

- 4 x 30 seconds "cut-downs" (slowest to fastest, beginning at roughly 5,000 race pace and finishing at 1,500/mile race pace) / 1:00-1:30 rest periods (walk/jog), 2 x 2 minutes on (first rep slightly slower than vVO_2max, second rep slightly faster than vVO_2max) / 1:30 off, 3-4 x 3 minutes on (averaging about vVO_2max) / 2:00-2:30 off, 2 x 1 minute on (first rep somewhere between 1,500 race pace and 3,000 race pace, second rep at about 1,500 race pace or slightly faster) / 1:30 off

This is useful as a variable-speed session inasmuch as most of the bouts are short enough (2 minutes or shorter) that you can tinker around with the speeds and determine how you respond to various degrees of pace pickup; i.e., what combination of speed and duration begins to become markedly anaerobic for you. This can give you an idea of how it may feel to launch a sustained drive during a race.

- 4-6 x (2:00-2:30 at vVO_2max / 30-60 seconds rest, 45 seconds at 1,500/mile race pace or faster) / 2:00-2:30 rest periods (walk/jog) between sets

This workout features a substantial anaerobic component with the segments of 45 seconds at faster than mile race pace. It should be reserved for runners who are already extremely fit in all regards, especially if six sets are performed. This is designed to get you accustomed to the feeling of running at a sustained rhythm while in a moderate state of acidosis.

- 4 x 30 seconds cut-downs / 1:00-1:30 rest periods (walk/jog), 4 x 2:30 on (averaging about vVO_2max) / 2:00-2:15 off, 4 x 30 seconds cut-downs (each slightly faster than in the initial set) / 1:00-1:30 rest periods (walk/jog)

This session is useful as a slight "taper" workout for experienced adult runners or as a complete mid-week, in-season workout for high school runners. It only involves about ten minutes of work at vVO_2max, fractionally less than the 15-20 minutes suggested for optimal aerobic development. *But* … weekend races (3M/5,000 in cross-country, 3,200 in track) have high school runners operating near vVO_2max often enough that care should be taken to avoid overburdening them with additional work at this effort level within the week, thus jeopardizing future development. It is *always* much safer to *underwork* high school runners in terms of intensity than it is to expedite their short-term progress with large amounts of anaerobic training and frequent all-out racing.

A multifactorial issue

Because oxygen uptake is influenced by so many factors, you need the *full spectrum* of training devices in order to maximize it. This means you should never lose sight of the *basics*. Without the fundamental aspects of overall fitness in place, application of more "scientific" principles and all the attention in the world to detail is only so much B.S. Attaining peak fitness involves getting a high mileage base, with the lion's share of your faster efforts at a maximum steady state of effort - at or near your "lactate threshold." Among other benefits, this will give you the extensive capillary network needed to supply oxygen to your muscles (a physical attribute which is unattainable through high intensity training alone).

You might ask, "Why not simply adopt the old school approach of 'get out there and work your tail off' without paying attention to any particular speed or effort level? Isn't that what the top runners in the 1970s and early 1980s did?" Yes, to some extent the best of that era did train this way - and they saw excellent results - *but* they were logging *more mileage* than you are probably running, and this was the principal ingredient in their success. It also turns out that they *did* operate fairly close to ideal speeds and durations, arriving at these parameters through the ultimate science of *trial and error*.

Are there other activities which will improve the ability for the muscles to receive and consume oxygen? Sure, but remember that training is largely "sport specific;" that is, you are best served by practicing the activity you expect to perform in competition! Since many commonly contested distances (3,000m - 5,000m) involve speeds within 5% of vVO_2max, working at or close to vVO_2max affords the added benefit of familiarizing you with your race pace.

****

****

JK Speaks: Progressing To Peak Fitness

by John Kellogg
July 1, 2005

From the coolrunning.com message boards comes this eloquent description of the *art* of training:

"I've always felt that there was a great deal of magic socked away in each runner's body - 'places,' if you will, that we can sneak up on, access, within a given run, if we're willing to ease back at crucial moments, warm up slowly, listen deeply and honestly to our bodies. HR monitors can help us isolate them; understanding the underlying physiological principles can give us the patience to segue effortlessly into them rather than demanding that they appear. But the magic still finally lives in the deep, sympathetic listening that we need to engage in: listening to the subtle rising and falling energies of our bodies at work. No amount of technology can ever replace that listening." - message board poster "**KudzuRunner**" on running by feel
(editor's note: JK posted as TG&P Oz on the thread above. We wondered what JK did with his spare time and now we see he really must read nearly every post on running on the internet)

This article will be a switch from cutting-edge jargon and tedious analysis of what the latest nugatory studies have to say about the changes that 10-second sprints invoke in the phosphocreatine system of lab rats. It will instead focus on developing the *knack* for the high-end, steady running that is a staple element (perhaps *the* key ingredient) of *actually getting in shape*! All stuff and no fluff. Nothing *new* will be revealed, but this should reinforce a few tried-and-true principles that many runners tend to forget in their dependence on exercise physiology and gadgetry.

As "KudzuRunner" has done, I also like to describe the weightless feeling achieved when you slot into the perfect pace on a fast, yet nearly effortless, continuous run as "summoning the magic." Sometimes *it* grabs *you* by chance and sometimes *you* invoke *it* by design, but there is no mistaking it. You will know it when you feel it. Being able to find it, developing a sensitive internal dialogue and turning your own body into a finely-tuned "lactate analyzer" is key. Pace guidelines are good as *general reference points* for many timed runs, but staying precisely on your "pace calculator"-determined speed should (in most cases) be trumped by the idea of making that magic last for the proper duration (or pushing the envelope just enough and not too much).

Without developing an internal sense of this crucial effort level, you will in essence be groping for a *mathematical* or *algorithmic* formula for success. Such "systems" can often produce apparently good results, since runners will be close enough to their ideal effort levels often enough to improve crucial aspects of fitness. Some athletes may even discover "the magic" through repeated workouts at speeds gleaned from a pace chart in a book. Yet adhering strictly to any predetermined schedule robs the athlete of full exploration of personal capacities for stimulation and recovery.

The *science* of running has come a long way, but it has an even longer way to go before it replaces the *art* of running. This is analogous to listening to a mechanized "player piano" versus listening to a professional musician. The machine relies on notes only (with at best minimal attention to dynamics); the human artist consolidates proper touch to the keys, either sudden or gradual increase or decrease of volume, sustaining certain notes, and many other techniques which make a piece "musical" rather than contrived or synthetic. No matter how many informative symbols are written on the music sheet, there are always hidden elements of a piece (usually the most pleasing aspects) which can only be uncovered and perfected through practice, practice and more practice. Consequently, there are many people who can play all the right *notes* but still miss the *music*.

Similarly, a beginning martial artist who manages only to memorize the positions and primary movements (stances, blocks, punches, kicks, etc.) of a kata (form) will not apply proper breathing technique, body torque and relaxation for the transitional movements (the stepping done between executing the primary movements) and will appear tense and robotic in comparison to a more advanced student or a master whose ability to store up and release energy is in perfect sync to produce a dynamic, fluid consolidation of rhythm and power.

So it is with training for the sport of running - the tyro attains isolated facts and pieces, but the master attains wisdom. The master has a deep, almost soulful, understanding of how to put all the pieces together to produce a finished product that transcends any other possible method of assembly. Cultivating this wisdom should serve as a polestar for every serious runner.

All this begs a question: Are there really distinct, preferable training zones which yield better results for the time invested or can training be done along the entire continuum of speeds between jogging and sprinting with equal effectiveness? This is a subject for another day, but the short answer is that running at certain effort levels for certain durations *unquestionably* produces more effective results. Notice that effort supersedes pace in this equation, although hitting a specific pace is often desirable. The intangible and largely unquantifiable aspect of zen-like rhythm achieved during a correctly executed high-end workout seems to promote extreme *efficiency* of movement, of ventilation and of substrate utilization, possibly by virtue of consistent, repetitive recruitment of motor units responsible for fine motor control, as well as (over several weeks) assisting in arriving at (and stabilizing) an ideal metabolism and weight. The notion of *rhythm* underscores the importance of favoring internal dialogue rather than gadgets or pace charts as a means of ascertaining effort.

Perhaps the best method of "aerobic endurance" running is personified in the Kenyan-style "progression run." In these runs, the pace is not normally restricted to any predetermined physical parameters and is done totally *spontaneously*. The start is slow, so slow that you should feel as though the easiest and most relaxing run of your life is in store. Complete relaxation with deliberate diaphragmatic breathing should be your primary focus. This creates the environment - opens the door - for a faster pace to materialize. If it does, the free-spirited nature of such running affords the opportunity to tune in on that inner dialogue which can guide you to mastery.

Again, "**KudzuRunner**" poetically describes a stage of this personal journey toward running wisdom:

"Having run easy on the out leg, with a few gentle accelerations as the turnaround point approached, I'd now do what I called 'opening up the throttle.' I'd gently and persistently float up into what I might now call my 'maximum aerobic pace' but had no words for back then. Sometimes, realizing that I was pushing just a little too hard, I'd back off the throttle just a hair, let my breath settle - and, as often as not, suddenly feel a little 'release,' a deep bubble of relaxation."

This quote embodies about 90% of "threshold" training in a nutshell. The idea is to start easy, with no set notion of running hard or fast, and let the pace come to you. You can have it in the back of your mind that if the magic is summoned, you'll go with it. But you don't force it to happen if it's not there.

Progression runs should not normally be miserable experiences in which you punish yourself in an attempt to develop your toughness. With an *occasional* exception, the time you accumulate prior to the point of struggling contributes at least as much to aerobic development as does the time you fight on after beginning to labor.

A "secret" to effective progression runs is to start slower than you would normally think would be of any benefit. This means operating at a *walking* pace for the first few minutes. Let the easy ambling slowly warm up every physical system in an impromptu fashion. While the pace should very gradually get a little faster, there should not be much of a definable point of effort increase between the walking speed at the start and the high-end aerobic pace in the "tempo" portion of the run. Of course, breathing will be stronger and perceived effort will be higher when running faster, but none of it should be labored, and there should not be a specific place to which you can point and say, "*There* was where I really noticed the conscious increase in effort." The real trick is to stay slow longer than you think is necessary. Each stage of pace increase should almost have you feeling antsy to progress to the next because it feels as though you've waited too long to start going faster.

"When you follow your bliss, doors will open where you would not have thought there would be doors; and where there wouldn't be a door for anyone else." - Joseph Campbell

The feeling you should get is basically the same as one of those planned easy runs that somehow spontaneously morphs into a notably fast, unforgettable high because you have no plans to push and you don't rush into a faster pace. The magic just seems to appear at some point in the run. Ideally, that's what you're after on a progression run. You have to have some baseline fitness to get this feeling, and that might mean spending some time in the hurt box on an occasional run until you are fit, but threshold running should for the most part be enjoyable. It's euphoric to feel simultaneously relaxed and invincible. Holding onto this euphoria at the fastest possible pace, not wanting the run to end, is more beneficial (and certainly more enjoyable) than fighting against your body in a "no pain, no gain" fashion.

The fast, steady, "high-end" pace of a progression run is the principal active ingredient in the outing. But it is also fine to occasionally go ahead and "release the hounds" as I call it - hammering it for a few minutes at the end - if it feels right. If you do this correctly, you'll be absolutely flying and well above (faster than) your "threshold," but you won't be spending

enough time at this effort intensity to show all your cards as you would in a race. If you are currently in shape to run 5,000m in 15:00, for example, you can start a progression run at 10:00 per mile and be at 8:30 pace after 7-10 minutes, 7:00 pace after 15-20 minutes, and so on until you're cruising along at your high-end pace (circa 5:20 per mile) by the time you're 35-40 minutes into the run. Keep it there on cruise control for another 15-25 minutes (as long as you are not straining), then smoothly tighten the screws for a final few minutes, squeezing the velocity down to 2-mile race pace or faster for the last 30-60 seconds. While this finish feels hard (and can be brutal if you unwisely *force* the pace), the fast but steady portion of the run should not be any trouble. Strong, purposeful and aerobically challenging, yes. Labored, no.

Try it that way. Let it start easy and stay easy until it feels right to pick it up. Do not pick it up all of a sudden, but make a minor increase and let breathing, heart rate, coordination of movement, et cetera all perceptually stabilize before smoothly and gently flowing into another pace pickup. The goal is to continue this process until you lock into the fastest pace that feels strong, smooth and controlled, one that will relax and train a runner (you) but kill a jogger (someone a few seconds per mile slower than you!). Hold that pace until you sense it is about to require some laboring, then either stop there or (if you are in an "I'm running to the barn" mood) gradually press the pedal toward the floor for about three minutes, finishing in a kick that leaves you not wiped out, but feeling so energized that you could conquer the world!

This obviously describes an *ideal* progression run. These efforts can derail just as often as they flow hitch-free. You might encounter some wind or hills or turns that break the magic spell, or you might get overeager or just suddenly hit a bad patch and run out of the zone for no apparent reason. Most of the time, rather than the wheels coming totally off, some pace or effort adjustments can get you back in the groove if you feel it slipping away from you. The perfect run, in which you don't need to make even the most minor mid-course corrections, is rare. But by becoming more and more sensitive to your body's feedback signals, you can learn to perceive when those minor regulations are needed even *before* a bad patch arrives, thereby avoiding strain and preserving the desired steady state of effort.

Objective methods of determining effort

If you can't find your ideal high-end pace by feel, the best available method for keeping effort intensity in the desired range is to use blood lactate data (correlated with heart rate data) to find your safe zone and go with the HR data on workouts until you know exactly what the feeling should be. A somewhat cruder field test involves performing a continuous run with pace increases at predetermined intervals, measuring heart rate at the end of each segment, and plotting a graph of HR vs. pace (or time spent running) to look for the point at which the HR no longer increased in a linear fashion. The popular "Conconi test" is such a protocol. It has a few drawbacks, but can be used in a pinch if you are desperate for numerical data.

If no physical data are available, you may use *pace* guidelines as "neighborhood" values. If you are a 13:00 5,000m runner, your maximum steady state of effort will likely occur at *around* 4:35 per mile (91%-92% of 5,000m PR pace), assuming the external conditions are similar to those during your PR race performance, assuming you are in racing shape at the moment and feel capable of a PR effort on the day, and assuming you are just as capable over longer distances as

you are at 5,000m. See why pace guidelines are less predictable than perceived effort as a protocol for workouts? If you *insist* on use of a pace chart for determining training speeds, it is best if you use *several* recent race performances as indicators rather than relying on a single all-time best effort. To continue, a runner whose recent performances *average* 14:00 for 5,000m (equivalent to about 29:18 for 10,000m) usually sports a "threshold" pace of *near* 4:56 per mile, a 15:00 5K (31:28-ish 10K) runner would aim for *roughly* 5:17 per mile as a strong high-end effort, 16:00 (33:40) runners would target *about* 5:38 pace, and so on. Again, if you use pace charts, you make the *assumption* that you are structurally and aerobically comfortable enough at the indicated "threshold" pace to sustain it long enough to achieve a training benefit while avoiding excessive distress. In any event, you must *experiment* with various speeds in training until you can find the desired effort intensity.

The format of a progression run assists you in finding the limit of your comfort zone. It also allows you to "bail out" and keep the run easy throughout if you feel that a quicker pace would be a bad idea due to excessive fatigue or incipient injury. The fact that you start slowly and rarely run outside of your "controlled" zone means that you can spend *some* time in that high-end state a few days in a row if the magic appears, as long as you know your recovery capacities well. Another benefit of progression runs is that since they are almost entirely effort-based, they are automatically tailored to suit your strengths (e.g., muscle fiber composition, current acquired fitness, etc.) while working peripherally on your weaknesses, provided you usually run them to *your* ideal effort and no one else's. Of course, they can be done with one or more partners on occasion to assist in locking in to the collective energy of the group and relieving some of the normal burden of making your own pace, but be careful to avoid racing these workouts too often.

It is important to do a fair portion of your progression runs on roads if you are going to be *racing* on the roads. Shifting from training on the grass, trails or track to racing on the more unforgiving surface of the road can lead to a lot more leg muscle stress, especially if hills or sharp turns are involved. At the least, this can cause you to struggle sooner than you would on a fast track. At worst, it can lead to injury. You also need to practice high-end running in somewhat hillier terrain from time to time, so you can get the feel for how the varied exertion should be meted out. At the same time, one of the most important aspects of high-end training is *even effort*, and the track is probably the best place to get those consistent foot strikes which lead to that "floating" rhythm. So you should balance your faster efforts - some on the track and some on the road.

Resist the impulse to turn every progression run into a time trial. Just run enough under control during most of it that you are able to pick up the last few minutes without fighting yourself. With enough overall mileage, this "train, don't strain" approach will pay off over time.

Well-conditioned runners often have the experience of having a high-end effort interrupted by a too-soon increase in pace and (upon recognizing the warning signals in time) slowing just briefly to recover, only to return effortlessly to that "too fast" pace and find it no more difficult than the high-end pace they had been running previously. This phenomenon is common and, once you experience it a few times, you can actually do it by *design* to amplify that "full of run" feeling and find a *faster* pace with *less* distress. As you get fitter, it often takes less time to warm up enough to find the feeling. When you reach this stage of fitness, you can do a short progression-

style warmup (12-20 minutes) followed by a few minutes rest (maybe stretch lightly), then run for about two minutes at a little stronger effort (perhaps at current 8K-10K race pace), rest another couple of minutes, then begin a planned tempo run. If you are at a stage of fitness and at a stable running weight where everything is "clicking" for you, these tempo runs can feel euphoric and are very cost-effective training devices which serve a number of purposes that translate into good racing down the road.

This done-by-feel running should comprise *most* of the faster training during an off-season period of *general* conditioning, in which fitness is allowed to develop at a comfortable rate. During a subsequent period of more *specialized* conditioning, the fast sessions are geared more toward target race pace, and intensity (as well as the frequency of the faster work) is increased in stages over the ensuing weeks (allowing a suitable taper period) with respect to the time remaining until the target races.

Laboratory research only confirms some of our intuitive concepts. For example, many physiologists recommend a continuous run of 20 minutes at the "lactate threshold." As it turns out, 18-22 minutes spent at the theoretical LT pace (which is a nebulous definition in any event) during most graded exercise test protocols will result in an adequately-trained runner exceeding the LT and hitting the respiratory compensation point, producing extreme hyperventilation. Knowing this as a specific scientific principle only justifies the general common-sense idea of keeping most "tempo" runs from becoming too anaerobic for regular use. For the self-made runner who has experienced the magic and operates by zoning in to "cruise control" speed, this means preserving that energized, free-spirited, weightless sensation of strong, on-the-brink running.

Having the head knowledge without the experience and wisdom, however, can lead to following strict pace guidelines with insufficient attention paid to other important potential benefits of the desired training. Those aforementioned physiologists, as a case in point, may fail to remember that their test subject's "LT pace" was determined by a laboratory protocol which not only controlled the temperature and other external conditions, but also began the treadmill speed at a walking pace and allowed the athlete's physical markers (HR, respiratory rate, etc.) to stabilize at each stage before the workload was increased for another stage. In order to effectively use the physiologist's pace and duration recommendations, then, the runner must duplicate the conditions of the laboratory test (and must go into a session with the same degree of freshness each time). This is usually impractical in the real world, where the *test* LT pace is replaced by LT pace *du jour*.

Add to this the fact that the average physiologist does not have a clue what the magic of threshold running should actually *feel* like, how frequently threshold sessions can be performed, or how they interact with other workouts, and you have the makings of a one-dimensional, "cookie-cutter" training program. Such a scheme will work for the one runner out of 50 whose by-feel pace happens to match up with the by-chart pace assigned to him for that day. But it will not be quite as effective for the 49 other runners who blindly adhere to the cut-and-paste schedules they obtain from their most recent books or magazines.

Frequency of high-end running

There is a point at which you optimally build fitness; if you go *beyond* that point very often, you begin giving some of it away. Your ideal frequency of threshold running (as well as your ideal mileage) simply depends on how often you can do it comfortably without needing a very slow recovery day (or series of recovery days). But it should also be regulated according to a few general rules:

1) Your age / running experience

2) Time of year (base training or competitive season)

3) Your long-term goals or lack thereof (also influenced by age)

Trial and error indicates that actually hitting that high-end pace more than three times per week will expedite your fitness at a small cost to long-term development (this is also dependent upon how much *higher*-intensity work is being done concurrently). The take-home message in this is that if you are a newcomer to the sport or if you are younger than your prime racing years (25-35 years old for most long distance runners), you will be better served (at least from a statistical standpoint - obviously not everyone responds in exactly the same manner) by including more easy running in your base training regimen. If you are an older, experienced runner who is in (or past) your prime, you may be better served by running at least a *portion* of your runs near your maximum steady state more often (4-6 times per week). If you are a high school or college runner who wants high school or college glory but doesn't plan to go a whole lot farther in the sport after those years, you will also probably be better off touching on your high-end pace four or more days per week during a base stage, as long as you have done enough preparatory running to be ready for it.

"The drops of rain make a hole in the stone, not by violence, but by oft falling." - Lucretius

Consistency in running is as vital a contributor to success as any other attitude-driven constituent of your preparation. Anyone can achieve personal *improvement* with steadily increasing mileage and more consistent and intelligent high-end running. Of course, each individual possesses different qualities which may impose physical limitations, so you have to experiment to find the right mileage and the right amount of threshold running for your current tolerance, body weight, and state of development. But the involved *principles* are *universal*; they work across the board. If you keep safely and steadily trying to push the boundaries out as the years go by, you may have some inevitable setbacks during the discovery process, but you will find what's right and you will continue to make an overall improvement for years to come.

****

****

This Low-Volume Rubbish

By: John Kellogg, aka JK
August 6, 2004

"Those who do not learn from history are condemned to repeat it." - George Santayana

In the 1970s, it was common for American runners - even high schoolers - to average well over 100 miles per week during their preseason periods. At that time, such a practice was in no way considered outrageous; it was merely the kind of thing serious runners did if they had big dreams. It was no coincidence that high school marks in the distance events were at an all-time high during this period, followed by a banner crop of American road runners and long track event specialists in the ensuing years. This higher mileage fell out of favor among high schoolers in the 1980s and the first half of the 1990s, being replaced by low-volume, high intensity work, and performances significantly *declined* from both a top-end standpoint and from a depth perspective. The cycle of mediocrity continued for American runners long past their high school careers and into adulthood.

With the popularity of Internet message boards and mailing lists in the late 1990s, the training methods of many former American greats have been disseminated at a grassroots level. Subsequently, there has been a return to higher mileage and more aerobically-based training, and performances have returned to (and even surpassed) pre-1980s standards at the high school, college and post-college levels.

But how can slow running make you faster?

Recent advances in physiology have shown that improvements in specific endurance-related indicators such as mitochondrial enzyme activity, vascular endothelial growth factor (VEGF) and other determinants can be elicited just as dramatically through higher intensity work *without* prodigious volumes of slower running. These findings have fueled the long-standing debate among runners, physiologists, fans and other enthusiasts as to whether the high mileage base work can be eliminated entirely from a training regime with equally impressive results. Many physiologists argue that it can indeed be excluded. Most serious runners who have actually acquired a base say that it cannot be omitted. History points compellingly to the fact that the vast majority of elite runners have at one time in their lives obtained a substantial base, but no one has been able to show exactly *how* high mileage base training contributes to improved performances. Obviously, the scientists are overlooking *something* - perhaps a single enigmatic ingredient or, more likely, some subtle interaction of many such factors. It is entirely possible that *part* of the answer has to do with *relaxation*, which fosters coordination (i.e., the elimination of tension and wasted motion), which in turn promotes superior *economy*.

In running, economy is defined by the amount of oxygen required by an athlete to sustain a steady pace. The *lower* the runner's VO_2 is at a given pace, the *higher* the runner's economy is at that pace. An athlete's oxygen consumption is also directly related to the amount of energy substrate (stored fuel) used during exercise. Carbohydrate (also known as CHO, which is short for "Carbon-Hydrogen-Oxygen") is stored as glycogen in the skeletal muscles and in the liver. The glycogen stored in the muscles is the primary substrate used during moderate or intense

physical activity. It is broken down into glucose ($C_6H_{12}O_6$) for ATP energy production. Basically, 5.0 kilocalories of glycogen are used per liter of O_2 consumed.

In long races, a runner's economy becomes extremely important inasmuch as poor economy (a high oxygen demand) at the chosen pace results in squandering available glycogen, which eventually leads to severe depletion. In shorter, faster-paced races, CHO depletion is not a factor, but higher economy allows for a larger fraction of the race's energy requirements to be met aerobically, thus forestalling the onset of acidosis.

Economy is influenced by many factors, some of which are efficient selection and mobilization of muscle motor units, contractile properties of the muscles themselves, the capacity to buffer acidosis and the ability to reconvert lactate to other metabolites or use it as a fuel. Some strategies for improving economy may be addressed in future articles.

How relaxation may pay dividends

Slow running maintains very low muscle lactate levels, which is likely one of the key factors in its ability to influence economy. As mentioned, higher intensity will also create important changes (such as mitochondrial density), *but* the resulting acidosis *interferes* with efficient movements (ultimately even inhibiting muscle contractions), which reinforces less orchestrated recruitment patterns and promotes inferior use of available oxygen. Relaxation is therefore synonymous with efficiency; i.e., using the *fewest* number of muscle motor units required to accomplish your task with the *lowest* O_2 requirement. In simple terms, this means "channeling your energy" to avoid the wasted motion and excess tension that detracts from forward propulsion and invariably leads to premature anaerobic metabolism.

With sufficient high mileage running over time, your body will adopt the gait mechanics which provide the highest economy. This has less to do with the outward appearance of good form and more to do with the way muscle fibers are mobilized and the way muscle groups work in unison to eliminate wasteful movements such as vertical oscillation. Some very experienced runners may exhibit apparently crude form, but this may actually be correcting for other *unseen* imbalances - perhaps leg length discrepancies, mild scoliosis, overpronation, or even joint or muscle weaknesses brought on by factors such as poor mineral absorption. Even non-prime mover groups such as back and buttocks muscles must work together in concert with other factors such as arm carriage to hold a runner comfortably in an upright position during a race. With enough relaxed running, these muscle groups become very proficient at eliminating tension and using the lowest energy requirements needed to perform the task.

Another advantage of slow, exertion-free running is that it provides some light muscle activation and blood flow with extremely low impact stress and little chance for muscle cell stress or overload. Very easy jogging is also beneficial for management of metabolism. Many of the top Japanese marathoners perform daily "shake-out" jogs at 8:00 per mile or slower to supplement their primary sessions of stronger-paced running. One of the purposes of such relaxed jogging is to promote *weight stabilization*. Arthur Lydiard (widely considered the founder of periodization and marathon-style training for track athletes) also recommends a few miles of light jogging as an adjunct to the faster aerobic running that comprises the staple training of his preseason

program. Lydiard believes the Japanese runners may actually be *overemphasizing* the longer endurance work at the expense of shorter speedwork; however, it is hard to argue against the Japanese results: a horde of male marathoners in the 2:06-2:10 range and an army of female runners between 2:19 and 2:24.

All systems must be optimized

It has been hypothesized by many athletes and physiologists (triple Olympic gold medalist Dr. Peter Snell among them) that slow or moderate-paced running, if done long enough, would actually necessitate *recruitment* of "fast twitch" (FT) muscle fibers (motor units) as "slow twitch" (ST) units become depleted. However, this is almost certainly *not* true in runners *unless* the speed is increased near the end of a long run or unless strides or drills are used at the conclusion of the run. It *has* been demonstrated conclusively that performing long single runs or maintaining regular high mileage definitely *depletes* both ST *and* FT units, causing adaptations (such as increases in glycogen synthetase and other oxidative enzymes) which improve oxidative capacity of the fibers.

In *unfatigued* muscles, motor unit recruitment is regulated according to Henneman's "size principle." Small motor neurons, which innervate slow twitch (Type I) muscle fibers, have the lowest threshold for synaptic activation and are recruited first. Requirements for greater forces are met by the recruitment of increasingly larger motor units. The largest motor neurons, which innervate the fast twitch glycolytic (Type IIx) fibers, have the highest threshold and are recruited last.

The slow twitch fibers are called on first *regardless* of the exercise intensity. If the intensity is low, these fibers may be the only ones that are utilized. If the intensity is high, as during an all-out cross-country race, ST fibers are recruited first, followed by the oxidative FT fibers and, finally, the glycolytic (non-oxidative) FT fibers, if required. During the most intense exercise, *all* fiber types will be elicited.

You can think of your muscle fiber distribution as having 100 men of various strength which can perform tasks for you. You have some strong men with relatively poor endurance and a number of weaker men with a greater capacity for endurance. If your task is to roll a boulder (the size of which represents effort intensity) up a hill, your cerebral cortex and central nervous system will initially attempt to enlist the weakest men (according to the size principle) to try to perform the task. If they cannot generate the requisite force, you will then call up the next strongest men, and so on until enough men of sufficient strength are present and able to move the boulder. If you are an elite *sprinter*, your stable of 100 men will probably consist of 85 or so strong men and a very small number of weak men. When you contest the 100m event, you are in essence rolling a very large boulder up a steep but short hill. Although you will in fact recruit the weakest men along with the stronger ones, the need for *any* of the men to be fatigue-resistant (well-trained for endurance) is negligible, owing to how short the hill is (i.e., the event requires virtually no oxygen consumption). *All* of your weak men *will* be *enlisted*, but they will *not* be able to *contribute* with any significance to an effort requiring such forceful contractions. Basically, they will not be able to "catch up" to the stronger men as they power the boulder along at a high velocity.

Having highly trained, oxidative, fatigue-resistant muscle fibers across the full spectrum (*both* FT and ST) is analogous to training your strong men and your weak men to roll the boulder up a *longer*, gentler hill. Training *only* at higher intensities (i.e., doing hard intervals and/or weight training, with low overall mileage) is tantamount to training the strong men and a very *slight* number of the weak men to roll the boulder. If you have the body type of a middle distance runner (e.g., 20 strong men, 40 slightly weaker men, and 40 still weaker men are available to roll a moderate-sized boulder for four minutes), but your 40 weakest men are poorly-trained and only *marginally* fatigue-resistant, they will not be able to contribute as much to the team effort and a greater burden will fall on the stronger men rather early in the task, and they will fatigue quickly. You will always be better served by having *all* of your weak men (as well as your strong men) trained to be as fatigue-resistant as they can be so they can shoulder as great a share of the workload as possible for as long as possible. While the weak men (ST fibers) are not instrumental in the 100m, the 1,500m *is* an event requiring a high degree of aerobic energy production, one in which the weaker men *will* contribute significantly. This contribution will not be as substantial as in an even longer race, such as the 10,000m, so it might be argued by some that large volumes of aerobic training are relatively ineffective for the 1,500m, or that such training delivers diminishing returns. It must be remembered, however, that diminishing returns are *returns* all the same, so any improvement in aerobic fitness, however slight, will be of benefit to the 1,500m runner *as long as* basic speed and a limited injection of anaerobic, race-specific work are not sacrificed.

High mileage tips

While *methodology* is not the main thrust of this piece, a few general guidelines about high mileage running should be mentioned.

The best policy on most regular easy runs is to start *extremely* slowly (literally at *walking speed*) and allow your breathing pattern and heart rate to stabilize before attempting to increase the pace any. *Never struggle* during an easy run. It's probably best that you do not time your easy runs, as timing every run usually leads to racing against previous efforts, which can be ruinous. If you feel awesome, it's fine to go fairly fast and count that workout as a "tempo" run, but by no means should you *force* the pace. The usual idea is to feel like you are *storing up energy* for the next day's run. If you get fatigued from a regular easy run, it should be from the *length* of the run (or from a *series* of fairly high mileage days), *not* from the pace.

About half of your easy runs should be done on a soft surface - safe, smooth grass or dirt trails. If you cannot find suitable courses (with no uneven grass or ruts or potholes), at least try to run a *portion* of each easy run on a soft surface. Perhaps do a few loops of a grass field in the middle of a run, or stay on the soft shoulder of a road rather than run on hard surfaces all the time.

Do not allow your shoes to wear down excessively. This is a major contributor to injuries and general fatigue. You should keep 2-3 pairs of shoes that are in good condition, and rotate your footwear regularly. It is a good policy to wear *racing flats* on many runs that are faster than an "easy" pace. You can also wear racers on short, easy jogs every now and then. This practice will promote ankle strength and flexibility, which will hopefully reduce injury risk.

It isn't *all* jogging

A substantial portion of preseason high mileage running (roughly between 15% and 40%, depending on your age and experience) needs to be done at just below your "maximum steady state" of effort, as this pace uses more glycogen as fuel (as opposed to fat, which is accessed more during slower jogging), and sufficient use of glycogen as the primary substrate allows for the greatest improvement of oxidative properties within the muscle cells.

These "high-end" aerobic workouts should at some point become the *staple* "fast" sessions of any serious runner's preseason training. They contribute to running success more than any other type of workout, since the cost/benefit ratio is favorable at a pace which is fairly quick yet still relaxed enough to eliminate tension.

The general idea on a high-end aerobic run is to find the fastest pace at which you can run without feeling as though you're having to fight to sustain the pace. You should start at your usual easy run pace and let your breathing and perceived effort stabilize before attempting any increase in pace. As the run progresses, lock in to the pace which will *train you* yet force a *slower* runner to *strain*. In layman's terms, this means "relax and train a runner, kill a jogger". The pace should always be manageable; that is, you should be well in control of the speed rather than forcing yourself to maintain it. Once you sense that struggling is about *10 minutes away* if you keep the pace you're running, it is time to wind up for the finish of the high-end portion of the run. You should then squeeze the pace down to a gradually faster speed for only about 2-3 minutes. At this point, you may find yourself *flying*, but you should *still* feel as though you are floating rather than straining. Because you will only be spending 2-3 minutes at the faster speed (above your lactate threshold), you will not accumulate enough time at this effort level to go into a predominantly anaerobic state. This is important. You should always finish a high-end workout feeling strong - almost *energized* from the sensation of running right *on the edge* of pushing it.

The most prudent approach is to work *with* your body rather than against it, watching for the signs that tell you that you are *about* to go too hard, as opposed to struggling and fighting yourself and undermining the effectiveness of your workouts.

A good analogy is to think of a high-end aerobic run as though you were driving across town, timing your speed so as to hit all the lights *green*. It's efficient, fairly comfortable, conserves energy, and involves the least risk of having a wreck or getting pulled over for running red lights. Think about that. If you were to actually try to drive in such a manner as to hit all the lights green, you would have to find out how long those lights *stayed* green. You would also have to be sure your car was working properly and that you had enough gas in the tank. Therefore, it would require a little *trial and error* to succeed in your mission to hit all the lights green! The analogy carries over to running. You need to practice finding your high-end effort by *feel*, and you must have some running background in order to do an effective high-end run.

Many runners relate that a moderately long run the day after a race feels great. The athlete is left wondering, "Why couldn't I have felt this good in the race?" This strong, weightless, free-spirited feeling is partly attributable to the fact that the recovery run is started very slowly and there are no expectations to increase the pace at any pre-planned point in the outing. This leads to all

systems warming up gradually and achieving a relaxed equilibrium, after which follows a spontaneous, memorably enjoyable run at a good pace. As long as this pace is not *forced*, but is allowed to happen in an impromptu fashion, this type of training can be repeated regularly without excessive torque, impact stress or acidosis and will ultimately lead to superior fitness. It must be mentioned, however, that *too much* fast running (though it may feel fine for a few weeks) can eventually backfire, and flying into an unplanned tempo run the day after a tough race should not become a *regular* practice.

Stay in touch with faster speeds

Regular inclusion of "alactic" fast running (buildups or strides of 10-35 seconds duration or short bursts of 7-10 seconds) and certain form running drills can be instrumental in maximizing the effectiveness of high mileage base work. The short strides promote efficient movement at all ranges of speeds. The drills foster *stability* and *neuromuscular control*.

An entire session may be devoted to strides, drills or both. You may also include 3-4 light to medium speed buildups or strides in the middle of your "cool-down" jog following certain high-end runs. This practice will re-elevate your heart rate and allow your body to "take up" some of the lactate you might have accumulated from running somewhat hard at the end of the high-end portion. It will also train your FT motor units to perform after your ST units are somewhat fatigued.

If you are feeling chronically sluggish or your progress seems to have stagnated, you might give yourself a jump-start with the following short routine:

1.) Very light pre-stretch

2.) Two sets of 10 traveling (moving forward) lunge steps (use shallower lunges in the first set and deep ones in the second set, but avoid bending your lead leg past a 90 degree angle)

3.) One or two sets of 30 steps of rapid high knees

4.) Skip the length of the infield (start out low and relaxed and begin skipping for height and distance when you get about one third of the way down the field - concentrate on getting a soaring feeling)

Do not recover much following these drills; instead, go straight into a run starting at an extremely slow pace. The drills are anaerobic, but they should remain alactic, accessing the high-energy phosphates as opposed to causing acidosis.

A set of 30 rapid high knees can also be inserted in the middle of an occasional run or can be tacked on at the end of the run in order to liven your routine up a bit.

The bottom line

Laboratory theorists and other non-runners often ask advocates of Lydiard-style training, "What *changes* take place through higher mileage that cannot be achieved through moderate mileage at higher intensity?" The question continues to be asked because no *specific* physiological changes have been demonstrated to date in an exercise physiology laboratory. However, the statistical evidence from the *larger* laboratory of real-world trial and error, head-to-head competition and marks on the stopwatch points overwhelmingly to the fact that one change - the most important change of all - takes place with higher mileage: *improved performance*.

Obviously, a balance must be struck between long, slow running and higher intensity work. The faster running increases neuromuscular control, elicits a different recruitment pattern (invoking more fast twitch units) and improves the athlete's ability to work in an anaerobic state, and these attributes are unquestionably essential for maximum performance in all-out competition. The main question for the individual runner is whether more running at a lower intensity will pose more of an *injury risk* than will a moderate amount of higher intensity running. The answer to that question depends largely on the athlete's structural integrity and not as much on muscle fiber composition. It is certainly possible to *abuse* either a high mileage approach *or* a high intensity method by relying on one system to the complete exclusion of the other.

From a standpoint of *enjoyment*, there may be some people who do give higher mileage a chance for several months out of each year and find that even after several years, they still *hate* every moment of it! These individuals will probably lose motivation and focus by forcing themselves to adhere to such a program and most likely will achieve more in the sport by bringing a fresh, positive attitude to sessions they *will* enjoy. In the end, the ideal balance for any given runner will be found only through patient trial and error.

****

****

How I Became A Guide

By John Kellogg, aka JK
Jan 7, 2004

A metaphor for the passion and joy of serious running, the trend toward abandoning the basics in favor of minor details and shortcuts, the use of drugs in sport, and what it takes to be a true leader

I must have made the journey ten thousand times. There was this mountaintop, you see, from which paragliders once soared in a manner which enraptured their souls and which even seemed to inspire awe and jealously in *eagles*. It was the meeting place for all the true adventurers and was the accepted hallowed ground among the aficionados. Much has been made over why this spot was like no other. Some said it was the scenery. Others claimed it was the updrafts. Still others maintained there was some mystical concentration of Gaia emanating from the planet at that precise locale which filled gliders with a supernatural euphoria. Whatever the reasons, there surely was a magic about the place which was largely inexplicable, and thrill seekers from far and wide would happily make the seemingly interminable expedition up the pristine, convoluted mountain trail for a chance at touching Heaven.

Heaven it was. I had spent countless lackluster years gliding at other venues, and even at lower takeoff points on this same mountain, but once I experienced the unspeakable joy that I had only heard and dreamed about, I knew I had found paraglider's paradise. But the hike to the top was not at all easy. Its difficulty lay not in any brutal steepness or the like; it simply took an extraordinarily long time! I spent most of my first trip up the mountain wondering if the flight from the top would really be worth all the time and effort spent getting there. I learned later that this is a question every newcomer asks. But it was worth it and then some! And not only did the climb up get easier each time I made it, the glide back down became more awe-inspiring as I became more proficient at working the air currents. I would have climbed *ten times* as far to get that dose of sailing free, that orgasm of the soul.

As if that wasn't enough, I began to truly *enjoy* the excursion up the trail. What a breathtaking place this was! Each stratum of the mountain featured its own peculiar ecosystem. And the view of the land below, horizon beyond, and sky above never failed to leave me open-mouthed in amazement. The main route had been established long before as the only accessible path to the top, and it had been worn to a clearly defined trail and subsequently marked, but I spent so much time there that I forged little trails off the main path which possessed their own quirks and provided their own unique experiences. There was not a single square meter of accessible ground on that mountain that I hadn't covered more often than *anyone* who had ever been there. I knew every turn, every rock, every tree and every squirrel as well as I knew my very spirit.

I wanted to show others every hidden niche I had discovered that made this place special, to show them what could be in store for them if they were willing to make the unconditional commitment to hike that twisting, hilly trail to the top, and to give them the opportunity to find personal joys in the journey itself, to make the mountain their own. I became a guide, a mentor to those whom I sensed could do great things in hiking, climbing and gliding and could come to love those activities as I did.

It was a very popular place then; many adventurers made their way up the established route. There were those before us and among us - I one of them - who had searched everywhere on Earth for a more enjoyable, rewarding, fulfilling experience, but no place had ever rivaled this one. We would often make the trip in tandem - or in groups, for that matter - as the company made the difficult stretches pass by more quickly. Though it helped at times to have others along, for each individual, the journey itself was unique, as was the exhilaration at the top and the euphoria on the glide down. It's strange how there was only that one spot and only the one main route that led there, yet there were ten different experiences for each ten adventurers. Each would try to describe the experience with words, but it was something that could not be expressed. All those who were in the fraternity could do was share the common bond and respect with their brothers who had been to that place that no outsider could know.

The trek to the top, although a tough uphill hike, featured very few steep faces which required rock climbing skills. However, there was one vertical cliff near the very summit. This was difficult climbing and necessitated some practice on similar terrain closer to the bottom. Supplementary exercises were sometimes needed to facilitate the climbing.

Some participants had a natural gift for paragliding, borne of purely physical qualities which were innate and which could never be attained, although each individual's basic abilities could be cultivated through diligent practice. Most of the naturally talented ones worked almost exclusively on improving their rock climbing skills and on "muscling out" longer flights. They had found outcrops well below our summit point to which they could climb using the latest equipment and from which they could launch themselves. Because of their superior gliding talents, some were able to sustain rather long flights, but never quite as long as those of the best of our group, who took off from the true summit. They claimed the experience was the same, that no one needed to go all the way to the top, but we had all tried it many times in our less enlightened days (and even experimented with it still), and we knew better. Furthermore, the objective criterion of "hang time" belied their assertions. As a group, they all fell short of our group in terms of duration in the air. This was something they could never quite explain to anyone's satisfaction, yet they continued a vain attempt to muscle their way upward to catch those updrafts that could only be caught from our starting point.

What we never understood was why these talented individuals would not make the trek to the summit, where they could have used their natural abilities to achieve mind-shattering glides. Maybe they simply hated doing anything other than rock climbing and paragliding, and the prospect of a time-consuming, arduous hike filled them with dread and a sense of pointlessness. Maybe they felt that they would not have the energy or the desire to enjoy the glide down if they had to travel that winding path to the top, that the result would not be worth the effort. Perhaps they thought some crucial aspect of their flight would be compromised. But they were *wrong*. Those who did decide to make the complete journey were rewarded with stronger updrafts, a more panoramic view of the world around them, and the longest, most fulfilling rides of their careers. Few who made the journey even once regretted having done it, and the more they made the trip, the more they came to embrace it as an unparalleled experience, reveling in the hike up as much as they enjoyed the floating, soaring ecstasy of the flight back down.

Many articles, treatises and books on the entire experience were written by those who had never so much as *seen* this or any other mountain, let alone climbed one or attempted a flight from any launching point on one. They spoke of many minor nuances of hiking and climbing, the dynamics of paragliding, and of all the ways one could become more proficient without ever having to leave solid ground! Like those before them who had debated why the Earth must be the center of the universe, its surface flat and its moon made of Swiss cheese, they put forth their armchair theories with conviction, supporting their spurious arguments with the scientific vernacular of the day. To our chagrin, they gathered more and more followers as the years rolled by. Something seemed to be rather appealing about clinging to the belief that a long mountain hike was unnecessary as a prelude to a record flight. Finally, nearly all the newcomers to the community had been lured by the siren song of the new theories. Classes were formed in which one could become a "certified instructor" by memorizing material from a book. But, alas, the *hang time* never lied, and those who followed these "instructors" and put these theories into practice never managed the prolonged, spirit-swelling flights that we had known.

We've seen many, even in our own time, who searched for another launching spot on the mountain, or for another trail which would bring them to our established takeoff point in less time and with less effort. We've also seen those who looked for other mountains. But we all -

every one of us - sought out those things ourselves, and they do not exist. There are higher mountains out there, but they have no accessible launching points to match the beauty and majesty of ours, no updrafts to rival those we soared on for what seemed days at a time. There was something special and awesome about that place, yet so many shortcut seekers who came after us consider us *arrogant* to say that we have exhausted all the possibilities or that our spot is and always will be best. But *they* are arrogant to think they are the first to seek what we have already found; it is *disrespectful* of them to overlook the fact that hundreds of thousands before them (who were equally smart and equally determined) had to suffer and struggle and learn from their own predecessors to find this wonderful place. If there was a better place to do what we love to do, we would have found it long before the shortcut seekers were born. And there is always that unbiased measuring stick known as hang time - their best simply cannot achieve what our best did, and no matter how many excuses they put forth, we know why they cannot.

Recently there have been those who have indeed found higher launching points on previously inaccessible mountaintops from which record-setting glides can be achieved, but they have installed *mechanical lifts* to take the gliders to the top. What a watered-down waste! Those of our group who have tried it say the flight down is truly remarkable in duration, but the scenery and the spontaneity are missing. It is merely a linear glide down, made longer by the sheer height of the takeoff point, but without those heart-thrilling updrafts we used to ride. It is not the same. And where is the love of the journey to the top? Where is the intimacy of *knowing* the mountain, its side trails, its crisp, clean air, its boulders and shrubs and animals as your personal friends and soulmates? Where is the time to pause for a long look at the land below and the sky around and above? Where is the freedom to explore and savor those out-of-the-way recesses one can call one's own? Where is the commitment and the character-building process of reaching the top through one's own efforts and having that trip become less taxing and more readily appreciated over time? Some things cannot be bought and some experiences should never be cheapened.

There remains only *one* genuine, virtuous path to the top. Many of this generation cling at all costs to the belief that there is another way, one which satisfies their love of a quick fix. There is not. Those who attempt to make the journey in such a way do not possess the spirit to be called paragliders and those who teach any method other than the one and only way possess neither the passion nor the wisdom to be called guides. I do not endear myself to many of these newcomers with such blunt honesty, but I did not become a guide to help the "wannabe" gliders feel good about themselves and fabricate new excuses while the "need-to-be" gliders soar out of sight far above them.

Few people know their raison d'être with certainty; fewer still pursue their purpose against all odds and in the absence of worldly rewards. Furthermore, it is *only* life-changing revelation through soul-stirring experience that earns one the authority to teach, lead, guide or advise. That is what elevates *wisdom* above mere head knowledge and what separates vision and passion from perfunctory duty. I found my own purpose and authority through thousands of journeys which were influenced heavily by the combined wisdom of the masters who forged the trail before me and beside me. I knew even then that someday I would lead others who loved so much to fly that they would set aside all other worldly things to be the best of the best. I still speak for Truth in this, the purest and most fulfilling of all athletic endeavors.

That is who I am and how I came to do what I do. Who are you and what do you do?

John Kellogg has logged over 70,000 miles in 28 years of running, with a highest week of 156 miles. He has experimented with as many combinations of training procedures as is possible in the course of a human running career while still devoting enough time to each mixture of techniques to ascertain their effectiveness. While he never reached the elite level himself, he was able to train himself effectively enough to run 14:22 for 5,000 meters while possessing a best time of only 57 seconds for 400 meters. John also has a Cross-Country 10,000 meters best of 30:46, and was nationally-ranked in the marathon as a Junior (under age 20).

He has trained in America and in Europe with runners of all ages, abilities, and nationalities, including world-class athletes, and has coached runners of all ages for 15 years, producing results at the state-class and national-class.

LetsRun.com co-founder Weldon Johnson trained under Mr. Kellogg's guidance in middle and high school and credits his return to Mr. Kellogg's training with his huge post-collegiate improvements. A 4:29 high school 1600m runner in high school, 30:14 10,000 meter runner in college, Weldon has run 28:06 for 10k, has finished 4th at USA Nationals twice at 10k.

When Weldon was a 29:49 10k runner, he then said John Kellogg was the best running coach out there. He still believes that today and we believe Weldon's results support this contention. One of the reasons this website was started was to spread the training philosophies of John Kellogg.

*John Kellogg now lives in Ithaca, NY with site founders Weldon and Robert Johnson and plays an integral role in the success of Robert Johnson's Cornell cross country and track teams, which in three years have gone from being an afterthought to one of the best mid distance teams on the East Coast. This year Cornell was 3rd at Penn Relays in the DMR (behind Michigan and Arkansas), 5th in the 4*Mile, and had the fastest time in the NCAAs indoors in the 4*800.*

John Kellogg's most recent articles include "This Low-Volume Rubbish", "Maximizing Oxygen Uptake", and one of our favorites, "How I Became a Guide"

John Kellogg formerly operated a website, we hope to have it up again soon. If you'd like to read JK's 4 training principles click here

****

****

Appendix B: Paragonrunning.com

****

****

[Paragonrunning.com was a short-lived website active between 2000 and 2001. It was created by John Kellogg and Kyle Heffner, a 2:10 marathoner and the 3rd-place finisher at the 1980 Olympic Marathon Trials. The motto was "Where the experience and training of the 1970s meets the science of today." The intent was originally to set up an online coaching service for a fee.]

****

****

The samples below are only example training weeks, and are individualized for the runner for which they were written. They will not work for everyone at every point of their training program. To understand their implementation, though, a brief bio of the athlete is included above the table of workouts.

Sample workouts of **Weldon Johnson**, *1998 Marine Corps Marathon champion, 1999 Vermont City Marathon champion, 6th place 1999 Camden-Clark Parkersburg Half Marathon, 1999 U.S. Half Marathon team, 2000 U.S. Olympic Marathon Trials and Olympic 10,000 Trials qualifier* (weeks taken from Feb., March, April 2000):

Early Pre-Season (Feb. 2000)

All runs are at 7,100 ft. altitude and are untimed unless otherwise indicated

S A.M. 6.5 miles easy on grass/trails
P.M. 15 miles easy on grass/road/trails

M A.M. 6.5 miles easy on grass/trails
P.M. 14.5 miles high mountain run (starting at 8,200 ft, going up to 9,500 ft., then back down to 8,200 ft.) at slow pace but moderate effort owing to the uphill and the altitude, 5 medium to fast buildups on a level surface following the run

T A.M. 6.5 miles easy on grass/trails
P.M. 15 miles on grass/road/trails

W A.M. 6.5 miles easy on grass/trails
P.M. 15 miles at low altitude (1,000 ft.) w/ 7 miles in middle at high-end aerobic pace (untimed, but fractionally slower than threshold pace), 4 buildups during jog following high-end pace

R A.M. 6.5 miles easy on grass/trails
P.M. 15 miles on grass/road/trails

F A.M. 6.5 miles easy on grass/trails
P.M. 14 miles easy on grass/road/trails w/ 4 light to medium speed buildups near end

S 24 miles easy at 3,200 ft. altitude on grass/trails w/ last several miles gradually picked up but untimed (water every few miles)

Total mileage for week = 151.5

(Weldon's highest week ever)

Late Pre-Season (March 2000)

S 13 miles easy on trails

M A.M. 5 miles easy on grass/trails
P.M. 13 miles comfortably-paced high mountain run (8,200 ft. to 9,200 ft.) w/ 4 buildups near end

T A.M. 6 miles easy on grass/trails
P.M. (Altitude of 4,500 ft., repeats done on dirt track) 2.5 miles jog, 4 buildups, 2 strides, 5 x 1,600 @ 5:03, 4:53, 4:53, 4:52, 4:36/ 400 meters jog between each, 3 miles jog w/ 4 medium to fast buildups included

W A.M. 6 miles easy on grass/trails
P.M. 14 miles easy on grass/road/trails

R A.M. 5 miles easy on grass/trails
P.M. (Low altitude of 1,000 ft.) 2 miles jog, 4 buildups, 3 strides, 8 miles @ 5:10 start, 5:04 average in middle, 4:46 last mile, 3 miles jog w/ 4 medium to fast buildups included

F 10 miles easy on grass/road/trails

S 25 miles easy at 3,200 ft.altitude on grass/trails w/ last few miles slightly picked up (water every few miles)

Total mileage for week = 122.5

Competitive Season (April 2000)

S A.M. 5 miles easy on grass
P.M. (Altitude of 4,500 ft., repeats done on dirt track) 2 miles jog, 4 buildups, 2 strides, 10 x 1,000 @ 3:10 start, 3:07-3:09 for next seven, 3:04, 3:01 on last two/30-35 secs. jogs between each, 400 jog after last rep, 1 x 400 @ 63, 2 miles jog

M A.M. 6 miles easy on grass
P.M. 10 miles easy on grass/road/trails

T A.M. 5 miles easy on grass
P.M. (Low altitude of 1,000 ft.) 2 miles jog, 4 buildups, 2 x 200 @ 33, 31 (to warm up further and to establish pace), 6 x 800 @ 2:09 for first five, 2:07 on last one/2 min. jog between each, 800 jog after last rep, 3 x 300 @ 50, 45, 42 w/ 100 meters walk/jog (@ 40 secs.) between each, 2 miles jog

W 9.5 miles easy on grass/road/trails

R 5 miles easy on grass + 4 light to medium speed buildups

F 2 miles jog, 4 buildups, 3 strides, Mt. SAC Relays 10,000 @ 28:27.58 (5th overall, 2nd American, PR by 1:22.10 - amazing!!!!!), 3 miles jog after race [*Weldon had run only **three** track workouts involving faster speeds than he ran in this race, still more proof that constant killer track work is unnecessary if the aerobic base is solid!*]

S 10 miles on grass/trails

Total mileage for week = 85

Sample workouts of *national-class high school distance runner* **Erick Hawkins** (weeks taken from Dec. 1991, Feb. 1992, and March/April 1992):

Base Training (Dec. 1991)

S 13 miles on grass/road @ 6:51 avg. pace w/ minor buildups during last 2 miles

M A.M. 4.5 miles easy jog on grass
P.M. 10 miles on grass/road @ 6:46 avg.

T A.M. 5 miles easy on grass
P.M. 11 miles on road w/ middle 9 @ 6:08 start, 5:40-5:45 for next 7, 5:27 last mile (51:30 total for 9 miles, 5:43 avg.), 4 buildups during subsequent cool-down mile

W A.M. 5 miles easy on grass
P.M. 9 miles on grass/road @ 6:58 avg.

R A.M. 5 miles easy on grass
P.M. 2.5 miles jog, 3 sets of 6 x hill strides/springing, 3 min. jog between sets, light form drills, 2.5 miles jog

F 6 miles on grass @ 6:54 avg.

S 18 miles on grass/road @ 6:36 avg. (last 2 miles 6:18, 6:03)

Total mileage for week = 95

(Erick's highest week during high school was 108)

Pre-Season Training (Feb. 1992)

S 13 miles on grass/road @ 6:44 avg. pace

M 13 min. jog, 4 buildups, switch to racing flats, 200 @ 42, 5 miles on road @ 5:32-5:18-5:16-5:17-4:54 = 26:17 (5:15 avg.), 15 min. jog w/ 4 buildups during middle

T A.M. 4.5 miles easy on grass
P.M. 9 miles on grass/road @ 6:38 avg.

W A.M. 4 miles easy on grass
P.M. 13 min. jog, 4 buildups, switch to racing flats, 200 @ 35, 10 x 2 min. on/2 min. off (avg. distance around 660 meters, 72-73 400 pace), 18 min. jog

R A.M. 4.5 miles easy on grass
P.M. 9 miles on grass/road @ 6:47 avg.

F 7 miles easy on grass/road w/ some buildups near end

S 15 miles easy on grass/road @ 6:50 avg.

Total mileage for week = 88

Competitive Season (Late March/Early April 1992)

S 13 miles on grass/road @ 6:42 avg. w/ light Fartlek (relaxed variable-speed running)

M A.M. 4 miles easy on grass
P.M. 6 miles easy (untimed) on road

T A.M. 4 miles easy on grass
P.M. 13 min. jog, 4 buildups, 2 x 200 @ 34, 31 (warmup), 2 x 800 @ 2:17, 2:13 (2 min. jog after each), 4 x 400 @ 65-63-63-60/rest periods of 1:40 (windy day), 17 min. jog.

W 8.5 miles on grass/road @ 7:03 avg.

R 4 miles easy on grass + 4 buildups on track

F 17 min. jog, 3 buildups, 2 strides, Texas Relays 3,200 meters @ 9:12.40 (auto timed) [*3rd place behind Andres Gomez (9:06.44) and Raffeg Ayyad (9:11.77) - At the time, these were the 2nd, 7th and 8th fastest times in the country; Gomez instantly gapped the others with a 13.4 (!) first 100 of the last lap, 28.0 for the first 200 of that lap, and 58.6 total*], 15 min. jog after race

S 13 min. jog, 4 buildups, 2 strides, Texas Relays 1,600 meters @ 4:17.80 (auto) [*2nd place behind Ayyad (4:15.81); outkicked 5A state 1,600 champion-to-be; got gapped by Ayyad on lap 3 while being stuck in traffic off a slow pace; compared with last night's perfectly paced run, this was a stupid tactical race; last lap of 60.8 but it was too late to make a bid to win; Gomez was favored but scratched*], 19 min. jog after race

Total mileage for week = 60

****

****

"Only those who risk going too far can possibly find out how far they can go." - *T. S. Eliot*

The implementation of proper distance running principles must include a *balance* of training components. The cornerstone of any well-balanced training system is *periodization*, which relies on establishing aerobic endurance *first*, while incorporating some alactic technique work and light speed maintenance to prevent injury and to allow a smoother transition to faster-paced running. The intense anaerobic training is performed in *limited injections* during peaking phases and must never be done to excess, particularly in youth.

Following are some of the fundamental tenets and types of workouts which are the principal ingredients of a solid training plan. Click on each component below to display a new window containing a detailed explanation of that component. *Defined terms* are highlighted the first time they appear in each page. Click on the word or term in question to display a new window (usually within the 'definitions' page) which explains the word or term. Or click on the sub-menu at left to go directly to the 'definitions' page, where a complete list of terms appears at top.

When devising any training schedule based on sample workouts, it is crucial to remember that these examples are merely *guidelines*. The specific speeds given in these workouts are just *numbers* which may or may not meet your current training needs. It is usually a mistake to copy another runner's training, even with corresponding alterations in pace. You must learn the

principles first, then gain *experience* so as to monitor your training speeds according to your own running background, basic abilities, and *current* fitness level. Also remember that in order for a sound, periodized training scheme to be *correctly orchestrated*, an objective, knowledgeable, and experienced coach is needed.

Age Group Progression Analysis - Here you will find information on what the ideal progression of a competitive distance runner should be from a young age and throughout his/her career. Some ideas on nutrition and general activity are also presented.

Continuous Easy Runs - This section outlines the purpose of regular "recovery" runs and offers detailed information on their durations, as well as explaining proper easy run protocol. Information is presented on proper form, breathing techniques, heart rates, shoe rotation, terrain changes, treadmill running, and altitude training.

Long Runs - Here you will find an explanation of different types and durations of long runs, the purpose behind them, and details on procedures for optimizing their effects on conditioning. Included are tips on breathing techniques, minor pace changes, and taking fluids while running.

Lactate Threshold Workouts - These workouts contribute more than any other to running performance if practiced regularly. Here you will explore the purposes and benefits of lactate threshold workouts, and will see specific examples which illustrate how to implement them to raise the lactate threshold and improve running economy.

VO_2max Workouts - VO_2max running refers to working at the very limit of aerobic energy production. Here you will find workout procedures and sample workouts which can enable you to improve your ability to use oxygen and improve the speed at which you can run while working at that highest level of oxygen consumption.

Speed Maintenance Workouts - Here you will find the best ways of staying in touch with your speed throughout the various training phases, and how to avoid overtraining by running too anaerobically. Included are detailed explanations of buildups, "cut-downs", and hill repeats.

Lactate Tolerance Workouts - These workouts are the least important of any of the many types of training, yet they are the ones most commonly used by unknowledgeable runners and coaches. This section provides information on the purpose and durations of workouts designed to increase the ability to run anaerobically. Important guidelines are given for limiting the amount of time spent in oxygen deficit. Sample workouts are also provided.

Conversion Chart - This is a unique table which lists equivalent performances for various race distances along with corresponding critical training speeds.

****

****

Training for Age Groups - A Progressive Approach

Endurance is to some degree an inherited quality, depending in part on percentage of slow twitch (ST) muscle fibers. However, a huge determinant of future running success for a population in general is the amount of aerobic activity pursued during childhood. This is one ultimate root of American distance running mediocrity in recent years. Youngsters are not as active as those of past generations and adults are not as demanding of more effort as the children grow older. The bar has been lowered for today's kids, and it all begins with what comprises their daily routines.

The kids of the 1960s and 70s would spend hours per day outside playing, "pacing" themselves to keep their exertions aerobic. No one was standing by with a stopwatch telling them to pick it up or to get busy again if they slowed down. Kids are inherently smart enough to give themselves a rest when they need one. This is one reason that casual *play* is better for the aerobic development of children under 12 than is organized running *training*. Other reasons to forego "workouts" at this age are, obviously, performance pressure and mental burnout.

Kids in past decades would often go *barefoot* during play sessions, which automatically increased ankle joint integrity and strengthened the "balancing" muscles in the lower legs and feet. This allowed for more endurance training to be accomplished without injury later in life.

Young children should be encouraged to *cover* (not necessarily *run*) as much distance as is comfortable during play. This is suggested not just to make better runners out of them, or even to get them involved in competitive running, period. It's simply advisable to have children be active for *health* reasons! Obviously, not every kid will (or can) become a good runner; it's merely a side effect that better runners will come out of a population of more active, healthy youngsters. Aerobic activity is more beneficial for children's overall health than is clicking a mouse button or tweaking a joy stick for several hours a day.

Nutritional and environmental factors also play a role in the health and development of children. These components act intimately in conjunction with heredity. A preponderance of sugars and additives in the American diet since the middle of the 20th century has resulted in an imbalance of microorganisms in people's digestive systems and, eventually, in the cells. As these flora are passed from parent to child, they become more difficult to keep in check or destroy, owing to the fact that the child starts with the problem the parent already had, and the concentration of detrimental organisms and their toxins is increased. Eating only small portions of the foods which led to the parent's imbalance of flora will therefore more readily trigger a problem in the offspring.

There is also reason to believe that the presence of these microorganisms actually causes cravings for the foods on which they thrive. In short, the "junk food sins" of past generations have left today's children more susceptible than their parents to forms of cancer, neuropathy, multiple sclerosis, arthritis, attention deficit disorder, depression, etc. While the genetic predisposition toward these diseases cannot as yet be controlled, most of the *symptoms* can be held at bay through proper diet. Anyone with arthritis, for example, can reduce or even eliminate the inflammatory component by fasting on nothing but distilled water for a few days. [*Obviously, fasting should not be undertaken while training. It needs a doctor's approval and should preferably be done with supervision - it's easy to do it incorrectly with no knowledge of what to expect, and breaking a fast properly requires care, as well*.]

Natural foods, including more fruits and vegetables than most people eat (and a little extra

grains for children), are the key to general health. These days, it's probably prudent to add some antioxidant vitamin supplements (but these do little good without the enzymes/phytochemicals present in real foods). Distance runners also appear to benefit from red meat on occasion, owing to the heme iron content. Blood type "O" tolerates red meat best and "O"s can eat red meat up to 5 meals per week without any real digestive problems. Females especially need a natural iron source. Most iron *tablets* are harmful if taken over many years; a liquid source is better and iron-rich foods are better still.

As people get past 40 years of age, they need to reduce their food intake by one-third in order to maintain DNA replication. This (and other factors) means less overall distance, more short to medium length time trials, and a "multi-tier" approach are the best training guidelines for masters. Click here to read an article in 'current events' for more specific information on masters training.

Following are somewhat more specific training principles for aspiring runners of different ages.

Under Age 12

In addition to prolonged play, young kids who are interested in specific running training need some kicking drills in a swimming pool, if one is available. Deep water running, flutter kicks, leg circles, and leg crossovers (2 x 30 secs. of each) are good exercises, by virtue of the fact that they can help build bone density. It is the torque of the muscle on the bone which stimulates bone density, not impact stress. Excessive impact stress during childhood can actually *decrease* bone density, particularly if running shoes are worn! Shoes restrict normal range of motion of the ankle and inhibit development of muscles in the feet themselves. Obviously, a sole of some sort is needed for running any significant mileage on a hard surface, so shoes are required by serious runners. But children need to do some of their playing as nature intended if they are to acquire full development of the lower legs and feet.

Actual *running workouts* at this age should mainly consist of effortless running and technique work (drills and buildups). Virtually *none* of the work should produce lactate; in fact, it should not be thought of as "work" at all by the children involved. In other words, stay away from Super High Intensity Training! This means that 2 sets of 5-6 buildups twice per week, followed by some of the easier drills such as toe raises, step-ups, skip bounding, and high knees are enough. Races of 200-800 meters can be done once per week during "all comers" track meets for a period of no more than 6 weeks in the late Spring or early Summer (only 1 race per meet, vary the distance week-to-week). A fun run of 5,000 meters or shorter on the road is fine once every few months, but no special training should be done for these and no pressure should be imposed to achieve a certain time goal.

Remember that *aerobic* exercise is the most important component of the early years, but under no circumstance should children under age 12 be pressed into attaining any predetermined mileage levels. They must always be allowed to stop when they feel they have played or run enough. Usually, they will get bored before they get tired, anyway. If young kids are going to *run* at all, they are almost always better than their elders at judging how much (and what speed) is right for them.

Ages 12-15

Aspiring runners in this age group need to have a *progressive* program of more aerobic endurance training while still doing something about their technique and speed. Since their hormone levels have not yet increased to the maximum, they should not do anything excessive, but the goal is to run enough more each year so that when the hormones do have their sharp upsurge, they activate processes which go toward making this person a better *runner*. This occurs through neurological feedback to the endocrine system. The end result of progressive training loads is that growth processes and subsequent metabolism will be directed toward enhancing aerobic endurance.

A 12-year-old should be able to handle an average weekly load of 15-20 miles, with a highest week around 25 and a longest single run of near 60 min. Not every season should be spent in organized running training at this age; team sports such as soccer or basketball in the off-season are encouraged to prevent physical and mental burnout on running over the many years to come.

Each passing year from age 12 to age 15 can see an increase in the weekly mileage of about 15 miles for boys and about 10 for girls. Girls need less endurance work because their hemoglobin levels are lower, so aerobic metabolism always plays less of a role in their performance capacity. Also, their ability to repair tissue and adapt to the training load is reduced due to lower muscle mass. A low to moderate mileage approach (as recommended by most physiologists) actually does work best for girls (not so for boys).

The yearly progression in aerobic workload puts a 13-year-old boy up to about 30-35 miles/week on average, with a highest week of 40-ish and a longest long run of 70 min. Girls can reach 25-30 mile weeks, and their longest runs may be just as long as those of boys until age 16. By age 15, the weekly average for boys can reach 60-65 miles (highest week of about 75) and long runs may go up to 95 min. (girls 40-45 miles/week). Off-season team sports are still fine at this age, but a small amount (15-25 miles/week) of supplemental running for a month or so prior to a competitive season is strongly encouraged.

Tough anaerobic workouts must still be kept to a minimum at this age. More technique work and speedwork (i.e., low-volume repetitions of less than 40 seconds) are used for ages 12-13, while 14- to 15-year-olds can have 8%-10% of their training during competitive seasons be truly *hard* in nature. This *includes* races; cross-country or track races should be used as the primary "hard" efforts for 14- to 15-year-olds, as they are usually long enough that youngsters cannot run them at an intense effort level. The pace will more likely work on the VO_2max in the longer events (cross-country races and 3,200 in track), which is where beginning runners notice their greatest initial gains in fitness. Seeing early progress can keep newcomers to the sport interested, but anaerobic interval training (using distances longer than 40 seconds) designed to expedite that progress generally needs to be avoided. The shorter track events (1,600 and down) should be raced at varying distances from meet to meet. Both cross-country and track competitions should be spaced apart so as not to occur every week; an alternative is to have runners under age 15 run the 400 (or shorter) every other week during the Spring.

Teenage kids have very sensitive nervous systems which cannot tolerate high lactate levels season after season for several years. Hard track training (e.g., 12 times a knee-grabber twice a week) and/or overracing at this age is even *more* detrimental to a young runner's future than is lack of an aerobic foundation! Many people who never competed in track in high school still have a chance to run well later in life with proper training. A lot of good runners fit this description. But a runner who has burned out on anaerobic interval training and no base in high school rarely recovers to run well in the future.

Ages 16-18

This is the time (beginning the Summer before the Junior year of high school) to really begin getting *serious* about running. Pre-season mileage levels need to reach *at least* 80 per week during that first Summer and climb up to *at least* 90 per week on *average* by the pre-track season of the Senior year. All indicated mileages and long run durations are for boys who have gradually progressed to the level of tolerance for such distance; girls should stay at about 60% of these levels. Pre-season highest weeks can range from a suggested minimum of 95 miles for ages 16-17 to almost 120 by age 18. Longest single long runs should range from 125-155 min. over these years. Regular season mileage levels can be reduced to 60-65 for the Jr. year and 70-75 on average for the Sr. year. These levels seem excessive by today's standards, but they were the norm in the 1970s, when high schoolers ran faster (and continued to run faster later in life) and they are the norm to this day for Africans in the same age group.

Young runners desire to be good at their sport. They even desire to work hard if that's what it takes to get good. But adults are no longer demanding enough and no longer set high enough standards for kids. This goes much deeper into societal values than just at the track, and changing it is not easy, but distance running is as good an endeavor as any in which to set high standards. The mileage levels outlined here *are* such high standards and it is only by attaining these mileages that young runners can reach their *ultimate* future potentials. As previously mentioned, prodigious mileage in high school is not absolutely necessary for a person to become a *good* runner later. But with extraordinarily few exceptions, as long as the training is progressive and periodized and the "quality" work is limited to no more than 15% of the total volume, high school runners have better futures with high mileage than with low mileage. It is *only* through personal experience with running that one comes irreversibly to this conclusion, but crushing statistical evidence also indicates that any runner who reaches the elite level without high volume during youth has done so in *spite* of the reduced training load and not *because* of it!

****
****

Workout Purposes - Continuous Easy Runs (up to 90 min.)

The bulk of any serious runner's training volume is comprised of slow to medium paced continuous runs. Experience has shown that easy runs of lengths which are multiples of about 30 min. have the optimum effect on aerobic development. No known scientific research has been undertaken to determine the reasons for this, but it most likely has to do with the recruitment of different muscle fiber types as various fuels are used. Different processes of ventilation and cardiac function also can occur as a run gets longer, and the neurological feedback via pressure receptors, etc. may reinforce selective muscle fiber recruitment. It is certain that correct recruitment patterns are reinforced by finishing some types of workouts faster than they are started. It is not entirely known why easy run lengths in multiples of 30+ min. have such significant effects vs. runs of other lengths, but running economy (at submaximum aerobic speeds) is without doubt in part a "step function" of the length of regularly performed easy runs, as opposed to a linear function. Thus, 55 min. is better than 35 min., but 65 min. is *far* better than

55 min.! This step functional relationship is only noticeable over a period of weeks, but it becomes quite pronounced after about 3 months. The "cumulative loading" effect of simply doing more sheer volume over months also plays a role in aerobic development, but it does not affect economy at low intensities as much as does the specific length of time spent on daily runs.

Some of the benefits of running in multiples of 30-ish minutes may stem from nothing more than the fact that humans simply organize their time in half-hour or hour long blocks. Running for these time lengths perhaps provides a measure of structure and a sense of fulfillment or completion of a task without deviating from what seem to be logical time constraints. This perceived organization may allow the training to blend in well with the other affairs of everyday life, hence yielding the best long-term results.

The main purposes of continuous easy runs are to build capillary beds, increase the size and number of mitochondria in the muscle cells, improve fuel metabolism, increase aerobic metabolites, and train fast twitch (FT) muscle fibers to become oxidative. Running easily for a day or two following a hard effort also clears lactate and speeds up recovery.

All easy runs should be started *very slowly* (this also applies to warmup periods prior to hard workouts). The early easy jogging allows the pulse to come up gradually and loosens out the muscles without having to do a pre-stretch. Stretching prior to any warmup at all can actually *increase* risk of injury, although post-run stretching is definitely advisable. The heart rate (HR) needs to stay *below* 70% of maximum effort during most easy runs. The ideal training zone for the purpose of recovering from hard workouts is between 60% and 65% of max effort. Effort level is ascertained by subtracting resting HR from maximum HR to obtain the *range*. 60% effort refers to 60% of the way up the range from resting HR to max HR. For a runner with a resting HR of 40 beats per min. and a max of 200 bpm, the range is 160. 60% of 160 is 96, so 60% effort for this runner would be 40 + 96 = 136 bpm. The HR can be kept under strict control by use of a telemetric heart rate monitor, but it is also necessary and *much more effective* to learn to run by *perceived effort*.

Many non-elite runners go too fast on easy days. This has been noted even in laboratory settings, where the Rating of Perceived Exertion (RPE) of non-elite runners was found to be significantly lower than actual heart rates and blood lactate levels were indicating. Elite runners were much better at judging their true effort levels. HR readings of 60%-70% generally correspond to about 1.5 to 2.2 millimoles per liter of blood lactate, which is very much under control. Of course, the only way to be *sure* that an effort is far enough below lactate threshold to be considered "easy" is to take blood lactate measurements. This can be done with a portable lactate analyzer. Again, it is more important to gain enough experience to be able to run by *feel* than it is to be a slave to a portable gadget or even to any of the *numbers* (training speeds) that we or anyone else have put in writing!

During some stages of training (specifically, after a solid aerobic base of *easy* running is established), many elite runners (Kenyans, Moroccans, etc.) run at near lactate threshold velocity (LTV) during a fraction of their "easy" runs up to 6 times per week. Of course, these runners are doing two-a-day workouts which include some supplemental *jogging* to aid in recovery. They also only *rarely* include running which is significantly *faster* than LTV during these training stages. Hovering at just below the LTV in day-to-day training will, over time, improve running *economy* and will also *lower* blood lactate levels at sub-LTV, facilitating quicker recovery. Even as an *experienced* runner, however, extreme care must be taken to keep the effort *aerobic* and the lactate levels *low* when training in this fashion. It's very easy to make a mistake and drift over into the anaerobic zone, and this can be disastrous. The elite runners who train in this fashion

know their bodies extremely well and/or have blood lactate and blood pH measurements taken regularly to determine if the training is remaining aerobic and manageable. For runners in the early stages of their careers, this daily threshold training can in no way be considered *easy*, and it's better to have a few years of development in which the easy continuous running is well on the *safe* side of the lactate threshold.

Roughly 40% of a runner's total training volume should consist of easy runs at 60% to 70% of maximum effort. This feels too slow to many competitive runners, but it still accomplishes the desired task if the duration of the daily runs is correct and if the overall training mileage is sufficiently high. An additional 5% to 10% of the total training volume can be at an effort level *below* 60%. This is *very easy* and is often called a "shake-out" speed or "super-O_2" pace. Another 25% to 30% of the training can be run at closer to 75% effort. This usually corresponds to a blood lactate level of about 2.5-2.8 mM/L and is still fairly easy, but it pushes out the boundaries of aerobic effort a little and has a slight effect on running economy at nearer to the lactate threshold. This leaves roughly 5% of the training volume devoted to alactic speed maintenance, about 10% to 15% assigned to threshold training, and 5% to 10% dedicated to harder running designed to improve oxygen uptake and lactate tolerance.

Most easy runs should be run on courses which have significant percentages of grass (or other soft surfaces) and some road. Concrete is usually better than blacktop for recruiting FT muscle fibers with a consistent foot strike pattern, but there may be a trade-off concerning injury risk. Injury prevention is more often a function of proper shoe selection and shoe rotation rather than the hardness of the running surface. Obviously, though, a flat surface is better than a cambered one for fast-paced running when it comes to reducing risk of injury. About 50% of total mileage should be done on grass, about 40% on road, and about 10% on a track. Too much on the road decreases bone density, particularly in preteens, while too little on the road does not completely develop the muscles in the lower legs, ankles and feet. Shoes should also be rotated regularly and racing flats should be worn sometimes to work different little "balancing" muscles in the ankles and feet, and to allow the ankle joint a more complete range of motion than is possible in heavy, restrictive training flats. Including a few minutes of barefoot jogging on smooth grass at the end of a couple of easy runs per week can develop ankle strength and integrity even further. Wearing racers occasionally during base training also helps make a smoother transition to faster-paced training and racing, and reduces risk of injury when racing in lower-heeled shoes.

Gently rolling hills of lengths ranging from 50 meters all the way up to 800 meters (most about 100 meters) on the uphill need to be incorporated 2-3 times weekly during base training. Trail running is also excellent provided it is done regularly. This varied terrain easy running may be very slow, but it develops aerobic enzymes in the quadriceps group, which ultimately improves aerobic capacity and allows for more training to be accomplished. Both the uphill (concentric contraction) and the downhill braking (eccentric contraction) contribute to the aerobic enzyme development in the quads. Knee joint integrity and muscular strength are also improved as long as the hill running isn't done to excess. A superb low-impact alternative to running on hills is *biking* up a series of hills while standing on the pedals. This can help some aspects of uphill running even *more* than actually running on hills, but it should not completely *replace* hill running. Complete recruitment of the FT motor units is lost on the bike, as is the pre-stretch of the ankle. In short, the uphill biking, as much as it benefits the quads, does not contribute to an explosive foot strike.

Running on an inclined treadmill can also be practiced to develop aerobic enzymes in the quads, but it is wise not to overdo it at first. If the grade is higher than about 6%, time on the mill

should be limited to around 10 min. for a few workouts in order to prevent Achilles tendinitis, particularly if the pace is fast. A slight incline (1.5% to 2% grade) should be used for all treadmill running, as the toe-off is not exactly the same as when running outside. Also, the lack of air resistance on the mill becomes more pronounced the faster the pace, so the grade should be fractionally steeper as the speed increases (or a huge fan can be placed in front).

Conscious effort should be made to use diaphragmatic breathing ("belly breathing") during all easy continuous runs. This will transfer to faster speed runs if practiced religiously. Diaphragmatic breathing is by no means a "slight" technique; it makes use of the body's preferred breathing method and provides the optimum pressure in the thoracic cavity for complete oxygenation. It may seem almost unnatural at first if done properly (attempting to "fill up" the entire torso from the pelvic area on up to the top of the lungs), but if mastered, it makes a huge difference in relaxation and in overall running performance.

The foot strike during a regular easy run will probably be a heel-toe pattern, but a preferred strike is closer to the midsole before toe-off, rather than the heel. It is also better form to have a greater pre-stretch of the gastrocnemius (calf) muscles. This can be practiced by allowing the knee to dip down a fraction of an inch lower during the "plant" stage before toe-off. However, care should be taken to avoid spending too long in the plant phase of a step, since this might create unwanted deceleration (braking). A quick (but relaxed) stride frequency can reduce the possibility of overstriding that would result in deceleration. Elite runners have a better pre-stretch of the calf muscles, yet they have also been observed to spend less time in the plant phase than slower runners (when at top speeds), and they usually have a quicker stride frequency. This contributes to a more explosive overall foot strike, while still maintaining a light, "gliding" motion. Involvement of the "gastrocs" is also maximized by keeping the hips forward, so that the buttocks are underneath the torso rather than behind it.

The arm carriage varies with speed; on very easy runs, the arms should stay fairly low, almost as though along for the ride except for a slight simultaneous pull back/push down motion. This motion becomes more pronounced the faster the pace. During a tempo run, the arms should act as though they were using ski poles to assist in the running motion, bending a little more when the hand comes up in front and unbending very slightly on the back/down swing. When sprinting, the elbow bend will be kept at a right angle and the hands will come up to face level in front and pull back quickly. It is the motion resembling a ski pole push-off that should be practiced most often, as this transfers best to correct tempo running.

If altitude training is desired, it's important to remember that merely *living* at higher altitudes will effect an increase in red blood cell count for most people. No hard workouts should be attempted until completely acclimated, as they might temporarily deplete the myoglobin oxygen reservoir. Best results are obtained by living and doing very easy base training (preferably on trails or other difficult terrain) at altitudes of around 8,000 ft., with occasional time spent at even higher elevations. All continuous training faster than 70% of max effort should be done at lower altitudes in order to achieve the fastest possible speed for a given effort. Running 5:00 mile pace aerobically at sea level has a better effect on raising the lactate threshold and improving economy than does running the same pace (or slower, as would probably be the case) at high altitude but having to significantly exceed the lactate threshold to keep that pace! The body's maximal ability to consume oxygen is lowered upon exposure to high altitudes, and may not return to normal levels for about 3 weeks after returning to sea level; hence the need for regular low-altitude faster running. Living high and training low has been known by runners for decades to be the most effective way to utilize hypoxic (reduced oxygen) training. It was demonstrated

statistically in the early 1990s. One major contributing factor to improved performance from altitude training comes from an increase in the red cell count brought about by higher levels of the hormone erythropoietin (Epo), which appears in elevated levels when the body's tissues are not receiving enough oxygen. Unfortunately, not all people respond equally favorably to living at high altitude. Some runners do not seem to exhibit significantly increased Epo as a result of moving to altitude. Perhaps the body is just "smart" enough to regulate hormone production so as not to risk dangerous situations (such as the clotting problem which could potentially occur with a sudden increase in red cells). Or perhaps some runners need exposure to even higher altitudes to effect an increase in Epo. For runners considering a move to higher elevations, a trial period of about 4 weeks at altitudes of near 8,000 ft. can be undertaken to determine if Epo increases take place; if they do not take place, alternative training strategies can then be implemented. An additional (and perhaps more influential) benefit of base training at elevations of 8,000 ft. or above is improved lactate buffering ability brought about by histochemical changes.

If easy base training is done at high altitude, it is essential to run 4-8 buildups on a flat, smooth surface almost every day after the last easy run of the day. This especially applies if most of the running in done in difficult terrain or in snow, where the pace will be exceptionally slow. Buildups 2-4 times per week during base training at low altitude are also a good idea if no specific speed maintenance workouts are being performed.

A light post-run stretch can prevent chronic stiffness and can promote tissue cleansing. It's also crucial to get plenty of water (and the proper balance of electrolytes)! Distance runners tend to eat copious amounts of carbohydrates, as they are the principal fuel source in aerobic metabolism. Carbs require lots of water to store properly, so getting enough water is important for that purpose as well as for rehydration. Proteins should not be neglected in the diet, either, as they help tissue repair and blood flow.

(to top)

Examples of Continuous Easy Runs

** 30-35 min. as a single on a very short day (following a long run day or coming back from/preventing injury) or as the shorter run of a double*.

This run, as all easy efforts, should be started at a slow enough pace so that no pre-run stretching is required. Many of the world's best runners begin their workouts (even hard ones) at about 9 minutes per mile pace! This is over *twice* as slow as their 10,000 meters race pace. Such a starting speed allows the heart rate to come up so gradually that initial equilibrium is achieved with virtually no access of the creatine phosphate stores.

30-35 min. of continuous, repetitive activity is the first duration that produces a significant training effect if used over time. Isolated easy runs of about 47 minutes will achieve the same benefits (mainly in stabilizing metabolism) as continual use of 30-35 min. runs, but the shorter outings are normally preferable as part of a two-a-day workout schedule. In order to bring about the desired results, the heart rate on these easy runs needs to remain at 60% to 70% of maximum effort. This refers, of course, to the percentage of the way up the *range* from resting HR to

maximum HR. A runner with a resting HR of 40 beats per min. and a maximum of 200 has a range of 160 bpm. 65% of 160 is 104, so 65% of this runner's maximum effort amounts to 40 + 104 = 144 bpm. The *pace* at this effort level may feel too slow to many runners, but it is good policy to run a little too slow than too fast day after day. This is particularly true during periods of very high mileage or sudden increases in mileage.

When a runner becomes adjusted to a certain volume or training regime, it is fine to reach 70% of maximum effort on occasional easy runs, but most easy outings should remain at or below 65% effort. Going below 60% effort is usually reserved for "shake-out" runs of less than 30 min. (such as the morning before an evening race). These very slow jogs are also called "super O_2" runs.

* *60-65 min. as a medium length single or as the longer run of a double*.

Runs of this duration comprise the bulk of the average runner's daily workout routine. Depending on pace, of course, the length ranges from 7 to 10 miles, but (as usual) the pace should be dictated by effort and should remain very comfortable throughout. High schoolers in particular have 60-65 min. runs as the staple of their afternoon workouts on easy days. Serious runners should have another run of 30-35 min. on most easy days.

For more guidelines on easy run procedures (shoe rotation, varying surfaces and terrain, incorporating altitude, correlation between heart rate and blood lactate levels), see the 'Continuous Easy Runs' Workout Purposes section.

* *90-95 min. as a long run for young athletes or as a moderately long run for experienced runners or as the longer run of a double*.

If this duration is used as a single long run (such as for a typical junior high or high school runner), it should be considered a *hard* day, owing to the time required for recovery. The pace can be picked up slightly during the last 10-15 min. of the run, or a few light to medium buildups can be done during the final mile. This will enlist some fast twitch (FT) muscle fibers, which promotes the selective recruitment pattern which is ideally used during races (ST first, FT later). If 90-95 min. is a long run, it should be followed the next day with a very short run (or no run) and/or 20-30 min. of easy exercise in a swimming pool, if possible. Those who are unaccustomed to long runs and jump suddenly to this duration may experience "march hemoglobinuria". For runners who were active in childhood, have followed a progressive training plan over time, maintain a healthy diet, and rotate their shoes and running surfaces regularly, march hemoglobinuria should not occur.

Very serious, experienced runners can use this duration as the longer run of a double, with a 30-35 min. run as the shorter outing. The mileage covered on such a day can get as high as 18-20 miles, and should obviously be attempted only by those who have worked up to this level over time.

* *120-125 min. as a very long run for younger runners or as a regular long run for experienced, well-trained runners over the age of 16.*

This run is long enough to create some depletion of glycogen and fatigue ST fibers even in experienced long distance runners. Ventilatory drift almost invariably occurs, as well, making a 2 hrs. (or longer) outing a useful opportunity to practice minor pace changes and breathing techniques. See the 'Long Runs' Workout Purposes section for information on long run protocol. As always with long runs, it is best to either run the last couple of miles gradually faster (but still aerobically) or include a few buildups in the last mile.

120-125 min. efforts were used during the aerobic phase as regular weekly long runs by the great champions coached by Arthur Lydiard. These elite runners often covered between 20 and 22 miles, which required a pace of 5:40 to 6:00 per mile. For aerobically trained sub-4:00 milers, this represents 80%-85% of their predicted lactate threshold velocity (LTV), or 30-50 secs. per mile slower than probable marathon race pace. Despite the fact that sub-6 min. mile pace for 2 hrs. during a weekly workout may seem very hard for many runners, this actually is still within the effective training zone for athletes capable of 3:54 for the mile or 13:35 for the 5,000. The telemetric heart rate monitor was not in use in the 1960s, but it is likely that Lydiard's athletes were performing at near 70% of maximum exertion during these long runs.

Breathing techniques, some pace changes or terrain changes, and stations for fluids every few miles are invaluable training procedures. See the 'Long Runs' Workout Purposes section.

* *150-155 min. as a very long single run*.

Regular long run protocol applies to these very long excursions, except that these should be done only once every two weeks *at most*, in light of the fact that glycogen depletion is bound to occur. Performing journeys of this length more frequently than bi-weekly tends to undermine the effectiveness of the training done in the meantime.

Elite runners may cover a full marathon distance in a 150 min. workout (e.g., Derek Clayton), and some of the Japanese and Korean marathoners have been known to go even longer than 4 hrs. (up to 40 miles) as overdistance work, but these athletes have been running for many years before reaching this duration. Even then, doing such distances is rather experimental for any individual runner.

Taking ample water and an electrolyte/carbohydrate replacement fluid before, during and after a super-long run is very important. Other legal supplements which may prove highly beneficial prior to running such distances are theobromine and choline.

****
****

Workout Purposes - Long Runs (over 95 min.)

As with all regular easy runs, long runs should be started at a slow pace. A slow pace requires *fat* metabolism, while faster speeds use *glycogen* (carbohydrate) as the principal fuel source. Balancing fat and glycogen utilization is essential for marathon races, obviously, but it also is important for training purposes. The pace in the middle of a long run must be kept decent but even and very comfortable (about 65%-68% of the range from resting HR to max HR). It is vital to never struggle until the *distance* itself becomes tough. The *pace* should not be a problem, even for most of a marathon *race*!

During a long excursion, it is prudent to practice taking 4-6 ounces of water from squirt bottles (or even from cups) about every 3 miles. About 150-200 meters before the bottles are reached, the pace should be picked up slightly so as to allow for a little harder breathing without hyperventilation. The effort should be kept aerobic throughout, but the deeper breathing affords the chance to practice a valuable technique. Adding an extra final exhalation during a slightly increased pace for 30 or so seconds gets rid of some of the air in the lungs which has participated for the longest time in the gas exchange. This air gradually acquires a higher percentage of carbon dioxide during prolonged moderate aerobic effort, which may lead to a gradual increase in breathing frequency (a phenomenon called "ventilatory drift"). Exhaling a little harder and longer through *pursed lips* for 30-45 secs. every few miles provides better oxygenation on subsequent breaths by clearing the "dead" air and increasing the interthoracic pressure. Using a water station as the pace pickup point is applicable to marathons, particularly elite races or crowded races which feature traffic jams at the water tables. Top level runners are also always making minor moves (and occasionally major ones) in marathons, so obtaining the ability to vary the speed comfortably can pay off handsomely.

It is paramount to remain relaxed on all long runs, with the jaw loose, and breathing through the *diaphragm*. A lot of this sport is neurological, so relaxation is essential. The nervous system must be trained to initiate the mobilization of the proper muscle fibers and go to different energy sources as the run gets longer. After 2 hours, the slow twitch (ST) fibers become somewhat fatigued, even at a relatively easy pace, forcing more fast twitch (FT) units to be recruited as the distance piles up. Over time, this allows the FT fibers to become oxidative by enhancing fuel storage capability, increasing mitochondrial enzyme (as well as the sheer size and number of mitochondria themselves), and multiplying the number of blood vessels per fiber.

The effect of FT fiber recruitment during a long run is important for races as short as 1,500 meters, and the benefit can be magnified by picking up the pace by about 10 secs. per mile for each of the last 2 miles. This helps counteract ventilatory drift at the most critical time in the long run, and it brings even more FT fibers into play. More carbohydrate is used as fuel at faster speeds, as well, so gradually picking up those last couple of miles trains the body to use the muscle fibers and the fuel sources in the *same sequence* that they will ideally be used in a race. A few light buildups can be inserted in the last mile of a long run if desired, rather than using a pace pickup over the final few miles.

Occasional long *tempo* runs can be performed if preparing for a marathon race. Usual long run guidelines follow on these; i.e., start slower and finish faster, with the bulk of the run at the target (marathon) pace or a few seconds per mile faster. Most people do *easy* long runs when preparing for marathons, but it's somewhat unrealistic to go into a marathon without having had some moderately *long* outings *at the goal pace*! In practice, these seem to yield the best results if 3-4 such runs are used, spaced about 3 weeks apart, with the last coming roughly 3 weeks prior to the marathon race itself. The first long tempo effort should be 12-13 miles in length, the second about 15-17 miles, and the third from 17-18 miles (possibly up to 20 for a very experienced marathoner, or if the run is done *at least* 3 weeks prior to the goal race). A fourth long tempo of 13-17 miles can be added in there somewhere, but remember to get plenty of recovery between these efforts and balance them with other workouts. Long races (such as 25K-30K) can serve as tempos provided the pace is kept under control early on. These runs also provide the chance to practice taking fluids *while running at race pace*, and to experiment with pre-run foods or fluids which will possibly be used on race day.

Lots of carbohydrates should be taken following a long run (and the next day, as well). This

will necessitate plenty of water, since carbs are "thirsty" (2.7 grams of water are needed to properly load each gram of glycogen). Sufficient protein intake should also be maintained to promote tissue repair, especially during periods of high mileage.

A short to medium length easy run the day before a long one is the usual policy. Three or four light buildups on this run often help the legs feel a little springier and stronger on the long run the next day. It doesn't hurt to have an easy long run come the day after a race of 5K or less, either, but longer races may be too stressful to the muscles to follow with a long day. It's generally best to think of *long* days as *hard* days, regardless of pace.

A very short, very easy "shake-out" run should normally be done on a soft surface the day after a long outing. It also helps greatly to get in a swimming pool right after the "shake-out" and do some easy flutter kicks, leg crossovers, and deep water running. This works out some kinks without impact, and the water is also a little therapeutic. Water running delivers a strong torque and actually helps build bone density. The "shake-out" jog can be skipped altogether in the event of extreme muscle fatigue or incipient injury. This very short (or nothing) day provides the chance to replenish some red blood cells which may have been crushed in the capillaries in the feet during the long run. This is known as "march hemoglobinuria", so called because armies that do 30-50 mile marches often have this problem and the killed red cells get passed through the urine.

****
****

Workout Purposes - Lactate Threshold Workouts

Training in the zone which influences the lactate threshold (LT) is perhaps the single most important sort of hard training a distance runner can do, although it does not by itself cover *every* base. The key speed involved with this fast aerobic running is often called lactate threshold velocity (LTV). This is roughly the speed which can be maintained for one hour if the pace is even throughout. Hovering at or just below this speed will bring the blood lactate level up to about 4.0 mM/L, while the heart rate will generally rise to near 85% of the way from its resting value to its max value. Breathing frequency at this pace will normally be 5-6 steps per exhalation. If a breath is required every 4 steps, the pace is probably too fast, and a slightly tight, uncomfortable feeling may shortly ensue.

The critical zone in which to run to improve LTV is between 95% and 105% of LTV. For example, if LTV is 5:00 per mile, 95% of this speed would be 5:15.7 pace and 105% would be 4:45.7 pace. Training within this range has several purposes.

Continuous running at LTV for 18-22 min. once or twice per week will raise the LT over time, while running at slightly slower speeds (95%-96% of LTV) for about an hour will have an impact on running economy. 95% of LTV will put the HR at about 80% of its range and will induce a blood lactate level of about 3.5 mM/L. The world's best marathoners can often run at this pace for the full marathon distance, with blood lactate levels at 3.5 mM/L for near 20 miles (a small oxygen deficit is meted out over the last 4-6 miles of the race). Most runners can manage no better than 93%-94% of LTV for their marathon race pace.

Serious runners may have trouble holding back to the correct speeds for workouts such as these and might be tempted to turn the runs into time trials. Time trials and races are important,

too, but they are too stressful to use year-round as training devices such as these threshold workouts are meant to be. It's important to stay within the most effective zone to improve LTV and economy. Many elite runners (particularly Kenyans) have developed the ability to approach (but not reach) the lactate threshold in training almost *every day*, but this is done by *feel* and not by timing the runs. While runners with less experience should limit their efforts at a near-LTV to 2-4 workouts per week, running by feel and not by time *is* the ideal way to use threshold (or "high-end" aerobic) training, even during repetition running. The Conversion Chart gives the predicted LTV based on current race times, but it's wise not to be a *slave* to such numbers, because (as mentioned in the 'Continuous Easy Runs' page) coming very close to the threshold too often or exceeding it on a regular basis can be *ruinous*.

Lactate threshold training also indirectly affects VO_2max and reinforces preferential muscle fiber recruitment *if* the speed is increased near the end of the workout. This principle of working *two* critical speeds (in this case LTV and vVO_2max) is one of the most important, yet least practiced, procedures of training. It is vital to *negative split everything* when running all *hard* workouts except pure sprint work. A "negative split" refers to running the last section of the workout the fastest. Runs at slower than LTV are considered *moderate* and need not be done with negative splits.

Performing the bulk of a workout at *faster* than LTV (e.g., 105%) should be reserved for repetition running; otherwise, lactate levels will rise too quickly to have enough running time to be effective. Repetition running can be used at any speed within the LT training zone, but it must employ extremely short rest periods to be of use. These rest periods can be as short as one-third or even one-sixth of the run periods for the particular workout being performed (e.g., 3 min. runs at LTV with 30 secs. rests).

Remember to warm up well (at least 12 min. of jogging plus a few buildups/strides is suggested), and do a sufficient cool-down jog and post-workout stretching in conjunction with any faster-paced workout effort.

(to top)

Examples of Lactate Threshold Workouts

** Continuous run of 26-32 minutes with the first 5-7 min. at 10-15 seconds/mile slower than LTV, the next 18-22 min. at exactly LTV, and the last 2.5-3 min. smoothly accelerated from 95% of VO_2max speed down to 105% of VO_2max speed.*

Suppose Dave is a good collegiate runner with a 14:20 5,000 PR and a 30:00 10,000 best. A 14:20 5,000 time predicts a LTV of 5:02 mile pace and a VO_2max pace of 4:30 per mile. Dave would thus probably benefit most from a LT workout beginning at roughly 5:10-5:15 pace for a mile, 5:02 pace for 18-22 min. (4 miles would take 20:08), then about 0.6 miles at an average speed of 4:30 mile pace (allowing the first min. of that last segment to squeeze the pace down). The total distance covered would be about 5.6 miles, give or take a bit, with a total time of around 28 min. (average pace of 5:00), plus or minus a few minutes if Dave decided to go longer

or shorter in the middle.

Since Dave could theoretically run 5:02 pace for an hour, he could obviously run *harder* during those middle 18-22 min., but the effect on his *aerobic* development would not be any better. In this case, going harder would only mean getting an *anaerobic* workout which would require more recovery time and which might actually *undermine* full aerobic development. Remember, economy is promoted through a steady VO_2, which can be controlled *perceptually* by keeping the effort aerobic, the breathing pattern consistent, and the heart rate constant. Heart rates during the time spent at LTV should stay *below* 85% effort. If Dave's resting pulse is 40 and his maximum is 200, his *range* is 160. 85% of 160 is 136, so by staying below 40 + 136 = 176 beats/min., Dave would be running within 85% of his maximum effort. A little higher pulse near the end of the workout is acceptable.

These LT workouts are *not* time trials and the reins should be kept on the pace until the very end. Notice, however, that *two* critical speeds (95%-105% of LT pace and 95%-105% of VO_2max pace) are being attained. This ensures that correct *neurological* feedback is achieved by recruiting more ST fibers early and more FT fibers later.

It is best to run all LT workouts in *racing flats* in order to develop ankle power and flexibility. This not only improves running performance, it also reduces the risk of injury. Heavy training flats restrict the full range of motion of the ankle, and performing every single continuous run in "trainers" is a prescription for injury.

** Continuous run of 60-70 min. at 95%-96% of LTV with only a minor increase in tempo during the last few minutes.*

This duration at this pace is comparable in intensity of effort to a run of 18-22 min. at LTV. It is therefore *not* as *hard* a workout as the continuous run described in the previous section, since additional running at a faster pace is performed in that shorter effort. Both workouts require similar recovery times, however. This is due to impact stress and the fact that the longer run expends more calories and requires more carbohydrate reloading. Heart rates should hover around 80%-82% of maximum effort.

This slower, longer tempo run was employed by the late Kiyoshi Nakamura in his coaching of 2:08:27 marathoner Toshihiko Seko, and it is still used as a staple workout in the training of Japanese marathoners. Statistical evidence (and experience) has shown that running at 95.2% of LTV for 65 min. provides the optimum training effect for improving both LTV and running economy. Elite runners generally run at 93% to 95% of LTV for a marathon race, so this 60-70 min. effort also provides a good *pace* workout without excessive impact stress and without risking glycogen depletion.

Collegiate runner Dave, with a 10,000 PR of 30:00 and a LT pace of 5:02 per mile, would run at 5:15-5:18 pace for a 60-70 min. tempo outing, and might get as far as 13.3 miles in 70 min. (the Japanese marathoners often go 20,000 meters, or 12.43 miles, in around 61-62 min.). Since Dave has a resting heart rate of 40 and a max of 200, 82% of his max effort would result in a pulse of 171. By keeping his heart rate around 170 or slightly under, he will derive the desired benefit from this particular workout.

Dave's 30:00 10K PR is equivalent to a 2:21:44 marathon, which requires a 5:24.3 mile pace, so by running a few secs./mile faster than this, Dave is also developing efficiency at the rhythm needed for the marathon in case he wants to contest this distance.

** 2 x 15-18 min. at LTV (no variation in pace during either run)/5-7 minutes easy jog between runs*.

This workout is a slightly harder effort than either of the previous two LT workouts, especially if the maximum run length of 18 min. is used on both reps (2 x 15 min. is normally used by runners with less base mileage or less experience). No attempt should be made to pick up the pace at the end of either rep, although the entire second run can be done faster than the first if the first seems excessively easy. This workout allows more time spent at LTV than would be prudent to spend in any *continuous* effort (without the 5-7 min. rest) short of a time trial. The 5-7 min. recovery jog period gives the time to clear any accumulated lactate and lets the neuromuscular system relax briefly.

For 30:00 10K runner Dave, 2 runs of 3.5 miles each at a 5:02 pace provides the optimum effect directed toward improving his LTV. Each 3.5-mile segment would require about 17:38 at Dave's LTV.

This type of workout is also excellent for improving *economy* (owing to the overall time spent at LT pace), provided the pace remains even throughout both runs and never exceeds LTV. Going *faster* than LTV for 18 min. twice would probably become too strenuous to affect running economy.

It is usually a good policy to add 4-6 buildups during the post-workout cool-down period in order to recruit FT fibers. This ensures that FT fibers will be mobilized after ST ones are fatigued from the workout. The purpose is to influence correct sequential fiber recruitment, which is one of the most essential components of fast-paced running.

** 10-15 x 3 min. runs at LTV (first 1-2 reps slightly slower, last 2-3 gradually faster)/30-35 secs. rest periods between*.

This workout provides 30-45 min. of running at LT speed, which would probably be too close to a time trial effort to maintain efficiency were it not for the rest periods. Notice how *short* the rest periods are in comparison to the run periods. This type of workout is sometimes referred to as being of *high density*. It is crucial to stay within the pace guidelines on high density sessions, since going too fast with very little rest would adversely affect relaxation and economy.

Dave, our college distance runner with PRs of 14:20 and 30:00, has a LT pace of 5:02 per mile. Dave would cover 950 meters in 2:58 at his LT pace (75 secs. per 400), so he could run the indicated workout on a track, then shuffle the remaining 50 meters to the next half-lap line before starting his next rep. This workout could also obviously be performed away from the track, either on a measured course or by effort. As usual, it's best to start slower and finish faster. So Dave could begin with 77 second 400s, warming up a little, and finish with 73 pace or even faster. The middle 2/3 of the reps should be done right at LT speed in order to promote efficiency.

Ronaldo DaCosta (2:06:05 marathoner) has reportedly run 15 x 1,000 meters at 3:00 each with 30 secs. rest periods. This is actually about 1 second per mile *slower* than his *marathon* pace! This is, however, just a *workout* (and no mention is made as to whether it was done at altitude). The moral is that relaxation and efficient rhythm are more important than "tying up like a big dog" when the objective of the workout is to train the *aerobic* component. If a former World Record holder runs his 3 min. repeats that slowly in comparison to his LT pace (which is

probably about 4:35 mile pace), then going a little *easier* than possible can't be all that bad! Actually, DaCosta's 1,000s are run at about 95% of his predicted LTV, which is still within the zone which has an impact on raising his LT, and the high volume at this pace will certainly improve his economy.

** 16-20 x 400 at 105% of LTV (about 3-4 secs. per 400 faster than LTV)/20-25 secs. rest periods.*

This workout gets to the upper limit of the training zone which works on raising the LT, and it actually approaches the speed which trains the VO_2max. Its effect on LTV results mainly from the very short rest periods. The pace involved is a little faster than 10K pace for most runners, and people slower than 35:00 for 10,000 should tend toward 16 reps rather than 20 (some world-class runners do more than 20) at this pace.

Our hypothetical 30 min. 10K runner Dave, whose LTV is 5:02 mile pace (75 secs. per 400), runs at 71-72 secs. for his 400s on this workout. A few can be slower at first, some gradually faster at the end (as usual), but about 3/4 of the reps should stay at 71-72 to reinforce the rhythm.

Since the rests are so short, the heart rate will not decrease much (if any), but this is *good* by reason of the fact that lactate is used as a *fuel* by the heart as long as the rate of its accumulation does not increase sharply. If performed correctly, this workout produces a virtual steady state of cardiac output at a much *faster* pace than could be attained on a continuous run without going into the anaerobic zone. The heart rates during this workout generally stay *above* 85% of maximum effort but *below* 90%.

Ronaldo DaCosta's published workouts include up to 25 x 400 at a 66.2 average with 15-20 secs. recovery periods. Because of the higher number of reps and shorter rest periods, this should represent 103% of his LTV, and indicates that he could run at a 4:34-4:35 pace for an hour (about a half marathon). This is equivalent to "only" 2:07:30 for the marathon, but is consistent with DaCosta performing better as the distance increases. DaCosta also appears to work out a little below his utmost capabilities, possibly to work more on economy or possibly because of the cumulative loading effect of his two long runs per week. He also reputedly performs drills regularly and would presumably want to remain fresh enough to make them productive. In any event, there's a lesson in this inasmuch as workouts which are meant to train the *aerobic* system should *not* be run as *hard* as possible!

****
****

Workout Purposes - VO_2max Workouts

As with lactate threshold training, VO_2max training is meant to work above all on *aerobic endurance*. The speeds and durations involved bring a runner to the very limit of oxygen consumption and also affect neuromuscular specificity and lactate tolerance. Velocity at VO_2max (vVO_2max) is the speed or pace required during continuous, even effort to bring about maximum oxygen uptake. This pace can normally be maintained for 9 to 11 minutes, but maximum oxygen uptake itself can only be sustained for around 3 minutes before the "lactate system" generates most of the energy. The running can be continued at the same pace only while in a state of ever-increasing oxygen deficit.

Training at 95%-105% of vVO_2max can help raise the VO_2max somewhat, but this is in part genetically determined by composition of muscle fibers, the size of the left ventricle of the heart, and other factors. What *training* mainly accomplishes is improving the *speed* at VO_2max. The workouts themselves involve repetition running for periods ranging from 2 min. to 3 min., with equal rest to run ratios, and a total duration of about 15-20 min. spent at VO_2max speed. Shorter distances can be run at slightly faster speeds (e.g., 105% of VO_2max pace). Or longer distances may be used at slower speeds and with slightly shorter rests (e.g, 5 min. runs at 95% of VO_2max pace with 3 min. rests), for a total duration of 25-30 min. The shorter reps tend to work marginally on speed maintenance and lactate tolerance, while the longer reps promote efficiency and serve as event-specific pace work (8K to 10K). All of the workouts within the critical training zone will cultivate proper muscle fiber recruitment if relaxation and efficiency are maintained throughout and if the last reps are run the fastest.

It should be the primary aim of all fast-paced workouts to maintain the operative speed precisely during the middle reps and run faster on the final 10% of the workout. Of course, choosing the correct starting speed is indispensable and depends on the purpose of the workout. The Conversion Chart gives predicted VO_2max speeds for various race times, but it's often sensible to *begin* VO_2max workouts at about 5K race pace, as this speed is almost certainly somewhat slower than vVO_2max. The pace can be ratcheted down to VO_2max tempo (or as near as is effective *on the day*) during the middle 60%-80% of the session, hopefully leaving room to squeeze down to a still faster velocity for the finale. The goal is to reinforce the ideal sequence of muscle fiber enlistment - slow twitch, oxidative fibers first, fast twitch, glycolytic fibers later. If the correct speeds are used for the correct durations, not only will VO_2max pace be improved, but the ST fibers will be trained to work anaerobically and the FT fibers will be induced to become oxidative, all with a minimum of lactate production.

See the Examples section for specific information on starting speeds and durations of VO_2max workouts. These workouts have been demonstrated experientially over decades to be *the most effective* for improving all aspects of running performance outlined here; however, the sample workout times are only *guidelines* and may not fit the current training needs of *every* athlete, even with corresponding time alterations.

Proper warmup and cool-down periods (including stretching) are always advisable when using VO_2max training or any other form of fast-paced running.

****
****

Workout Purposes - Speed Maintenance

Speed maintenance involves a moderate number of repetitions of 10-40 seconds using either a buildup format or an even speed. The idea is to enlist a large variety of muscle fibers without exhausting the creatine phosphate supply. The intensity can be easy to moderately hard, depending on the time of year, the intent going into the workout, and whether a competition is imminent.

Buildups are usually run in 2-3 sets of 5 or 6 reps each, with a jog period between sets. Following the standard warmup jog of at least 12 min., the buildups can be started without any stretching. See the Examples section for more information on how to perform sets of buildups. By starting each rep (and each set) slowly and finishing faster, the heart rate is allowed to come up very gradually (preserving the

creatine phosphate) and the muscles themselves warm up comfortably. Using a jog period between sets and starting the second set slowly again (but a little faster than beginning the first set) eliminates the possibility of lactate accumulation and relaxes the neuromuscular system briefly so that the second and third sets can be performed with increased mechanical efficiency.

Even-speed runs can be done as strides (15-25 secs. each) or as sets of 200s. Strides are more often used as part of a warmup before a hard workout or a race to help determine the correct starting speed. Sets of 200s can be used as a moderately hard workout during base training (when hardly any other fast running is done) or as the first fast-paced workout following a long run or a race. Normally, 2-3 sets are used. More than 3 sets results in too much lactate production to serve the purpose of speed maintenance, which in part is efficiency at medium to fast speeds. During sets of 200s, the pace should be made slightly faster on each successive rep in order to recruit as many muscle fibers as possible throughout the workout. Speed maintenance is often called "neuromuscular specificity" training when it applies to a certain goal race pace. Workouts which do something about the speed component should be run at least twice per week during base training (more often if at altitude and/or confined to trails or snow).

Running longer than about 40 seconds at any pace which maintains or improves speed will produce enough lactate to be counterproductive to the goal of speed maintenance sessions. Reps of over 40 secs. are used as lactate tolerance training. The Examples section discusses speed maintenance in more detail.

(to top)

Examples of Speed Maintenance Workouts

** 2-3 sets of 5-6 x 100 meters buildups (with the wind if it's windy), starting slowly and making each rep slightly faster than the previous one, jogging back 100 between reps, 1/2 mile to 1 mile jog between sets.*

As with all speed maintenance repetitions, the goal of this workout is to reach the fastest speed which can be attained without sacrificing mechanical efficiency, without tapping into the creatine system, and without incurring any significant oxygen deficit. This is an easy enough workout to be useful as the first fast session following a tough race or very long run or for off-season, very high mileage weeks. At least a few buildups should be employed 4-5 days per week during periods of otherwise extremely slow running (such as when attempting extremely high mileage or when running on trails at very high altitude).

All buildups should be run relaxed, with the jaw loose, the elbows in, the eyes looking straight ahead, and with a natural running motion. Staying tall is ideal, but it may be counterproductive to make a forced effort to do so. The basic style and foot strike pattern should be akin to a 5,000 meter race. As the speed increases near the end of the faster buildups, the style will naturally shift toward more of a 400/800 pattern.

One purpose of buildups, as mentioned, is to keep the CP store intact by gradually warming up into the workout. The first reps of each set should be the slowest in that set. Each rep should start at a jog pace and smoothly accelerate so that only the final 20-25 meters involves any real speed. It's best to gradually tail off, as well, rather than coming to an abrupt stop.

** 2-3 sets of 5-6 x 200 meters starting at about 5K race pace and going roughly 1 second faster on each successive rep (with the wind if any), jog 200 between reps, jog 1/2 mile to 1 mile between sets. Each set can be started with a 200 at about 1 second faster than the first 200 in the previous set.*

Reps run in this fashion are often called "cut-downs". They are not buildups; a continuous speed should be maintained throughout each 200. They are also not meant to be specific training for any particular event, or even any precise *speed*, for that matter. What they do is recruit all manners of muscle fibers at many different speeds, while keeping lactate production to a minimum.

Ken, a hypothetical top-level master, runs 5,000 meters in 15:00, which is a pace of 36 per 200. An effective "cut-downs" workout for Ken might entail 6 x 200 in 36-35-34-33-32-31, with a 200 recovery jog after each rep, followed by a short break of about a mile jog, then a second set of 6 x 200 in 35-34-33-32-31-30. Obviously, it's difficult to run *exactly* 1 second faster on each successive 200, but a small pickup of some sort is the general idea. By starting no faster than 36, Ken keeps his creatine phosphate (CP) stores intact, and as he warms up into the workout, he can squeeze the speed down without tapping very deeply into that CP reserve. After the break between sets, he starts over at a medium speed again (but a little faster than the first set, since he's pretty well warmed up at this point).

Ken could do a third set of still faster 200s (depending on how much speed he's retained in his 40s - this isn't meant to be a *very hard* workout; only a *fast* one). If he felt that he would have to sacrifice technique and efficiency by cutting down to 29, he could do 3 sets of 5 instead of 3 sets of 6, and would only have to cut down to 30 in the last set. That may not sound like much of a variation, but most runners are well aware that a second faster in a 200 makes a huge difference in effort and relaxation as *top* speed is approached.

Ken might choose to stop at 2 sets if he had an important competition in a few days, or if he had just run a long race a few days before. Or he might not have performed this type of workout in awhile and wouldn't want to overdo it. Or he might just not have it on this particular day. It's important to finish speed maintenance workouts while still feeling fairly sharp and strong rather than feeling cashed.

** 10-15 x 75-95 meters uphill @ 3%-5% grade (this is a rise of 10-16 feet in 100 meters) at about 3,000m-2 mile race speed/jog down slowly after each rep.*

These runs should take about 12-15 seconds each, so few runners will get as far as 95 meters. The grade should not be so steep as to sacrifice speed or risk Achilles tendon trouble, but it needs to be enough of an incline to get a good pre-stretch of the ankle.

A complete warmup period (including some buildups) is needed for this workout. These reps are not buildups themselves; they are fast enough throughout that creatine phosphate would be

used if a sufficient warmup were not taken. Owing to the short duration of each rep and the low density (rest periods up to 3 times longer than the runs), not much overall lactate will be produced.

The chief purpose of this exercise is to develop ankle power, flexibility and drive, and to increase knee integrity. It's important to keep from leaning into the hill (that's one reason for not making it too steep). Staying fairly upright forces the muscles in the ankle and knee joints to perform the correct movements.

****
****

Workout Purposes - Lactate Tolerance Training

This is the tough stuff, the piano-pushing, rigging, knee-grabbing, rubber-legged torture that most runners dread. It is an unavoidable aspect of training for any serious runner who wishes to be competitive. Unfortunately, Americans in general and high schoolers in particular place far too much emphasis on this hard anaerobic work, and they usually do it improperly, to boot. Many top Americans have remarked how "the training must be very hard" to reach the top. This is not entirely *wrong*; runners absolutely must "go to the well" in training from time to time in order to attain maximum performance capacity. However, lactate tolerance work has little to no effect on overall aerobic fitness, and it is aerobic endurance which is by far the most important component of running performance.

In essence, lactate tolerance training can only bring a runner from the bottom of a particular fitness level to the top of that same level in terms of race worthiness. It *never* allows anyone to *change* fitness levels! *Anybody* can run intervals *very hard*. Even football players can and do. But they are not *fit* enough to run faster than 70% of top 400 speed for even one mile. Increasing fitness to the point of running 80% of top 400 speed for 5,000 meters is only accomplished with months (and ultimately years) of progressively higher mileage with specific times spent at specific *aerobic* speeds.

The purpose of intense lactate tolerance work is to recruit FT muscle fibers for specific time lengths, to train ST and FT fibers to become glycolytic, to induce the heart and skeletal muscles to use lactate as fuel (reconverting it to pyruvate), and to fortify the bicarbonate buffer system. These ends are best achieved if sufficient speed maintenance has been used, and LT and VO_2max workouts have been performed regularly and properly *before* introducing lactate tolerance to the training regimen. This is to say that a smooth transition must be made from slower forms of training to hard anaerobic work. The first lactate tolerance session of the season should never be excessive; that's like trying for an end-of-Summer tan on the first day at the beach! Speed maintenance and drills in the pre-season help make the transition smooth. In general, any repetition running which is fast enough to maintain speed during the off-season will produce enough lactate to be considered truly anaerobic if continued longer than 40 seconds per rep. So speed maintenance reps should be limited to no longer than 200 meters each.

The most effective implementation of lactate tolerance work involves running between 3,000 and 4,000 meters of *total* distance, with no more than 10 repetitions and no single rep shorter than 300 meters or longer than 1,000 meters. Thus, 8-10 x 400 would provide the optimum overall distance, as would 6 x 600 or 4 x 1,000 or some combination of distances of 300 to 1,000

meters (e.g., 2 x 800 + 2 x 500 + 4 x 300).

Rest periods should never exceed twice the length of time required for the rep just run, and the ideal ratio is a rest period of 1.4 to 1.6 times the previous run period. For example, if the workout involves 3 x 2 min. runs + 4 x 1 min. runs, the rests should remain around 3 min. (give or take about 15 secs.) after each 2 min. bout and about 1:30-ish after each 1 min. run.

The reason behind limiting the rest periods has to do primarily with venous "pooling", in which the blood collects in the legs and feet post-exercise due to gravity and the fact that the legs are the prime movers in the exercise. Pooling usually occurs when the heart rate falls below about 120 bpm., and it undermines the body's ability to re-use lactate as fuel. Other factors are involved, but the end result is that resting too long between anaerobic repetitions does not train the lactate buffer system to its fullest.

During hard anaerobic training, it can become extremely difficult to maintain speed for long, but the effort should *still* be made to run the final reps the *fastest*. This is why it is crucial to select the proper starting speed and to limit the total volume of the workout. Basing the speed on current 1,600/mile race pace is a good strategy. The Examples section provides suggested starting speeds and average speeds for lactate tolerance training.

On occasion, these efforts can be made *exceptionally hard* (even harder than races), but it is advisable to remember that it does little good to try *harder* while running *slower*! It's better, therefore, if 8 reps are scheduled, to stop at 6 if the 6th was all-out and a 7th or 8th rep would without doubt be slower. To salvage the effect of finishing the workout faster, a few 200s can be run in lieu of the final repetitions of longer distances.

A limited volume (2,500-3,200 meters) of lactate tolerance training can be used the week of an important competition. This type of workout achieves the best result (both for the race and for later weeks) if the distances are shortened and the speeds rotated as the workout progresses. A few 200s can be tacked on at the end to increase the speed even further and to add a little volume to the workout. An example of this "taper session" would be 2 x 800 @ 2:15 and 2:10, followed by 4 x 400 @ 66-64-62-60 (3,200 meters so far), followed by some "speed maintenance" 200s @ 33-31-29-27. This would be a good workout for a 14:00 5,000 runner 3-4 days before a big meet. Race pace is about 67 400 pace for this runner, so not all of the reps are hard, yet various muscle fibers are recruited, some lactate tolerance work is accomplished, and the runner should be sufficiently recovered to feel very sharp by race day.

High school runners tend to perform excessive amounts of anaerobic interval training, owing to the fact that it gives them a "quick fix". The fruits of proper progressive training with sufficient base mileage and periodization may not be realized for years, so today's high schoolers (and the adults who cater to their "win now" desires) go for the intensity while ignoring the more important volume. Such training very rarely pays off for more than a few years. Consider that the nervous system responds (via chemoreceptors) to high lactate levels and chronically low blood pH with excessive ventilation and improper selection of muscle fibers. This means that too much anaerobic work in adolescence invariably results in uncoordinated, inefficient, struggling movements. Acidity may also lower aerobic enzyme activity, so that "interval-trained" high school runners may be *fast*, but they have poor *endurance*.

(to top)

Examples of Lactate Tolerance Workouts

** 8-10 x 300 averaging about 1 second per 300 slower than 800 race pace (start slightly slower than this, finish faster)/1:15 walk between reps.*

This is good as the first lactate tolerance work of the season. Because the distances are short, it's difficult to get in horrible trouble on this, even if a fairly substantial pacing mistake is made early. Still, it's better to estimate the speed a little on the slow side. The speed can always be increased in the middle if the first reps really were too slow. This is also a workout which can be repeated every few weeks at ever faster speeds as anaerobic capacity improves.

Imagine Lisa is a world-class middle distance runner with bests of 1:58 for 800, 4:20 for 1,600 (4:21.7 mile), and 8:45 for 3,000. As an early season introductory lactate tolerance session, Lisa might try 10 x 300 starting at 47 secs. and working down to the 45 range (Lisa's 800 PR averages 44.25 per 300). This might be too fast for a first effort, but if Lisa has been doing sufficient amounts of speed maintenance and drills, she should be able to continue at least in the 46 range and will most likely hit 44-45 on some of the reps. The workout could always be shortened to only 8 reps or some 200s could be substituted for the last few 300s if Lisa was unable to manage the desired speeds on all the 300s.

** 8-10 x 400 averaging about 3 secs. per 400 faster than 1,600/mile race pace/1:30-2 min. walk between each.*

These can probably be run faster than the indicated speed by mid-season, but this is a suggested speed for the first time this particular workout is attempted during the early season. As usual, it's best to start slower so as to establish where the tolerance level will be on the day.

For Lisa, who has a 1,600 time of 4:20 (65 secs. per 400), a session of 8 x 400 would ideally be done at something like 65-63-62-62-62-62-61-60, with about 1:30 or so rest between each. If Lisa has been performing enough anaerobic work to be accustomed to (and confident with) a very tough interval workout, she might run a full second faster on each rep. This is, after all, *hard* track work! These reps are short enough that this workout can be used fairly often during the competitive season and can usually be done up to 3 days prior to all but the most important competitions.

** 5-6 x 2 min. runs averaging about 1 second per 400 slower than 1,600/mile race pace/3 min. walk between each (about 1 min. of easy jogging can be done during the middle of each rest period).*

Again, these runs can quite possibly be run even faster/harder than specified, but the durations are long enough that most runners cannot get away with "going to the well" on this within a few days of a major competition. If these are to be run as hard as possible, they should probably be reserved for a non-competition week, when a "make it or break it" approach can be taken to this

workout.

Our world-class middle distance runner Lisa (1,600 PR of 4:20, a 65 400 pace) would aim to average 66 400 pace for 5-6 2 min. runs. This would put her at 1:55-1:56 at the 700 mark, which would be as good a place as any to stop. The rest periods could range from 3 min. to possibly 3:30, but longer than this would result in pooling due to the lowered heart rate).

Six reps of 2 min. each amounts to the limit of total distance for a lactate tolerance workout, and may exceed that limit (about 4,500 meters) for many runners. Unlike aerobic training, anaerobic training is meant to be as *fast* as possible. Five reps of 2 min. each may be more manageable, faster, and more effective for most runners than six reps.

** 4 x 1,000 averaging 3-4 secs. per 400 slower than 1,600/mile race pace (or 2-3 secs. per 400 faster than 3,200/2 mile race pace)/4 min. walk/jog between reps.*

This workout, like the previous one, employs a total volume which is near the maximum limit of effectiveness for anaerobic work. Generally, the best results from lactate tolerance training come from workouts which total 3,000 to 4,000 meters in distance, with none of the individual reps longer than 1,000 meters. A 5th rep *could* be added to this session (people do that sometimes), but it's probably not a good idea. If any more distance is to be added, it's better to add one 400 or one 300 or 2 x 200. This *really* is the limit on this type of training. The purpose is in part to run as *fast* as possible on these reps. More than 4,000 meters of distance just isn't usually as productive toward this end.

4:20 1,600 runner Lisa would shoot for about a 68 400 pace on 4 x 1,000. This is 3 seconds per lap slower than her 1,600 pace and 2 seconds per lap faster than her 3,000 race pace (about 2.3 secs./lap faster than predicted 3,200 pace). The 1,000s could be run at 2:52-2:50-2:50-2:48, with roughly 4 min. of walking/easy jogging as rest periods.

****
****

Conversion Chart For vVO_2max/LTV/Race Times
(1,600 time = Mile time x 0.9938)

vVO2max (per mile)	LTV (per mile)	Mile	2 Miles	5,000	8,000	10,000	15,000	½ Mar.	Mar.
4:00.0	4:25.7	3:40.2	7:51.1	12:33.2	20:41	26:09	40:08	57:51	2:02:44

4:05.0	4:31.8	3:44.9	8:01.8	12:50.9	21:11	26:48	41:08	59:17	2:05:54
4:10.0	4:37.8	3:49.6	8:12.4	13:08.6	21:41	27:26	42:08	1:00:43	2:09:04
4:15.0	4:43.9	3:54.3	8:23.0	13:26.3	22:11	28:05	43:08	1:02:08	2:12:14
4:20.0	4:49.9	3:59.0	8:33.6	13:43.9	22:42	28:43	44:09	1:03:34	2:15:24
4:25.0	4:56.0	4:03.7	8:44.3	14:01.6	23:12	29:22	45:09	1:05:00	2:18:34
4:30.0	5:02.0	4:08.4	8:54.9	14:19.3	23:42	30:00	46:09	1:06:26	2:21:44
4:35.0	5:08.1	4:13.1	9:05.5	14:37.0	24:13	30:38	47:09	1:07:52	2:24:54
4:40.0	5:14.1	4:17.8	9:16.2	14:54.7	24:43	31:17	48:09	1:09:18	2:28:04
4:45.0	5:20.2	4:22.5	9:26.8	15:12.3	25:13	31:55	49:10	1:10:44	2:31:14
4:50.0	5:26.2	4:27.2	9:37.4	15:30.0	25:44	32:34	50:10	1:12:09	2:34:24
4:55.0	5:32.3	4:31.9	9:48.1	15:47.7	26:14	33:12	51:10	1:13:35	2:37:34
5:00.0	5:38.3	4:36.6	9:58.7	16:05.4	26:44	33:51	52:10	1:15:01	2:40:44
5:05.0	5:44.4	4:41.3	10:09.3	16:23.1	27:15	34:29	53:10	1:16:27	2:43:54
5:10.0	5:50.4	4:46.0	10:19.9	16:40.7	27:45	35:08	54:11	1:17:53	2:47:04
5:15.0	5:56.5	4:50.7	10:30.6	16:58.4	28:15	35:46	55:11	1:19:19	2:50:14
5:20.0	6:02.5	4:55.4	10:41.2	17:16.1	28:45	36:24	56:11	1:20:45	2:53:24
5:25.0	6:08.6	5:00.1	10:51.8	17:33.8	29:16	37:03	57:11	1:22:11	2:56:34
5:30.0	6:14.6	5:04.8	11:02.5	17:51.5	29:46	37:41	58:11	1:23:37	2:59:44
5:35.0	6:20.7	5:09.4	11:13.1	18:09.1	30:16	38:20	59:12	1:25:03	3:02:54
5:40.0	6:26.7	5:14.1	11:23.7	18:26.8	30:47	38:58	1:00:12	1:26:29	3:06:04
5:45.0	6:32.8	5:18.8	11:34.4	18:44.5	31:17	39:37	1:01:12	1:27:55	3:09:14
5:50.0	6:38.8	5:23.5	11:45.0	19:02.2	31:47	40:15	1:02:12	1:29:21	3:12:24
5:55.0	6:44.9	5:28.2	11:55.6	19:19.9	32:18	40:53	1:03:12	1:30:47	3:15:34
6:00.0	6:50.9	5:32.9	12:06.2	19:37.5	32:48	41:32	1:04:13	1:32:12	3:18:44
6:05.0	6:57.0	5:37.6	12:16.9	19:55.2	33:18	42:10	1:05:13	1:33:38	3:21:54
6:10.0	7:03.0	5:42.3	12:27.5	20:12.9	33:49	42:49	1:06:13	1:35:04	3:25:04
6:15.0	7:09.1	5:47.0	12:38.1	20:30.6	34:19	43:27	1:07:13	1:36:30	3:28:14
6:20.0	7:15.1	5:51.7	12:48.8	20:48.3	34:49	44:06	1:08:13	1:37:56	3:31:24
6:25.0	7:21.1	5:56.4	12:59.4	21:05.9	35:20	44:44	1:09:14	1:39:22	3:34:34
6:30.0	7:27.2	6:01.1	13:10.0	21:23.6	35:50	45:23	1:10:14	1:40:48	3:37:44
6:35.0	7:33.3	6:05.8	13:20.7	21:41.3	36:20	46:01	1:11:14	1:42:13	3:40:54
6:40.0	7:39.3	6:10.5	13:31.3	21:59.0	36:51	46:39	1:12:14	1:43:39	3:44:04
6:45.0	7:45.4	6:15.2	13:41.9	22:16.7	37:21	47:18	1:13:14	1:45:05	3:47:14
6:50.0	7:51.4	6:19.9	13:52.5	22:34.3	37:51	47:56	1:14:15	1:46:31	3:50:24
6:55.0	7:57.5	6:24.6	14:03.2	22:52.0	38:22	48:35	1:15:15	1:47:57	3:53:34
7:00.0	8:03.5	6:29.3	14:13.8	23:09.7	38:52	49:13	1:16:15	1:49:23	3:56:44

****
****

Examples [the form drill videos seem to be lost]

Form Drills:

Download Form Drill Videos (in **Mpeg** format)

1. Quick Steps
2. High Knees
3. Skips
4. Kick Outs
5. Hill Bounding
6. One-Foot Hill Hops
7. Ankle Bounding
8. Toe Hops (in place)

Continuous easy runs:

* 30-35 min. (as very short day or shorter run of double)
* 60-65 min. (medium day or longer run of double)
* 90-95 min. (long run for young runners/beginners or moderately long run for experienced adults or longer run of double)
* 120-125 min. (very long run for young runners or regular long run for adults)
* 150-155 min. (very long run)

Lactate Threshold workouts:

*** Continuous run w/ 5-7 min. at 10 secs./mile slower than LTV, next 18-22 min. at LTV, last 2-3 min. gradually worked down from 95% of vVO_2max to 105% of vVO_2max**
*** Continuous run of 60-70 min. at 95%-96% of LTV (12-18 secs./mile slower than LTV or about 4-10 secs./mile faster than marathon race pace)**
*** 2 x 15-18 min. at LTV w/ 5-7 min. very easy jog between**
*** 10-15 x 3 min. runs at LTV/30-35 secs. rest periods**
*** 16-20 x 400 at 105% of LTV (3-4 secs. per 400 faster than LTV)/20-25 secs. rest periods**

VO_2max workouts:

*** 12-16 x 400 at 105% of vVO_2max (3-4 secs. faster per 400) w/last 2-3 gradually faster/55-60 secs. easy jog between each**
*** 8-10 x 2 min. at vVO_2max/2 min. moderate jog between (sometimes called 2 on, 2 off); 6-8 x 800 can be used instead**
*** 6-8 x 3 min. at vVO_2max/3 min. easy jog between**
*** 5 x 5-6 min. at 95% of vVO_2max (14-18 secs./mile slower)/3 min. very easy jog between**

Speed maintenance workouts:

*** 2-3 sets of 5-6 x 100m. buildups (each one gradually faster)/jog back 100 between each, 800-1,600 jog between sets**
*** 2 sets of 5-6 x 200 starting at 5K race pace, cutting down 1 second faster on each rep, jog 200 between each, 1,600 jog between sets, start 2nd set at 1-2 secs. faster than on 1st set and cut down by about 1 second on each rep**
*** 10-15 x 75-95 meters uphill @ 3%-5% grade (a rise of 10-16 feet in 100 meters) at 3,000m-2 mile race speed/jog down slowly after each rep**

Lactate tolerance workouts:

*** 8-10 x 300 averaging about 4 secs. faster per 300 than 1,600 (mile) race pace (start slightly slower, finish faster)/1:15-1:30 walk between each**
*** 8-10 x 400 about 3 secs. per 400 faster (avg.) than 1,600 race pace/1:40-2 min. walk rest**
*** 5-6 x 2 min. at 1 sec. per 400 slower (avg.) than 1,600 race pace/3 min. walk rest**
*** 4 x 1,000 at 3-4 secs. per 400 slower than 1,600 race pace (2-3 secs. per 400 faster than 3,000 or 3,200 race pace)/4 min. walk rest**

****
****

DEFINITIONS AND TERMINOLOGY

Authors: Kyle Heffner and John Kellogg

START HERE if you are not familiar with any basic exercise physiology jargon. Some of the terms may seem confusing at first, but stick with it and you'll pick it up. We're not here to overwhelm you with our knowledge of fancy words and we realize all this terminology may be unfamiliar, but it will *simplify* further discussion of training principles. Instead of repeatedly writing the phrase "the speed you could run for an hour", we will refer to this as "LTV" or the "lactate threshold velocity". Plus, you will better understand other articles and books about running if you know some of the terms. We assume you're very *serious* about this sport but that you may not be acquainted with some of the *lingo*, so we'll start at the beginning.

METABOLISM refers to changes within the body which pertain to life processes and functions. CATABOLISM is the breaking down of organic components (such as stored nutrients or even living tissue), which ultimately results in energy production. ANABOLISM is the building up of tissues or other organic structures from simpler constituents (such as the

rebuilding of muscle tissue). Metabolism, in short, basically refers to the processes that keep the body functioning.

The CARDIOVASCULAR SYSTEM is anatomically the circulatory system, including the heart and blood vessels. The blood vessels can be divided into the PULMONARY CIRCULATION, which carries blood to and from the lungs, the CENTRAL CIRCULATION (heart), and the SYSTEMIC CIRCULATION, which carries oxygenated blood to the tissues of the body.

Blood vessels are also classified as ARTERIES, which carry blood away from the heart, and VEINS, which carry blood toward the heart. The smaller ARTERIOLES and VENULES branch out from main arteries and veins and are connected by even narrower CAPILLARIES.

The RESPIRATORY SYSTEM consists of the organs, muscles, and tissues involved with the act of breathing. These include the diaphragm and intercostal muscles, the lungs, bronchii, bronchioles, trachea, larynx, pharynx, and nasal cavity.

AEROBIC EXERCISE is activity which depends on the use of *oxygen* and energy sources such as fats, carbohydrates and amino acids to produce the energy required for muscular movement. Aerobic metabolism (use of O_2 to "burn" stored fuels) produces 19 times more energy (ATP - adenosine triphosphate) per unit of fuel than does anaerobic metabolism, and is therefore the body's preferred state of energy production.

ANAEROBIC EXERCISE is activity which relies on an intramuscular energy system capable of supplying energy *without* the use of oxygen. Two basic types of anaerobic systems in the muscles are the CREATINE SYSTEM (alactic), which uses high-energy phosphates such as creatine phosphate, and which does not produce lactic acid as a by-product, and the LACTATE SYSTEM, which relies on the rapid metabolism of glucose to pyruvate and ultimately lactic acid or lactate. Both systems are used when the muscles are recruited for activities in which the body's energy requirements are too great to be met by aerobic metabolism (in other words, not enough O_2 is available to continue the exercise in an aerobic state). By-products of anaerobic exercise (i.e., lactic acid) tend to interfere with muscle movement (this is actually a *protective* mechanism designed to keep the muscle cells from being in an environment which is too acidic). Prolonged anaerobic exercise therefore becomes increasingly difficult and eventually impossible.

OXYGEN DEFICIT is the deficit of energy produced during anaerobic metabolism that is reflected by the additional oxygen consumed following exercise. OXYGEN DEBT is the additional oxygen required following the energy expenditure.

The CAPILLARY NETWORK is a system of very small blood vessels present in muscle tissue to provide gas exchange, water, and nutrients for the body's tissues. It is generally accepted that large amounts of physical aerobic activity, particularly early in life, can develop a very extensive capillary network. Such development is one of the principal goals of progressive training.

An ERYTHROCYTE is a red blood cell (from "erythro-", meaning "red colored" and "cyte", meaning "cell"). There are normally about 5 trillion red cells per liter of blood in the human body. Red cells carry oxygen to all tissues; hence, they are crucial components of aerobic metabolism.

ERYTHROPOIETIN (EPO) is a hormone which naturally occurs in the kidneys and which acts to increase the production of erythrocytes (red cells) when the body's tissues are not receiving enough oxygen. This can occur during some forms of anemia or in response to being at high altitude. The process of red cell formation is called ERYTHROPOIESIS ("-poiesis" means "production").

Epo is also available in synthetic form as a drug, and its use is potentially dangerous due to risk of thrombosis (clotting). It is banned in athletic competition because of its potential health risks and because its use is considered cheating by artificially raising the red cell count (and therefore the aerobic capacity). Living for a few months at high altitude can naturally result in a higher red cell count, but some endurance athletes live at altitude and reportedly use synthetic Epo (or synthetic blood comprised of perfluorocarbons) *as well* to illegally enhance performance.

HEMOGLOBIN is the substance contained within red blood cells that is responsible for binding with oxygen and transporting the oxygen around the body via the circulation. There are 12-18 grams of hemoglobin per deciliter of blood in most people. Men generally have more hemoglobin than women have, owing to the fact that the globin is a protein and is enhanced by higher testosterone levels. Hemoglobin is extremely important for aerobic exercise because it is the means of oxygen transport; therefore, raised testosterone levels during puberty account in part for boys showing more improvement in distance running during their high school years than girls show. However, it is believed that women tend to slow down less later in life, owing to the fact that their testosterone levels do not decrease as do those of men.

MYOGLOBIN is a substance resembling hemoglobin which is found in muscle cells (particularly in the heart) and which provides a reserve oxygen supply for the muscles. People who live at high altitudes (above 8,000 ft.) often exhibit higher myoglobin levels; however, unacclimated runners who attempt hard workouts at altitude can actually *decrease* their myoglobin reserves, at least temporarily.

Altitude training is best accomplished by living (and doing very easy base training) at higher altitudes (preferably above 8,000 ft.) and going to lower levels (below 3,000 ft.) to perform workouts in which a fast pace is a factor. This has the optimum effect on the myoglobin O_2 reservoir and can also boost the red cell count. Low altitude fast continuous workouts also allow a runner to maintain a relaxed, efficient, aerobic effort at a *faster pace* than could be achieved *aerobically* at high altitude.

A MUSCLE FIBER is a muscle cell (or, sometimes, a bundle of muscle cells of similar composition which perform the same biomechanical task - this is more often referred to, along with the connecting motor neuron, as a MUSCLE MOTOR UNIT).

FAST TWITCH (FT) fibers are activated by a large motor neuron which is capable of recovering quickly before delivering another impulse to the muscle fiber. The FT fibers generally perform explosive work (such as short sprints or shot putting) and fatigue quickly. They contain low amounts of myoglobin and aerobic enzymes and usually have a low capillary supply, so they are ill-suited for prolonged aerobic activity, although they *can* be trained to work aerobically.

SLOW TWITCH (ST) fibers have smaller connecting motor neurons and require longer periods of time between successive contractions, so they are not suitable for explosive activity. They do have better blood supply, more myoglobin, aerobic enzymes, metabolites and organelles which enable them to use oxygen to produce energy. They are therefore the fibers which perform lower intensity work for longer periods of time. They *cannot* be trained to contract more quickly, but they *can* to a limited degree be trained to work anaerobically.

In prolonged continuous activity, the ST fibers are used as long as they are capable of performing the work. As they begin to fatigue and muscle contractions become less forceful, more and more FT fibers are recruited to continue the exercise. This may be referred to as PREFERENTIAL (or SEQUENTIAL) RECRUITMENT OF MUSCLE FIBERS. All correct training must take into account the recruitment sequence of muscle fibers which is specific to the event(s) being contested.

A MITOCHONDRION is an ORGANELLE (structure within a cell) which serves as the location of energy production within the cell. Some muscle cells may contain around 1,000 mitochondria each. Prolonged aerobic training can increase the density (number per cell) of mitochondria in certain muscle cells by a factor of four versus the initial (untrained) condition.

Since aerobic energy production occurs within the mitochondria, increasing their density is one of the principal goals of training. In general, any exercise which increases the size of a muscle belly (such as lifting weights to improve maximum lift capacity), will *decrease* mitochondrial density (and capillary density) relative to the muscle size. Such exercises must be carefully balanced by runners. Though they may be counterproductive from an aerobic standpoint, they

can assist endurance athletes in other ways such as developing muscle contractile properties, as well as providing a measure of injury prevention.

FUEL SOURCE or SUBSTRATE UTILIZATION refers to stored nutrients within the body which are used during aerobic metabolism or anaerobic metabolism for the purpose of performing biomechanical work (such as exercise). The preferential fuel sources or substrates for aerobic exercise are (in descending order) FATTY ACIDS, CARBOHYDRATES (GLUCOSE, GLYCOGEN), and AMINO ACIDS (PROTEIN). For energy production, the body uses a nearly equal mixture of fat and carbohydrates almost 24 hours a day, with generally less than 15% of the energy supplied by protein metabolism. However, fat is the preferred fuel at rest or during sleep and for very low intensity or prolonged aerobic exercise. Although the energy yield from fat is very high, it requires more oxygen than carbohydrate metabolism and may be considered "slower" in generating energy for muscle contraction. Therefore, during prolonged intense activity (such as race-pace running), fat is unsuitable as the primary substrate without carbohydrates to supplement the energy production. It is analogous to burning logs (i.e., fat) after the fire is started with smaller pieces of wood (carbohydrates).

Carbohydrates are stored as glycogen in the skeletal muscles and in the liver. Glycogen is the preferred fuel for high intensity aerobic exercise. Training and diet should take into account the glycogen depletion-repletion processes within the muscles so that sufficient glycogen is available during target performances.

GLYCOGEN DEPLETION occurs in adjacent muscle fibers during endurance events, although the slow twitch fibers are depleted first, followed by the fast twitch fibers as the event progresses. Liver glycogen, which provides blood-borne glucose for sustaining brain function, can be depleted during prolonged intense running. As a consequence of falling blood glucose, a runner may experience depression-like symptoms associated with hypoglycemia (often referred to as "bonking"). Gradually, nearly all muscle glycogen of the PRIME MOVER fibers (those muscles used for the activity) during a long race (such as a marathon) will be depleted while the blood glucose supplied by the liver continues to decline throughout the race. As the supply of glycogen decreases in first ST muscle cells, the glycogen within the FT units is accessed due to the need for the FT fibers to boost the declining ST muscle contractions to sustain the given pace. As a runner's glycogen stores are depleted, the prime mover muscles can no longer maintain the power output, as they must shift to *fat* metabolism. This results in a slower pace, generally accompanied by extreme overall fatigue ("hitting the wall"). Continued exercise will reduce the fatty acid store enough to initiate the breakdown of functional proteins. Such a state is unhealthy and requires a long period of recovery.

The chief *anaerobic* fuel sources are CREATINE PHOSPHATE (CP), GLUCOSE, and LACTATE. CP serves as a quick energy source for very short, explosive bursts. It is accessed when it isn't possible to have a sufficient warmup period to allow the heart rate to come up enough for aerobic metabolism to dominate. This is the energy source used in nature's "fight or flight" scenario, in which predators must suddenly chase prey animals, which in turn must unexpectedly try to escape or defend themselves. Some CP is always used at the beginning of a physically demanding effort for the first 15-20 seconds, followed by the lactate system generating energy anaerobically for several minutes. Within less than a minute of activity, the level of oxygen consumption increases to allow acceleration of aerobically dominated

metabolism. If the O_2 consumption stabilizes, the state of effort may be referred to as INITIAL AEROBIC EQUILIBRIUM.

GLYCOLYSIS is the metabolism of glucose for energy without the use of oxygen. Glucose is rapidly converted to PYRUVATE, which is further reduced to LACTIC ACID during anaerobic exercise. Even though this is rapid, the overall energy produced is only 2 ATPs per glucose molecule, relatively *smaller* than that produced via *aerobic* metabolism. The process of glycolysis is far more costly from a mechanical efficiency perspective, since continued lactic acid production will eventually interfere with muscle contraction. For this reason, distance runners must train in such a way as to ensure that *aerobic* energy production will dominate their race efforts for as long as possible.

During glycolysis, lactic acid quickly dissociates into lactate and positive hydrogen ions (free protons). Lactate and the hydrogen ions diffuse from the muscle cells into the blood. The blood lactate itself can be taken up as a fuel by the MYOCARDIUM (heart muscle) and by the liver. Enzymes are present to convert the lactate molecules back to glucose by a biochemical process known as GLUCONEOGENESIS. It is recognized that the body's capacity to re-use lactate can be enhanced through correct training. The *hydrogen ions* inhibit muscle contractions by competing with calcium ions for binding sites at the surfaces of muscle cells. This causes a runner to "tie up", or to reach a level of fatigue that exhibits muscle contractile failure. This is a protective mechanism which prevents continued lactic acid production, which would cause damage to some of the organelles within muscle cells (this could ultimately result in rupture of the cells). However, the "tying up" during a brief anaerobic performance (less than a minute) makes this nearly impossible. Unfortunately, many months or years of large volumes of anaerobic training can produce an acidic internal environment which results in chronic fatigue, inefficient or uncoordinated movements, and possibly even muscle cell damage. Proper training should therefore include only limited periods of "killer" anaerobic work.

VO_2 or OXYGEN UPTAKE is the rate of oxygen consumption by the body. In order to produce energy aerobically, the body must consume oxygen. It is usually measured in liters or milliliters (ml.) of O_2 consumed per minute and represents the energy used (i.e., calories). It can also be expressed in relative terms (to compare between individuals) in ml. of O_2 used per minute per kilogram of body weight (usually written as ml./kg./min.). The "V" (for ventilation) is often written with a dot over it to represent "per minute ventilation".

VO_2max or MAXIMAL OXYGEN UPTAKE is the maximum rate of oxygen consumption that the body can achieve. It is usually expressed in ml./kg./min. The "average" man has a VO_2max of about 40-45 ml./kg./min., while the "average" woman has around 30-35 ml./kg./min. By comparison, the best male and female runners in the world achieve values around 85-90 and 70-80, respectively. A racehorse can have a VO_2max of over 100 ml./kg./min.!

VO_2max is an excellent measure of a runner's aerobic power (although as a single measure, it does *not* always predict running performances or success with any certainty). Running performance depends on many physical and psychological attributes, including cardiac output, peripheral circulation and other related factors such as capillary density, mitochondrial density,

hemoglobin levels, myoglobin reserve, pulmonary capacity, and percentage of ST/FT muscle fibers. Of course, numerous physical factors may be improved to various degrees from training, but the change is mediated by hereditary limitations. It has been observed that VO_2max can be increased by 10% to 30% over its initial (untrained) value.

The energy production required to run at high intensity levels near VO_2max is strongly assisted by anaerobic metabolism. At supermaximal intensities, the VO_2 sometimes *declines* while the anaerobically supplied energy temporarily sustains the work output. In practice, the aerobic metabolism's contribution to the power output at VO_2max can be maintained for about 3 minutes and at supermaximal efforts for less than one minute. The fact that VO_2max can only be maintained for around 3 minutes before anaerobic metabolism supplies the majority of the energy has important implications for training at the speed required to achieve VO_2max.

RUNNING ECONOMY (RE) is a measure of the energy expended by a runner to maintain a given speed and is generally indicated by the amount of oxygen (VO_2) consumed during a steady pace. The lower the VO_2 for a steady state pace, the less energy used; hence, the better the RE of the runner at that speed or pace. For example, if Thomas has a VO_2 of 52 ml./kg./min. at 6 min. per mile pace (10 mph) and Frank consumes only 47 ml./kg./min. at the same pace, Frank has the better economy for that pace. Measurements of economy are taken at speeds below the runner's anaerobic (ventilatory) threshold (AT or VT), due to the fact that a pace above VT does not have a steady VO_2. In other words, VO_2 increases during any pace above VT or may be said to be "non-steady state". Runners with very large VO_2 capacities may consume more oxygen for any given sub-threshold speed, but their RE may or may not be relatively worse when compared to other runners.

Comparisons of RE between runners may be done using the measured VO_2 at a given pace divided by the runner's maximal VO_2 to derive a relative VO_2 or %VO_2max at which the runner is performing. For example, if the VO_2max of the above runners are 75 and 70 ml./kg./min., respectively, Thomas is running at 69.3% VO_2max (52/75 x 100%) at 6 min. per mile pace, while Frank is running at 67.1% VO_2max (47/70 x 100%) at the same pace. Frank still has the better running economy in both absolute and relative terms. Note: It is probably best to use RE to track changes within the individual runner's efficiency rather than an open comparison between runners.

Changes in RE across time demonstrate the effectiveness of the training program. RE seems to be affected by neuromuscular coordination (mechanical efficiency) and the sequence in which muscle fibers are mobilized while running (i.e., "good form"). Other trainable factors that also influence running economy include the utilization and transport of oxygen within the body; that is, circulatory factors such as the number of blood vessels per muscle fiber (capillary density). These factors are often impacted early in life by the volume of aerobic activity (not necessarily organized long distance running workouts) such as running back and forth to school or during play in childhood, and by spending specific amounts of time at certain critical training speeds later in life.

VCO_2 is the ventilation of carbon dioxide. VCO_2 is generally measured in liters or milliliters of CO_2 produced per minute. As exercise effort increases, VCO_2 will increase as will VO_2. As workloads or running speeds increase, additional CO_2 will be released by two mechanisms: the increase in carbohydrate metabolism and the buffering of lactic acid by the bicarbonate system. Eventually, the CO_2 production will begin to increase more rapidly than the O_2 consumption is increasing. This marks what is referred to as the ANAEROBIC THRESHOLD (AT) or VENTILATORY THRESHOLD (VT). This is one of many measurable indicators that anaerobic processes are increasingly involved in supplementing the energy production. VCO_2*max* is a rough indication of how much anaerobic work a person can tolerate.

RESPIRATORY EXCHANGE RATIO (RER) is the ratio of VCO_2 divided by VO_2. At rest, the ratio reflects the substrates (such as fats and carbohydrates) used by the body's metabolism. A mixture of both fats and carbohydrates results in a ratio of about 0.84. Pure fat burning yields a ratio of 0.7, while pure carbohydrate burning yields a ratio of 1.0. This ratio is also called the NON-PROTEIN RESPIRATORY QUOTIENT (RQ or R). Pure protein metabolism yields a ratio of 0.83, but the contribution of protein to the ratio is not generally known without additional measurements to indicate the breakdown of amino acids. During exercise, however, the ratio will climb as carbohydrate metabolism increases. For example, if the VCO_2 is 3.5 liters per min. while the VO_2 is 4.0 liters/min., the RER would be 3.5/4.0, or 0.875, which would indicate the athlete to be performing well below maximum capacity. As long as the VCO_2 is lower than the VO_2, it can be concluded that the runner is still performing in a predominantly aerobic fashion. Exercise or running efforts where the RER exceeds 1.05 are considered "maximal".

RESPIRATORY CAPACITY refers to the dynamics of lung ventilation and the body's ability to absorb and utilize oxygen (essentially, VO_2max). The performance of physical work is strongly related to the ability to consume and transport O_2 to the working muscles. As the energy demand increases (such as a faster pace), so does the demand for oxygen (VO_2). Respiration at the cell level is affected by a cascade of events from the availability of oxygen at the lung level (atmospheric O_2, barometric pressure, water tension), the blood pH, the temperature of the tissues, O_2 carrying capacity of the blood, tissue enzyme activity, and a host of circulatory factors.

RESPIRATORY COMPENSATION POINT (RCP) is a point during increasing exercise workloads at which the CO_2 production begins to accelerate, or "drives" the per minute ventilation. At this point, ventilation increases faster than VCO_2, thus reflecting a change in the ventilation-VCO_2 relationship. By the time the RCP is reached, a runner may begin to hyperventilate due, in part, to large amounts of blood lactate affecting chemoreceptors in the brain's respiratory centers. The processes that occur when RCP is surpassed have important implications for the amount of time runners should spend at various speeds in training.

LACTIC ACID is the end product of anaerobic glucose metabolism (glycolysis). During extremely intense effort of moderate to long duration, glucose is converted to pyruvic acid, which is in turn reduced to lactic acid. Lactic acid dissociates quickly into LACTATE (its negative ion) and positive hydrogen ions, and it is usually referred to as lactate (most acids are referred to by their negative ions, since by definition they dissociate quickly and donate protons to their surrounding environment). See also FUEL SOURCE.

BLOOD LACTATE is referred to in exercise physiology as the measure of lactate in a small sample of blood, usually expressed in millimoles of lactate per liter of blood (mM/L or mmol/L). This measurement is the principal figure used in determining degree of anaerobic effort; the higher the blood lactate, the more anaerobic the exercise. At rest, a low level of blood lactate is measurable, owing to the fact that some degree of lactate production is normal. Measurements in elite runners (mostly middle-distance runners) shortly after all-out exertion can reach in excess of 20 mM/L (record levels near 30 mM/L), but most runners can usually only attain levels of 11-15 mM/L.

LACTATE THRESHOLD (LT) is a point during increasing exercise intensity when there is a rapid accumulation of blood lactate following an "inflection point" or a change in the normal level of blood lactate. By convention, LT is defined by a blood lactate level of 4 mM/L for the purpose of laboratory measurements, although the *actual* LT for any individual runner may vary from this figure. It is not uncommon that a well-trained runner can maintain an effort just below 4 mM/L for over 22 minutes before surpassing the LT with a fairly rapid climb in blood lactate. It is known that many runners can sustain a pace close to LT for over an hour, but the effort will likely alternate between high levels of aerobic and anaerobic metabolism after the first 22 minutes. Another often-used term which describes the sudden increase in blood lactate levels is ONSET of BLOOD (or PLASMA) LACTATE ACCUMULATION (OBLA or OPLA).

ANAEROBIC THRESHOLD (AT) and VENTILATORY THRESHOLD (VT) are often used interchangeably with LT, but the points by which these are defined are not synonymous. AT is defined by the relationship between workload and ventilation, while VT is defined by the VCO_2-VO_2 relationship, and LT is defined by blood lactate. These concepts remain controversial and are affected by the training states as well as the testing protocols used to measure them.

LACTATE THRESHOLD VELOCITY (LTV) is the speed (expressed in meters per second or kilometers per hour) or, more commonly, the pace (expressed in minutes and seconds per mile) required to bring a runner up to the LT or just below the point of rapid lactate accumulation. Most well-trained runners can maintain LTV for 18-22 min. before surpassing this point. A near-LT pace may be maintained for about an hour, but once LT is reached, the accumulation of lactate is inevitable, so the effort will become dominated by steadily increasing anaerobic

metabolism and, eventually, the pace will have to slow. At such times, the Respiratory Compensation Point (RCP) may be reached, resulting in extreme hyperventilation. Experiencing this may help the athlete learn to monitor the pace just below the LT in a tempo run during training.

VELOCITY AT VO_2max (vVO_2max) is the speed or pace required to bring a runner to the maximal oxygen usage (VO_2max). This speed may be maintained during an evenly-paced run for around 9-11 minutes (possibly over 11 minutes in a runner with excellent anaerobic tolerance). At this pace, VO_2 requires roughly 4 min. to reach its maximum value, and will remain at max for about 3 min. before anaerobic metabolism provides the preponderance of the power output. At this point, the VO_2 has sometimes been observed to *decrease* by 2% to 4%.

It is believed that running within the range of 95% to 105% of VO_2max pace is most effective for increasing the VO_2max. *Exceeding* 3 min. at *exactly* vVO_2max in training bouts usually does not show any distinct training advantage due to lactate accumulation adversely affecting muscle contraction and efficiency.

VENTILATORY DRIFT is a gradual change in the ventilatory pattern during continuous exercise. During steady long runs at a light to moderate aerobic effort, areas of the lungs may be relatively inactive in the gas exchange process (hence referred to as physiological "dead space"). It is believed that these areas may also exhibit a higher than normal concentration of CO_2, which may accumulate to levels sufficient to stimulate an increase in ventilation. In addition, increases in ventilation can be precipitated by fatigue in the respiratory muscles. The resulting change can be larger tidal volumes (the amount of air moved with each breath) or even a more rapid breathing frequency (tachypnea). Ventilatory drift may be minimized or counteracted during long runs by certain breathing techniques in conjunction with minor variations in pace throughout the run. Picking up the pace gradually near the end of a long run is effective as well, and this also provides variation in the sequence of muscle fiber recruitment.

****
****

Article: Mastering Running After 40

- *John Kellogg*

Owing to the "running boom" of the late 60s and early 70s, a large proportion of the country's running population is now in the *masters* (40 and up) category. In fact, in most road races, many of the *top* finishers (sometimes even the overall winners) are masters! If you are an over-40 athlete who is pushing yourself to remain competitive, it's important to remember that your *workout* regimen should differ from that of younger runners. While those in their prime require higher base mileage and stricter periodization to reach full potential, masters usually perform

better by focusing more on shorter training cycles and by staying in touch with a short-distance and middle-distance component year-round.

When considering training guidelines for the over-40 runner, it behooves us to examine some of the physiological changes that take place with age, how those changes affect running performance, and what can be done to keep those negative effects of aging to a minimum.

Problem:

Your pituitary gland releases less growth hormone as you age. One upshot of this is that you find yourself losing raceworthiness (anaerobic tolerance and speed) *incredibly* quickly following a competitive season, and that it's a *shocking battle* to get that sharpness back.

What you can do about it:

Use *multi-tier* training. This utilizes small training pyramids which begin with slower, longer endurance work and which build through faster-paced training stages to a *moderate*-intensity, reduced "peak". Then the process is repeated, with each stage performed at a *higher* intensity (faster average pace) than before.

Most *young* runners focus on *six-month* "macrocycles" in which they do long, slow to moderate distance for two or three months, tempo runs and long intervals for a month or two, then hone up with hard speedwork, time trials, and races. This general approach is preferred for those in their prime, but as a master, you need to *shorten* those macrocycles to *weeks* rather than months. That is, emphasize longer endurance training for about three weeks, ease yourself into faster tempo runs and stamina-oriented intervals for a few weeks, then introduce the harder anaerobic intervals, sharp speedwork, and time trials for three or four more weeks. This general cycle can be repeated several times per year, with more time or more intensity devoted to the anaerobic phase during the times you wish to approach peak racing shape. In a non-competitive season, you should still use the fast anaerobic training stage, but the intensity should be made deliberately lower, as though you were just "going through the motions". More time and emphasis in the off-season can be devoted instead to relaxed tempo running and endurance-directed intervals with short rest periods. [Note: the multi-tier approach is *not* as effective for young runners as is periodization. Young athletes (particularly preteens and teens) cannot tolerate (and do not need) a profusion of stressful anaerobic training. Too much killer track work will burn youngsters out quickly and may harm their future running careers.]

Problem:

Blood vessels begin losing elasticity and capillary density tends to decrease. You fatigue more quickly because the blood supply to your working muscles simply isn't as high as it once was.

What you can do about it:

Run at a "sub-threshold" pace 1-3 times weekly during an "endurance training" stage and occasionally during the faster training phases. "Threshold tempo" refers to the pace which, when *exceeded*, will cause you to experience a sharp upsurge in lactic acid production. This pace is actually slower than most runners realize. It can be estimated as the pace you could run for one

hour in an all-out, evenly-paced effort. After about 20 minutes at this pace, subtle changes (and often some not-so-subtle ones) take place in your breathing pattern, muscle fiber recruitment, and access of fuel sources. This makes running continuously for significantly longer than 20 minutes at *exactly* "threshold tempo" a less-than-optimal workout for maintaining or improving your ability to run using aerobic metabolism. If you slow the pace by 15-20 seconds per mile, however, you can accumulate up to an hour of running time which works almost exclusively on your ability to maintain a decent pace *aerobically*. This sub-threshold running is often referred to as "steady state" training, since no significant changes occur in your effort level at those speeds. Most runners will be exhaling once every six to eight steps while running in a steady state of effort. If you find yourself exhaling once every four or five steps, chances are you're going too fast for this type of workout. Staying in complete control allows you to spend enough time at a "high-end aerobic pace" to extend capillary beds.

Problem:

The ability for motor neurons to contract muscle fibers is compromised, meaning that you will never be as *fast* (sprint-wise) as you were in your teens and twenties. This decline in nervous system transmission is ultimately a result of reduced DNA replication.

What you can do about it:

From a *nutritional* perspective, eating one-third *less* than you did in your 20s will forestall the process of lowered DNA replication. Of course, this means that you must also keep your training volume somewhat in check (although running more does simulate eating less, so the more you run, the more you get to eat!). Obviously, eating *healthy foods* ensures you get the most from your food intake! You should also take a good multivitamin supplement with your meals, and (particularly in hot weather) a colloidal mineral supplement may prove useful, as many minerals are lost through sweat.

From a *training* perspective, *do something* about your speed! This ties in with the multi-tier training approach. Using shorter training cycles guarantees that you will always stay in touch with *some* faster running, even though it won't be quite as fast during a non-competitive season. It's a good policy, though, to add some light, relaxed strides or buildups to your daily runs 2-3 times per week even during a "long, slow distance" stage of your training. These pickups should never be *hard*; they should feel loose and smooth and should just be fast enough to provide some variety in your routine. Hills and drills also work different muscle fibers, maintain joint strength, and prevent boredom. Again, these should be fairly *easy* during the off-season. There's no need to go hard on all of your hill workouts; if you use the correct form, the hill will work the proper muscles even at a medium pace!

Problem:

Maximum heart rate (HR) decreases with age. This is also mainly due to a drop in nervous system transmission.

What you can do about it:

During an anaerobic training period (and possibly during the end of a pre-anaerobic phase, as well), push your HR up near its maximum by running at "VO_2max speed" one or two times per week. Another hard day during the week can perhaps be devoted to a "steady state" effort or a difficult anaerobic interval workout. VO_2max speed is roughly the speed or pace at which you could run for ten minutes in an all-out, evenly-paced exertion. If you run 3,200 meters in 10:00, for example (an excellent time for a master), your VO_2max pace would probably be right at 75 seconds per 400. The best results from training at VO_2max pace come by running 8-10 repeats of about 2 minutes each, with recovery jogs of just under 2 minutes. Time trials of 7-8 minutes at the same pace (virtually all-out for a workout atmosphere) are also effective training devices. Spending some time at VO_2max pace will slow down the rate at which your max HR declines over time. It also helps you maintain a high stroke volume (a principal determining factor in VO_2max), so that more O_2-carrying blood is pumped to your muscles with each heartbeat.

Problem:

Testosterone levels are lower (in men), resulting in fractionally lower hemoglobin and myoglobin levels, with a corresponding reduction in oxygen transport capability. Women will tend to slow down less later in life than will men, owing to the fact that their already low testosterone levels do not exhibit this sharp decrease.

What you can do about it:

Running hard, fast workouts regularly will keep your testosterone levels higher *provided* you don't run hard more than three times per week. Your body needs time to "absorb the training", as famed Australian coach Pat Clohessy says.

The best training procedures for stimulating androgen production in over-40 runners appear to be time trials of 2 minutes to 10 min. in length; in other words, *hard* short-distance to middle-distance running at VO_2max pace or faster. Tough anaerobic interval sessions (such as 8 x 400 at 3-5 seconds per lap faster than mile race pace, or 5 x 600 at mile race pace) and pure speedwork outings are also productive. Remember, though, that no single workout stands alone; a proper balance of hard work and recovery is necessary in order to maximize training effectiveness.

Problem:

Tissue repair capacity is lower. This is also mostly a result of lower androgen levels.

What you can do about it:

Since your ability to repair tissue is lower than it was in your 20s, your mileage levels will probably also be lower as a master. This is particularly true if you were a serious runner earlier in life and piled up 100 or more miles per week. It's very tough to do that much past age 40 and stay uninjured! The more volume you can tolerate, the better you will run (and the less you will have to rely on multi-tier training), but chances are you'll break down trying to train like a 20-year-old.

A healthy diet is as important as any training technique as far as injury prevention is

concerned. Avoid additives and refined sugars in particular, as these are the main culprits in connective tissue deterioration. Some supplements (such as glucosamine, fish oils, chondroitin sulfate, gelatin, and MSM) have helped many people retain cartilage and synovial fluid, thereby easing stress on joints.

Returning to the issue of training volume, remember that high mileage *days* are more important than high mileage *weeks*. Even for younger runners, high mileage blocks of three to five days provide ample stimulus to the aerobic system. We tend to operate on a *seven* day cycle, but that's not always necessary as far as running training goes! For example, you might build one of your higher training weeks around a Saturday long run by going very short on Friday and Sunday, then going higher on Monday through Thursday. A short, easy swim or bike workout could be substituted for running on Friday or Sunday or both. Where aerobic fitness is concerned, five high days out of seven are just about as good as seven out of seven, and the two low days can actually be somewhat therapeutic.

Running on soft surfaces (grass or trails) about 50% of the time is invaluable as an injury prevention measure. You don't want to do *all* of your training on soft surfaces; if you did, you would be more injury-prone if you began *racing* on the roads. However, the well-cushioned impact afforded by grass or trails certainly goes a long way toward preserving (or possibly increasing) joint integrity. You may have to go *slower* on a soft surface, but pace shouldn't be a concern on most easy runs, anyway, and your legs will probably thank you later for the off-road running!

Your easy days must usually be *extremely* easy to ensure full recovery. Don't do a hard workout (or a long run) unless you feel fresh; otherwise, you probably won't be going fast enough (relative to your comfort level) to achieve the desired results. Take a day off at any time if needed.

In summary, masters need a wide variety of training procedures year-round in order to prevent injury, maintain a high max HR, keep hormone levels up, preserve capillary density, reduce boredom, and retain speed. The 40-and-up crowd appears to benefit most from an 8-12 week training cycle which features a 3-4 week stint of extremely *hard* training 2-3 times weekly (with particularly easy recovery days). Varying the running terrain is helpful, especially during a slower stage of training. Taking time off occasionally (or cross-training) can also be crucial to allow for optimal recovery. A healthy diet is essential as well in order to keep feeling young and to have a long, enjoyable running career.

****
****

****
****

Appendix C: The Training Wisdom of John Kellogg

****
****

[This is a collection of posts made by John Kellogg on the old Letsrun.com message board. They were collected and organized by Tim Galebach (CarolinaRunner), a 2007 graduate and runner for Harvard University]

Page compiled by Tim Galebach (galebach at fas dot harvard dot edu)
I apologize in advance for any formatting mistakes

John Kellogg Training Advice

Posted on Letsrun by Carolina Runner on 8/9/2003

6-Month Cycles

The human body operates very nicely on a 6 month cycle, since it take about 20 weeks to go through the base phase (10-12 weeks), transition phase (4-6 weeks) and peaking phase (4-ish weeks), then you can hold your peak for 4-6 weeks before condition starts to deteriorate. I'd recommend only trying to hold a peak for 4 weeks, then taking a week off and having another week of very short runs (light jogging). Peaking twice per year will also prevent boredom, allow you to develop better, and allow you to run some

good X-C races and track races. Don't do Summer track, though (unless you missed all or most of the Spring season) - that requires you to keep the anaerobic stuff going too long and it doesn't give you enough time to lay a base for the Fall.

Buildups/Strides/Maintenance

They are done to stay in touch with quicker turnover and to help retain mechanical efficiency and relaxation at moderately fast speeds. In order to IMPROVE speed, you have to generate a bit more power. The way I'd recommend going about this is to start with SHORT (7-10 secs.) reps at as fast a speed as possible without sacrificing form. Of course, you need a thorough warmup (including several progressively faster buildups or accelerations) prior to starting this type of session. Then try 2 sets of 2 x 50m extremely fast (use a running start to avoid pulling anything). Take 1 min. rest between reps within a set and 8 min. rest between sets. This protocol will use only creatine phosphate and will not invoke the "lactate system". At first, you will have to concentrate to keep from flailing about form-wise. But the distances are so short that you can easily hold form throughout. You'll need 8 min. between sets to replenish your creatine phosphate. Do this during a week when there is no scheduled race. After a few of workouts of this nature, you should be ready to launch into the more standard workouts involving 150s or 200s. When doing these to IMPROVE speed, you need nearly FULL recovery between reps. Starting with 2-3 reps of 20-35 secs. is fine, and you can progress to a FEW more reps in the fashion you've outlined OR you can use a slightly different protocol that I prefer for longer distance specialists (I might get into that sometime). Doing no more than 5 reps of 200m (as you've outlined) seems pretty sound. At some point right about there, it starts getting pretty risky to keep increasing the number of reps. The creatine phosphate becomes depleted, the session becomes way too dependent on anaerobic glycolysis, and injury risk goes up sharply (not to mention the fact that mechanical effiencey is sacrificed.

Lethal Combination of Mileage And Intensity

The best method for high school boys is one which EXPOSES them to short blocks of high mileage (progressively higher from year to year) but drops the weekly mileage down substantially (perhaps as low as 50-65 mpw, depending on age and experience) during the competitive seasons. The mileage in the high blocks can certainly reach over 100 per week (obviously, this has to be worked up to over a number of years) without ANY risk of future "burnout" - as long as an increase in mileage is accompanied by a general reduction in intensity. High mileage itself is NOT a problem. CONTINUAL high mileage (i.e., 100+ miles per week for 5 months) usually does present a problem, and this often stems from harder training being introduced without a corresponding reduction in mileage. Repeat: It is BENEFICIAL to a young runner's future to INTELLIGENTLY push the boundaries out mileage-wise. It is a grave mistake to push the mileage way up and KEEP it up there too long. It is a bigger mistake to FORCE the intensity up (regardless of mileage) from week to week (or from year to year) when the athlete has already reached a "peak" or anaerobic limit (this includes overracing, and it is this - not high mileage - that ruins most high school and college runners). It is a bigger mistake STILL to push the mileage up AND add lots of

hard training. The blame lies either with the ignorance of the coach or with the impatience of the athlete. Case in point: Webb appears rather impatient at this point and seems to be someone who would hammer himself to oblivion on a high mileage regime. Even if the prescribed training was sound, he would probably bypass the intended PURPOSE of the workouts and would challenge the stopwatch on every scheduled hard day (and might go too fast on easy days) in an attempt to FORCE his way to a 3:45 mile in the next few months. This is not to single him out; most other teenagers would do - and have done - the same thing, only they aren't in the spotlight and their training and patience aren't questioned by all the "Monday morning quarterbacks". The core problem here is a society-imposed quick fix mentality among young athletes.

Every day's workout has (or should have) a purpose. So does every SEASON'S structure. People need to be taught to relax, relax, relax when necessary, even if that means running so easy that they don't THINK it's doing them any good. A well-placed easy "shake-out" run is just as important a training tool as a 10 mile run at the high end of aerobic effort, and it's likely MORE important than 10 stomach-knotting quarters. Easy runs (and a predominantly "easy attitude" during the preseasons) are absolutely vital training devices. It's up to the coach to schedule easy runs in appropriate places, and it's up to the athlete to execute these runs PROPERLY. High school or college "programs" that have week after week of two hard track workouts sandwiching a tempo run stem from ignorance of basic distance running principles. A more mature and experienced runner might be able to get away with three successive days of track-tempo-track every once in awhile, but for a younger runner, it's just pulling a stupid stunt to do such a thing on a regular basis. The payoff, if any, from doing so is short-lived. Runners MUST have proper recovery. They must also learn how to periodize properly, and periodization must be more pronounced for high school and college runners, since they have not yet reached full maturity as endurance athletes.

Regular Long Runs of 2 hours +- a bit

You should be running a substantial portion of many of your long runs at a pace which gives you a "full of run" feeling - strong and floating in the middle and well-trained but not strained by the end. You should also gradually pick up the pace during the last few miles of the run (but avoid STRUGGLING). This is what trains you to be able to use FT fibers at the correct time in a race (as the ST ones start to run low on fuels). It also provides the stimulus needed for your muscle fibers to store the right balance of fat and carbs. Start with picking up the pace on regular "easy" long runs at about 1-2 miles from the finish, then get to where you can comfortably do it from about 5-7 miles out.

If you're already well-trained (i.e., you've worked your way up to regular high mileage) and you run at this high-end, "train don't strain" pace, you'll usually start to recruit your FT units after about 110-115 min. You'll also have to ventilate more as a result of a gradual increase in the CO_2 content of the residual volume of air in your lungs. This will train your respiratory muscles, particularly if you're gradually increasing the speed over the last several minutes.

You have to balance stimulation with adaptation or you'll go over the edge (remember, it shouldn't all be just a bunch of JOGGING on these things). Running longer than 125 min. seems to require too much recovery time to be effective as a WEEKLY long run. So I think Snell and Co. found the right distances for their long runs (20-22 miles) since they were reportedly running 5:40-6:00 per mile on most of these outings. Frank Shorter always advocating running 2 hrs. or 20 miles (whichever came first) and to go at a

"comfortably fast" pace. Sound advice there.
Most of the above applies as much to track specialists as it does to roadies. A serious MARATHONER might run an overdistance run once or twice during a buildup and should certainly have two or three "dress rehearsals" in the form of moderately long runs (15-18 miles - maybe even 20 miles for an elite) at target pace, but that, as we say in Texas, is a whole 'nuther story.

Improving VO2Max

Because O2 uptake is influenced by so many factors, you really need the FULL SPECTRUM of training devises in order to maximize it. Of course, we know that VO2max is not always the determining factor in running performance, but a high value is generally an advantage.
A diet of high mileage during a base-building stage (with some of it at or near the lactate threshold) will extend capillary beds and increase the number and size of muscle mitochondria. This will improve the O2 delivery system and the ability for the muscles to actually produce energy aerobically. It is also desirable during a base phase to touch on short speed a couple of times per week and to OCCASIONALLY (once every 2-3 weeks) reach near-maximum heart rate via sessions such as 10-20 x 1 min. on/1 min. off at a comfortably hard effort (or by adding a 2-7 min. time trial at 90%-95% effort following sets of strides). This will maintain both neuromuscular efficiency and a fairly high stroke volume. Maximum stroke volume is highly related to VO2max, so some specific workouts which work on this need to be used during the regular season.
I'd recommend determining the pace you could run for 10 minutes in an all-out, evenly-paced effort (for most serious runners, this will be between 3,000m race pace and 5,000m race pace) and using this pace as a baseline for training at maximal O2 uptake. This pace is often called "velocity at VO2max" (vVO2max). A good formula for figuring it is (vVO2max in seconds per 400m) = 0.07 x (5,000m race time in seconds) + 6.9. For a runner with a 5,000m best of 15:00 (900 seconds), the formula yields a vVO2max of 69.9 seconds per 400m. Of course, the value will vary slightly from day to day, since you cannot ALWAYS expect to be able to equal your 5,000m PR every time you head out for a workout or a race. It is therefore most important that you learn to run BY FEEL rather than being a slave to a stopwatch (or a HRM or any other device).
It takes about 4 minutes to reach your actual VO2max if you begin running at vVO2max from a dead start (near resting HR), but you can achieve VO2max repeatedly (and elicit maximum stroke volume) during repetition running. The best results come from spending 15-20 min. total time at this pace, divided into 2-4 min. bouts, with rest periods slightly shorter than the run periods. For example, a 15:00 5,000m runner might run 7-8 x 800m in 2:20-ish with active rest periods of 2:00-2:20. It is best to keep the run distances (or durations) pretty constant during the workout (i.e., use all 800s or all 1,200s rather than using "ladders" or "step-downs"). This trains you to monitor effort better and to mount rising fatigue with additional effort in a more LINEAR fashion. It is also desirable to vary the distances used each time you do a session such as this, so as to provide variety in cadence and rhythm and to prevent obsessive comparison of times from previous workouts (which leads to forcing too fast a pace too early in the workout). So if you ran 8-10 x 2 min. one week, you might switch to 5 x 4 min. the next week and 6 x 3 min. the following week. You can also occasionally use shorter distances at faster than vVO2max (such as 12-15 x 1 min. with a minute or less rest) or longer distances (e.g., 5 x 1,600m) at a somewhat slower

pace with shorter rest periods (60%-75% of the run periods). This practice recruits different motor units while still taxing the same basic systems (i.e., strengthening the heart and respiratory muscles) and provides variety in the routine. It's important to combine these VO2max workouts with other training in a sensible fashion (based on fatigue, weather, recent race efforts, or upcoming races).

Do it by Feel at First

Here's the preseason stuff I posted awhile back. Just make sure you cover the major bases - spend some time at the high end of aerobic effort at least twice per week, stay in touch with some strides or reduced-intensity repeats (keep these aerobically challenging but never tie up in the preseason!), run some in hills from time to time, vary your running surfaces (grass, road, trails, track), etc.
4-8 WEEKS EARLY PRESEASON:
2-4 days per week - Progression runs (no pace parameters yet - start slow, gradually and spontaneously increase speed to the high end of aerobic effort and stay there from 30-65 min., with a faster finish if feeling strong)
1-2 days per week - Sets of buildups or strides (ex.: 2-3 sets of 5-6 x 15-40 secs., jogging equal distance between reps and jogging 5-10 min. between sets - always do buildups, strides, and drills WITH the wind, if any) + drills and/or hills on occasion + 2-8 min. @ 90% effort (following last set of strides) every 2 weeks
1 day every 2 weeks - Long easy run (getting longer each time, last 1-3 miles gradually faster if feeling good)
Phase in doubles 1-2 times per week for 2 weeks, 3-4 times per week for 2 weeks, 4-6 times per week after that
4 WEEKS LATE PRESEASON:
The basic outline below totals 65-80 miles for a week at MINIMUM (depending on average training pace) and totals 125-150 miles at MAXIMUM (depending on pace).
Sun. A.M. 0-35 min. very easy ("shake-out" or "super-O2" pace) / P.M. 30-95 min. easy (normal comfortable pace)
Mon. A.M. 35-50 min. very easy / P.M. Progression run (spending 30-65 min. at a high end of aerobic effort) OR Tempo run with 20-25 min. at LT effort OR High Density LT repeats (ex.: 8-15 x 3-4 min with 30-60 secs. rest periods)
Tue. A.M. 35-50 min. very easy / P.M. 35-95 min. easy
Wed. A.M. 35-50 min. very easy / P.M. Progression run (spending 30-65 min. at a high end of aerobic effort) OR High Density LT repeats (ex.: 15-25 x 60-90 secs. with 20-25 secs. rest periods) OR Sets of strides OR Lower Density short LT repeats (ex.: 12-20 x 45-90 secs. at roughly current controlled 3,000m Time Trial pace with nearly equal rest-to-run ratios)
Thu. A.M. 35-50 min. very easy / P.M. 35-95 min. easy
Fri. A.M. 0-35 min. very easy / P.M. 35-65 min. easy with 4-10 strides near the end
Sat. 125-155 min. easy with last 10-20 min. gradually faster if feeling good OR 95-125 min. with last 30-60 min. picked up to a strong high-end pace OR A.M. 30-35 min. very easy / P.M. Long warmup (25-35 min.), CONTROLLED (deliberately slow start) Time Trial of 3,000m-8,000m - designed to determine critical training speeds and make adjustments (60-65 min. total)

****
As you see, this includes alactic speed maintenance and retains a small middle distance component (if you do it right) throughout the whole preseason. Drills and hills cover the "plyos" base. Most of the running is indeed easy, but this is assuming the runner is trying to build up mileage to perhaps new levels.

More Buildup Stuff

"... a patient buildup consisting of a diet of long runs, long controlled repetitions with short recoveries, and fast sustained tempo runs of six to 10 miles. This was coupled with appropriate speed and speed endurance workouts as the competitive season approached. No magic formula, just patience and consistency."
That's what it all about. Run more and concentrate on longer aerobic endurance workouts. If you're a natural middle distance type (as opposed to a pure distance type), it'll probably (but not always) require a longer time frame to reap the rewards from patient aerobic training. Do SOMETHING about your short speed year-round, but only have a 6-8 week period out of every six months in which you hammer yourself with tough anaerobic training.
"We do only two workouts per week, a workout and a tempo run, or a workout and a race. This way the workouts are of a high quality of volume with time allowed for recovery. This formula, I believe, works best for most athletes. Very few are capable of three workouts per week that would be of sufficient quality. Indeed, I suggest to British athletes who are doing three workouts per week and not progressing, that they are probably working too hard and not recovering. There are, of course, exceptions; but they are few and far between."
Agree on all points. At least half of the training weeks should only have two hard workout days. Exceptions may occur if the fast-paced sessions are of the "progression run" nature, in which a near-best aerobic pace can be hit several times per week, but these runs must be spontaneous and they must begin at a STUMBLING-slow pace. And the runner must have the discipline and experience to know PRECISELY where the "threshold" occurs. But there's no secret workout - and exceeeding your LT too often will backfire. Instead, it's a day-after-day training load (mileage) at easy to medium speeds with JUDICIOUSLY SPACED and PERTINENT hard workouts that forms the recipe for long term success.
"No individual workout assumes vital importance. Rather, the workout is in the context of the week and the week in the context of the month. You need to recover from the workout with no great carry over. Have confidence in the system you have chosen and give it time to produce results. When track aficionados look at the finishing speed (that is, 25/26 seconds for the last 200m of a Haile Gebrselassie, Ben Limo or Charles Kamathi at the end of a distance race) they may view speed as the definitive answer to performance. We would beg to differ and infer what wonderful basic conditioning they have that allows them to utilise that speed at the end of a race. It is this level of conditioning the western athlete must seek to achieve."
Couldn't have put it better.
Though it's not THE SECRET workout, I particularly like this conditioning session:
"... 10 x 3 mintutes (with one minute recovery)."
This is a LT workout that has tremendous benefits in concert with a high mileage base. I usually prescribe 10 x 3 min. with 30-60 secs. rest periods. The idea is to hit the highest end of aerobic effort for the early

reps (maybe cross the threshold a little at the tail end of some of the latter reps) and rest only long enough to feel ready to go again. The best results come from resting about 35-40 secs., but anything in the 30-60 secs. range is adequate, and of course the recovery duration depends on the speed achieved. The feeling should be similar to that of a good, strong continuous run, but the pace will be faster because of the short rest periods. While I consider this a staple session (i.e., done at least once per month), as mentioned, no workout stands alone as a magic bullet. You have to cover all your bases.

"Total weekly mileage in this period (conditioning phase) averages between 100-110 miles per week, most of which is run at a moderate to easy pace. Only one race is scheduled at around the ninth week to check on progression."

I'd put weeks of 120+ miles in the conditioning phase (maybe even over 150), as long as the athlete is mature and experienced. This additional "safe aerobic pressure", combined with the work on strenthening sheer "gristle", tends to enable better quality training to occur at somewhat lower mileage loads (90-110 mpw). It looks like most African track specialists train best at 100-110 mpw, but the mzungu NEEDS injections of additional mileage in order to attain the same aerobic fitness. Whether this is genetic or a result of a lifetime aerobic base (or both) is not known for sure, but African runners can thrive on moderate mileage with a higher intensity than most mzungus can tolerate.

Hill Training Phase

Hill running should be something you do MOST of the year, with varying degrees of attention assigned to it during different stages of training.

At the BEGINNING of a base stage, you should run routes 2-3 times per week that have gently rolling hills ranging from 20 seconds to 3 minutes in length on the uphills. The downhills should not be so steep as to cause jarring. If you're on the "dreadmill", you can't get those downhills, which is a bit of a disadvantage. Running both up AND down hills improves your aerobic conditioning, even when running fairly slowly. On the mill, try using grades which are between 5% and 10% and run them for 20 secs. to 2 min. at a time (restrict the grade on the 2 min. runs to a 5% grade). You can adjust the speed to a slower pace on the uphills. Concentrate on keeping the hips FORWARD rather than leaning into the hill. Using this form, you don't have to run FAST at all to get the proper workout. When you lower the platform, go all the way down to a 0% grade for a few minutes. This will minimize risk of Achilles tendon trouble. If you're outdoors, you can safely find uphills that are 3 min. long, since you have the opportunity to run down the hill afterward.

Another excellent way to improve your hill running is by biking uphill while standing up on the pedals. This works your quads in a no-impact fashion and does everything which will improve your hill running EXCEPT develop ankle integrity and power. Hence, you do need the actual RUNNING on hills to improve to the max!

In the MIDDLE of a base phase, you need to incorporate some strides and form drills twice per week on a flat field. Things like high knees, quick steps, skips, etc. will prepare you for hill drills, which are very effective for all aspects of running. Near the END of the base stage, the flat-surface drills can be phased out and hill drills such as bounding, springing, and one foot hops can be brought in. It's nearly impossible to do these effectively on the mill, so you're out of luck trying to develop a truly explosive foot strike indoors!

In a pre-competition stage, switch from level-surface strides to uphill strides for form (hips forward, butt underneath torso). These should be 20-30 secs. in length and somewhat faster than an easy pace, although not sprinting.
Actual WORKOUTS on hills - done during the late pre-competition phase or the early competition phase - include:
1.) 8-10 x 55-60 secs. up a 3% to 5% grade at the speed you could run for about 1.5 miles in an all-out race effort. Jog down slowly for recovery periods (or jog about 90 secs. on the mill at a 0% grade).
2.) 10-15 x 12-15 secs. up a 5% to 6% grade at a faster speed, jogging down slowly for recovery. It's tough to do this on the mill, since the time it takes for the platform to lower to 0% and get back up to a steeper grade is TOO LONG a rest period (not to mention having to wait for the SPEED to get slower and then increase again). You COOOUULD just jump off the belt and jog around the room for 30 secs., then jump back on, but ... I didn't think so. Better do this outside.
3.) 8-10 x 45-50 secs. DOWN a 2% to 3% grade at about 800m race pace (or a little slower), jogging back up between each rep. Can't do this on an ordinary mill, though. Best to be accustomed to easier-paced downhill running before doing this, or your shins and lower back will suffer.

There HAS Been One Missing Component in the US

The ingredients for making the most out of your talent are consistency, high mileage with a focus on high-end aerobic running, a proper transition to hard track training, a limited amount of VERY HARD training, and an overpowering desire to MAKE yourself into the runner you want to be.
When you DO train intensely (and when you race), you must be willing to REALLY HURT BAD to achieve your goals. I mean go to the sludge at the bottom of the well. However, I've seen numerous elite runners (most from the 1970s) do this kind of hard training and can say with no hesitation that I've also witnessed countless high school nobodys who have trained every bit as hard relative to their own fitness levels as any elite runner I've ever seen. The difference is that the HSers don't HAVE much fitness either because they simply have less natural aerobic capacity or (more often) because they spend MOST of their time doing the hard track training and they ignore the base work and transition work.
The "secret" you're looking for is the high-volume, high-end aerobic base training. Without that, you won't ever reach your personal summit. You may be so gifted that you still turn out awesome compared to most others, but you won't be the BEST you COULD be. For over a decade, Americans wanted dearly to believe that they could skip the foundation work and hammer themselves into greatness. Why? Probably because a quick fix is more alluring. But the experiment resulted in FAILURE. Dramatic, obvious, measurable-by-the-stopwatch FAILURE.
We're doing a bit better during the last few years, but MOST Americans still don't get it. They need to forget the "horses for courses" training LIE and start training like REAL DISTANCE runners. Once they set the base over first months, then years, THEN they can spend more time on the specialized training which they have found by trial and error to benefit their racing most.
Lydiard said, "Miles make champions." Runners aren't physically any different today than they were 40 years ago, so that fundamental principle still applies. Toshihiko Seko's coach, Kyoshi Nakamura, likened correct training to the steady fall of raindrops which slowly forges a hole in a rock. Some days the rain falls harder and some days it doesn't fall at all, but the process cannot be HURRIED. There is the "secret"

of training. I once wrote that even a football player can train himself to run 10 balls-out quarters, but still won't be in SHAPE. Being in shape means having the aerobic power to run CONTINUOUSLY for 5 miles or 10 miles at a very high percentage of top speed. Any intense training that can be done WITHOUT that kind of basic fitness can be done AFTER that fitness is acquired - and it can be done MORE EFFECTIVELY.

Well, there's another rant. Pertaining to the PSYCHOLOGICAL characteristics of elites, one trait that's shared by most of the best is that they can stay relaxed and confident going into a race, yet can maintain total focus throughout the race itself. Being able to lock into a "competitive zone" and place winning over ANYTHING else is a hallmark of all champions.

Speedwork

Running buildups SLOWER than all-out is meant to foster mechanical efficiency and relaxation. This will ULTIMATELY help with top-end speed by virtue of recruiting the motor units in the most economical fashion. Buildups are smooth accelerations which are designed to preserve a good deal of your creatine phosphate (quick energy). This way, you can do an adequate number of repetitions to promote neuromuscular reinforcement, but without form breakdown or risk of injury. And when doing sets of buildups, the first few in each set should be the slowest (i.e., you should not accelerate to as high a speed at the end of your first few reps in each set). But a couple of the latter reps in each set can involve an acceleration to FLAT-OUT speed (for about 20-30 meters). If you do these things correctly, you'll warm up gradually and enlist a wide variety of muscle fibers without any lactate accumulation and without exhausting your creatine phosphate reserves.

Even-speed strides (up to about 35 seconds) should follow the same format - the slowest ones are done at the beginning of the first set so you'll warm up properly and can set a precedent for running relaxed and with decent form throughout the remainder of the workout.

Bursts of 7-10 seconds should normally be done after FAST buildups and strides have become a COMFORTABLE part of the routine, and a few weeks prior to lactate-intensive (anaerobic tolerance) training. They shouldn't be used year-round. Buildups and strides (even fairly fast ones) CAN be done year-round.

It's important for a distance runner to focus on distance running; therefore, only a minor to moderate emphasis needs to be placed on the kind of workouts which attack 100m-400m speed. Stay in touch with SOME speed even during base training so it will be there for you when you begin race pace repetition running later. Only spend 3-4 weeks on honing your all-out speed. PRACTICE kicking HARD at the end of your races. Train in this fashion whether your primary event is 1,500m or 10,000m.

Intense Intervals and Burnout

A PROPER amount of pure speed training is GOOD for a young runner. A LIMITED amount of fast 300m-1,000m repetitions is also necessary for ideal development. But it's all too easy to overdo those intense middle distance repeats - the ones which invoke the "lactate system" (yes, you can do too much of the pure speed variety, too). The sad thing is that young runners recover quickly enough from highly intense lactate tolerance work and can repeat it often enough that the problems with it don't manifest

themselves for several YEARS.
This isn't BS; it comes from frustrating observation of SCADS of careers which started out promising and ended up on the jagged rocks of burnout. I've seen hundreds of HSers hit the track HARD and show excellent AGE GROUP results only to stall out or regress later. Often, they give up on the sport as other runners pass them by. Some continue to run road races recreationally, but they never fulfill their talent. Look, if you run 4:15 for 1,600 in HS and don't flirt with 14:00 for 5,000 as an all-time PR, you probably did something WRONG somewhere along the way. And from what I've seen, it's MOST LIKELY the wrongdoing occurred in the early to middle teenage years. There's no excuse for so many 4:15 HS milers running in the 15:30 range for road 5Ks while they're still in their mid-20s! A large proportion of these guys should be bordering on - if not making - national class. But all too often, recreational status is where these guys find themselves firmly entrenched by the age of 25 - if they're still running at all. Sad.

60-ish is Moderate Mileage for HSers, etc.

Moderate mileage - even HIGH mileage - is not incompatible with working on top-end speed.
As long as most of the speedwork is alactic and as long as relaxation is stressed, MAINTENANCE can be done year-round. Even short bursts designed to IMPROVE pure speed can be incorporated in the weeks immediately prior to traditional interval training, so the runner feels capable of running efficiently at the race-specific speeds that will be used during interval training.
Per INTENSE interval training, it only takes a few weeks to maximize the training effects of workouts designed to help you buffer or reuse lactate. This doesn't stem from theory; it comes from trial and error. I don't know how much of this Webb did throughout HS, so I can't make any comment on it. Obviously, he did what was necessary to become the fastest U.S. HS miler of all time, destroying a record I thought would not be broken in my lifetime. Bottom line: If he relied on a lot of intense middle-distance (300m-1,000m) interval training, he sacrificed some degree of future development for his HS career. Not that that's particularly BAD - we NEEDED a guy like him to come along - and he WILL be a major force even if he doesn't improve at all. If he kept that high intensity running to a reasonable quantity during HS, he will likely turn out to be the best miler this country has ever produced - and a strong candidate for major championship medals.
As far as mileage goes, higher base mileage with more relaxed high-end aerobic running FOLLOWED by moderate mileage with higher (gulp) "quality" is better than year-round moderate mileage with moderate to high intensity, and it is better for every event which lasts longer than about 3 minutes. It's even best for most 800m runners who wish to run several fast rounds in a 2- to 3-day period (as in a global championship). The best way to prepare runners for high mileage base training is to EXPOSE them to short periods of progressively higher mileage when young. How much mileage are we talking about? It all depends on the individual. As much as is necessary to "push the boundaries out". For Webb, 63 miles might have been that mileage level. For Ritzenhein, it might have been a 90-mile week. In general, runners who are suited to short- or middle-distance events require more time to develop the aerobic component; that is, they may need 5 or more years to achieve a mileage level that a natural distance runner could reach in 2 years. Bottom line on this: Anything you can do without a high mileage base (or a lifetime base) can be ADDED ON TOP OF a strong base, and the rewards will be ENHANCED.
Regarding the components of speed which can and cannot be trained, the ability for a motor neuron to contract a muscle cell and recover for successive contractions is something which CANNOT be trained.

So there is a distinct limit to how fast somebody can become (duh!). But neuromuscular PATTERNS (muscles working in concert) CAN be made more efficient (and therefore QUICKER). Power can also be increased through training.
But traditional weightlifting (which, in theory, will increase explosive power) actually can be COUNTERPRODUCTIVE, since the movements do not transfer to the act of running.
I will take some excerpts from the following article:
Sale, D., &q MacDougall, D. (1981). Specificity in strength training: A review for the coach and athlete. Canadian Journal of Applied Sport Sciences, 6, 87-92.
You can find the article in its entirety at:
http://rohan.sdsu.edu/dept/coachsci/vol21/sale.htm
Pay attention to the following passages:
"Mix fast movements to train the nervous system (movement patterns) and slow to train the muscle structures. The difficulty is to have the training movement patterns replicate those of the contest activity."
"The type of contraction must duplicate that of an event to have carry-over value. To stimulate muscle growth, eccentric contractions have a greater potential for effect than concentric contractions."
"Eccentric training is the primary stimulus in plyometric or 'rebound' training."
"1.) Strength training should be as specific as possible. The movement pattern and contraction speed, type, and force should replicate the intended activity. Any departure from one of these factors will result in inappropriate adaptations.
2.) High-velocity sports may need supplemental low-velocity training to induce maximal adaptation within the muscles.
3.) Supplementary maximal training may be beneficial because it stimulates maximal adaptation. However, that adaptation should be achieved before serious technique work begins.
4.) Non-specific training has a high probability of being counter-productive. 5.) There is no evidence to support the 're-education of strength gains' hypothesis."
The "re-education of strength gains" refers to the erroneous notion that strengthening muscle groups alone is sufficient and can be "re-educated", or carried over into sport-specific requirements.
As you can probably deduce, the best form of resistance training for improving running performance involves predominantly eccentric activity which most closely resembles the running motion (or, at the least, several specific COMPONENTS of the running motion). The drills and speed maintenance workouts that I suggest meet these requirements. The resistance aspect comes from working the body weight against gravity (i.e., step-ups, hill bounding, one foot hill hops, and normal hill running). The "fast movements" aspect comes from quick steps and from progressively faster buildups and short strides (with attention continually paid to relaxation and economy of movement). An "exaggerated range of motion" aspect comes from lunges, high knees, kick-outs, and skips.
There is no need for most healthy young runners to lift weights. Only in cases of glaring weakness or during injury rehab would I recommend traditional weightlifting for young runners. Older runners are a different story, since they may need to burn fat in more muscle groups and may need to stimulate androgen production. As the article indicates, GENERAL muscle development does not mean jack unless it carries over to the movements used in the sport you're training for. In fact, it may be detrimental.
So what does this mean for REALLY FAST people (like Webb) who have lifted weights as part of their training? It means that it was their RUNNING (or hills and drills which transfer to running mechanics) which was responsible for their improvements - NOT the weightlifting. Many people might take exception to that, but that's the way it is. If you WANT to lift weights for GENERAL muscular strength,

go ahead, but remember that you can easily make it counterproductive if you FOCUS on that and not on your running.
Well, there's a long rant for you.

Speedwork for Distance Runners

Always include relaxed buildups, strides, and hills (and possibly drills) in your routine, even during base training. Buildups or strides should be EMPHASIZED 1-2 times per week, and they should also be done before and after many high-end aerobic workouts. If you're at altitude above 8,000 ft. and can't get to sea-level, you need to do some of these "quickies" nearly every day. As the competitive season approaches, these buildups and strides can be run with a little more determination (i.e., WORK on your speed, as opposed to merely "staying in touch" with it). Every now and then, include a time trial of 2-7 minutes at 90%-95% effort after your buildups (this keeps a small middle-distance component in your base work). Another middle distance workout consisting of structured Fartlek (repeats of 1-3 min. at a fairly fast but still predominantly aerobic pace) can be substituted for a workout of strides once every 2-3 weeks.
Anyway, SPEEDWORK. Assuming you've been doing the above speed maintenance stuff, you might start your PURE SPRINT work with 2 sets of (2 x 7-10 secs.) nearly flat-out. Get a running start before you blast the 7-10 secs. portions. Take about 1 min. walking rest between the two reps in a set and take 8 min. walking rest between sets. That's basically the whole workout right there (not counting a thorough warmup and a short cool-down).
The second time you try this workout (about 10 days later), increase the number of reps in each set to 3
The next sprint workout (another 7-10 days later) can be along the lines of 4 x 150m at 98% effort, with 1 min. walking rest between each.
From there, proceed to 3 x 300m at 98%-100% effort with rest periods of about 3-4 min. of walking.
The next sprint workout is 2 sets of 2 x 400m at 95%-98% effort, with only about 1 min. between reps and full recovery (nearly 10 min.) between sets. You may have to jog a little or do a few "high knees" steps prior to the start of the second set to feel like you're ready to go again.
If you survive those workouts, you ought to run a time trial of 700m full-blast (start out very fast, only pacing yourself a tiny bit) about 5 days after the 2 x (2 x 400m) workout (include another hard but lower-intensity workout in between those two). About 2 days later, run a time trial of 1,000m. Again, get out FAST on this thing.
It's tricky sometimes to fit in other key workouts and races while doing this really fast stuff. You don't know for sure if you'll get sore from sprints like these; nor do you know how LONG you'll be sore. But if your schedule allows, these workouts can fortify your "quick energy" systems (creatine phosphate) and can enable you to buffer (and reuse) lactate better during races of all distances.

Some Tempos on Road, Grass, and Track

Doing tempo runs on grass and/or hilly terrain will obviously result in a somewhat slower pace than you would achieve on the track or on a flat road course. But workouts are not races, and PACE can therefore sometimes take a back seat to EFFORT on fast aerobic runs, so high-end running (relaxed the whole time) and/or tempo running (on the edge the whole time) should certainly be done in order to get full

development. If you fit in the right balance of varied-terrain running, you'll feel light and smooth during cross races and hilly road races. You'll also be able to insert some "invisible hills" (pace changes) in flat track races.
Having said that, you should use ALL surfaces (if possible) for "threshold" training, so as to achieve a variety of speeds. This is sort of the same principle that's behind using continuous runs AND interval training for LT (AT) work. You don't HAVE to run continuously at your "one hour race pace" for 20+ minutes to do LT training. You can accumulate 40 minutes at a marginally FASTER pace by taking very short (30-60 seconds) rests between bouts of 3-4 minutes. You can also stay 10-15 seconds per mile SLOWER than "one hour race pace" and run for a full hour without appreciable discomfort. Or you can run 20 x 1 minute at close to 10,000m race pace and take less than 30 seconds rest periods, yet still train the same systems.
Running at least a portion of some tempo runs on the track promotes consistency in footstrikes and a good sense of rhythm. The way I like to do this sort of run is to have a loop of about 2-3 miles right next to an easily-accessible track (no fences or gates). Start with 6-8 laps on the track in the clockwise (reverse of normal) direction and find your groove after about a mile by squeezing the pace down from the slow side, checking the splits for a few more laps (to see if you're locked into the right pace).
Head out to the road course for a loop, then come back to the track and finish in the counterclockwise (normal) direction with about 6 more laps. The first few laps can be used to check if your pace stayed consistent (in case your road loop is not measured). Gradually work the last couple of laps down to a fast finish.
Starting on the slow side in the CLOCKWISE direction prevents overdevelopment in certain leg muscles (or overstressing tendons) which would occur if you exclusively ran counterclockwise ALL the time. I never recommend running anything FASTER than a threshold speed in the clockwise direction, though. Do all of your faster track running in the normal direction to develop the lower leg strength and stability needed for track racing.

Weights

The MAIN PURPOSE of lifting weights is to BUILD lean muscle tissue, and that's also the most common OUTCOME of lifting. Ask yourself if you need to have the musculature of a wrestler (freestyle, that is - not WWF) or that of a RUNNER!
We've learned through the decades that ALL of the muscle contractile properties needed for running can be developed with drills which involve body weight vs. gravity (or exaggerated motion), hill work, and (surprise) running. Barbells, dumbbells and machines are not needed except in special cases. Neither is upper body work.
Those special cases are:
1.) Rehab following injury - This is pretty self-explanatory. If you can't support your own weight (due to injury or atrophy), you'll obviously need some other form of weightlifting (machines or free weights) in order to rehab.
2.) Injury prevention - I include this ONLY if you have an obvious structural weakness which causes chronic imbalance or discomfort or injury. In that case, you MAY need some progressive weight training (example: internal hip rotators). "Body weight vs. gravity" exercises (such as pushups, pullups, ab rollers, dips, toe raising/lowering, step-ups, etc.) are preferable to standard forms of weightlifting, since they

involve more core muscle groups and/or stress BALANCE. Be sure to work the same muscles on BOTH sides of the body (to prevent imbalance) AND work the agonists and antagonists (e.g., quads and hams) of the areas you're targeting. Also lower the weight SLOWLY so as to work the "eccentric" phase. It's these eccentric movements that usually contribute to DOMS (and possible injuries), since fewer muscle units are being used during the lowering phase and that's where people are weakest. This is why you might have read that you should LOWER your body weight in a "reverse toe raise" to strengthen your Achilles tendons (if you do this exercise, remember to keep the knee straight on some reps and bent on other reps, since the gastroc and the soleus work in concert when running).

3.) Extremely poor muscular development - Well, I suppose by BRUTAL'S standards we distance runners are ALL complete wimps in the muscular strength department! Realistically, though, there aren't too many SERIOUS runners (those who can run numerous 100-mile weeks without snapping into pieces) who are so frail that they're unhealthy. They may LOOK frail and unhealthy, but some of these twigs are sub-13:00 5,000m runners. And they DON'T lift weights! To repeat: Ask yourself if you want the musculature of a wrestler or that of a RUNNER!

4.) Aging - If you're past your prime racing years (somewhere around age 35, give or take a few years), you might benefit from weightlifting by virtue of burning fat (post-exercise) in a wide variety of muscle groups. If you can train (running-wise) like a 20-year-old (read: high mileage), you probably don't need very much weight training, but it does get a lot tougher to keep the body fat low as you get older. Again, "body weight" exercises are best in most cases.

Workout Suggestions for a Finishing Kick

From a physical standpoint, your kick is a function of your raw speed, your ability to accelerate, AND how deeply you've had to rely on anaerobic energy production up to the point in the race that you launch the kick. Bearing that in mind, having a high AEROBIC capacity will give you a greater speed RESERVE (how much of your maximum sustainable oxygen debt you still have to "give away") than many runners who are flat-out faster than you are over 100m or 400m or whatever. So you should primarily train for aerobic endurance. The guy who trains ONLY for the kick shouldn't be close enough to you to use it, anyway.

As far as speedwork goes, you should ALWAYS be doing a little something about your turnover, even during a base-building phase. I refer to these workouts as "speed maintenance". They provide variety in footstrikes, muscle fiber recruitment, etc., which can not only keep you in touch with some speed, but can also help prevent injury.

Examples of speed maintenance workouts are simple buildups and strides and some form drills. You might try two to three sets of 5-6 buildups of 15-25 secs. WITH THE WIND (if any), jogging back (or jogging an equal distance) between each, and jogging 5-10 min. between sets. The first buildups in each set should be the slowest, but each set can be started slightly faster than the previous one (since you're going to be more warmed up). Every 2-3 weeks, you should tack on a fairly fast 2-7 min. run following the last set of buildups. The purpose of this is to get your heart rate up NEAR its maximum (also close to VO2max) WITHOUT tying up very much. Only run the 2-7 min. thing at about the pace you could run for TWICE the selected distance at first (e.g., run 3 laps at the pace you COULD currently run for 6 laps in a race).

Another speed maintenance session could be 2 sets of 5-6 x 30-35 secs. progressively faster EVEN-

SPEED strides. Jog the same distance between each and jog 5-10 min. between sets. These can be run as 200m reps on a track (with the wind, if any) or they can sometimes be run DOWN a very gentle hill (keep the surface soft, perhaps on a golf course) to concentrate on a light, quick turnover. The purpose of emphasizing turnover on occasion is as a prelude to quick accelerations. You can also run some UPHILL reps, but they don't necessarily need to be FAST. Just using the correct form (hips beneath the torso - NOT leaning too far into the hill with the buttocks back) will work the correct muscles for hill running. At some point near the start of a competitive season, the speed on sessions such as these can be deliberately WORKED a little more. You can also do about 10-12 progressively faster 12-15 secs. uphill repeats, finishing really fast. BUT - you should avoid tying up horribly in any case. Make sure you can hold form. The more you practice relaxation at close to top end speed, the easier it will be for you to recruit the necessary motor units (muscle cells and their connecting neurons) when it's time to kick it in at the end of a race.

Provided you've stayed in touch with your speed in the above fashion during a non-competitive season (or during the early part of a competitive season), and provided you've done some form drills (an entirely separate topic) you can introduce some "creatine phosphate" training. This initially entails a thorough warmup followed by 2 sets of 2-3 x 7-10 secs. all-out (take about a 20m running start before rally blasting the next 7-10 secs. - you don't want to strain anything!), with 30-60 secs. walking rest between reps and 8 min. rest (water break) between sets. After you've done this workout a couple of times (maybe once per week), you can add a third set to the above for one outing only.

Having completed 3 of the above "acceleration" workouts (remember to cover other training bases as well!), you should then proceed to a workout of 3-4 x 150m at 98%-100% effort with 30-60 secs. walking rest between each. Following this session (allow enough time for recovery and to include one or two other hard days), proceed to 3 x 300m at 98%-100% effort with 2-3 min. walking rest periods. The next "kick-specific" workout (about 4-5 days later) should be 2 sets of 2 x 400m at 98%-100% effort with shorter rests (near 1 min.) between reps and full recovery (8-ish min.) between sets. You may need to jog some and add a couple of light strides at the end of the 8 min. rest period in order to prevent straining anything at the start of the second set of 400s. These longer sprints work lactate "clearance" and use the creatine phosphate stores simultaneously. These two energy systems are precisely the systems which are invoked when you kick at the end of a race.

I might repost the drills if I can find the floppy disk I stored them on. There are also some more "advanced" workouts which involve pace changes, but those aren't really necessary unless you're at the highest levels of the sport.

Doubles, and why they're good

First, the plain and simple explanation to satisfy the old guard who don't like all the technical BS: You should do doubles because they've been proven by trial and error to benefit your running. I actually like this explanation just as much as the long, BS-filled version.

I like the long-winded explanation, too, because once something has been proven to work, it's only logical to try to figure out WHY it works. In this way, you can isolate what seem to be the "active ingredients" and experiment with adding more of them until the benefits max out (or are outweighed by "overdosing" on those ingredients). You can also cut out what seem to be the extraneous "filler ingredients" and see if they really ARE extraneous or if they're good for something after all and need to be left in the mix.

Remember, the SCIENCE of training is (or at least SHOULD BE) no more than quantifying the ART of training. Both science and art require scrutiny and refinement.
Anyway, the BS version: Your body adapts best to what it does most often - provided you give it a chance to adapt. Doubles increase your capillary density FASTER than singles do, and even if you've been doing them for a few years, they can still CONTINUE to improve your capillary density and your mitochondrial density. PACE should not really be a concern on the shorter run (or the run which is not the primary workout of the day). Look at what the Japanese do - they'll run 10K in 50 freakin' minutes as a secondary session! And we're talking 2:10 marathon types here! The main purpose of such an outing is simply to get time on your legs. I like going so easy that I can envision myself as "storing up energy" for the next workout.
Speaking of pace, putting in a short jog at a LAUGHABLY slow pace as your secondary outing actually ENHANCES your primary run and the two sessions can work synergistically. If you do your "real" workout in the P.M., a "shake-out" in the morning will often help you feel BETTER (more warmed up and less injury prone) for the later outing. If your "real" run is in the A.M., a slow second run later will help relax you and will possibly prevent stiffness from setting in (it might help you sleep better, too, if you keep the pace super-slow). Either way, if you're performing the same basic activity (running) that you normally perform at a medium or hard effort level - albeit at a much-REDUCED intensity - you're providing blood flow to the primary working muscles without overstressing them and without generating a lot of impact stress. If you can get into a good two-a-day routine, these dog-slow jogs can help prevent injuries that might result from your principal workouts
For a long time, Lydiard never counted easy, "shake-out" runs in his mileage totals. But I've ALWAYS counted such running, no matter how short a run is and no matter how slow it is. As mentioned, even those butt-dragging jogs do have some positive effects, and should therefore count as part of your training. Having said that, I'll add that the shortest a REGULAR run should be is 20 min. (preferably between 30 and 35 min.) to provide any real benefit to capillarization. I'd recommend 20 min. as the shorter run of a double only as a stepping stone to those of 30+ min.
How much time between runs? After a googolplex seasons of trial and error and observation of others, I say that if the second run is the PRIMARY run, it should usually be done six to eight hours after the first run (a "shake-out") IF you intend to optimize extension of the capillary network. If you just want a warming up effect for your "real" workout of the day, you can reduce the time between runs to about four hours. If your A.M. run is the primary session, you can wait a little longer than eight hours to do your second run. You may need a few extra hours to guard against overburdening yourself if your first run was fairly taxing (in terms of length or pace or both).
Finally, there are some intangible benefits to running twice a day several days per week, not the least of which is the sheer familiarity with putting one foot in front of the other - a practice, if INGRAINED in the subconscious recesses of the mind/muscle interactive process, can let you hold form to the finish of some races by operating on sheer AUTOPILOT!

Career Training Outline

Here are the fundamentals of our training approach…

[reproduced earlier in this document]

Progression Runs

On other forums, Hodgie-San has advised the readers to just get out there and run twice a day and "let the tempo come to you", after which things will all begin to fall into place. This is a very good place to start. Once you use this trial-and-error method (within reasonable guidelines), you'll be able to identify the critical point between maximum repeatable steady state and reckless overtraining BY FEEL. Those reasonable guidelines may restrict you to a certain percentage of sustainable VO2max AT FIRST (to guard against challenging yourself too much) or under other circumstances, but the BEST method of "aerobic endurance" running is personified in the Kenyan-style "progression run". In these runs, the pace often goes well BEYOND any predetermined physical parameters and is done totally spontaneously (actually, we've determined the optimal ultimate achieved speed to be 105% of vVO2max, but that's nothing you need to WORRY about - it'll probably be as fast as you CAN run safely for the final few seconds of a progression run). Even if you spend a mere 100 meters at the end really cranking it, as long as you DO NOT TIE UP, you can eventually improve your running economy at all ranges of running speeds. Parameters are useful at times (particularly if a progression run is planned IN ADVANCE during a phase of training in which other hard workouts are incorporated) to make sure the initial portion of the workout is kept under control. The Japanese use rather strict guidelines for their long progression runs (picking up the pace by x seconds per kilometer every 5K), but this is not entirely necessary all the time. A good progression run is one of those easy days that turns fast because you start feeling really sharp, strong and relaxed, and you can do no wrong, like you're running OVER the ground instead of ON it. By the very end, you can be absolutely FLYING, but you should have the discipline to pull the ripcord BEFORE you experience any tying up. The benefit to running economy comes by virtue of spending some time covering nearly every possible running speed.

The Kenyans are well known for using these runs on a near-daily basis in their training camps. The trick to the whole process is that they start at an absolute SHUFFLE - about 9:00-10:00 mile pace for the first half mile and rarely faster than 15:00 through 2 miles - no kidding! But the pace does get faster, and when it does, the fastest Kenyans are hitting sub-5:00 miles for much of the second half of a one hour progression run. The last mile can be in the 4:20 range, with the last quarter at or under 60 seconds (remember that 105% of vVO2max? - there it is in actual practice, and they're doing it without trying to hit a certain speed). That's duly impressive for a workout in itself, but no greater a feat than a national class American (or even an elite college runner) could do - IF running HARD! The phenomenal things is that some of these Kenyans can repeat this same basic workout several days in a row without overtraining!

It's in our vain American nature to believe that since this is impossibly intense training for US, it must be for THEM, as well. But the best Kenyan runners have incredibly high economy from learning exactly how to read their bodies on runs such as these. They also know how to REST between runs. Some of them still manage to prove they're human by crashing and burning as a result of COMPETING on these workouts. But for the most part, the Kenyans benefit from such progression runs by starting at a butt-dragging SLOW pace and allowing every system to warm up to a state of equilibrium BEFORE attempting any faster running. And if they feel they need to STAY at an easy pace for the entire run, the smart ones do so.

Politically incorrect or not, the white man generally has a harder time adjusting to these near-DAILY progression runs and needs a fairly extensive background of slower high mileage running FIRST. Even WITH such a background, most mzungus need more easy recovery days than the Kenyans do - basically benefiting more from a traditional hard day/easy day pattern - although there ARE some exceptions. Hey, there are some big-boned, SLOW Kenyans, too, so you've got to expect a few outliers in any population! If you are one of those runners who finds it difficult to hit a strong high-end pace and recover enough to do it again within 24 hours, or if 7:30 pace is easy, 5:30 pace is hard and 6:30 pace is too uncomfortable to be a recovery workout but too slow to have a training effect, then you probably need to adopt more of a hard/easy workout schedule. You can always experiment with progression runs during base training in order to find the groove and get comfortable with such training. The general idea is to train at a high-end aerobic pace as often as is functionally comfortable during a base phase, then move more and more toward a hard/easy scheme as the goal races get nearer. If this seems grossly obvious to you, you'd be SURPRISED to find out that many runners (some of them quite serious) do not know that this is the way to approach a buildup and a subsequent racing season.

Six Suggestions

1.) You'll get in very good shape eventually by jogging or by running lots of mileage very slowly (HR of 130 is pretty low). BUT ... "eventually" is the operative word here. It will take a LONG TIME to get to ultimate fitness if you're not regularly challenging yourself a little more than that. In short, long, slow distance is good, but long, comfortably fast distance is BETTER. Do a couple of runs per week in which you progress from your regular easy pace to a "high-end" aerobic pace. Also known as "maximum steady state", this is the fastest that you can run while feeling smooth, strong, comfortable, and in control. Any faster would result in distress. Not that there's anything wrong with REALLY HAMMERING the end of a run every now and then if you feel awesome; you just don't want to make EVERY one of these high-end runs as hard as that. Keep most of them at a pace that will train YOU but force someone SLOWER than you to struggle to keep up. It's usually best to PLAN at least ONE of these runs per week, but give yourself the OPTION to run another one or two if you happen to be feeling good during a regular easy run. Don't run hard more than two days in a row, though - at least not until you're extremely sure about what pace you can handle on a near-daily basis. Some runners can reach their maximum steady state for a PORTION of a run nearly EVERY DAY. Lydiard's top runners did this, as do most of today's elite Kenyans and Moroccans, but this requires quite a bit of experience (and discipline) to not OVERDO it.

2.) Do a little something about your speed a couple of times per week. Set aside one day each week for 2-3 sets of buildups or strides of 15-35 seconds in duration (5-6 reps in each set). Run them with the wind, if any (or sometimes on a very gentle downhill soft surface), jogging back to the start between each (or jogging an equal distance). Jog 5-10 minutes between sets. Make each rep in a set slightly faster than the previous rep. Start each new set slower than you FINISHED the previous set but a little faster than you STARTED that previous set. Run RELAXED, not tying up or experiencing any form breakdown, but some of the last ones in each set can be very fast. For variety, every second or third week, you could run 10-15 x 1 minute moderately fast (not tying up, though - about current 2 mile race pace) with 1 minute jogs between each. DO NOT TIE UP! This is BASE training; all you're trying to do is stay COMFORTABLE and neuromuscularly EFFICIENT at faster speeds. You're NOT doing hard anaerobic

work yet. Oh, yeah, forgot to mention that you can also add 3-6 short buildups or strides in the middle of the cool-down jog following a "high-end" run.

3.) Vary your running surfaces. Giving your legs a litle variety will improve your chances of running more injury-free mileage. Do about 50% of your running on SOFT surfaces, about 40% on roads, and about 10% on a track. Note: "track" does NOT necessarily mean speedwork. Some of this track running should be very easy. You don't HAVE to run HARD just because you're at a track; this is just to give your legs an opportunity to use a different surface and to become comfortable with the torques and "gripping" effect that tracks can have. By developing your ankles, knees and hips for track running at SLOWER speeds FIRST, you'll be more ready to run FAST on the track when it's time.

4.) Alternate high weeks with low weeks while you're building up into uncharted mileage territory. Stress/Recovery. Stimulation/Adaptation. You'll reap more benefits from pushing your boundaries out if you give your body some chance to "absorb the training". These high and low blocks don't HAVE to be seven day periods, either. You can experiment with this and find out what gives you the best returns, but the main idea is to stress yourself enough mileage-wise so that you're running somewhat TIRED for a few days or so, then back off just long enough to start feeling fresh again. Pretty soon, you'll be able to run longer high mileage stints and only need the occasional few super-short days. Oh, yeah: NEVER drastically up the mileage AND the intensity simultaneously. That's how many people get in trouble and claim that "high mileage doesn't work for them".

5.) Begin incorporating two-a-day workouts at some point. Start with one or two "doubles" per week (make the shorter run an easy 25-30 minutes at first), and build up to 3-4 doubles per week on your high weeks. People have debated in other threads whether singles or doubles are more productive. Let's settle that: Doubles are MORE productive for base training - WITH THE QUALIFICATIONS that you've learned what time of year to use them and when to back off, and as long as your longer run of the day eventually becomes long enough to count as a decent length single in itself. People have been asking, "Should I do 13-14 in a single or should I break it up into two runs of 5 and 8-9?" Answer: Do BOTH - 13-14 in a single AND another run of 5 that day! Once you've safely BUILT UP to that kind of mileage, of course.

6.) Tough, tying-up, knee-grabbing stuff is not TOTALLY bad - as long as it's done in moderation. You've got to have SOME of it if you're ever going to RACE well. Incorporate a brief period (6-8 weeks) of very hard anaerobic training (1-3 times per week) once every 5-6 months (following a good base, of course), thereby bringing yourself to a peak twice per year. Do not attempt to peak more than twice per year. Despite what some dabblers may say to the tune of "you can peak in Cross, Indoors, and Outdoors if you do it right", you CANNOT do this with as SHARP a peak as you will get by peaking only twice per year. Furthermore, trying to peak three times per year (or more) will never allow you to reach your full potential over the course of your career. It takes about 20 weeks to do a correct buildup/peak scheme and you can HOLD your peak for only a few weeks, after which you'll need a couple of weeks of "down time", so two peaks per year works quite nicely.

There are Benefits from Several Types of Long Runs

Slow runs:
These should be slow enough so as to give the feeling of "storing up energy" (Ernst van Aaken called this pace a "super-O2" pace). The only thing which might present any difficulty is the sheer time spent out there; otherwise, the effort should be completely conversational. Relaxation is paramount. Water and/or "road race" fluids should be taken every 20-30 minutes (depending on weather conditions) to stay hydrated and to practice taking race day fluids with ease while running.

Primary benefits include fatiguing "slow twitch" muscle fibers to the point where "fast twitch" ones must be mobilized to continue the energy output, increasing capillarization, improving mitochondrial density, neurological and psychological relaxation (which promote efficient running mechanics), incrementally (and, hopefully, SAFELY) increasing muscle and joint integrity, balancing glycogen/fat metabolism, and simply becoming familiar with the feelings of running long. The last 1-2 miles of such a run should be SLIGHTLY picked up to reinforce correct muscle fiber recruitment and to gradually train the body to handle increased carbohydrate metabolism when somewhat fatigued. A slight pickup at the end of a long run may also provide some psychological benefits.

It's probably a good idea during a pre-season to build these up in duration until they are just a little over two hours long (occasionally longer for runners who specialize at distances above 5,000m). While increasing the duration, the long run day should be treated as a HARD day (low to moderate mileage and little or no intensity the day before, low mileage and no intensity the day after). For those who will race 2-4 times per month once the competitive season arrives, assuming the long runs have been at 2-ish hours a few times, the weekly long run can be reduced to about 90-95 minutes for maintenance (as Lydiard said, "Jealously guard your good condition ..."). At this point, the long run can come the day following a race (and probably the day before a moderately hard workout), since 90-ish minutes will no longer be any strain.

Accelerated runs:
These are more directed WORKOUTS of 90-120 minutes. Done in a manner most people would associate with Japanese/Kenyan style (although Americans also did them like this decades ago), they feature a very slow start (like the aforementioned super-easy runs), and aerobic equilibrium should be achieved long before any pace changes take place. This means breathing pattern, muscular recruitment, heart rate, perceived effort, and mechanical rhythm should all be stabilized (in simple terms, the pace should feel GOOD N EASY). Once this equilibrium is attained, a very slight increase in pace can take place every 10-20 minutes until the final miles (sort of like a graded exercise test on a treadmill). The last few miles are normally run slightly faster than marathon race pace (fractionally slower than half marathon pace), with the ultimate 2-3 minutes REALLY MOVIN' (@ 10,000 pace). This may take lots of practice to get the correct feeling. The runner should feel "on top of" the pace (i.e., in control and NOT struggling) even through those last few minutes. It should only be a workout, not a race effort, and should be something that can be recovered from within 2-3 days. Again, fluids should be taken before, during, and after the run.

These workouts provide more stimulus for aerobic development than the really slow ones do, but - IF the overall mileage is adequate - they should not be done on EVERY long run day; otherwise, recovery time will be too long to integrate other aspects of training into the overall scheme. Besides EXPIDITING all

the benefits mentioned for the slower long runs, these acceleration runs also improve running economy (the ability to use oxygen more efficiently and preserve stored fuels) and improve the ability to metabolize small amounts of lactate before a spike is reached and the "threshold" is crossed.

Pace runs:
These are usually reserved as "dress rehearsals" at target pace for an upcoming marathon race and can involve distances anywhere from 12 to 20 miles. Pre-race fluids/foods and in-race fluids are taken for practice (but no taper or special supercompensation scheme is undertaken during the days before), and the run is done as close to goal pace as possible for the early miles. The last few miles are gradually squeezed down to a faster pace. There should be 2-3 of these prior to the target race, spaced about 3 weeks apart, with the last one 3-4 weeks out from the race. These are very hard runs and will obviously require several days of easy running for full recovery.

Push the Boundaries Out a Little at a Time

During the off-seasons, experiment with going slightly higher than you've ever been for a few days in a row. It doesn't have to be done in 7-day blocks; 3-5 days at a time of higher mileage is fine at first. Recover from that injection of higher mileage with a lower week or two, then go up in mileage for several days again. Run EXTREMELY RELAXED during the times which you are pushing up your mileage to previously unattained levels. DO NOT increase both mileage and intensity at the same time until you've done several seasons of each SEPARATELY. You CAN run some short (15-30 secs.) buildups or strides every other day to provide variety, but avoid "knee-grabber" anaerobic workouts and races.

With each passing year, you'll be able to increase both the mileage itself and the length of time you're spending in your high mileage phases. By the time you're in your mid-20s, you should be capable of several WEEKS in a row of VERY high mileage without needing a low week and without having any stress-related problems. Your average pace will probably also become much faster than it once was, but you don't need to FORCE that. At some point, you'll find that you can hit a pace at near the high end of aerobic effort on MANY (if not most) of your easy runs and will recover within a day's time. You must always start laughably SLOWLY on EVERY run in order to do this type of training successfully, though, and it's not something you should consiously worry about improving. Just allow the faster running to come to you over the years as your body becomes ready for it.

As far as mileage goes, though, start INTRODUCING it in short stints when you're YOUNG, but allow your body to "absorb the training" by dropping back down in mileage for a little while between high segments. Push those boundaries out more and more (and with ever longer stints) from year to year as you mature.

Economy and Mechanics

Economy and mechanics (impact stress) are the two main differences between people who can reach the high end of aerobic effort day after day and those who need to have slower days between their high-end

runs (or harder workouts).

If you tend to use LESS oxygen than most people as you run close to your "threshold", you'll almost certainly be the type of runner who can spend a fair amount of time at a high-end aerobic pace several days per week. Some of this "economy" appears to be a HEREDITARY trait, although it can definitely be trained to some degree. If you have NATURALLY good economy, you'll find it much easier to recover very QUICKLY after you run at your threshold. All of the crap above is a roundabout way of saying that some people can handle "threshold training" better than others. It CAN be trained a little over time, though, and it WILL help your long-term development to improve that aspect of your fitness, so you should experiment a little with it during unimportant times during an off-season, see how you respond, and learn from that, maybe adding more of it during subsequent preseasons.

Also, if you are light for your height or if you have more of a marathoner's "shuffle stride", you'll likely be able to maintain a faster average training pace without grinding yourself into the ground. I know somebody's going to come up with counter-examples of this; for instance, one of the FIRST runners to hit a near-maximum steady state day in and day out - Peter Snell - was a bit stocky compared to many of today's top runners. But ... he was only running about 5:30-5:45 pace as a maximum repeatable high-end pace (as opposed to the 4:45-5:00 pace that some of the "threshold trainers" are hitting these days). So, once he worked a little on that point of his fitness, that pace was not really that big a deal for him and was something which obviously TRAINED him rather than STRAINED him. Plus, his ECONOMY at those medium speeds was probably VERY good.

All in all, I'd suggest the more traditional "hard-easy" approach MOST of the time, but to EXPERIMENT with some high-end running on back-to-back days AS LONG AS YOU FEEL GOOD doing it. The day AFTER a high-end effort, always set out on your run as though it was going to be a regular EASY run, but if the feeling grabs you as you get into the run or if the "magic" is there, THEN "run for the barn".

Do Not Exclude the Hills or the Time Trials

By all means DO some specific hill training for about a month of the preseason. If done properly, it will prepare you for faster running with minimal risk of overtraining anaerobically. It also develops aerobic enzyme activity in a variety of muscle groups. Oh, crap, that was jargon, wasn't it? Well, whether you like it or not, you should learn WHY you're doing something.

Those time trials are what MOST people do as "high-end" runs. But these things are supposed to be more time-conscious efforts than a true high-end run. The high-end run (or as Lydiard called it, "maximum steady state" - which I would term "REPEATABLE maximum steady state") can be done on a near-daily basis in the "long aerobic running" phase. The way to spend time at your TRUE LT (which for some of these guys is about 4:40 per mile) several days per week is to start at a LAUGHINGLY slow pace and make DEAD SURE you re-establish your equilibrium each time you increase your speed (and NEVER increase the speed so suddenly that your breathing pattern changes NOTICEABLY). Lydiard's runners got up to a pretty good speed by the end of most of their runs - in fact, you might even say they were FLYING on some of these runs - but they were NOT fighting themselves to "make something happen".

Note: you MUST do some limited faster running as well in order to expidite your progress at high-end running.

Now here comes some more of what the unenlightened would call "pseudoscience", but which is ACTUALLY MEASURABLE stuff (I am now touching my thumb to my nose, waggling my other fingers, and blowing my raspberry at those who hate physiobull - PBTHLBT!!!!!): Did you know that many top runners run at only about 2.5 mmol/L of blood lactate during 90% of the kind of "progression run" we're talking about here? This is quite comfortable but not necessarily SLOW. They also become very adept at monitoring their pace increases near the END of these runs so that they can repeat the same type of effort (at HOPEFULLY the same basic pace) several days per week. In fact, they may even go up to 5 mmol/L of lactate for less than a minute at the VERY end of such a run, but they are still NOT fighting to do this. They are just not spending enough time at the higher lactate levels so that they would FAIL to buffer the lactate or reconvert it.
The 3-mile and 6-mile time trials that Lydiard advocated are VERY important components of transitioning fitness. They can be done a couple of times per week once enough "maximum steady state" running has been done.

Now, the slam: A lot of people would LIKE very dearly for some pile of middle distance $#!+ to be the "right way" to train. Those guys lose. They'll never know the true joy of this sport or have any clue how far they could have gone performance-wise. Any of that stuff (repeat: ANYTHING) that can be done WITHOUT a Lydiard-type base can be done FAR BETTER once the base IS established. WITFH is so effing difficult about understanding that? I guess some people frankly don't WANT it badly enough to TRULY prepare.

Lydiard Almost Got it PERFECT!

It's SPOOKY how much of this stuff Lydiard got dead on with practically NO ONE'S shoulders to stand on. Through 20+ years of personal refinement and examination of hundreds of other careers (to separate the UNIVERSAL principles from the "experiment of one" quirks), I have only been able to make the most MINOR modifications to this near-flawless system.

A few of the fine points that Lydiard couldn't get around to addressing are:

1.) Career development goes smoothest if technique work and joint/muscle integrity are developed in the pre-teen years (up to age 15 in some people), and if gradual, INCREMENTAL exposure to high mileage in LIMITED SEGMENTS is introduced from the start. In this way, the athlete can always be preparing for a future of very high REGULAR mileage while also getting the needed adaptation time in the early years. There are some hormonal and neurological considerations as rationale for this approach.

2.) There are specific training speeds and durations which optimize your "objective function value" (getting the most profit with the least squandering of available resources). These weren't known precisely to Lydiard, but he got EXTREMELY close through trial and error alone. His long "progressive pace" runs of 20-22 miles (125 minutes for the elites he coached) was one thing he got PERFECTLY, and he also

had his runners do some EXTREMELY slow jogging which was not initially included in his mileage totals (I know now to count that stuff, though, because it DOES have several real training effects - the Japanese have latched on to this, as well). Though the "trial and error" method is the ultimate science, examination of physiological processes and of other careers CAN provide some basis for refinement.

3.) There are some workouts which improve lactate "clearance" via muscle cell transport (MCT) proteins which were not known in Lydiard's day. SOME of the INDIVIDUAL workouts have been done through the ages, but there are specific distances to run and there is an optimal SEQUENCE for these types of workouts. Of course, exercise scientists will NEVER be able to figure out how to incorporate these workouts into the overall scheme, since the SCOPE of exercise science is too myopic to account for the number of variables present in a well-rounded training program. Knowledge of WHY something is working is fine, but can hardly replace trial and error. Nowadays we have BOTH laboratory-gleaned knowledge AND decades of trial and error by thousands of real running careers. The trick is putting both the knowledge and the WISDOM together in the right fashion, with a profound emphasis on the WISDOM.

Those are about the only things I can think of right now that Lydiard didn't nail, but it was probably ONLY because he didn't have TIME to do that much refinement. Look how much he got exactly! His long runs (at a progressive pace) were refined to a length of near 125 minutes. I can tell you through untold suffering that this figure is uncannily accurate. Moreover, there are MANY physical processes that occur just PRIOR to the 2 hour mark in such a progressive run which train the nervous system, the respiratory muscles, and the ability to store and access fuels (and muscle fibers) in the OPTIMAL sequence.

Unfortunately, many in the U.S. got away from Lydiard's methods and were lured by the siren song of low mileage and hard intervals and the quick fix those things can often provide. If we had only used Lydiard's endpoint as our starting point, think where we'd be now. That's what I devoted my life to during the years I was able to train at a high enough volume to make learning my lessons a real possibility, so you can jolly well take my word that Lydiard's system is the ONLY basic system that will truly maximize the potential of the "mzungu". Many Africans seem to have characteristics (capillary density, myoglobin, MCT proteins) which allow them to train more intensely more often, but the white man MUST develop the endurance FIRST by spending as much time at or below the threshold as possible.

But, I ramble ... Get out there and put in the relaxed high-end aerobic running!

I'll just reiterate what JK says above. If you've taken the time to read all the way down to here, don't just go back to running 2 10x400 workouts a week. Take a year or two, build yourself a legit base, and then come back and tear up the track.
See you on the trails/Cambridge roads,
Tim Galebach, 2003

****

Appendix D: John Kellogg’s Conversion Chart

(reproduced from earlier for quick reference)

****

Conversion Chart For vVO2max / LTv / Race Times

(1,600 Time = Mile Time x 0.994)

vVO2max (per mile)	LTv (per mile)	Mile	2 miles	5,000	8,000	10,000	15,000	½ Mar.	Mar.
4:00.0	4:25.7	3:40.2	7:51.1	12:33.2	20:41	26:09	40:08	57:51	2:02:44
4:05.0	4:31.8	3:44.9	8:01.8	12:50.9	21:11	26:48	41:08	59:17	2:05:54
4:10.0	4:37.8	3:49.6	8:12.4	13:08.6	21:41	27:26	42:08	1:00:43	2:09:04
4:15.0	4:43.9	3:54.3	8:23.0	13:26.3	22:11	28:05	43:08	1:02:08	2:12:14
4:20.0	4:49.9	3:59.0	8:33.6	13:43.9	22:42	28:43	44:09	1:03:34	2:15:24
4:25.0	4:56.0	4:03.7	8:44.3	14:01.6	23:12	29:22	45:09	1:05:00	2:18:34
4:30.0	5:02.0	4:08.4	8:54.9	14:19.3	23:42	30:00	46:09	1:06:26	2:21:44
4:35.0	5:08.1	4:13.1	9:05.5	14:37.0	24:13	30:38	47:09	1:07:52	2:24:54
4:40.0	5:14.1	4:17.8	9:16.2	14:54.7	24:43	31:17	48:09	1:09:18	2:28:04
4:45.0	5:20.2	4:22.5	9:26.8	15:12.3	25:13	31:55	49:10	1:10:44	2:31:14
4:50.0	5:26.2	4:27.2	9:37.4	15:30.0	25:44	32:34	50:10	1:12:09	2:34:24
4:55.0	5:32.3	4:31.9	9:48.1	15:47.7	26:14	33:12	51:10	1:13:55	2:37:34
5:00.0	5:38.3	4:36.6	9:58.7	16:05.4	26:44	33:51	52:10	1:15:01	2:40:44
5:05.0	5:44.4	4:41.3	10:09.3	16:23.1	27:15	34:29	53:10	1:16:27	2:43:54
5:10.0	5:50.4	4:46.0	10:19.9	16:40.7	27:45	35:08	54:11	1:17:53	2:47:04
5:15.0	5:56.5	4:50.7	10:30.6	16:58.4	28:15	35:46	55:11	1:19:19	2:50:14
5:20.0	6:02.5	4:55.4	10:41.2	17:16.1	28:45	36:24	56:11	1:20:45	2:53:24
5:25.0	6:08.6	5:00.1	10:51.8	17:33.8	29:16	37:03	57:11	1:22:11	2:56:34
5:30.0	6:14.6	5:04.8	11:02.5	17:51.5	29:46	37:41	58:11	1:23:37	2:59:44
5:35.0	6:20.7	5:09.4	11:13.1	18:09.1	30:16	38:20	59:12	1:25:03	3:02:54
5:40.0	6:26.7	5:14.1	11:23.7	18:26.8	30:47	38:58	1:00:12	1:26:29	3:06:04
5:45.0	6:32.8	5:18.8	11:34.4	18:44.5	31:17	39:37	1:01:12	1:27:55	3:09:14
5:50.0	6:38.8	5:23.5	11:45.0	19:02.2	31:47	40:15	1:02:12	1:29:21	3:12:24
5:55.0	6:44.9	5:28.2	11:55.6	19:19.9	32:18	40:53	1:03:12	1:30:47	3:15:34
6:00.0	6:50.9	5:32.9	12:06.2	19:37.5	32:48	41:32	1:04:13	1:32:12	3:18:44
6:05.0	6:57.0	5:37.6	12:16.9	19:55.2	33:18	42:10	1:05:13	1:33:38	3:21:54
6:10.0	7:03.0	5:42.3	12:27.5	20:12.9	33:49	42:49	1:06:13	1:35:04	3:25:04
6:15.0	7:09.1	5:47.0	12:38.1	20:30.6	34:19	43:27	1:07:13	1:36:30	3:28:14
6:20.0	7:15.1	5:51.7	12:48.8	20:48.3	34:49	44:06	1:08:13	1:37:56	3:31:24
6:25.0	7:21.1	5:56.4	12:59.4	21:05.9	35:20	44:44	1:09:14	1:39:22	3:34:34
6:30.0	7:27.2	6:01.1	13:10.0	21:23.6	35:50	45:23	1:10:14	1:40:48	3:37:44
6:35.0	7:33.3	6:05.8	13:20.7	21:41.3	36:20	46:01	1:11:14	1:42:13	3:40:54
6:40.0	7:39.3	6:10.5	13:31.3	21:59.0	36:51	46:39	1:12:14	1:43:39	3:44:04
6:45.0	7:45.4	6:15.2	13:41.9	22:16.7	37:21	47:18	1:13:14	1:45:05	3:47:14
6:50.0	7:51.4	6:19.9	13:52.5	22:34.3	37:51	47:56	1:14:15	1:46:31	3:50:24
6:55.0	7:57.5	6:24.6	14:03.2	22:52.0	38:22	48:35	1:15:15	1:47:57	3:53:34

7:00.0	8:03.5	6:29.3	14:13.8	23:09.7	38:52	49:13	1:16:15	1:49:23	3:56:44