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Intelligent Training for Distance Runners

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WHAT REALLY DETERMINES RUNNING PERFORMANCE?

What is the single most important factor that determines running performance?

Is it VO2 max? Not exactly. Is it genetics? Only partly. Is it Power Bars? Not likely. Mental toughness? Well, it helps. Reindeer milk? Bee pollen? Caterpillar fungus? Try again.

Dr. Edward Coyle, of the University of Texas at Austin, knows THE ANSWER. Dr. Coyle has been unravelling the mysteries of endurance performance for 20 years. In a series of 8 studies with runners, cyclists, and race-walkers, Coyle and his colleagues looked at everything from aerobic enzyme activity to gross mechanical efficiency, and how each of these factors contributes to racing speed. In a 1995 paper in Exercise and Sports Science Reviews, Dr. Coyle condensed the results of 2 decades of research into 3 words.

LACTATE THRESHOLD VELOCITY

Lactate threshold velocity? That's right, lactate threshold velocity (LT Velocity) is the single most important determinant of distance running success. In fact, a study with distance runners by Farrell et al. found that over 94% of the variation in racing speed was explained by differences in LT velocity, as compared to only 79% by variation in VO2 max.

So, what exactly is LT velocity?

LT velocity is simply how fast you can run at your lactate threshold. Your LT velocity is directly determined by just 2 factors: your lactate threshold VO2 and your running economy. A study using competitive cyclists found lactate threshold VO2 (LTVO2) and economy to explain 99% of the variance in LT velocity.

LTVO2 is the highest rate at which you can utilize oxygen before lactic acid starts to build-up in your muscles. LTVO2 also happens to be approximately the level of oxygen consumption that you can maintain during a marathon. (Oxygen consumption is measured as milliliters of oxygen consumed per kg of bodyweight per minute.)

To illustrate the advantage of a high LTVO2, say 2 runners have identical VO2 max values of 60 ml/kg/min, but one runner's LTVO2 occurs at 50 ml/kg/min, while the other runner's LTVO2 occurs at 40 ml/kg/min. If the 2 runners try to race the Boston Marathon at a speed that requires 48 ml/kg/min, runner #2 will build-up lactic acid and will have to slow down, and runner #1 will elbow him as she cruises past.

LTVO2 is not the answer by itself, however, because we don't all use the same amount of oxygen at a given speed. Just as some cars are more economical than others in their consumption of gasoline, some runners are more economical than others in their consumption of oxygen. A more economical runner consumes less oxygen to maintain a specific pace.

For example, say 2 runners with identical LTVO2 values of 50 ml/kg/min are racing the Cherry Blossom 10-miler

at 6 minutes per mile pace. Sounds like they should both be working equally hard, right? Not necessarily. If runner #1 has an oxygen requirement of 48 ml/kg/min at 6 minute pace, and runner #2 requires 55 ml/kg/min, then runner #1 will be comfortably below LTVO2 and will be able to maintain the pace, but runner #2 will start to accumulate lactic acid and will have to slow down. In this case, runner #1 has a higher LT velocity because she uses her LTVO2 more economically!

What determines LTVO2?

LTVO2 is the highest rate at which you can use oxygen before lactic acid accumulates in your muscles and blood. In a study comparing elite versus good cyclists, Dr. Edward Coyle and colleagues found that 75% of the variation in LTVO2 is explained by VO2 max and aerobic enzyme activity. VO2 max sets the upper limit to your LTVO2, and aerobic enzyme activity and other factors inside the cells determine how close your LTVO2 is to that upper limit.

VO2 max is the maximal amount of oxygen that your cardiovascular system can transport, and which can then be utilized by the working muscles. VO2 max is determined by the amount of blood your heart can pump (the amount of blood pumped per heart-beat times the number of heart-beats), and the amount of oxygen that can be extracted from the blood and used by the muscles.

The good news is that you can increase your VO2 max substantially through training. The bad news for those of us who have been running a long time is that VO2 max tends to increase during the first few years of training but then plateaus.

Since VO2 max plateaus after several years of training, but lactate threshold continues to increase, there must be adaptations occurring inside the muscle cells that allow you to run at a higher percentage of VO2 max without building up lactic acid. The most important adaptation is an increase in aerobic enzyme activity.

Aerobic enzyme activity represents how much energy is being produced aerobically. Aerobic energy production takes place in the cells' mitochondria. Aerobic enzyme activity is determined by the number and size of mitochondria in your muscle cells. Endurance training increases both the number and size of mitochondria, which increases aerobic enzyme activity, which increases LTVO2, which increases LT Velocity, which means you can race faster!

What kinds of workouts will improve LTVO2?

The best way to improve your LTVO2 is to train at your LT Velocity. The problem is, how do you know your LT Velocity? You could go to an exercise physiology lab, and after measuring your lactate at various running speeds, the physiologist could tell you what pace coincides with your lactate threshold. Unfortunately, not many of us have access to a lab. Fortunately, you can estimate your LT Velocity fairly accurately using your race pace for 15K to the 1/2 marathon.

Let's say Alison just ran 70 minutes in the Cherry Blossom 10-Mile Race. To increase her LTVO2, Alison should allocate a portion of her training to running at about 7 minutes per mile. My favorite lactate threshold workout is the classic tempo run popularized by exercise physiologist and coach Jack Daniels in the 1980's. This workout consists of a continuous run of 20-40 minutes at LT Velocity. Alison would warm up, and then do a 3 to 6 mile tempo run at a pace of 7 minutes per mile, followed by a short cooldown jog.

Rather than doing a continuous tempo run, you can gain a similar benefit by breaking the tempo run into 2-4 segments, for a total of 20-40 minutes. For example, 3 repetitions of 10 minutes each at LT Velocity, with a 4-minute jog between reps, will also boost your LTVO2. Low-key races of 5K to 10K make a great substitute for tempo runs. A well-designed schedule would include a tempo run or race 2 out of every 3 weeks. This schedule will improve your lactate threshold, but also help prevent overtraining.

Now we know how to increase LTVO2. So far, we have solved half the puzzle. Next month we will look at what determines your running economy, and how to improve it. For now, get out on the roads and do some tempo runs. Your race times will go down as your lactate threshold VO2 goes up!

*(This column originally appeared in **Running Times Magazine**.)*