

Intensity Training for Cyclists

Using Perceived Exertion, a Heart Rate Monitor and a Power Meter to Maximize Training Effectiveness

By Coach John Hughes

Paris-Brest-Paris '79, '87, '91, '95, '99;
Furnace Creek 508 '89 (Course Record), '93 (1st);
Boston-Montreal-Boston '92 (Course Record);
Reno-Tucson record '94 (849 miles in 54:17, still standing),
Oregon North-South record '95 (292 miles in 14:23, still standing);
Race Across America '96; Rocky Mountain 1200 '04

Table of Contents

[Introduction](#)

[The Human Power Train](#)

[Fuel Storage](#)

[Fuel Pump](#)

[Human Engines and Fuel Types](#)

[Transmission](#)

[Engine Economy](#)

[Proper Intensities Are the Key!](#)

[Benefits of Training by Intensities](#)

[Levels of Exercise Intensity and Training](#)

[Fitness and Goals](#)

[Gauging Intensities](#)

[Perceived Exertion](#)

[Heart Rate](#)

[Power](#)

[Training Zones Using Perceived Exertion, Heart Rate and Power](#)

[Training by Intensities Made Simple](#)

[Overload and Recovery](#)

[Hierarchy of Intensities](#)

[Rules for Intensity Training](#)

[Gauging Progress](#)

[Beware of Excess Stress](#)

[Your Personal Training Plan](#)

[The Training Year](#)

Follow Coach Hughes <https://twitter.com/HughesCoaching> and
<https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

[Health and Fitness Rider](#)
[Club and Endurance Rider](#)
[Performance Rider](#)
[Types of Workouts](#)
[Training Objectives and Intensities](#)
[Active Recovery](#)
[Increase Endurance](#)
[Increase Fat-burning and Sparing of Glucose](#)
[Increase Cruising Speed](#)
[Higher Intensity Workouts](#)
[Increase Power](#)
[Improve Riding at LT or FTP](#)
[Increase Racing Speed](#)
[Increase VO2 Max](#)
[Improve Sprint](#)
[Improve Pedaling Economy](#)
[Mixed Intensity](#)
[Go For It](#)
[Resources](#)
[About the Author](#)
[Other Publications by Coach John Hughes](#)

Introduction

Want to have more power and drop your buddies on the weekend ride? Or ride faster on your commute so that you have more time for the family when you get home? Or maintain your fitness as birthday after birthday rolls around? Or build endurance for a tour in the summer or for a fall century?

But you're not paid to train and race! You don't have a lot of time. What to do? If you want to ride faster and have more power you need a bigger engine. How can you get a bigger human engine, a V-6 or even a V-8, instead of your fuel-efficient but relatively weak V-4?

By training at different intensities you can get an engine that's not just bigger, but better – with greater acceleration, more power and better mileage.

You may notice some differences from earlier articles of mine. This is because I've incorporated the latest research in this article.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

The Human Power Train

Your body is much more complicated than a car; however, the analogy is useful. Your body is more like a hybrid that uses electricity, gas and diesel for propulsion. Your body uses several different systems to produce energy to fuel your muscles. Further, your transmission is more complicated. Rather than shifting from one gear to another, your body adds another gear on top of the first gear! And then can add a third gear as well.

Your power train is composed of:

Fuel Storage

Your body burns two fuels: glucose, from carbohydrates, and triglycerides, from fat, and has two different fuel tanks. Glucose is stored as glycogen in your muscles and liver. Through training you can increase your glycogen storage by 20 to 50% through training *at a moderate intensity*. Triglycerides are stored in your body fat. Even the skinniest racer has enough fat to ride all day. You can increase your reliance on fat by riding *at a moderate intensity*, thus sparing precious glycogen.

A gram of glycogen contains four calories of energy while a gram of fat contains nine calories, which is why fat is the preferred way for the body to store energy. Glycogen stores in a well-trained athlete are limited to about half a kilogram or 2,000 kilocalories. That's enough for just two to three hours of hard riding.

A half-kilogram of fat produces about 4,500 kilocalories, more than twice as much energy as glycogen. If you weigh 150 lbs (68 kg) at 10% body fat, then you have a total of 61,200 calories of energy available from fat! You can't metabolize all of this and survive, but you clearly have enough energy from fat for a long ride!

Just like in a car, oxygen is necessary to burn both of these fuels. Unless you have compromised lung capacity, for example from asthma, or ride at high altitudes like I do in the summer, oxygen supply from your lungs isn't a limiter.

Fuel Pump

Although you burn two different fuels from two different tanks, you have one fuel pump: your heart. How much fuel and oxygen it delivers to your working muscles is your cardiac output. Cardiac output is the result of stroke volume, how much blood your heart pumps per beat, and the number of beats per minute it can sustain. Stroke volume increases during light to moderate exercise, at which point it plateaus, but your heart rate continues to increase to supply your working muscles. When your heart is delivering enough oxygen for your muscles, you are riding *aerobically*. Aerobic exercise increases your stroke volume and *may* result in a lower heart rate at a given effort.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

The beats per minute keep increasing until your maximum heart rate, which is primarily the result of age and genetics. Maximum heart rate doesn't matter unless you like to sprint. What matters is how *fast* your heart can beat and still *deliver enough oxygen to your working muscles* so that you are riding *aerobically*.

As you ride even harder, your heart beats even faster but your heart *can't deliver enough oxygen to your muscles*. You are riding *anaerobically*. Riding anaerobically produces lactic acid, which causes that burning in your legs. The point at which your body is producing more lactic acid than it can process is called your *lactate threshold (LT)*. You can only minimally increase your max heart rate through training; however, you can significantly increase your lactate threshold by training at higher intensities.

Human Engines and Fuel Types

Your body is like a hybrid with three engines burning different types of fuel.

In 2015 Kurt Searvogel logged a total of 76,076 miles over the course of a year, averaging 208 miles per day in breaking the Highest Annual Mileage Record. He has a big engine, i.e. great stroke volume. His engine is tuned to run primarily *on fat and oxygen* with great fuel economy so he can ride all those miles. He'd eventually drop you on a long ride.

Some RBR readers with higher cardiac output have a different engine tuned primarily to run *on glucose and oxygen*—you could drop him on a sustained climb.

Other readers with even higher cardiac output have yet a different engine tuned to run *on glucose without oxygen*—you could dust him in a sprint.

Every rider actually has all three of these engines. The engines are located in different parts of the muscle cells and use different enzymes to produce energy, another reason for training at different intensities.

Here's how the energy systems work in the hybrid that is your body:

Imagine that you are on a group ride. Several riders go off the front and you decide to catch and ride with them. You:

1. Launch an all-out sprint, burning the small amount of fuel that is already in your muscle cells.
2. After 10 – 15 seconds your legs aren't just talking to you, they're screaming at you! You have to slow down and your heart is rapidly delivering glucose and fat to the muscles but can't supply enough oxygen. You catch the break, and slow down a little more, but keep riding hard with your buddies to continue to establish a gap.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

3. You know there's another hour or so left in the ride and you persuade your fellow riders to settle into a sustainable pace so that your heart can supply enough oxygen so that your muscles burn fat and glucose more economically.

Every time that a muscle contracts to exert force it uses energy produced by adenosine triphosphate (ATP). If ATP is depleted, then muscle action stops, so the ATP supply must be continually replenished. ATP comes from three different sources:

1. **ATP-PC** (high power but very short duration) This system produces energy that can be used for maximal effort — a sprint. Training this system increases your sprint from 50 – 100 meters to about 300 meters.
2. **Glycolytic anaerobic system** (moderate power for short duration) As your attempt to catch the break continues, you run out of ATP. The glycolytic system metabolizes glucose *anaerobically* to produce the ATP to provide the energy to bridge up to the breakaway. This system provides energy for very hard efforts of about 30 seconds to two minutes. The glycolytic system is anaerobic and lactic acid is a by-product. As soon as enough oxygen is available, the lactic acid is converted to energy. Because this system is anaerobic it is relatively inefficient, producing only two molecules of ATP per molecule of glucose.
3. **Oxidative aerobic system** (low power for a long duration). When you are riding at an *aerobic* pace the oxidative system produces energy from two different fuel sources: glucose and triglycerides. This system is much more efficient than the glycolytic system. One molecule of glucose produces 34 molecules of ATP and a molecule of fat produces even more ATP. (Allen, 2012)

All of the energy systems are operating all the time; however, depending on the level of effort, one system dominates.

Transmission

Your body's transmission is also more complicated than a car's drivetrain. An individual muscle, for example, one of your quadriceps, is composed of motor units, each of which is controlled by a separate nerve fiber. A motor unit is made up of the neuron and just one type of the following three fibers:

- **Slow-twitch motor units** are composed of small fibers that contract slowly and generate relatively small forces. These muscles are rich in myoglobin, which transports oxygen, and mitochondria where fat is metabolized for energy. These motor units provide the power for activities that require sustained muscular contractions, such as an endurance ride. They are called slow-twitch fibers because of the relatively slow rate at which the fibers contract (not how slow your cadence is).

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **Fast-twitch IIa motor units** have bigger fibers and generate more force; however, these fibers have very few mitochondria and are therefore easily fatigued. These units are especially important for brief exertions that require large forces, i.e., riding accelerating from a stoplight. These are called fast-twitch fibers because of the relatively fast rate at which the fibers contract.
- **Fast-twitch IIb motor units** have properties that lie between those of the other two types. The fibers are of intermediate size and contract not quite as fast as fast-twitch IIa units. Fast-twitch IIb are substantially more resistant to fatigue than IIa, and generate about twice the force of a slow-twitch motor unit.

Your body's different muscle fiber types are your different gears. The different gears (fiber types) burn different mixes of fuels and may operate simultaneously. Your muscles aren't like gears on your bike where you switch from one gear to another; rather, the motor units are recruited progressively. You're riding with the group using primarily your slow-twitch fibers. On climbs these continue to produce power and your fast-twitch IIb motor units also kick in. A dog suddenly starts to chase—all of your fast-twitch IIa fibers fire simultaneously along with your slow-twitch and fast-twitch IIa fibers!

Each of us has a different mix of fiber types. Searvogel's legs are rich in slow-twitch fibers so he has great endurance. Sir Bradley Wiggins, who currently holds the hour record on the track, has plenty of fast-twitch IIb fibers—the hour record is an endurance event! Wiggins also does quite well in other endurance races, including winning the Tour de France. Jason Kenny took gold in the 2012 Olympics with a time of 9.713 seconds for the flying 200-meter time trial. His legs have almost all fast-twitch IIa fibers.

Your mix of fiber types is determined genetically. You cannot increase the number of muscle fibers of a specific type; however, you can focus your training on a specific type of muscle fibers and improve the force of those fibers.

Muscle fibers atrophy if you don't use them. Fast-twitch IIa fibers atrophy first, since they are the least used followed by IIb. Slow-twitch fibers atrophy the least. Even though you don't ride with the big dogs and sprint for the city limits, maintaining your fast-twitch muscles is important for the times that you do need them to climb a particularly steep pitch, dodge a car about to run into you or even climb stairs carrying a heavy load of groceries.

By training at different intensities you can prevent each of the different fiber types from atrophying and improve the performance of each fiber type.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Engine Economy

Engine economy has two components: VO2 max and optimal muscle firing. VO2 max is the maximum amount of oxygen that your working muscles can use. In an untrained state your muscles only use a fraction of the oxygen that your blood delivers. Your VO2 max is the upper limit of how much power your muscles can produce and your speed *riding aerobically*. Through training you can increase your VO2 max and since almost all riding is aerobic, a higher VO2 max is better.

However, riders with a higher VO2 max aren't necessarily the best. You may have read about pros with an economical or supple pedaling style. The firing of their individual muscle fibers is more coordinated than the muscle firing of other riders; the timing of their engines is better.

Both your VO2 max and the firing pattern of your muscle fibers can be improved by training at different intensities.

How should you train given all this complexity?

Proper Intensities Are the Key!

The difference between top bike racers and us mortals is that they *vary* the intensities (plural!), while we ride at about the same level of effort most of the time. Changing the intensities of workouts is *the fastest way to improve*.

Eddy Merckx famously said, "Ride more!" when asked how to improve. Don't have enough time to ride more? Ride smart! By varying the intensities.

Benefits of Training by Intensities

Coaches express the different intensities in training zones, which may be defined by Rate of Perceived Exertion (RPE), Lactate Threshold Heart Rate (LT) or Functional Threshold Power (FTP). These are explained in detail below. Training in *different zones at different intensities* has these very desirable effects:

- **Target training more effectively.** Each of the three different energy systems (ATP-PC, glycolytic anaerobic and oxidative aerobic) improves from training in different zones. Similarly, the performance of each of the three muscle types (slow-twitch, fast-twitch IIa and fast-twitch IIb) improves from a specific type of training in a particular zone. Depending on your goals you can target your precious training time more effectively.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **Build endurance more effectively.** You might be riding too fast to build the most endurance! Slowing down to the right zone will yield more improvement in your eight hours a week than riding more time at a too-fast pace.
- **Improve power faster.** You'll improve more by cutting back to six hours a week with two of the hours in the right zone(s) to build power and more recovery, than if you find a way to increase your training to 10 hours a week.
- **Tailor training to your body.** By learning to listen to your body or gauging your LT or FTP you can *tailor the training zones* and workouts in this article *to your fitness*.
- **Optimal overload.** To improve you have to ask more of your body. But if you overload your body too much your fitness may actually get worse, and if you don't overload it enough your fitness won't improve. Further, different levels of overload in different zones bring about different adaptations.
- **Optimal recovery.** Your fitness improves while you *are not training hard*. You can use the training zones in this article to provide optimal recovery between hard intervals and to determine how much recovery you need between hard days.
- **Spare precious glycogen.** The amount of glycogen your body can store is limited—just enough for 2-3 hours of hard riding—but everyone carries enough fat to fuel long, less-intense rides. Riding at an endurance pace, you train your body to use more fat and less glucose for fuel. (Training your muscles to burn more fat won't result in weight loss. That results from burning more calories than you consume.)
- **Power produced increases before the glycolytic system kicks in.** Training at the proper intensities enables you to ride harder using just aerobic energy before you call on your glycolytic system and start to produce significant amounts of lactic acid.
- **Better performance.** By training at the right intensities you can ride faster and climb hills better using your oxidative system. You can also produce more power with your glycolytic system. And you can sprint better to outrun that dog!

If you are new to exercise, training at the right intensities will allow your heart to beat faster before your lactate threshold is reached, a good thing. If you already have good fitness, don't expect much change, if any, in your LT.

Before you begin training at different levels of intensity talk with your health-care professional.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Levels of Exercise Intensity and Training

To improve you should exercise at the different intensities that will use your different energy systems and muscle fiber types. Remember the earlier example:

1. You launch an all-out sprint burning the small amount of fuel that is already in your muscle cells. After 10 – 15 seconds your legs aren't just talking to you, they're screaming at you!
2. You have to slow down and your heart is rapidly delivering glucose but not enough oxygen to the your muscles.
3. You catch the break, and slow down a little more, but keep riding hard with your buddies to continue to establish a gap. You're all breathing heavily.
4. You know there's another hour or so left in the ride and you persuade your fellow riders to settle into a sustainable pace.

You are recruiting your muscle fibers progressively in this sequence.

Slow-twitch aerobic endurance riding. Even though you are going hard after catching the break (#4 above) you are riding *aerobically*, primarily using your slow-twitch muscles.

In training, riding at the classic conversational pace uses and trains your slow-twitch muscles. You aren't breathing hard and your muscles have plenty of oxygen, so you're using your oxidative system to fuel your muscles. If you're riding at a slow conversational pace, then you're burning primarily free fatty acids in the mitochondria in your muscle cells. Riding at this pace increases the number of mitochondria and the enzymes used to convert fat to ATP.

If you pick up the pace a little (you can still talk in complete sentences) you start to burn more glucose for energy while still continuing to metabolize fat. This type of riding trains your body to use more fat and less glucose at a moderate intensity of riding.

Training at this intensity, *not harder*, is the way to improve your endurance.

Fast-twitch IIb anaerobic riding. You've caught the break and you're all still working very hard to stay away (#3 above).

You're riding hard enough that your muscles aren't getting enough oxygen. You're still using your slow-twitch muscles *and* you're recruiting your IIb fast-twitch fibers, which have some endurance. You can only talk in short phrases "pulling through."

Training at this pace trains your glycolytic system, which metabolizes glucose without enough oxygen using a different metabolic process. This training increases the enzymes necessary for this type of energy production. Your oxidative system also continues to provide some of energy you need.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Training at this intensity is the optimal way to increase your overall power.

Fast-twitch IIa anaerobic riding. You've got a gap on the main group and are going as fast as you can for the several minutes it will take to catch the break (#2 above). You're riding so hard that you can't talk at all. You are recruiting your IIa fast-twitch fibers, which have maximum power but limited endurance. Your fast-twitch IIb and slow-twitch fibers are still firing, too.

Training at this pace you're still training your glycolytic (anaerobic) energy system and if you train at the upper end of this system you're increasing your VO2 max.

Fast-twitch IIa ATP-PC riding. During your initial jump you go all out for 10 – 15 seconds and are recruiting all of your IIa fibers and using your ATP-PC system. (#1 above) Jumping from the bunch and sprinting not only trains your IIa fibers and glycolytic system, but also improve your neuromuscular firing pattern, the coordination of the firing of individual muscle fibers.

Fitness and Goals

The ability to ride at different intensities helps you to succeed with your cycling goals.

- **General fitness** improves if you train both the slow-twitch aerobic and fast-twitch IIb anaerobic systems. Each promotes cardiovascular and muscle fitness differently.
- **Club rides** of several hours use mostly the slow-twitch aerobic system for endurance, even on brisk rides, and also draw on the fast-twitch IIb anaerobic system for steeper climbs, chases, etc. Training your VO2 max determines how fast you can ride *aerobically*. Sprinting for city limit signs requires the fast-twitch IIa system.
- **Centuries and touring** rely even more on aerobic metabolism, as does randonneuring. The most efficient long-term pace is when you stay in your aerobic zone rather than going anaerobic at any point. Therefore, primarily train your slow-twitch aerobic system. Although the vast majority of your training is aerobic, some training at the lower range of anaerobic riding will increase your power so you have less fatigue even at moderate paces, and training your VO2 max will increase how fast you can ride *aerobically*.
- **Racing** is mostly aerobic but, of course, fires up the anaerobic system more of the time. Riding a time trial you consistently use fast-twitch IIb fibers, which have moderate power and moderate endurance. Road races are a mix of aerobic and anaerobic riding, drawing on the slow-twitch, fast-twitch IIb and fast-twitch IIa

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

fibers depending on the action. A winning effort often results from your ability to stay aerobic more than the competition, so train your VO2 max, which determines how fast you can ride *aerobically*.

- **Commuting and casual recreational riding** are aerobic. Train at moderate and brisker conversational paces.

Gauging Intensities

You ride to *have fun*. You probably also ride to improve your fitness and cycling. To get better you need to train the different metabolic systems and fiber types. This requires a way of assessing how hard your body is working. Here are three methods:

- **Perceived exertion** is the simplest, requiring no equipment. It means learning to listen to your body. Lab studies show that perceived exertion is as good a way of tracking intensity as heart rate.
- A **heart rate monitor** tells how fast your heart is beating. It is an *indirect* way of measuring how hard your muscles are working because it's looking at the *input* to your muscles. Heart rate may be inaccurate because it is determined not only by how hard your muscles are working but also by how well you slept, if you are excited or stressed, how hot it is, what you ate (e.g., sugar, caffeine), if you are dehydrated and other factors.
- A **power meter** measures the wattage you produce at any given instant. It is a *direct* way of measuring how hard your muscles are working and is the most accurate method, but it requires the most specialized equipment and learning how to interpret complicated data.

Which method of gauging intensity is best for you depends on your goals. If you have a high goal, for example being competitive in age group racing, then you need very accurate feedback on intensities when you train so you'll find a power meter very helpful.

If you are training for good performance, for example on club rides, but aren't racing, then either perceived exertion or a heart rate monitor is fine. If you ride for recreation, then perceived exertion is the way to go.

The right method also depends on your personality. Some people like data and keep extensive training logs, some people don't care for numbers. Data alone are useless. If you like numbers and can interpret them (or have a coach who can interpret them) to provide useful information, then you may want to use a heart monitor or power meter. If numbers don't mean a lot to you then stick with perceived exertion.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Once learned, the rate of perceived exertion (RPE) has several advantages over a heart monitor. RPE's advantages:

- **Free.** You don't have to buy any equipment.
- **Simple.** You don't have to interpret numbers and remember training zones.
- **Faster to respond.** When you change your level of effort, particularly when suddenly going much harder, it takes a few minutes for your heart rate to increase all the way to the new level; however, you feel the new intensity instantly.
- **May be more accurate.** You are sensing how hard your muscles are working rather than how fast your heart is beating, which can be influenced by other factors such as nerves, heat, dehydration, etc.
- **Pacing.** With prolonged exercise your heart rate may increase even though your muscles aren't working any harder. This is known as cardiovascular drift. Because your heart rate has gone up, you may think you should slow down. With RPE you'll continue to ride at the same level of effort.
- **More reliable.** Feedback is not subject to equipment blips or failures.
- **Safer and more fun.** You can look at the road and scenery instead of numbers on a gadget.

A heart rate monitor has several advantages over RPE, *if it is accurate and not influenced by other factors*:

- **Data for analysis.** With most heart rate monitors you can collect the time spent riding at different heart rate intensities for later analysis. For example, how long you were riding at different percentages of lactate threshold. You can then assess if you were riding at the right intensities for different training benefits.
- **Recovery.** When heart rate monitors were first introduced, the 7-11Team used them to learn to ride *slowly enough* on their recovery rides. Most amateurs ride too fast on what are supposed to be easy recovery rides.
- **Pacing in a group.** On a group ride it's easy to get sucked into riding too hard for your planned workout. Numerical feedback can slow you down to the right intensity.
- **Riding hard enough.** With RPE you may have trouble pushing yourself hard enough when doing intensity workouts. Or, full of enthusiasm, you may push yourself too hard and burn out before you have enough volume of the right intensity.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

The primary advantage of a heart rate monitor compared to a power meter is simplicity. You only have one number to focus on while riding and to analyze later: heart rate. Because of its simplicity a heart rate monitor is much less expensive than a power meter.

A power meter has several advantages a heart rate monitor:

- **Most accurate.** It measures *output*, what your muscles are producing. Heart rate monitors gauge *input*, how hard your heart is working to supply your muscles with oxygen, glucose and triglycerides.
- **Instantaneous.** A power meter responds instantly to changes in intensity, unlike heart rate, which lags changes in intensity. However, because it instantly responds to even small changes, the power reading bounces around and it may be harder to ride at a specific intensity.
- **Reflects training improvement.** As you get fitter your lactate threshold may not change; however, how much power you can produce at lactate threshold will increase.
- **Most effective training.** Power production improves with training, while lactate threshold may not change. Thus, planning workouts based on power is more effective than planning them based on heart rate.

However, a power meter is a complicated piece of equipment. It takes more time to learn how to use one effectively. Although costs are coming down, because of the complexity a power meter is still significantly more expensive than a heart rate monitor.

Effective training results from riding at *different* intensities on *different* rides. Perceived exertion, heart rate and power can all be used to gauge intensity.

Human power production is a continuum. You don't shift gears like in a car, but rather increase power continuously as you ride faster or climb harder. For training purposes coaches divide the power continuum into different sections or zones. Different coaches divide power into more or fewer zones. Here are the zones that I use for perceived exertion, heart rate and power.

Gauging Intensities by Perceived Exertion

Training by Rate of Perceived Exertion (RPE) often uses a 0 to 10 scale. Zero is no exertion and 10 is a maximal sprint for just a few seconds. I have my own way of gauging intensity and give the RPE numeric equivalents. Because power production is a continuum, the different paces and RPEs blend into each other.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **Digestion pace:** How you ride after a big meal, an RPE of 1-2. This is the pace for active recovery rides.
- **Conversation pace:** You can easily carry on a conversation in full sentences, an RPE of 2-3. This pace builds endurance and trains the aerobic system to burn more fat and spare glycogen.
- **Hill climbing and headwind pace:** You are climbing a long, moderate grade or riding into sustained headwind. You're working hard enough that you can still talk in short sentences but you can't whistle, an RPE of 3-4. Riding at this pace you are training the aerobic system to burn glucose and improving your cruising speed.
- **Power pace:** You are riding harder up a relatively short climb or into a headwind but not yet sub-barf. You can talk in short phrases but not short sentences. An RPE of 4-5.
- **Sub-barf pace:** You are making a hard, sustained effort, an RPE of 5-6. This is the pace for a 20-40 km time trial or racing up a sustained climb. You're riding anaerobically to train the anaerobic system to burn glucose without enough oxygen and your muscles are producing lactic acid—we all know that feeling in our legs.
- **Barf pace:** This is the classic hammering pace, a hard effort for 5 - 10 minutes — any longer and you'd barf—an RPE of 6-7.
- **Eyeballs out pace:** Riding as hard as you can for only a few minutes with your eyes bugging out, an RPE of 8+.
- **Ouch pace:** Sprinting at maximum effort, an RPE of 10.

Gauging Intensities by Heart Rate

Your maximum heart rate is determined by your age and genetics, not by your physical condition. Defining your exercise intensities based on your maximum heart rate would be like telling you what size shoes to wear given your age and parents.

Your lactate threshold (LT) is also determined *in part* by your parents and age. However, LT is also a function of how fit you are, so heart rate training zones are defined relative to your LT.

Your lactate threshold is the heart rate that you can sustain for a 1-hour time trial, but that's a pretty painful test. Here's a less painful test to estimate your lactate threshold. Your actual LT is about 95% of your average heart rate for a 20-minute time trial:

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

1. Ride a 20-minute time trial solo rather than competing with anyone. If you ride it competitively, then your average heart rate for 20 minutes will be more than 95% of your average heart rate would be for an hour and your calculated LT and your training zones won't be accurate.
2. Do the test after a very easy week when you've only ridden a few hours so that you are fully recovered.
3. Use a course that is flat or slightly uphill and will take you at least half an hour to ride going flat out. You use a course that takes longer than 20 minutes so that as your fitness improves you can repeat the test and go farther on the same course.
4. Do the test on a calm day and at the time of day when your personal energy level is good.
5. Warm up thoroughly for about half an hour.
6. Start your computer and ride as hard as you can for 20 minutes.
7. Try to pace yourself so that your effort is pretty constant for the full 20 minutes rather than starting out too fast and fading.
8. You may need to repeat the time trial several times *each time after an easy week* to get an accurate average heart rate and LT.

Record how far you rode, your average speed and average heart rate. (If your heart rate monitor doesn't calculate average heart rate just eyeball it.)

Your lactate threshold is about 95% of your average heart rate for the 20 minutes. To get your LT subtract 5% from your average heart rate for the time trial.

Gauging Intensities by Power

To gauge intensity with a power meter you need to estimate your Functional Threshold Power (FTP). Your FTP is the maximum average power you can sustain for an hour. An hour is a long test—here's a common, shorter method:

Follow the same 8-step protocol as for a lactate threshold time trial.

The course can also be a hill climb. Many riders have a higher FTP climbing than on the flats so you may want to do both flat and climbing 20-minute tests. Then in training you can use zones based on your flat FTP for relatively flat intensity workouts and zones based on your climbing FTP for those types of workouts.

Record your Normalized Power (NP), average heart rate, distance and average speed. Average power is simply the arithmetic average of all your instantaneous power levels. NP takes into account the variability of your power output and is a more accurate measure of the metabolic cost. Your NP will be about 105% of your Functional Threshold Power. To get your FTP subtract 5% from your normalized power.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Training Zones Using Perceived Exertion, Heart Rate and Power

As noted above, there aren't discrete jumps in energy production. You just work a little harder and one level of intensity becomes the next one. Thus, the RPE numbers blend into one another.

Training Zones Using RPE, Heart Rate and Power

Zone	Workout	Hughes RPE	RPE	Heart Rate % LT	Power %FTP
Zone 1	Recovery	Digestion	1-2	<68%	<55%
Zone 2	Endurance	Conversation	2-3	69-83%	56-75%
Zone 3	Tempo	Headwind	3-4	84-94%	76-90%
Sweet Spot	Power	Short hill	4-5	93-97%	88-94%
Zone 4	Sub-Threshold	Sub-barf	5-6	95-100%	91-100%
Zone 5	Super-Threshold	Barf	6-7	101-105%	101-105%
Zone 6	VO2 Max	Eyeballs Out	8+	> 106%	106-120%
Sprints	Maximum effort	Ouch!	10	N/a	N/a

(Allen, 2006)

You can download a spreadsheet to calculate your own training zones from my [website](#).

Training by Intensities Made Simple

Before we talk about how to use the different levels of intensity let's review briefly how training works. The concept of conditioning is simple whether you are exercising for fitness, racing or anything in between.

Overload and Recovery

Overload => Stress => Recovery => Adaptation

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

For continued improvement there must be progressive overload. If you just do the same rides every week and don't stress your body any differently, you don't improve. To improve you need to increase one of these key factors at a time:

- *How much* you ride
- *How often* you ride
- *How hard* you ride

Training includes *recovery* as well as progressive overload and stress. Your body adapts to the overload during recovery, not during the overload itself. To increase the overload follow these four principles:

1. Increase just one type of overload at a time: volume, frequency or intensity.
2. Mix hard, moderate, easy and rest days each week.
3. Progressively build your training for three to five weeks or alternate harder and easier weeks with each pair of weeks progressively harder. Then cut back for a recovery week before ramping up again.
4. Every two to three months take a physical and mental break for a week. Do just a few hours of *easy* riding or hiking or playing catch with the kids.

As you add intensity to training you also need to train more responsibly. *It's essential to give your body time to rest, recover and grow stronger.*

Hierarchy of Intensities

Unless you are a masochist *and* want to risk injury and overtraining, don't jump right to training at Sub-Barf, Barf and Eyeballs Out intensities.

Top endurance riders spend about 75% of their training time riding at low intensity, 15 – 20% riding hard and not much time in between. (Connor, February 2016) They build a huge endurance base and so should you. If you only have time to do one kind of training then *ride aerobically*. You should have several months of steady, conversational riding in zones 2 and 3 before you ratchet up the intensity at all, and then you should increase the intensities progressively.

Training at each intensity from the sweet spot through super-threshold builds the necessary fitness to handle the next level of intensity. You should train for a month or two in the sweet spot before stepping up to sub-threshold training. Then train there for four to six weeks before moving up to super-threshold efforts. Moving up a level of intensity is one way of increasing the overload. If you just do sweet spot training, at some point your fitness will plateau. To continue to improve you need to go harder.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

As you add the different kinds of intensity workouts beyond endurance and tempo rides, do so in this order:

1. **Sprints.** These will benefit most riders from health and fitness riders to racers and everyone in between. Sprinting increases the coordination of the firing of individual muscle fibers. This means you *increase your pedaling economy* without using more fuel or oxygen.
2. **Sweet Spot.** Sweet spot training *increases the power* that your muscles can produce. Riding in the sweet spot overlaps the top of tempo riding and the lower part of sub-threshold riding. The harder you ride, the more you overload your body, which stimulates more adaptation. However, the harder you ride, the more recovery you need both between efforts and between hard days. The need for more recovery limits the total volume of hard efforts. The sweet spot is the range that balances intensity and recovery to produce *the most total overload on your body*.
3. **VO2 Max.** VO2 max is the amount of oxygen that your working muscles can utilize. Training to increase your VO2 max also *increases your pedaling economy*. These efforts are *very tough* mentally as well as physically. Be conservative.
4. **Sub-threshold.** Training just below your threshold is the most direct way to *increase your power* after a period of sweet spot training. These efforts are *tough* on both your body and your mind.
5. **Super-threshold.** The physiological adaptations from riding this hard *increase your tolerance for lactic acid* as well as continuing to increase your power. These efforts are also *very tough* mentally as well as physically.

How to do each type is explained later in the article.

Depending on your riding goals you don't need to train at all the levels.

- **Health and fitness riders.** In addition to active recovery, endurance and tempo rides, you will benefit from sprints and VO2 max intervals; however, if you don't want to do either of these—don't!
- **Recreational and endurance riders.** In addition to active recovery, endurance and tempo rides you will also benefit from sprints, VO2 max intervals and sweet spot training; however, if you don't want to push yourself that hard I won't fault you.
- **Fast club riders and racers.** In addition to active recovery, endurance and tempo rides you will benefit from also training at all five of the above intensity levels.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

However, if you don't want to push all the way up to super-threshold, then don't inflict the pain on yourself.

Rules for Intensity Training

Some riders like unstructured intensity rides—I do. For example, ride a course with three to five rolling hills. Ride to the first hill to warm up. As the main part of the workout climb each hill at the planned intensity and recover until the next climb. After the climbs then cool down by riding home. Other riders like more defined structured intervals. For example, warm up for at least 15 minutes in zones 2 and 3. For the main set repeat 3 to 5 times [5 minutes in the sweet spot and 3 minutes recovery]. Cool down for at least 15 minutes. Both unstructured and structured intensity workouts work. Whether you do unstructured or structured intensity, follow these rules:

- **Always warm up** before a main set of intensity and always cool down after.
- **Mix hard and easy riding** during each main set.
- **Ride at the target intensity.** You've planned a workout to have a certain training effect. If you go harder or easier your efforts won't bring about the specific physiological adaptations you are trying to achieve.
- **Start timing the interval when you start riding hard.** RPE and power respond immediately to an increase in effort; however, your heart rate may lag the increase in intensity. Stop timing the interval when you stop pedaling hard; your heart rate may not fall immediately
- **Always recover fully before the next hard effort** unless you are training to hammer club rides or race.
- **Don't struggle to maintain intensity.** If you can't stay in the intensity zone planned for the main set of a workout then just cool down and go home. Riding below the target intensity will just fatigue you without the intended training benefit. If you continue below the planned intensity, then you'll just need more recovery time before an effective training session.
- **Build intensity appropriately during the main set** rather than peaking early and then fading. For example, if you're riding in the sweet spot up five hills try to pace yourself so that you're putting in your best effort on the fourth or fifth hill rather than on the first and second.
- **Plan a range of efforts**, for example, three to six repeats. The number you actually do should depend on how many *quality repeats* you can do at the planned intensity.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **Stop with one more hard effort still in your legs.** Always end the main set feeling like you could have done one more good effort.
- **Master the starting range of efforts before increasing the overload.** For example, the starting range is 3 – 5 repeats of [6 – 8 minutes hard with 3 – 4 minutes of recovery between each hard effort]. Start with 3 repeats of 6 minutes hard with 3 minutes of recovery between each. Build up to doing 5 repeats of 8 minutes hard with 4 minutes recovery between each. Only then increase the overload.
- **Master the finishing range of efforts before stepping up to the next level of intensity.** For example, by the end of your sweet spot training you should be able to do a total of 20 – 40 minutes (plus recovery) in the sweet spot. When you can do 20 minutes, then you *may* step up to sub-threshold training *depending on your goals*.
- **Increase overload by increasing just one of the following** at a time:
 - Increase the number of repeats
 - Increase duration of the hard efforts
 - Reduce the recovery between hard efforts
 - Increase the intensity of the recovery breaks between hard efforts, still staying below the intensity of the hard efforts.
 - Step up to the next level of intensity. When you increase the intensity, start with shorter and / or fewer intensity efforts and build back up.
- **The harder the effort, the shorter the duration.** Sweet spot efforts are the longest, sub-threshold are shorter, super-threshold are even shorter, VO2 max are very short and sprints are the shortest.
- **The harder the intensity, the more days of recovery you need** between sessions. You may do two days of tempo workouts in a row *if* you can do a quality workout the second day. Allow *at least* one recovery day between sweet spot workouts and *at least* two days between sub-threshold, super-threshold, VO2 max and sprint workouts.

Gauging Progress

Whether you use RPE, a heart rate monitor or a power meter to gauge intensity, repeating your baseline time trial every 4 to 6 weeks on the same course under the same conditions is a good idea.

If your time is improves then your power and pedaling economy are improving.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **RPE.** If you are using RPE, as you get faster your power is increasing and you will be faster at the same perceived effort.
- **Heart Rate.** If you are using a heart rate monitor your average heart rate for the time trial *may* go up. This means that your lactate threshold is increasing, that you can put out more power and go faster before you start to accumulate significant amounts of lactic acid in your blood. If your LT goes up, then you should redefine your heart rate zones.

Don't worry if your LT doesn't go up as long as your time improves, which means that your efficiency and power are increasing. If you are already pretty fit your LT may not change with training.

- **Power.** If you are using a power meter, then if your time improves your Normalized Power has gone up and you should redefine your FTP and training zones.

Beware of Excess Stress

Intensity training is like prescription medicine: not enough and you won't get better, too much or the wrong kind and you might get worse!

Neal Henderson is the former director of Sports Science at Colorado's Boulder Center for Sports Medicine and was USA Cycling's Coach of the Year in 2009. He coaches both top-notch pros and budding amateurs.

In an interview with *VeloNews* Henderson said, "I try to seek the point of maximum adaptation to the minimum of training stress, rather than to try to achieve the greatest level of fatigue. Excessive fatigue does not guarantee improvements or adaptations."

In a talk he added that 75% of the athletes he sees over-train (too much and / or too hard), 10% under-train and 15% get it right—usually pros that are paid to race. When in doubt, err on the side of less volume and less intensity.

If you aren't improving, you may be on the verge of overtraining, especially if your performance in your baseline time trials isn't improving. Instead of adding more overload, try reducing the total overload and adding more recovery—this usually allows improvement.

Your Personal Training Plan

Your training plan depends why you ride, your specific goals and *the kinds of riding that are fun for you*. Many roadies cycle for good health and fitness and don't have any specific goals. This may be you. Including *appropriate intensity efforts at the right times*

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

of the year will improve your health and fitness. You don't need to hurt very much — that's no fun!

Some roadies enjoy a half-day or more in the saddle. If this is you, then mixing in *the right kinds of hard riding at the best times of the year* will let you ride *more challenging courses and not fatigue as soon*. A little of the right kind of training that does hurt will actually make your longer rides more enjoyable.

Other roadies ride in the weekend hammerfest. Progressing through the *levels on intensity in the right seasons* will give you the *fitness to dust your buddies*. You won't suffer as much if you train the right way at the right intensities.

The Training Year

To train most effectively divide your cycling year into phases, each with a different purpose. The phases vary depending on your goals:

- **Preseason.** The purpose is to *get used to riding again* after the off-season. If you've been moderately active during the off-season, then a month of preseason is enough. If you are coming off the couch, then two months will be better.

My eArticle [Productive Off-Season Training](#) describes appropriate activities for cardiovascular endurance (including cross-training and indoor cycling), pedaling technique, strength and flexibility.

- **Base Phase.** The purpose is to continue to *improve your endurance*, your capacity to transport oxygen, the blood supply to your muscles and your ability to utilize fat as a fuel. If you are a health and fitness rider, then one or two months will provide a good base. If you are a club rider and want to build power and speed, then you need a longer base of two to three months. If you plan to do rides of 50 to 100 miles (100 to 200K) or to race, then two to four months will be better. As a rule of thumb, your Base Period should be at least 50% longer than the following Build Period.

My eArticle [Spring Training](#) includes four different 10-week workout plans depending on how much riding you've done in the winter and your goals. Each 10-week plan is divided into two 5-week blocks, so you can tailor a plan to the time you have available.

- **Build Phase.** The purpose is to *increase your power* while maintaining an endurance base. A few weeks are sufficient to start getting the benefits, and six to eight weeks are better. This is when club, endurance and performance riders start intensity workouts.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **Main Season.** The purpose is to *enjoy riding, maintain the fitness that you've built and to reach your goals.* To maintain power and speed, you continue some of the intense types of riding that generated your improvement, although you don't need to do as much hard riding unless these hard rides come naturally in your favorite type(s) of events.

My eArticle [Your Best Season Ever, part 1: How to Plan and Get the Most Out of Your Training](#) describes in detail how to plan the phases to your personalized training plan.

Here are three different scenarios for three different types of riders with different goals. Each one gives suggested percentages of riding time for different phases and intensities.

Health and Fitness Riders

This scenario is for riders who want to improve overall health and fitness. VO2 max efforts and sprinting aren't necessary for good health; however, including either will improve your overall fitness.

The total time for VO2 max riding includes warm-up and cool-down totaling at least 30 minutes per ride and the time of the main intensity set(s). The main set(s) includes both hard and recovery efforts.

Period	Purpose	Recovery Pace	Endurance Pace	Tempo Pace	VO2 Max	Sprinting
Pre-season	Get used to riding	20-50%	50-80%	0-10%		
Base	Build endurance	20-30%	50-70%	10-20%		
Build	Increase cruising speed	20-30%	40-60%	20-30%	Optional up to 10%	Optional
Main season	Have fun and maintain fitness	10-20%	50-80%	10-30%	Optional up to 10%	Optional

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Club and Endurance Riders

The club and endurance scenario is for riders who want to do long rides at a faster cruising speed, i.e., improve power and climbing. Start at the lower end of the range for tempo riding and build to the upper end. Then graduate to sweet spot riding and build to the upper end of the range. In the Main season you do less volume of intense riding—just enough to maintain power.

The total time for sweet spot and harder riding includes warm-up and cool-down totaling at least 30 minutes per ride and the time of the main intensity set(s). The main set(s) includes both hard and recovery efforts.

Period	Purpose	Recovery Pace	Endurance Pace	Tempo Pace	Sweet Spot	VO2 Max	Sprinting
Pre-season	Get used to riding	20-30%	60-70%	10-20%			
Base	Build endurance	10-20%	50-70%	20-30%	Optional up to 10%		Yes
Build	Increase power and speed	20-30%	40-60%	10-20%	10-20%, <i>OR</i>	Optional 5 - 10%	Yes
Main season	Have fun, ride events & maintain fitness	10-20%	30-50%	20-30%	5-15%, <i>OR</i>	Optional up to 5%	If fun

Performance Riders

The Performance scenario is for riders who like to do fast club rides or race and want to improve power, speed and climbing. Start at the lower end of the range for tempo, build to the upper end, then move up to sweet spot efforts and build to the upper end of that range. If your Main season rides will include very hard riding around your LT or FTP

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

you could include some sub- and super-threshold and VO2 max riding during the Build and Main season phases. If you add in sub- and super-threshold and VO2 max riding, then decrease your sweet spot riding by more than the same volume because the harder riding puts significantly more stress on your body. In the Main season you do less volume of intense riding—just enough to maintain power.

The total time for sweet spot and harder riding includes warm-up and cool-down totaling at least 30 minutes per ride and the time of the main intensity set(s). The main set(s) includes both hard and recovery efforts.

Period	Purpose	Recovery Pace	Endurance Pace	Tempo Pace	Sweet Spot	Sub-Threshold	Super-Threshold	VO2 Max	Sprinting
Pre-season	Get used to riding	20-30%	60-70%	10-20%					
Base	Build endurance	10-20%	40-60%	30-40%	Optional up to 15%				Yes
Build	Increase power & speed	20-30%	40-60%	10-20%	10-20%, <i>OR</i>	Optional 10-15%, <i>OR</i>	Optional up to 10% <i>OR</i>	Optional 5 – 10%	Yes
Main season	Have fun, ride events & maintain fitness	10-20%	30-50%	20-30%	5-15%, <i>OR</i>	Optional 5-15% <i>OR</i>	Optional up to 10% <i>OR</i>	Optional up to 5%	Yes

Be flexible

All of the percentages above are recommendations; however, they may not fit your riding at one or more times during your year. That’s okay as long as you follow the general

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

logic of each plan. For example, you may want to do more tempo riding and less endurance riding in a phase. It's fine to do somewhat more tempo riding to fully customize the plan. Just don't eliminate a particular pace from the plan—each type of riding is there for a reason.

Types of Workouts

Some riders like structured workouts with measured periods of intensity and recovery. Others prefer unstructured workouts that just mix intense efforts with easy cruising. I coach riders using both approaches. They all get fitter! And you don't have to stick to just one or the other.

Here are some sample workouts. Before you start any of these, review the [Hierarchy of Intensities](#) so that you tackle them in the proper order. Then identify your training objective(s) in this table. Click on the link to jump to those workouts. While planning and doing the workouts follow the [Rules for Intensity Training](#).

Training Objectives and Intensities

Training Objective	Zone	Hughes RPE	RPE	Heart Rate % LT	Power % FTP
Recovery	Zone 1	Digestion	1-2	<68%	<55%
Increase Endurance	Zone 2	Conversation	2-3	69-83%	56-75%
Increase Fat-burning and Sparing of Glucose	Zone 2	Conversation	2-3	69-83%	56-75%
Increase Cruising Speed	Zone 3	Headwind	3-4	84-94%	76-90%
Increase Power	Sweet Spot	Short hill	4-5	93-97%	88-94%
Improve Riding at LT or FTP	Zone 4	Sub-barf	5-6	95-100%	91-100%

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

<u>Increase Racing Speed</u>	Zone 5	Barf	6-7	101-105%	101-105%
<u>Increase VO2 Max</u>	Zone 6	Eyeballs Out	8+	106-120%	106-120%
<u>Improve Sprint</u>	Sprints	Ouch!	10	N/a	N/a
<u>Improve Pedaling Economy</u>	Sprints	Ouch!	10	N/a	N/a

Active Recovery

Zone 1: Digestion pace, RPE 1-2, <68% of LT, 55% of FTP.

Recovery rides metabolize fat and require lots of oxygen. You should be riding so slowly that you almost feel embarrassed to be on the bike.

Unstructured Training

- **Errands.** Don't bother to put on your cycling kit. Just hop on your bike and ride to the store, post office, bank, etc.
- **Commute.** Ride your bike to work and back. You'll fit in more training and help the environment.
- **Lunch break at work.** Take your bike to the office. At lunch go for a short ride, pick up a sandwich, ride back to work and eat at the office after your break.
- **Family.** Go for rides with your kids or non-riding significant other. Multi-use paths without cars are great for this.

Structured Training:

- Same types as unstructured training.

Increase Endurance

Endurance rides metabolize primarily fat with some glucose and require lots of oxygen. You should easily be able to carry on a conversation.

Zone 2: Conversational pace, RPE 2-3, 69-83% of LT, 56-75% of FTP

Unstructured Training:

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **Club rides.** On longer rides with friends or with your club, pay attention to your pace and keep talking. Don't ride too hard or you'll lose the benefits of endurance training. Don't worry about time off the bike—stop for coffee, admire the views, enjoy the ride.
- **Ride to lunch.** Make your longer endurance rides more enjoyable by riding at a conversational pace to a café and then riding at digestion pace afterward.
- **Longer commutes.** A great commute is a short recovery pace ride in the morning—don't even break a sweat—and then an endurance pace ride as long as 60 to 90 minutes on the way home.
- **Family outings.** If the family doesn't ride with you, arrange to meet them a few hours away for a picnic or other excursion.

Structured Training:

- Same types as unstructured training

Increase Fat-burning and Sparring of Glucose

Zone 2: Conversational pace, RPE 2-3, 69-83% of LT, 56-75% of FTP

Unstructured and Structured Training

- See the workouts above for Increase Endurance

Increase Cruising Speed

Tempo rides continue to metabolize fat and also burn more glucose with oxygen. Riding slightly harder than your normal endurance pace will increase your cruising speed. You should still be able to carry on a conversation in short sentences but not whistle.

If you like unstructured intensity efforts approximate these times. If you prefer structured intervals use a more regular pattern.

After warming up start your main set with 2 to 4 hard efforts of 6 to 15 minutes. The recovery time between each interval is 25 to 50% of the duration of the hard effort. Increase the number and / or duration of the hard efforts week by week until you are doing 2 or 3 hard efforts of 20 to 30 minutes each, totaling about 40 to 90 minutes. Then continue the hard efforts of that length and decrease the recovery between hard efforts until you are riding 60 to 90 minutes without recovery.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Zone 3: Headwinds / hills pace, RPE 3-4, 84-94% of LT, 76-90% of FTP

Unstructured Training:

- **Rolling hills.** Ride up each hill breathing deeply but able to talk. Recover on the way down. These work best on less steep, fairly long hills or up a valley.
- **Headwind.** Ride into the wind early and then enjoy the tailwind home. It's a great workout and good fun.
- **Brisk after-work ride.** Riding home increase your average speed by 1-2 mph (1.5-3 km/h). Remember, you are riding more briskly, not time trialing.
- **Coffee stop.** Ride at a brisk pace to a coffee house and then cruise home at a conversational pace.
- **Hustling.** Up the pace to get home before dark or approaching rain.

Structured Training:

- **Intervals.** Follow the guidelines above.
- **Farm roads.** If your area has a grid of roads, ride briskly to a road, then easily to the next intersection, then hard, etc. Or you can ride around a rectangle. Two miles briskly, right turn and a mile easily, right turn and two miles hard, right turn and then easily back to the start. Or you can use mileage markers along a road.
- **Leading the bunch.** Take consistent long turns at the front of a group; say for 7 or 8 minutes.
- **Aerobic time trials.** After a month or so of tempo rides, ride an *aerobic* time trial of 30 – 60 minutes. Go steady and fast, but staying in zone 3. Every month repeat the time trial, trying to go farther but still able to talk a bit.

Higher Intensity Workouts

The types of intensity rides—sweet spot, sub- and super-threshold and VO2 max—are the same; however, the intensities and durations of each type of effort are different. The harder the effort, the shorter the duration of the effort. Sweet spot efforts are the longest, sub-threshold efforts are shorter, super-threshold efforts are even shorter and VO2 max efforts the shortest.

If you are very fit you may, of course, increase the number and / or duration of the efforts beyond what is recommended *as long as you are doing high quality efforts, not struggling.*

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

A particular type of workout, for example hill climbs, can be used at several different intensities. When you are looking at different workouts for one intensity also look at other intensities for additional options.

Increase Power

Sweet Spot rides build sustained power. If you like unstructured intensity efforts approximate these times. If you prefer structured intervals use a more regular pattern.

For the main set, start with 3 to 5 hard efforts of 4 to 6 minutes. The recovery time between each hard effort is 50% the duration of the hard effort. Increase the number and / or duration of the hard efforts week by week until you are doing 2 or 3 hard efforts of 10 to 20 minutes, totaling about 20 to 40 minutes and reduce the recovery time between each hard effort to 25% the duration of the hard efforts.

Zone: Sweet Spot Short hill pace, RPE 4-5, 93-97% of LT, 88-94% of FTP).

Unstructured

- **Push up the hills.** Use the same course you use for tempo rides, just go little harder.
- **Mixed climbing.** Most climbs don't have a constant grade. Push significantly harder on the steeper sections and really back off when it's less steep.
- **Use the wind.** This takes discipline. Ride into the wind for a while, turn around and recover for a bit and then turn around and ride into the wind again. Your reward is riding home with a tailwind!
- **Hustling.** Similar to the tempo workout alternate riding at a conversational pace with some sections of sweet spot riding to get home before dark.
- **Paceline.** Take about 4- to 8-minute pulls in a brisk (not racing) paceline.

Structured:

- **Intervals.** Follow the guidelines above.
- **Pyramid.** Climb up a pyramid of successively longer intervals and then work your way back down. Here is a 27-minute pyramid:
 - 2 min sweet spot and 1 min recovery
 - 4 min sweet spot and 2 min recovery
 - 6 min sweet spot and 3 min recovery
 - 4 min sweet spot and 2 min recovery
 - 2 min sweet spot and 1 min recovery

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **Ladder.** Just go up the pyramid. You could climb even higher to 8 minutes sweet spot and 4 minutes recovery, etc. These are physically and mentally very tough.
- **Descending.** Just descend the pyramid. You could start even higher at 8 minutes sweet spot and 4 minutes recovery, etc. These get easier as you go down!
- **Farm roads.** It's easier psychologically to push yourself to a certain point than to keep looking at your watch and thinking about how much longer you have to suffer. If your area has a grid of farm roads, use the grid the same way you did for tempo rides.
- **Teammate pulls.** Alternate sweet spot pulls with another rider. This is better than riding in a paceline since you're pulling half the time riding with your buddy.

Improve Riding at LT or FTP

Riding just below your LT or FTP you are metabolizing glucose without enough oxygen and building more power. If you like unstructured intensity efforts approximate these times. If you prefer structured intervals use a more regular pattern.

For the main set, start with 3 or 4 hard efforts of about 3 to 5 minutes. The recovery time between each hard effort is 50% to 75% the duration of the hard effort. Increase the number and / or duration of the hard efforts week by week until you are doing 2 or 3 hard efforts of about 8 to 10 minutes each, totaling about 15 to 30 minutes and with the recovery time between each hard effort 50% the duration of the hard efforts.

If you race formally or informally on group rides you may make these longer.

Zone 4: Sub-barf pace, RPE 5-6, 95-100% of LT, 91-100% of FTP.

Unstructured:

- **Hammer hills.** Use the same course you use for sweet spot rides, just go harder.
- **Race to the city.** Start at least several miles away (so that it takes at least 5 minutes) and race to the city limit sign.
- **Escape and chase.** Send a rider down the road. Let a 1- or 2-minute gap open, then chase back into contact. For a tougher workout escape down the road yourself and let the group chase you.
- **Fast group.** Riding with a group that's *a little faster* than your normal pace is a classic way to improve fitness.
- **Pick a destination.** In open country ride hard to a landmark you can see.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Follow Coach Hughes <https://twitter.com/HughesCoaching> and
<https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Structured:

- **Intervals.** Follow the guidelines above.
- **Yo-Yo.** Mix longer and shorter intervals, for example:
 - 8 minutes Z4 & 4 minutes easy
 - 2 minutes Z4 and 1 minute easy
 - 6 minutes Z4 and 3 minutes easy
 - 2 minutes Z4 and 1 minute easy
 - 4 minutes Z4 and 2 minutes easy
- **Hill repeats.** Start at a specific point and climb hard for a certain time, e.g., 5 minutes. Spin back down and recover for a couple of minutes. Attack the hill again and try to go a little farther. Start with 2 or 3 repeats. As you get stronger increase the number of repeats and / or the time.
- **Time trial.** Repeat your baseline time trial. Or challenge a friend to race up your favorite climb. Time trials are very hard mentally as well as good training so unless you race, don't do one every week.

Increase Racing Speed

Riding above your LT or FTP you are metabolizing more glucose without enough oxygen and improving your tolerance of lactic acid. If you like unstructured intensity efforts approximate these times. If you prefer structured intervals use a more regular pattern.

For the main set, start with 2 or 3 hard efforts of about 2 to 4 minutes. The recovery time between each hard effort is 50% to 75% the duration of the hard effort. Increase the number and / or duration of the hard efforts week by week until you are doing 2 or 3 hard efforts of about 4 to 6 minutes each, totaling about 10 to 20 minutes and with the recovery time between each hard effort 50% the duration of the hard efforts.

If you race formally or informally on group rides you may make these longer.

Zone 5: Barf pace, RPE 6-7, 101-105% of LT, 101-105% of FTP).

Unstructured:

- **Hill accelerations.** Hammer short hills and go even harder toward the top.
- **Race to the city.** Start about a mile or two away and race to the city limit sign.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **Race to the stop sign.** On a road with frequent stops hammer to a stop sign, make a complete stop, soft pedal until you are fully recovered and hammer to the next stop.
- **Paceline.** Take fast pulls in a racing paceline.

Structured:

- **Intervals.** Follow the guidelines above.
- **Hill repeats.** It's often easier to push yourself to the limit on hills than on a flat road. Use the same method as sub-threshold repeats, just don't go as long.
- **Fast miles or kilometers.** See how fast you can ride 2 miles or 3 km, recover and repeat trying to beat your time.
- **Time trial.** Your sub-threshold pace (zone 4) is the pace at which you could ride a 60-minute time trial. In a significantly shorter time trial you're in zone 5. Challenge a friend to time trial or ride your club's time trial. Time trials are very hard mentally as well as good training so unless you race, don't do one every week.

Increase VO2 Max

Your VO2 max is the maximum amount of oxygen that your muscles can use. Your muscles don't naturally use all of the oxygen that your blood supplies (low VO2 max). Training significantly above your threshold brings about structural changes in your muscles and in your metabolism so that your muscles use more of the available oxygen. If you like unstructured intensity efforts approximate these times. If you prefer structured intervals use a more regular pattern.

For the main set, start with 1 to 3 hard efforts of about 1 to 2 minutes. The recovery time between each hard effort is 100% to 200% the duration of the hard effort. Increase the number and / or duration of the hard efforts week by week until you are doing 2 to 4 hard efforts of about 2 to 3 minutes, totaling about 5 to 15 minutes and with the recovery time between each hard effort still 100% – 200% the duration of the hard efforts.

Zone 6: Eyeballs out pace, RPE 8+, >105% of LT, 106-120% FTP

Unstructured:

- **Race a friend.** This provides motivation!
- **Over the top.** Climb at a tempo pace and then accelerate very hard over the top.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **Pace with a car.** On a road with a good shoulder and slow speed limit try to keep up with a car. Don't draft – it isn't safe!

Structured:

- **Intervals.** Follow the guidelines above.
- **Hill repeats.** It's often easier to push yourself to the limit on hills than on a flat road. Use the same method as other workouts, just don't climb as long and recover more between each interval.
- **Very fast mile or kilometer.** Do the same workout as you do for zone 5, just go harder for a shorter distance with more recovery in between.

Improve Sprint

Sprinting you will exhaust your available ATP and train your muscles to store more ATP and go longer until they run out of ATP. If you like unstructured intensity efforts approximate these times. If you prefer structured intervals use a more regular pattern.

For the main set, start with 1 to 3 hard efforts of about 10 to 20 seconds. The recovery time between each hard effort is at least 5 minutes. You *may* increase the number and / or duration of the hard efforts week by week until you are doing 2 to 4 hard efforts of about 30 to 40 seconds each and still recovering for at least 5 minutes between each. You could include these in an endurance or tempo ride with as much as 30 minutes recovery between each.

If you race you may do longer sprints; however, sprints of a minute or more are really VO2 max efforts.

Sprints: Ouch pace, RPE 10, LT and FTP are not applicable.

Unstructured:

- **Race a friend.** This provides motivation!
- **Chase cars.** Pick a color and every time a car of that color passes sprint after it.
- **Sprinting.** Flat out for city limit signs.
- **Dogs.** Outrunning a dog, the classic speed training from the movie "American Flyer."

Structured:

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **20-second drill:** Repeat 3 to 5 times: Sprint for 20 seconds, go very slow for 40 seconds and then ride tempo (zone 3) for 4 minutes. To increase the overload increase the number of reps. Or increase the length of the sprint and decrease the duration of the very slow riding. Or decrease the duration of riding tempo.

Improve Pedaling Economy

During a sprint your muscles are trying for maximum power so they learn to coordinate better the firing of individual muscle fibers, like improving the timing of your car engine. Use the same workouts as above.

Mixed Intensity

Doing either unstructured or structured intensity workouts can get old. You may mix up the types, intensities and durations of the unstructured and structured efforts to make the riding more interesting.

Zones: During a mixed intensity ride the highest intensity should be one you've already trained at. For example, if you've done several weeks of sub-threshold training you could do a ride that mixes up tempo, sweet spot and sub-threshold riding with endurance riding. Don't include super-threshold since you haven't already trained at that intensity.

Unstructured:

- **License plates:** Use the first digit of a plate to determine the level of intensity by RPE and ride at that intensity for X minutes. X is longer the lower the level of intensity.
- **Chase cars:** Chase different colored cars at different intensities.
- **Pacelines:** Leader gets to decide the pace and duration. Every time you change leaders pedal easily to allow *everyone* to recover.
- **Rolling hills:** Mix up the steepness and / or the length the hills and / or how hard you attack them.
- **Ramps:** Pick a point down the road or the top of a hill and gradually increase your intensity from the bottom of a zone, for example the sweet spot, to the top of the next zone, for example sub-threshold.
- **Formal and informal races.** Riding with the big dogs on the weekend and in organized races mixes up the intensities. Before riding this way train up to the highest level of intensity you'll hammer on one of these rides.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

- **Race simulations.** Mix up the intensities on your own to cover the range and duration of intensities you expect during actual rides.
- **Mountain bike.** This is a great varied-intensity workout and a lot of fun!

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Structured:

- **Pyramid through the gears.** Start in your lowest gear. Every minute shift up one gear. When you get to your highest gear ride in it for a minute. Then work your way down gear by gear until you get to your lowest gear. This is also a good trainer workout to relieve boredom.
- **Tower of pain.** Climb a pyramid of steps of increasing intensity and decreasing duration and then back down. For example:
 - 5 minutes Z3
 - 4 minutes sweet spot
 - 3 minutes Z4
 - 2 minutes Z5
 - 1 minute Z6
 - 2 minutes Z5
 - 3 minutes Z4
 - 4 minutes sweet spot
 - 5 minutes Z3

You could climb the pyramid with no recovery between each effort, or with recovery.

Go for It!

Breaking out of your routine by *varying the intensity* is the fastest way to improve your cycling. Whether you are riding for fitness, going out with the club on the weekend, training for a century, racing or just riding casually, adding intensity will overload your body in beneficial ways—if you include recovery days and weeks to let yourself grow stronger.

By riding differently from day to day you'll also enjoy cycling more. Varying the intensity opens more routes and increases the number and kind of riding partners. You can mix in an easy after-dinner ride with your significant other, a mountain bike ride, a fast club ride and perhaps a monthly time trial.

The variety, progress and enjoyment will improve your motivation. At the end of the week you're more likely to say "What a great week!" and start looking forward to the next one.

We started riding as kids because it was play. Just keep playing. Bet I can beat you to the top of this hill! Let's see who can go fastest in this tailwind! Just keep playing.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

Resources

- Allen, Hunter and Stephen S. Cheung, Ph. D. (2012) *Cutting-Edge Cycling*. Human Kinetics, Champaign, IL
- Allen, Hunger and Andrew Coggan, Ph. D. (2006) *Training and Racing with a Power Meter*. VeloPress, Boulder, CO.
- Connor, Trevor. When Less is More. (February, 2016), VeloNews, Boulder, CO.
- Friel, Joe. (2009) *Cyclist's Training Bible, 4th ed.* VeloPress, Boulder, CO. 2009.
- Friel, Joe. (2012) *Power Meter Handbook*. VeloPress, Boulder, CO.
- Friel, Joe. (2015) *Fast After Fifty*. VeloPress, Boulder, CO
- Henderson, Neal. (July 2010) Interview, VeloNews, Boulder, CO.
- Henderson, Neal (Spring 2010) Talk on Power, Boulder Center for Sports Medicine, Boulder, CO.
- Hughes, John. (2012). [Optimal Recovery for Improved Performance](#)
RBR Publishing Co., Inc., Atlanta, GA.
- Hughes, John and Dan Kehlenbach. (2011). *Distance Cycling: Your complete guide to long-distance rides*. Human Kinetics, Champaign, IL.
- Lanza, Ian R., Befroy DE and Kent-Braun JA, Age-related Changes in ATP-producing Pathways in Human Skeletal Muscle in Vivo, J Appl. Physiol. 99: 1736–1744, 2005.
- Roth, Stephen M. (2006) Why does lactic acid build up in muscles? And why does it cause soreness? Scientific American. <http://www.scientificamerican.com/article/why-does-lactic-acid-buil/>
- Russ, David W. and Kent-Braun JA, Is Skeletal Muscle Oxidative Capacity Decreased in Old Age? Sports Med 2004; 34 (4)
- St. Pierre, Adam. (Fall 2009) Talk on Weight Training for Endurance, Boulder Center for Sports Medicine, Boulder, CO.

About the Author

John Hughes earned coaching certifications from USA Cycling and the National Strength and Conditioning Association. He enjoys coaching riders with a variety of goals and fitness backgrounds. For more information, visit www.coach-hughes.com.

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

John's cycling career includes course records in the Boston-Montreal-Boston 1200-km randonné and the Furnace Creek 508, a Race Across AMERICA (RAAM) qualifier. He has ridden solo RAAM twice and is a 5-time finisher of the 1200-km Paris-Brest-Paris. Much of this was accomplished during a 24-year career at Stanford University, where he balanced a professional career, family and cycling.

John lives in Boulder, Colorado, where he served for 12 years as Managing Director of the UltraMarathon Cycling Association and editor of *UltraCycling* magazine. In 2011 he participated in the International Conference on Cycling and Health in Shanghai, China.

John is the author with Dan Kehlenbach of [*Distance Cycling: Your complete guide to long-distance rides*](#), published by Human Kinetics, Champaign, IL



Other Publications by Coach John Hughes

His other publications available from [RoadBikeRider](#) include:

[Your Best Season Ever, pt.1](#): How to Plan and Get the Most Out of Your Training

[Your Best Season Ever, pt. 2](#): Peaking for and Riding Your Event

[Optimal Recovery for Improved Performance](#)

[Endurance Training and Riding](#): 3-Article Bundle

1. [Beyond the Century](#): How to Train for and Ride 200 km to 1200 km Events
2. [Nutrition for 100 km and Beyond](#): Detailed Nutrition and Hydration Guidance for Successful Distance Riding
3. [Mastering the Long Ride](#): Riding and Finishing 100 km and Longer Events

[Eating and Drinking Like the Pros](#): How to Make Your Own Sports Food & Drink – Nutritional Insight from Pro Teams

[Preventing and Treating Cramps](#)

[Butts, Hands, Feet](#): Preventing and Treating Pain in Cycling's Pressure Points

[Gaining a Mental Edge](#): Using Sports Psychology to Improve Your Cycling

[Cycling Past 50 series](#): 4-Article Bundle

1. [Healthy Cycling Past 50](#)
2. [Healthy Nutrition Past 50](#)

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes

3. [Off-Season Conditioning Past 50](#)
4. [Performance Cycling Past 50](#)

[Cycling Past 60: 2-Article Bundle](#)

1. [Part 1: For Health](#)
2. [Part 2: For Recreation](#)

[Cycling Past 50, 60 and Beyond: Fit for Life](#)

[Cycling Past 50, 60 and Beyond: Training with Intensity](#)

[Cycling Past 50, 60 and Beyond: Peak Fitness](#)

[Cycling in the Heat: 2-Article Bundle](#)

1. [Cycling in the Heat, Part 1](#): How to acclimate, how to ride in the heat, what to wear, what to eat and how to keep cool
2. [Cycling in the Heat, Part 2](#): How to assess your needs and develop a personal hydration and electrolyte plan

[Productive Off-Season Training](#): Two 12-week Programs

[Spring Training](#): 10 Weeks to Summer Fitness

[Year-Round Cycling](#): How to Extend Your Cycling Season

[Stop Cycling's Showstoppers](#): How to Eliminate the Things that Keep You from Reaching Your Goal

Follow Coach Hughes <https://twitter.com/HughesCoaching> and <https://www.facebook.com/john.hughes.5283> © Copyright 2016 by John Hughes