

# **Heart rate, Lactates and all the Stuff – Physiology for the Practicing Coach.**

**By Wayne Goldsmith**

Coaches are always looking for an edge – a new idea or innovative technique that might provide their athletes with a performance advantage.

Sports scientists are in the same game. They search for evidence to support ideas that may lead to breakthroughs in sports training techniques and competition performances.

Sports science is not a magic trick or short cut or easy way to the top. The methods and techniques of sports science are tools – and like the tools of any trade their effectiveness lies in the skills of the user.

The challenge is to provide the coaches and athletes with what they need – an edge – without giving them too much information or the wrong type of information and pushing them over it!

## **Tricks of the Trade – Physiology and coaching**

The basic tricks of the trade for physiology are the H.E.L.P.P. techniques:

- HEART RATE
- ENERGY SYSTEMS – TRAINING ZONES
- LACTATE
- PERCEIVED EXERTION

These basic techniques are used to help the coach determine the key aspect of training - EXERCISE INTENSITY – how hard the athlete is working.

Whilst the VOLUME of training is an important issue, it is intensity of training that is the key determinant of how the athlete responds and adapts to the training program.

Intensity of training is THE key aspect of exercise physiology. Training adaptations, fatigue, recovery and other issues are all directly effected by training intensity. Successful coaches must have a thorough understanding of training intensity, how to manipulate to achieve performance goals and very importantly how to measure it.

To illustrate this, consider swimmers training 30 kilometres in training in a given week. The volume of training is 30 kilometres and there are some physiological adaptations that will occur because of that volume. However, the key to the physiological adaptations is the intensity of training done.

For example the swimmer could:

Swim slowly for 5 kilometres per session for 6 days and enjoy one day off.

Swim slowly for 10 kilometres each session on 3 days and enjoy one day off.  
Complete 3 x 10 kilometre hard sessions all at or near maximum speed.  
Complete a 20 kilometres open water swim one day then 5 x 2 km time trials at or near maximum speed over the next 6 days.

There are countless combinations of training activities that could be completed as part of the 30 kilometres training volume. However it is the changes and variations in the intensity of training that will determine if coach and athlete achieve their program outcomes.

### **Primary and secondary measures – An important concept.**

It is important here to distinguish between primary and secondary measures. A primary measure is the more constant or controllable of the measures. For example, consider a swimmer training over 400 metres. The primary measurements here are time and distance as they can be accurately and reliably measured.

The secondary measure in this situation might be heart rate as it can not be measured with the same accuracy as time and distance (especially if it is being measured manually) and it is subject to many other internal and external factors.

The coach generally wants to know how hard the athlete is working at a specific speed over a specific distance. With speed and distance known, then secondary variables such as heart rate and lactate can play an important role in providing feedback on the fitness level and progress of the athlete.

### **Heart Rate**

Once the panacea of sports physiology, heart rate as the primary determinant of exercise intensity is increasingly coming under attack. The reason stems from heart rate being a very volatile indicator of what is happening to the body. For example, heart rate is affected by caffeine, alcohol, fatigue, hydration, nervous system arousal, mental stimulation and many other factors. As it is so volatile and subject to so many factors and daily fluctuations that basing training loads exclusively on heart rate is not logical.

However, heart rate is a valuable tool when used in combination with other measures of exercise intensity. In swimming coaches use speed or time as the primary measure and heart rate as a secondary measure. The reason is that speed and time can be standardised and measured accurately – heart rate can not.

A coach would want to know what is the athlete's heart rate at a set speed or at a specific time to provide valuable information on the progress of physiological adaptations that are being targeted by the training program.  
However.....No one wins gold medals for having the best heart rate: it is one tool – not the “magic pill!”.

Recent research suggests that heart rates taken manually, particularly at intensity levels above 130 beats per minute are very inaccurate and heart rate should not be the exclusive determinant of higher intensity exercise.

## **Energy Systems / Training Zones**

This is one of the most confusing areas of exercise physiology primarily because the sports scientists themselves can not agree on the number or nature of training zones that can be recognised and utilised in training for sport.

Some sports scientists recommend 3-4 aerobic training zones alone and up to nine different training zones in total!!!

It is impractical and unrealistic to expect that a coach – especially a coach working with team sports in a field situation – can identify at most any more than 3 or four training zones.

For practical purposes the most readily identifiable and useable zones are:

- Recovery level, relaxed, comfortable
- Low intensity, easy aerobic
- High intensity, sustained pace work – what some might call threshold training
- Specific pace work at the speed of the targeted competition (with race specific dynamics)
- Speed development work (neuro muscular training).

Whilst it is possible to identify other zones in a laboratory setting with an individual athlete, for all practical purposes, these four training zones will cover the vast majority of training needs for the majority of sports.

## **Lactate**

Lactate is one indicator of how hard the body is working in terms of the relative contribution of the aerobic and anaerobic systems. In general terms, the greater the athlete uses their anaerobic system to produce the power and energy to perform an activity, the higher the level of lactate will be.

Lactate is produced in working muscles during hard work and high intensity efforts. The lactate then “leaks” out of the muscle into the blood where it can be collected by a simple blood sampling technique usually from the ear lobe or finger.

The challenge with lactate as a measure of exercise intensity is that it too is subject to variables such as nutrition, recovery level and fatigue. It is relatively expensive to use and for coaches working with teams of athletes with limited support or assistance is highly impractical.

## **Perceived Exertion**

The concept of perceived exertion relies on the subjective judgement and “feel” of the athlete to provide feedback on the intensity level of the training activity.

For example, an athlete may be asked to perform a training activity at a specific intensity level. The coach may chose to prescribe the intensity level not in terms of objective measurements like speed or time, but in terms of how the athlete “feels” these things.

Whilst there are documented scales of intensity, many coaches and athletes formulate simple scales that are practical and meaningful to them. A one to five scale is popular and when used in combination with other measurements can give a relatively accurate understanding of the athlete’s intensity level.

<b>INTENSITY LEVEL</b>	<b>FEELS LIKE</b>	<b>EQUATES TO</b>
1	Very relaxed	Recovery
2	Easy	Easy Aerobic
3	Tough	Threshold
4	Very hard – uncomfortable	Race Pace
5	Fast but not hard	Speed / Neural

The downside to using perceived exertion levels is that each athlete’s subjectivity about how things “feel” applies to that individual only. A “four” for one athlete may feel like a “two” for another athlete. Also the feel and rating of an activity may change from day to day as the athlete’s level of fatigue, motivation , attitude and recovery status change.

So what is the best way for a coach to determine the intensity level of training activities?

Recent research (see references) has suggested that heart rate taken by manual palpation is so inaccurate that alternate methods should be sought. Lactate – even with the introduction of hand held portable analysers over recent years is expensive and generally impractical for the majority of coaches. Both heart rate and lactate are subject to a wide range of influences and variables that question the validity of using them in many field situations.

In the end, the coach must determine the most appropriate way of monitoring training intensity in their athletes. As athletes become more experienced and get older, it is important that the coach take time to demonstrate and teach athletes to self manage and self monitor so that they themselves can determine accurate training loads.

A summary of the research suggests that the best way may be a combination of two or more of the above physiological measurement techniques.

**Practical Example:**

Coach and athlete meet at the training venue.

The coach has determined that the training activity should be completed at a moderate pace.

The instruction from coach to athlete may go something like this:

“I would like you to swim 400 freestyle somewhere around 5:30 pace. It should feel about six out of ten pace. Just steady swimming. Moderate effort”.

In this instruction, the coach has given the athlete the same information three ways and has clearly indicated the intensity of the workout. The athlete, educated and trained to understand accurate pacing and the concept of perceived exertion performs the training activity to the demands of the coach.

On the completion of the 400 metre swim, the coach takes the athlete’s heart rate to determine how hard the athlete is working at the prescribed training pace.

The coach and athlete then exchange “FEEL” and “FEEDBACK”.

Coach: “It looked good. It looked comfortable. How did it feel?”

Athlete: “It felt easy. About 6 out of ten. What was my time?”

Coach: “The time was 5:28. Nice pacing”.

Athlete: “What about heart rate?”

Coach: “Pretty comfortable – about 140”.

Through the interaction of coach and athlete and the combination of “feel” and feedback, the training session can be fine tuned to achieve the program goals.

**In most cases, simplicity is the key.** An educated athlete with a strong feel for pace and an understanding of how their body works, training together with an intelligent coach who has an understanding of and empathy for their athlete AND an understanding of the principles of sports science can achieve anything.

Whilst sports physiology can provide coaches and athletes with technology and tools to measure a wide range of responses and adaptations, often it comes down to what is practical, simple, immediate and affordable.

Just as no sensible investor put all their eggs in one basket, no coach or athlete should place all their faith in one particular physiological measure or technique.

It is with a combination of the art of coaching and the feel for the athlete together with the science of sport through the appropriate use of heart rate and other measurement techniques that the most effective training methodologies lie.

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