CompassSport Series - Fitness for Orienteering

Training Intensity – Getting it Right!

This series of articles is covering a range of topics within the field of strength and conditioning, with the aim of helping to develop the orienteer's physical performance, irrespective of age or ability. In this issue, we revisit the training factor of 'intensity' and discuss methods of gauging this…..

In one of the early articles in this series (Murgatroyd, 2010), we discussed the issue of training intensity and looked at the importance of assessing this accurately, alongside the difficulty for orienteers of gauging effort precisely during exercise. Research has shown that many individuals often tend to train in a 'comfort zone', usually pitched around 70-75% of maximum, and end up churning out a generic mass of steady state exercise that tends to result in a plateau effect (Foster et al., 2001). The orienteer that falls into this trap ends up becoming one-paced and often frustrated by their inability to make further gains in fitness and performance. More careful assessment of training intensity and use of other tools, such as a periodised approach to fitness work, often results in significantly improved levels of performance and can help in avoiding other issues, such as fatigue, boredom and staleness (Esteve-Lanao et al., 2007). This article explores how to calculate intensity to ensure that each session undertaken is set to the appropriate level, and given a definite focus that will hopefully avoid many of the issues mentioned above.

Calculation of Training Intensity

In the previous article on this topic, we looked briefly at the variety of methods exist to calculate the appropriate exercise intensity for training sessions, varying from simple, imprecise techniques, such as gauging effort through perceived exertion, to complex, potentially expensive methods, such as calculating exact levels via laboratory testing. Obviously, use of the first method, whilst easy and inexpensive, is undermined by inaccuracy and subjectivity and the orienteer that is serious about their training should be looking to be more scientific and precise in their approach. We will thus outline two relatively cheap, yet effective, methods for ensuring exercise intensity is set at the correct level.

Use of heart rate monitoring

This was discussed previously in some detail (Murgatroyd, 2010), but is worth revisiting here. The use of heart rate monitors by athletes in a wide range of sports has increased enormously in the past fifteen years and basic models can be acquired for relatively low cost. They provide the orienteer with a solid basis to calculate intensity, and monitor this quickly and easily throughout their sessions, particularly those of a steady state, aerobic nature.

Heart rate training zones are calculated by taking into consideration an individual's maximum and resting heart rates (MHR and RHR, respectively). To determine RHR, take three measurements on separate days, ideally not following a demanding day's racing/training. On waking, and before getting out of bed in the morning, take a fifteen second count (and multiply by 4) to determine resting pulse rate (beats/min). Use the lowest value recorded over the three separate days as the absolute RHR.

To determine maximal heart rate (MHR) use one of the three methods below:

1) Wear a heart rate monitor (HRM) during a maximal test (such as a bleep test) and record the highest value achieved in the last minute before cessation of exercise.
2) Following a good warm-up, which gradually increases in pace, conduct a repeated (2-3 times) maximal three minute all-out effort. Ideally wear a HRM during this test and record the highest heart rate seen during the repeated bouts of exercise.
3) Finally, sprint and short hill races, where it is likely that the running will be at or around maximal intensity, can be used. Also, a 3km time trial often results in the athlete reaching maximal HR levels during the final stages and this will be discussed again in detail later in this article. Take the highest recorded HR value during the race/time trial.

All of the above methods obviously require the individual to apply maximum effort in order to derive an accurate and absolute maximum heart rate figure and it may require some familiarization and at least two or three attempts before ‘true max’ is achieved.

The calculation of training zones is now performed in the following way:

- Take MHR using one of the methods above and record RHR
- Subtract your RHR from your MHR giving you your working heart rate (WHR), also known as heart rate reserve (HRR)
- Calculate 10% of the WHR giving us "x" (rounding up or down to a whole number)
- Deduct "x" from your MHR to give 90%
- Continue deducting “x” to give the 80, 70 and 60% values

Example: The orienteer's MHR is 200 and their RHR is 60. They wish to calculate their four key training zones for performing a range of sessions from aerobic intervals down to recovery runs (ie. 90-60%). Thus:

- MHR - RHR = 200 - 60 = WHR of 140bpm
- 10% of 140 = 14bpm
- MHR-10% = 200 - 14 = 186 bpm (90% zone)
- MHR-20% = 200 - 28 = 172 bpm (80% zone)
- MHR-30% = 200 - 42 = 158 bpm (70% zone)
- MHR-40% = 200 - 56 = 144 bpm (60% zone)

Therefore our orienteer now has a number of zones calculated for their various training they will be undertaking and using this method should give them a workout that will be both effective and scientific.

However, it is worth pointing out, at this stage, that there are certain issues with use of heart rate for monitoring exertion during exercise and it should not be seen as panacea for every type of workout. The orienteer needs to be aware of certain times when heart rate is not going to be an accurate measure of exercise intensity and an alternative needs to be sought. The potential problems are:

Cardiac Drift – A physiological effect that is brought on as stroke volume (the amount of blood expelled from the heart per beat) drops during the time course of exercise, due to a gradual loss of water from the blood, through factors such as sweating. Thus heart rate tends to increase over time, even when maintaining an even pace. Usually this begins at around 20 minutes into a run and will gradually increase over the duration of the workout, giving an inflated heart rate value, which runners believe is an indication that they are working harder than they actually are.

Weather Conditions - Running in hot weather conditions has been shown to cause an increase in heart rate, as the body needs to divert more blood supply to the maintenance of an optimum core temperature. As sweat rates increase in hot climates, this will logically drive up the cardiac drift effect. Heart rates can increase from 15 to 30 beats per minute above those seen when exercising in moderate or cool weather conditions. A runner using heart rate training during hot weather conditions will almost certainly under estimate their training intensity.

Altitude – Occasionally orienteers may train and compete at altitude (usually deemed to be an elevation in excess of 2000m above sea level) and it has been estimated that sub maximal heart rates may increase by as much as 50% in the early stages of high altitude acclimatization. As the acclimatization process kicks in, due to time spent living and training at altitude, this effect begins to reduce and the use of heart rate to gauge intensity becomes valid once again.

Supplements/Drugs/Medicines - Some supplements, such as caffeine, will artificially raise heart rate and make use of this variable inaccurate. Many prescription drugs and over the counter medicines will also affect heart rate and the orienteer needs to be aware of this and factor it into any training being undertaken when on medication.

Sleep Patterns/Fatigue – Poor quality or lack of sleep, too much stress and overtraining are all factors which can cause increases in both resting and exercise heart rate. Anything that causes an increase in basal heart rate will have an adverse affect on the reliability of heart rate training.

High Intensity/Intermittent Exercise – When an orienteer engages in interval sessions, where the effort approaches maximum and the time\distance of each interval shortens, such as with 400m repetitions, heart rate no longer becomes a useful indication of intensity. The time course of such intervals is too short to allow the heart rate to reflect the effort being expended and the repetition is usually completed before the heart rate plateau is reached. In instances such as this, an alternative method of gauging intensity needs to be utilized. Let us turn our attention to this method now.

Use of time trials

An alternative to heart rate monitoring, but one that can also be used in conjunction with heart rates very easily, is that of running pace based on time trial data. A variety of distances can be used for this, but the one that has the advantage of being relatively quick to perform, and has a profile linked to the aerobic and anaerobic characteristics of orienteering, is that of the 3k time trial (3kmTT). It has been suggested that the relative contribution of aerobic and anaerobic metabolism to a 10 min, 3 kmTT is 85 and 15% respectively (McArdle *et al*., 1994), which allows us to monitor the top end level of an orienteer's fitness and ascertain in what state both their aerobic and anaerobic fitness levels are at. Grant et al. (1997) estimated that the 3 kmTT was run at 95% of $\dot{V}O_2max$ and 92% of the velocity at $\dot{V}O_2max$, which allows us to gain an estimate of heart rate maximum, generally achieved in the final kilometre of the test as the runner pushes hard to achieve their best result, and is a sensitive enough measure to detect changes to an orienteer's fitness status as their programme develops. Slattery et al. (2006) also showed that 3kmTT running performance was significantly linked to the velocity at $\dot{V}O_2max$ (Vmax) and that Vmax is a strong predictor of running performance over a range of distances from 1,500m to the marathon, highly relevant to all race distances that an orienteer would engage in, from sprint through to classic. Finally, as an aside, it has been suggested that Vmax represents the interplay of $\dot{V}O_2max$ and running economy, and may be useful in explaining similarities in performance in subjects with dissimilar $\dot{V}O_2max$ and running economy values (Daniels, 1985).

The standard protocol for performing the 3kmTT is as follows:

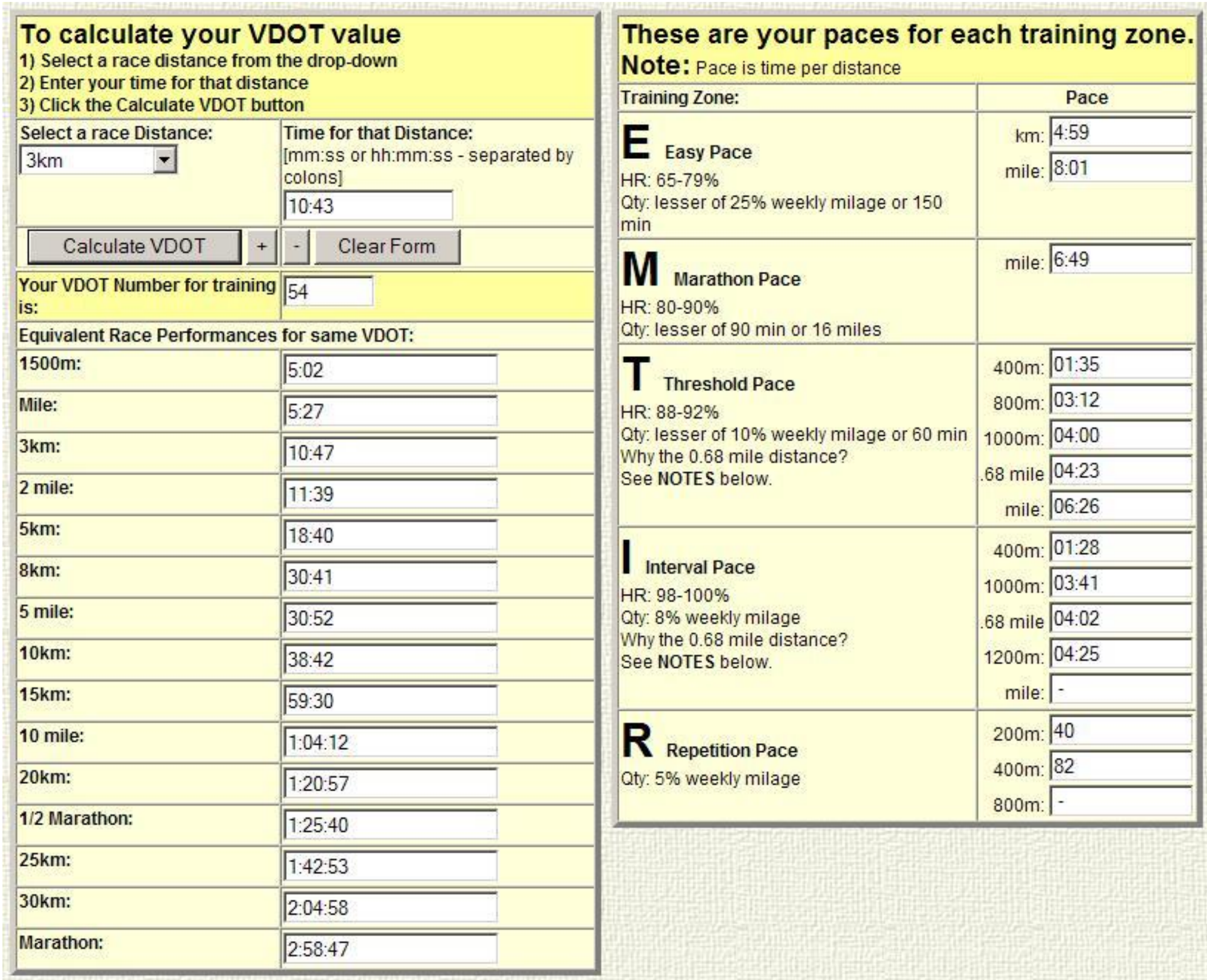
Test Procedure

1) A marked 400 m athletics track is used for the 3km time trial (7.5 laps x 400 m). A synthetic surface is preferred although well-cut and maintained grass track could be a suitable alternative. The ambient temperature, relative humidity and wind speed should be recorded.
2) The test protocol is a single, maximal effort, 3km time trial. Participants should be given a 10-15 minute warm-up of running, stretching and basic instructions.
3) Participants should be encouraged to adopt an even pacing strategy. An orienteer expecting to run ~11 min for 3 km should lap at ~88 seconds per lap, or ~92 and ~96 s per lap for 11:30 and 12 min respectively. A common mistake is to go out too fast on the first lap. A heart rate monitor can also be used by experienced orienteers to gauge the correct effort and pacing.
4) If performed in a group, participants should be given verbal instructions during the 3 km time trial including the numbers of laps completed or remaining, the elapsed time and general encouragement on effort and performance.
5) If use of a heart rate monitor is worn to estimate maximum heart rate, then record the highest value seen in the last 2.5 laps.
6) The total time in minutes and seconds for the 3 km for each participant is recorded.

Familiarisation with the test protocol is important, as the orienteer may take some time to ascertain their optimal pacing strategy to achieve their true 'max' result and thus it may require two-three testing sessions, spread over several weeks, before their optimal time is recorded.

This data can then be used to calculate training zones, as with heart rates earlier, by using an online calculator. A number of these exist, but an example is provided below, available at http://www.runbayou.com/jackd.htm

Figure 1. Screenshot illustrating the Daniels' online pace calculator



To calculate your VDOT value
1) Select a race distance from the drop-down
2) Enter your time for that distance
3) Click the Calculate VDOT button

Select a race Distance:	Time for that Distance: [mm:ss or hh:mm:ss - separated by colons]
3km	10:43
Calculate VDOT + -	Clear Form
Your VDOT Number for training is:	54

Equivalent Race Performances for same VDOT:	
1500m:	5:02
Mile:	5:27
3km:	10:47
2 mile:	11:39
5km:	18:40
8km:	30:41
5 mile:	30:52
10km:	38:42
15km:	59:30
10 mile:	1:04:12
20km:	1:20:57
1/2 Marathon:	1:25:40
25km:	1:42:53
30km:	2:04:58
Marathon:	2:58:47

These are your paces for each training zone.
Note: Pace is time per distance

Training Zone:	Pace
E Easy Pace HR: 65-79% Qty: lesser of 25% weekly milage or 150 min	km: 4:59 mile: 8:01
M Marathon Pace HR: 80-90% Qty: lesser of 90 min or 16 miles	mile: 6:49
T Threshold Pace HR: 88-92% Qty: lesser of 10% weekly milage or 60 min Why the 0.68 mile distance? See NOTES below.	400m: 01:35 800m: 03:12 1000m: 04:00 .68 mile 04:23 mile: 06:26
I Interval Pace HR: 98-100% Qty: 8% weekly milage Why the 0.68 mile distance? See NOTES below.	400m: 01:28 1000m: 03:41 .68 mile 04:02 1200m: 04:25 mile: -
R Repetition Pace Qty: 5% weekly milage	200m: 40 400m: 82 800m: -

By selecting the race distance and entering your 3kTT result, the table automatically calculates the optimal paces for each training zone across a range of training types, from easy/recovery running all the way through to short, speed-based intervals. The orienteer can then use this information to train at the appropriate pace and get the maximal benefit from each training session. The information and database used to create this spreadsheet is based on the work by Daniels (2005), has a strong basis in science, and has been shown over the past twenty years to be effective in improving the training and race performance of a whole range of athletes.

The obvious rider attached to the use of this method for calculation of training intensity is that the orienteer must make sure of two things when applying the information from the table. Firstly, the 3kTT must have been a maximum effort under optimal conditions (ie. conducted on a calm, dry day), otherwise the paces predicted will not be accurate, and that, secondly, the training is carried out on the same surface as the 3kTT. If the orienteer wishes to train on undulating, rough surfaces, as they should at some point to improve the specificity of their training, then the 3kTT should have been performed on the same, or similar, surfaces. In an ideal world, the orienteer will have a number of 3kTT results to match up with the surfaces they will conduct their training on!

Conclusion

Use of these two methods, particularly if used in conjunction with one another, will allow the orienteer to accurately assess their fitness status and gauge the intensity that their different modes of training should be performed at. Time trials, with associated heart rate monitoring, can be repeated on a regular basis (for instance, two to three times a year or when changing phases of a periodised programme) to monitor fitness levels, assess the effectiveness of a training programme and reset the pace/zones for the next period of training. Overall it will allow the orienteer to be much more scientific in their training and help to maximise its effectiveness.

These articles will now begin to look at trends in the world of fitness and examine the 'hot topics', starting with an examination of the growing evidence of use of explosive power work to develop endurance running.

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