Anaerobic Training Effect Assessment

White paper by Firstbeat Technologies Ltd.

This white paper has been produced to describe a heartbeat derived, physiology-based measure of Anaerobic Training Effect developed by Firstbeat Technologies Ltd.
Parts of this paper may have been published elsewhere and are referred to in this document.

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KEY TERMS

- **Training load =** The overall load upon body originating from intensity, duration, and frequency of all training. For example, performing training sessions with high Training Effect frequently leads to high training load.
- **Aerobic Training Effect =** The impact of training session on the development of aerobic fitness, i.e. VO2max.
- **Anaerobic Training Effect =** The impact of training session on the development of anaerobic fitness, i.e. high-intensity sprinting and performance abilities.
- **Physiological effects of training =** Functional and structural changes occurring in the body due to training. The physiological effects occur in those areas that have been stressed, e.g. maximal oxygen uptake, lactic acid system, fat metabolism, or neural activation of different type of muscle fibers.
- **EPOC** = Excess Post-Exercise Oxygen Consumption. A measure of disturbance of body's homeostasis that reflects the increased oxygen consumption after exercise session due to recovering of body's metabolic processes.
- **Oxygen deficit** = Temporary oxygen shortage in the working muscles resulting from high-intensity activity leading to higher reliance on anaerobic energy production and causing higher EPOC.

SUMMARY

- Training Effect developed by Firstbeat indicates the effect of a single exercise session on the improvement of aerobic and anaerobic performance abilities.
- Aerobic training effect describes the magnitude of effect of the training session on the development of VO2max, i.e. maximal oxygen consumption.
- Anaerobic training effect describes the magnitude of effect of the training session on the abilities to perform and repeat high-intensity sprints.
- The physiological effects of training are analyzed by modelling EPOC from aerobic and anaerobic activity, the latter performed through high-intensity interval detection and characteristics analysis.
- Training Effect algorithm uses physiological information from heartbeat signal that can be accompanied with external, mechanical work output (running speed or cycling power).
- Training Effect assessment provides fundamental information on the effects of exercise training for all individuals from beginners to athletes, for different disciplines, and training stages.

INTRODUCTION

The purpose of each training session for a goal-oriented athlete is to make an impact on the body, whether that is to improve fitness, qualities needed to perform better, or to allow the body to recover through facilitation of metabolism [e.g. 1-4]. For assessing the effects of each training session, there must be a way to measure the physiological training effects. This paper introduces an analysis method for measuring the exercise-induced anaerobic training effects, developed by Firstbeat. This paper complements another Firstbeat white paper related to determining physiological training effects entitled "Aerobic Training Effect assessment" [5].

The method for analyzing Anaerobic Training Effect is based on modeling of anaerobic work, and scaling the load of the session based on the user's current physiological capabilities or fitness level. The method provides a tool for assessing the physiological training effects of any type of exercise session for those aiming to develop their anaerobic, high-intensity sprint performance abilities. In this document, Training Effect refers mostly to the impact of training sessions on the development of anaerobic performance.

DESCRIPTION OF THE FIRSTBEAT METHOD

Method for determining Anaerobic Training Effect

The Firstbeat method for determining Anaerobic Training Effect (TE) is based on quantification of the work performed via anaerobic energy pathways during periods of high-intensity activity. Thus, Firstbeat has developed a method to assess how much the anaerobic system has been stressed during exercise and the impact of a training session on high-intensity performance capability. Training Effect is determined through the identification and analysis of high-intensity intervals and modelling the characteristics of those intervals which have metabolic meaning and exceed VO2max intensity (Figure 1).

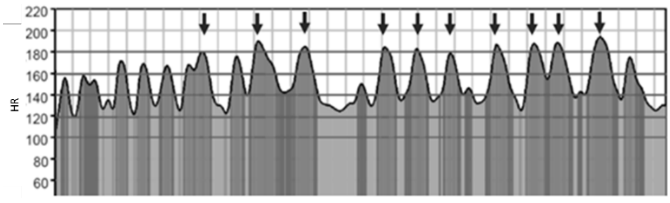

Figure 1. The basis of anaerobic work modelling is to detect those high-intensity intervals that have metabolic meaning (presented with black arrows) and to analyze the characteristics of these intervals.

The intensity of work performed during the anaerobic periods such as sprinting can be much higher than 100% of VO2max (e.g. 100-200% work intensity as compared to VO2max level) even though heart rate cannot exceed 100% of the person's HRmax, regardless of exercise intensity. For these reasons the heartbeat dynamics must be utilized to assess anaerobic training effects.

The modeling is, therefore, principally made by analyzing heartbeat dynamics but the model can be fed external, mechanical data (e.g. running speed, cycling power) to enhance the detection and analysis of high-intensity intervals. Anaerobic work performed is then scaled using information regarding the individual's fitness level and training history to place it in the appropriate context and to provide personalized feedback.

The anaerobic work quantification is affected by the level of effort, i.e. the intensity and speed of the intervals, the duration of intervals (aerobic vs. anaerobic energy supply), recovery status before intervals (work:rest ratio and state of the body's metabolism before intervals), as well as fatigue accumulated during the session. This way, the method takes into account aspects relevant to anaerobic metabolism.

Anaerobic Training Effect calculation in short:

- The greater the impact of training activities on anaerobic metabolism, the higher the Anaerobic Training Effect.
- The higher the rate of acceleration and intensity of the interval the higher the amount of anaerobic work performed.
- Short duration intervals elicit higher amounts of anaerobic work than long intervals.
- Recovery level before the start of the interval affects the amount of anaerobic work.
- Intervals performed when already fatigued elicit a lower anaerobic effect than those performed in a fresh state.

Aerobic Training Effect calculation summarized

In addition, Firstbeat has an accurate method of determining Aerobic Training Effect based on modeling excess post-exercise oxygen consumption (EPOC) using heartbeat data [42-44]. The EPOC assessment models EPOC accumulation during exercise from momentary exercise intensity values, such as %VO2max. When the intensity of exercise is high, EPOC accumulates, whereas during periods of rest or low-intensity activity, EPOC decreases. Aerobic Training Effect is defined by the peak EPOC achieved during the session. For more information about the Firstbeat EPOC assessment method and EPOC based Aerobic Training Effect, please see the related white paper [45].

Thus, a comprehensive system for determining both Aerobic and Anaerobic Training Effect has been developed. These methods can give real-time Training Effect feedback at any given moment during the session. This allows users to modify training activities during the session to ensure desired training targets are achieved (Figure 2).

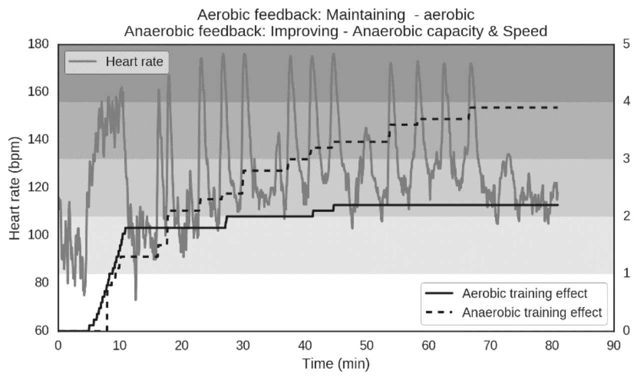

Figure 2. This example session primarily developed anaerobic capacity and speed, and included: warming up, 6 x 200m and 4 x 150m full speed running with 3-4 min recovery between the intervals followed with a cool down. Aerobic TE: 2.2, Anaerobic TE: 3.9.

Feedback and Insights provided on Training Effects

Aerobic and Anaerobic Training Effect feedback can be augmented with additional layers of detail and personalized insight. (Tables 1-3, Figures 2-6) This includes accounts of which physiological systems were impacted by training activities, how they were impacted, recovery advisements, and other forms of guidance. It is, therefore, possible to reveal whether the session improved speed, anaerobic capacity, aerobic capacity (VO2max), lactate threshold, etc.

Table 1. Different **Anaerobic Training Effects** and their interpretation.

TE score	TE description	Interpretation	Example training
0.0 – 0.9	No Anaerobic Effect	The exercise did not have effect on anaerobic fitness.	Light aerobic running 30-60min without high-intensity intervals. (e.g. 60-70% HRmax).
1.0 – 1.9	Minor Anaerobic Effect	Exercise has slight effect on anaerobic performance abilities by activation of fast-twitch muscle fibers and muscles.	Light running 40min with some short speed drills (e.g. 6 x 10s spurts /3min recovery).
2.0 – 2.9	Maintaining Anaerobic Effect	Exercise maintains anaerobic fitness. Builds up foundation for harder anaerobic training in future.	Easy extensive intervals. E.g. 10 x 200m at 100-105% VO2max with good recovery OR 10 x 50m sprint running with 3min recovery.
3.0 – 3.9	Improving Anaerobic Effect	Exercise improves anaerobic fitness if done 2–3 times per week. Special attention on recovery especially in the case of speed training.	Maximal speed endurance running 3 x 150m + 3 x 120m + 3 x 100m / 2min / 4min (2min recovery between repeats and 4 min between sets) close to maximum speed (≈150 %VO2max) OR Extensive interval running: 2 x 5 x 400m at 105-110% VO2max /2min/4min OR Ice-Hockey / Football game.
4.0 – 4.9	Highly Improving Anaerobic Effect	Exercise sharply improves anaerobic fitness when done about 1–2 times per week. A few (2–3) easier exercise sessions (TE 1–2) is also recommended to balance the training. More attention on recovery.	
5.0	Overreaching Anaerobic Effect	Dramatic increases occur in anaerobic fitness after an overreaching exercise if only adequate recovery is applied after the exercise. This kind of exercise should be performed only occasionally. Special attention on recovery.	Intensive interval running 2 x 5 x 400m @ 110-120% VO2max / 2min/ 4min.

Table 2. Different **Aerobic Training Effects** and their interpretation.

TE score	TE description	Interpretation	Example training
0.0 – 0.9	No Aerobic Effect	The exercise did not have effect on aerobic fitness.	Very light walking 20min which elicits no or very limited demands on cardiorespiratory system.
1.0 – 1.9	Minor Aerobic Effect	Exercise does not improve cardiorespiratory fitness. This type of exercise is also suitable for the purposes of enhancement of recovery and for development of endurance base with long duration exercise (over 1h).	Light running/walking for 30min (e.g. 60-70% HRmax).
2.0 – 2.9	Maintaining Aerobic Effect	Exercise maintains cardiorespiratory fitness. Builds up foundation for better cardiorespiratory fitness and harder training in future.	Moderate running for 60min (e.g. 70-75% HRmax).
3.0 – 3.9	Improving Aerobic Effect	Exercise improves cardiorespiratory fitness if done 2–4 times per week. No special recovery requirements.	Moderate running for 45min with harder sections, for example hills. (e.g. 75-85% HRmax).
4.0 – 4.9	Highly Improving Aerobic Effect	Exercise sharply improves cardiorespiratory fitness when done about 1–2 times per week. A few (2–3) easier exercise sessions (TE 1–2) is also recommended to balance the training. More attention on recovery.	Vigorous running for 60min incl. warm-up and 3 x 10min around lactate threshold (e.g. 85-95% HRmax).
5.0	Overreaching Aerobic Effect	Dramatic increases occur in cardiorespiratory fitness after an overreaching exercise if only adequate recovery is applied after the exercise. This kind of exercise should be performed only occasionally. Special attention on recovery.	Very high intensity running for 40min plus warm-up and cooldown 20min (e.g. race 90-100% HRmax).

VALIDATION OF ANAEROBIC TRAINING EFFECT IN THE FIELD

The method has been developed based on Firstbeat's extensive exercise database, which includes thousands of exercise sessions from the laboratory and from the field. The database contains measures of oxygen consumption, blood lactate, EPOC, ratings of perceived exertion, and ratings of perceived fatigue describing the physiological demands of the exercise sessions over a wide variety of different sports such as running, cycling, football, ice-hockey, handball, rugby, basketball, and cross-country skiing.

Figures 3-6 and Table 3 show example-results of the method in field conditions. In addition to TE values and feedback phrases, Table 3 also shows estimated time to full recovery after each exercise. More information regarding Firstbeat's EPOC modeling techniques and methodological validation can be found in separate white paper published by Firstbeat Technologies Ltd [45].

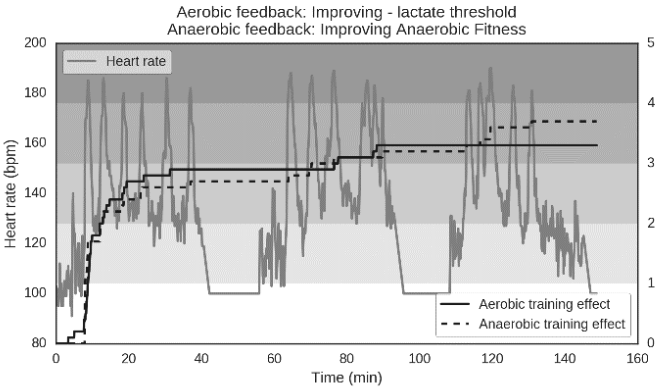

Figure 3. Ice-hockey game including three periods and measurement breaks in between. Lactate after the game: 13.1, Rating of Perceived Exertion (RPE): 17. Aerobic TE: 3.2, anaerobic TE: 3.7.

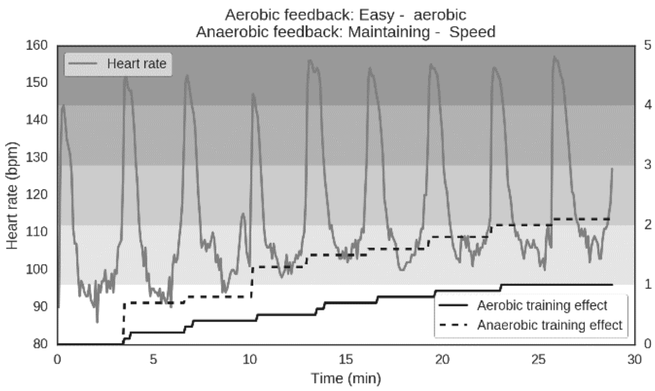

Figure 4. 9 x 50m sprint running intervals, lactate after the session: 8.2, RPE: 14. Aerobic TE: 1.0, anaerobic TE: 2.1.

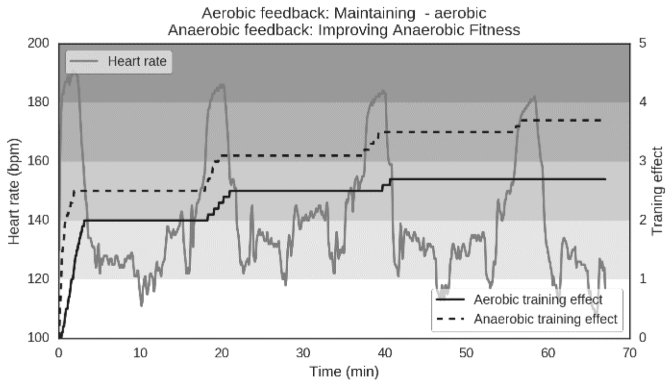

Figure 5. Cross-country skiing sprint race simulation (4 x 2min full speed). Lactate after the workout: 18.7, RPE: 20. Aerobic TE 2.7, anaerobic TE: 3.7.

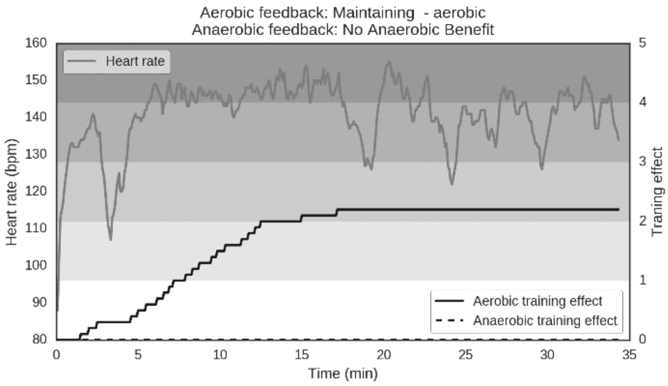

Figure 6. Moderate intensity running 35 min in hilly terrain, lactate after the run: 2.6, RPE: 12. Aerobic TE: 2.2, anaerobic TE: 0.0.

Table 3. Examples of validation measurements performed and measurement results achieved in the field testing

Speed / Intensity	Description of activity	Main focus	Aerobic TE	Anaerobic TE	Aerobic Feedback	Anaerobic Feedback	Recovery time (h)
Speed (alactic)	10 x 50m run	Speed	1,3	2,1	Easy - aerobic	Maintaining - Speed	23
	2 x 5 x 100m run	Speed	2,2	2,7	Maintaining - aerobic	Maintaining - Speed	42
	Running 6 x 60sec 95%speed	Submaximal speed endurance	3,1	3,2	Improving - aerobic	Improving - Anaerobic power & capacity	52
	3 x 150m +3 x 120m + 3 x 100m running	Submaximal speed endurance	2,0	2,8	Maintaining - aerobic	Maintaining - Speed	47
Anaerobic base	Warm-up + 15 x 200m / 200m recovery	Extensive intervals	3,8	3,1	Improving - lactate threshold	Improving - Anaerobic power & capacity	45
	2 x (4 x (300m/1' + 200m)/2')/5 run	Extensive intervals	3,6	3,6	Improving - lactate threshold	Improving - Anaerobic base & economy	44
	Running 4 x 4 x 200m/ 1'/ 2' recovery	Extensive intervals	3,4	3,6	Improving - aerobic	Improving - Anaerobic power & capacity	59
	Running 8 x (400+200m)	Extensive intervals	3,0	3,8	Improving - aerobic	Improving - Anaerobic power & capacity	66
VO2max	4 x 2min cross-country skiing sprint race simulation	VO2max / anaerobic capacity	2,9	3,9	Maintaining - aerobic	Improving Anaerobic Fitness	65
	Maximal exercise test on treadmill (VO2max test)	VO2max test	4,3	2,3	Highly improving - VO2max	Maintaining Anaerobic Fitness	67
	Running 5 x 1000m/ rec 1,5-2'	VO2max intervals	4,3	3,7	Highly improving - aerobic	Improving - Anaerobic power & capacity	64
	Running 5 x 2km + warm-up and cool down 1+1km	VO2max intervals	4,3	2,4	Highly improving - lactate threshold	Maintaining Anaerobic Fitness	43
Lactate threshold	Tempo running at LT pace 4 x 8min + warm-up and cooldown	Tempo training	4,1	2,6	Highly improving - VO2max	Maintaining Anaerobic Fitness	38
	Tempo running at LT pace8x1000m	Tempo running	3,8	3,1	Improving - lactate threshold	Improving - Anaerobic base & economy	39

Results are generally in accordance with a recent study showing that the most relevant factors effecting training load (training effect and recovery time) in sprint/interval training are intensity and length of sprints as well as recovery periods between sprints [51]. Similar to the study referred, in the case of running, the highest Anaerobic Training Effect values, as determined by the Firstbeat method, were typically achieved from 400-500m intervals. This is also in line with observations [52], where highest ATP resynthesis from glycolysis were found in maximal exercises lasting 40-50 sec.

As can be seen from the results, different combinations of sprinting intensity, length, and recovery durations can lead to high Anaerobic Training Effect values, confirming that the determination method is valid across a wide scale of interval type exercises.

SCIENCE BEHIND ANAEROBIC TRAINING EFFECT

Energy pathways in different types of exercise

Energy for athletic training and exercising can be produced using anaerobic or aerobic pathways. Anaerobic energy production pathways are utilized when oxygen-based energy production is insufficient to meet the demands of external work, i.e. when a person performs a high-intensity activity, such as sprinting, at an intensity greater their capacity to produce energy aerobically (higher than VO2max intensity) [5-6].

Both energy pathways supply energy in the form of adenosine triphosphate (ATP) which is the actual energy source for the contracting muscle cells. Due to the breakdown of ATP into adenosine diphosphate (ADP) and adenosine monophosphate (AMP) molecules during muscle contractions, ATP must be continuously reformed using either muscular creatine phosphate (CP), or muscle glycogen (lactic acid formed as a result) [7-8]. Short anaerobic exercise bouts lasting only few seconds can be performed without significant lactic acid formation due to the use of CP stores but glycolytic anaerobic metabolism will start to accumulate lactic acid when high intensity activity continues longer. However, lactic acid can be further oxidized to yield ATP, or resynthesized in liver into glycogen. The substrates of aerobic energy systems include muscle glycogen, and circulating glucose and fatty acids [5-6, 9-11].

Energy production pathways overlap and complement each other, and are exercise intensity and time related. Figure 7 describes energy distribution in all-out exercises having different durations. Energy for very fast sprints (0-10s) is mainly yielded via immediate alactic pathways (ATP+CP), for high-intensity intervals (10-120s) via lactic energy production (anaerobic glycolysis), and for longer term activity (over 2min) mainly via aerobic, oxidative metabolism [5-6, 9-15].

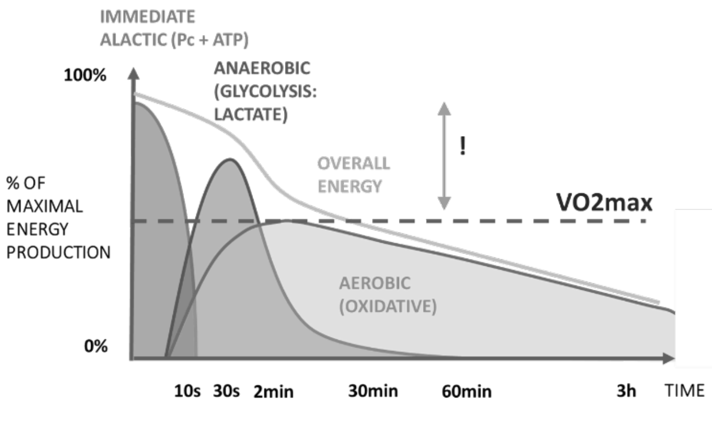

Figure 7. Energy pathways used for exercising are related to exercise intensity and time. In maximal very short performances, the alactic anaerobic system produces energy via ATP and CP, in performances lasting 10-120s lactic system is the most prominent, and in longer sessions the aerobic pathway dominates.

Traditionally, heart rate (HR) training zones have been used to differentiate aerobic and anaerobic portions of an exercise session. For example, HR >90% of individual maximal HR (HRmax) has been used to categorize activity as anaerobic training, and HR<90% HRmax as aerobic training. More sophisticated approaches delineate these categories using the individual's lactate threshold. These methods, however, lack deep understanding of the relationship between HR responses, external work performed, and the physiological responses eliciting training adaptations.

Physiologically, when exercise intensity is quickly increased resulting in a need to use anaerobic energy pathways, there can be a divergence between HR and metabolic responses. This needs to be considered to evaluate anaerobic contribution of energy production and to assess training load accurately. In practice, a sudden and substantial increase in exercise intensity will cause the body to work very anaerobically, while HR initially remains below the level reflecting lactate threshold. This occurs, for example, at the start of a sprint. This kind of activity generates a large oxygen deficit [12-15]. Therefore, to evaluate anaerobic training effects, HR dynamics need to be considered, as in the Firstbeat method. On the other hand, steady-state exercises performed at lower intensities, below VO2max, rely on aerobic metabolism. Even when HR is high, these activities remain aerobic, despite stressing the cardiorespiratory system very hard. This kind of activity does not produce much oxygen deficit in the body and does not cause as rapid an accumulation of lactic acid (see examples below in Figure 8A and 8B).

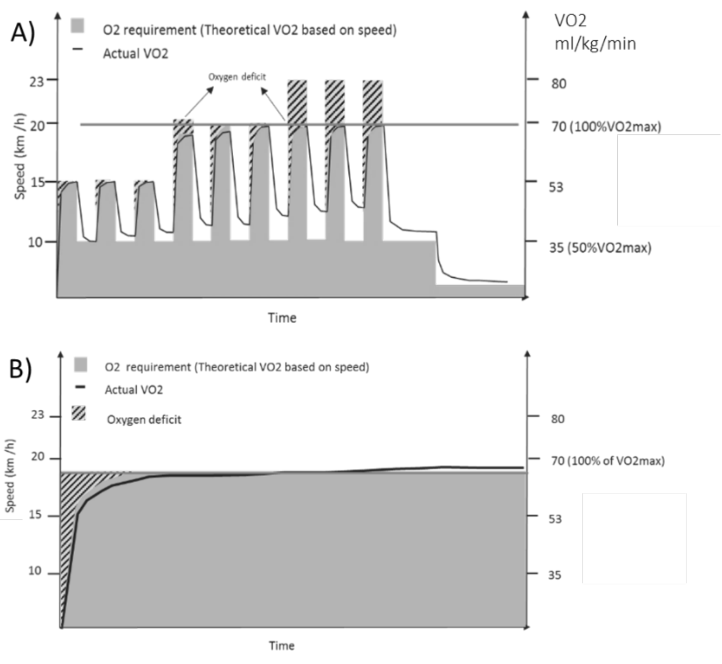

Figure 8A & 8B. 8A) In high-intensity sprinting, the energy demand is so high that the body cannot meet the energy demand aerobically as the intensity exceeds 100% of VO2max. This produces high oxygen deficits (visualized as asterisk) and lactic acid accumulation. The higher the intensity, the greater the oxygen deficit. 8B) During steady-state exercise below VO2max the body can produce sufficient energy through aerobic, oxidative pathways. This results in low need for immediate energy sources and limited need for anaerobic glycolysis. Thus, the oxygen deficit is smaller and lactic acid accumulation is much slower.

EPOC reflects disturbance of homeostasis

Excess post-exercise oxygen consumption is a measure describing how much more oxygen the body uses after an exercise as compared to a resting state. It is used as the measure of the overall disturbance of the body's homeostasis brought on by exercise [16-22]. EPOC reflects the body's recovery requirements after the exercise. Active oxygen-consuming recovery processes occurring in the body are due to replenishment of body's resources (O2-stores, ATP, CP) and increased metabolic rate (increased HR and respiratory work, elevated body temperature) caused by metabolic by-products and hormones produced during exercise.

EPOC accumulates with higher intensity and/or longer duration exercise (both anaerobic and aerobic types of exercise). Accrual of EPOC also reflects the oxygen deficit buildup during supramaximal workouts, i.e. the higher the oxygen deficit the higher the EPOC (see Figure 9 below) [16-22].

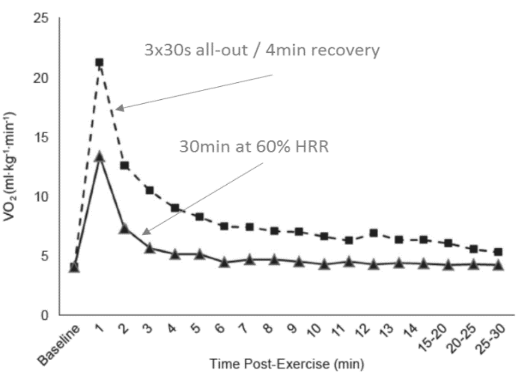

Figure 9. The body's homeostasis can be disturbed with very short intervals as shown in this comparison of EPOC values produced during high-intensity intervals vs. steady state exercise. 90 seconds of all-out effort causes significantly higher EPOC value compared to 30 minutes of moderate exercise.

Firstbeat's Anaerobic Training Effect calculation considers both total accumulated EPOC and peak EPOC achieved during periods of high-intensity exercise. The former correlates with total lactate produced over the course of exercise and the latter reflects effects on fatigue resistance and lactate tolerance associated with momentary demands of the anaerobic system. For example, several sprints performed in short succession cause Anaerobic TE to increase faster than sprints performed with long recovery periods in between. During high-intensity interval training with short recovery periods both lactate production and lactate tolerance are developed, whereas with long recovery periods mainly lactate production capability is developed.

Physiological effects of aerobic vs. anaerobic training

Good cardiorespiratory, aerobic fitness is related to the ability to perform moderate to high-intensity physical activity for prolonged periods. Increased cardiorespiratory fitness results from: 1) increased heart pumping capacity, 2) improved pulmonary function, 3) increased oxygen transport capacity of blood, and 4) improved oxygen extraction and utilization [23]. Maximal oxygen uptake (VO2max) is accepted as a measure of cardiorespiratory fitness [24].

Good anaerobic fitness is characterized by robust ability to produce power, and to perform and repeat high-intensity activities. Individuals having good anaerobic fitness are able to sustain high-intensity performances by producing high amounts of energy anaerobically through alactic and lactic pathways (anaerobic glycolysis) and to tolerate high lactate levels [25].

Accordingly, increased anaerobic fitness results from: 1) improved ability to utilize immediate energy sources (ATP and CP) as well as glycolytic (lactic acid producing) pathways in energy production, 2) improved tolerance of increased acidity in the body, 3) improved neural activation of fast-twitch muscle fibers resulting in higher maximal speed and power, and 4) improved work efficiency during high-intensity activities [26-29]. There is no gold standard measure of anaerobic fitness, but there are methods that are used to evaluate anaerobic power and capacity, for example the Wingate 30s all out cycling test [30], 30-60s jumping tests [31], and the MART-test in running [32]. The physiological effects of aerobic and anaerobic training are reviewed in the table 4.

Table 4. Physiological effects of aerobic and anaerobic training.

EFFECTS OF AEROBIC TRAINING:	EFFECTS OF ANAEROBIC TRAINING:
• Improved endurance and fatigue resistance abilities (+VO2max) • Improved aerobic metabolism due to higher capillary density and aerobic enzyme activity • Improved central and peripheral blood flow • Enhanced ventilation/ pulmonary fitness • Improved fat metabolism and utilization • Biomechanical & neuromuscular adaptations	• Improved ability to produce high-levels of energy anaerobically and turn that into sprinting performance • Improved anaerobic metabolism and enzyme activity • Elevated CP and ATP stores in the muscles • Enhanced glucose and glycogen metabolism • Biomechanical & neuromuscular adaptations

Specificity of training adaptations

One of the key principles of training is the specificity principle. It means that training effects and physiological adaptations occur in those capabilities that have been practiced for. These sport-specific adaptations include structural, physiological, neural, psychological, and endocrine functions of the person [33, 37]. Thus, it is essential to realize what (physiological) capabilities are needed in different sports, and to accurately measure which characteristics have been trained for and to what extent. This is especially crucial for athletes who constantly aim to prepare themselves based on sports-specific requirements. So, training of physiological and neuromuscular systems should be harmonized to competition requirements in each sports discipline [33, 35, 37-39]. For example, training for a marathon requires very aerobic oriented training whereas training for ice-hockey should include much more anaerobic focused training.

PRACTICAL USE OF THE ANAEROBIC TRAINING EFFECT

Training Effect helps to optimize training

Training Effect assessment can be used e.g. to:

- control the effectiveness of a single exercise session
- control the overall load of training
- control training to avoid over- and undertraining, i.e. optimizing training

For more information on these aspects, as well as factors affecting TE values, please see another Firstbeat white paper related to Aerobic Training Effect assessment [5].

Targeting training to key performance characteristics

In athletic training, it is central to maximize sports-specific performance characteristics by gradually increasing the number of intensive training sessions that mimic the requirements of specific sports complemented with easier, recovery oriented sessions. Characteristics essential for achieving peak performance include, for example, aerobic fitness (VO2max), capacity to achieve and maintain high performance velocity, optimized muscular characteristics for fast force production, high anaerobic capacity, lactate threshold level (fractional utilization of VO2max), fatigue resistance, efficient energy metabolism and substrate utilization, performance technique, and economy of movement.

Typically, performance capabilities are best improved by maximizing key performance characteristics over longer periods by gradually increasing the training load, for example performing moderate- to high-intensity exercises regularly, followed by reducing the training load significantly for a few weeks. This allows the body to reach its full capacity in well recovered state. This is called tapering [48].

To improve specific performance characteristics, different types of exercise sessions must be performed. For example, a high-intensity (and velocity) interval workout has a greater impact on fast force production and economy of movement than a longer workout performed at a lower intensity as shown by higher anaerobic TE, despite the same aerobic TE. On the other hand, a longer session performed with a slightly lower intensity can enhance fatigue resistance.

When targeting performance gains in a short period of time, interval type exercises are typically more efficient as they allow one to improve aerobic and anaerobic characteristics simultaneously. High-intensity interval training has been shown to be very beneficial not only for anaerobic fitness but also for improving maximal aerobic performance [38-39, 49-50]. In aerobic type of sports, it is also important to take care of the endurance base and aerobic metabolism by doing long, easy workouts with low TE scores. Firstbeat's Aerobic and Anaerobic Training Effect assessment shows the overall impact of the training session on aerobic and anaerobic fitness as well as more detailed feedback about neuromuscular and physiological characteristics developed during exercise.

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