More Research on the Aerobic Benefit of Sprinting

In the article The Surprising Aerobic Benefit of Sprinting I reviewed a unique study that showed that a sprint only training program resulted in some surprising aerobic benefits. Specifically, the research resulted in the finding that the subjects both doubled their endurance performance at 80% of VO2peak (from 26 minutes to 51 minutes) and increased their muscles' oxidative potential (i.e. to produce energy aerobically). As noted in that article, the doubling of endurance performance finding was considered remarkable because while sprints have been used for many years by endurance athletes to improve performance, they have traditionally been added into an endurance training program. This was the first study to test if a program consisting of sprints alone resulted in improvements in endurance performance.

Following the publishing of that study the same research team has been busy with additional follow-on studies examining the surprising endurance benefit of sprint training. Two of these follow-on studies provide additional insight into "aerobic" physiological and performance changes caused by sprint training. As noted in my first article on this topic there are modern training programs that are based on the belief that significant differences exist between "aerobic" and "anaerobic" training; that "aerobic" training produces different training adaptations than does "anaerobic" training. So strong is the distinction between "aerobic" and "anaerobic" training in these programs that some even suggest that "anaerobic" training interferes with aerobic development and may even decrease aerobic capacity (see the article The Surprising Aerobic Benefit of Sprinting for additional discussion of these programs). These training programs maintain a fairly high profile in the running community so it is appropriate for us to review the two new studies on the "aerobic" benefits of sprint training and to discuss the results in relation to the belief that a) "aerobic" and "anaerobic" training produce different and distinct physiological and training adaptations and b) "anaerobic" training interferes with and may decrease "aerobic" capacity.

(My analysis is based on the abstracts that were presented at the Canadian Federation for Biological Sciences meeting Summer 2005 and my personal communications with the lead researcher, Martin Gibala, PhD, Associate Professor, Dept. of Kinesiology, McMaster University.)

Research

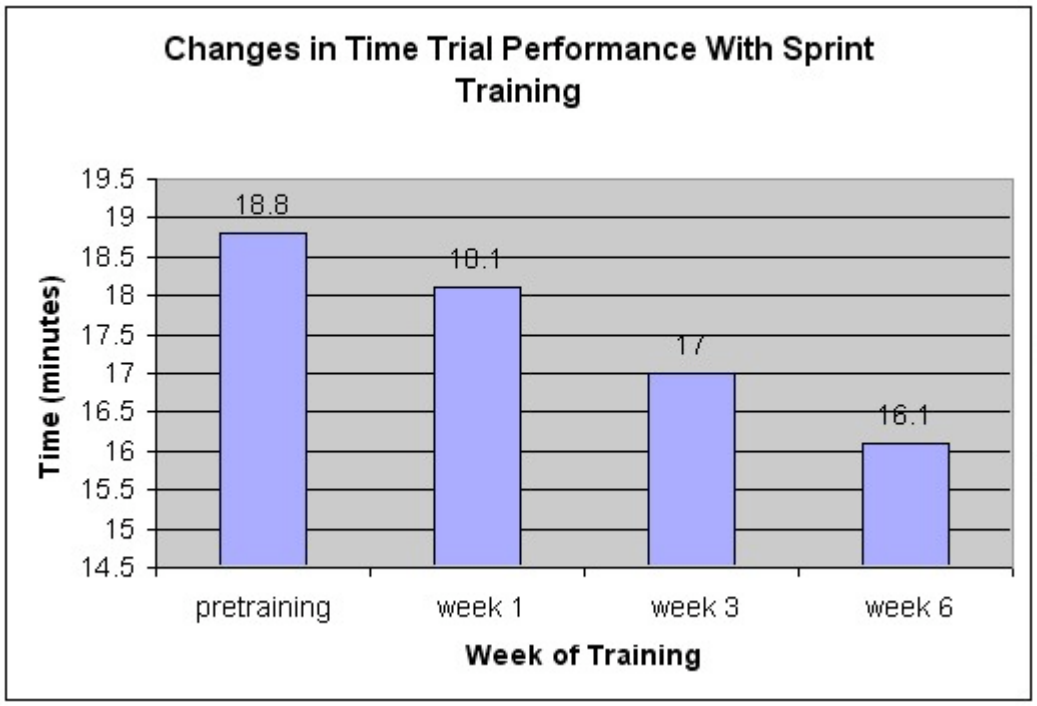
Study 1: Sprint Training For 6 Weeks

As noted above the initial research study this team conducted resulted in some surprising findings, especially in relation to commonly held beliefs on the nature of physiological adaptations to "anaerobic" training. The results of the initial study caused the researchers to speculate that specific adaptations occurred within the muscle fibers that at least partially accounted for the increase in endurance performance from sprint training. To test this hypothesis they

conducted a follow on study designed to "examine the time-course for changes in time trial performance" and changes within the muscle fibers (1). They recruited eight active male subjects to perform 6 weeks of 3 x weekly sprint training consisting of 4-6 x 30 second all-out sprints. This was the same training protocol used in their original study, with the exception of an increase from 2 weeks of training in the initial study to 6 weeks of training in the follow on study. Time trial performance for the subjects was tested pre-training, at 1, 3, 6 weeks of training, and finally at 1 and 6 weeks post training during a detraining phase.

During the 6 weeks of the study the subjects time trial performance steadily improved. From an initial pre-training time of 18.8 minutes, time trial performance declined to 18.1 minutes at week 1, 17 minutes at week 3, and 16.1 minutes at week 6. Muscle biopsies revealed significant training-induced increases within the muscle fibers (MCT1 increased between 30-530% and MCT4 increased between 15-200%). The changes in performance are summed in figure 1.

Figure 1: Changes in time trial performance with sprint training pre-training through 6 weeks of training



Study 2: Sprints vs. Traditional Endurance Training

In the initial study the finding was that sprint training resulted in increases in muscle oxidative potential and endurance performance comparable to traditional endurance training. The result of the initial study brought up the question as to how a program of sprint training compared to a traditional endurance training

program. This comparison had not been previously researched. The researchers note, "...no study has systematically compared sprint training versus traditional endurance training with respect to changes in exercise capacity and muscle adaptations." Therefore the research team conducted a follow-up study "to compare performance and muscle metabolic adaptations" from 3 distinct training programs - sprint interval training, modified interval training, and traditional endurance training (2).

The researchers recruited 23 recreationally active males and divided them into 3 training groups with all 3 groups training 3 x week for 2 weeks.

A **sprint interval group** conducted 4-6 x 30 second all-out sprints at 250% VO2peak
A **modified interval group** conducted 8-12 x 60 second sprints at 100% VO2peak
An **endurance training group** conducted 90-120 minutes of cycling at 65% VO2peak

Total training volume for the endurance group was 70-85% higher than the 2 sprint training groups. Pre and post training all subjects conducted both a short time trial of approximately 2 minutes and a long time trial of approximately 1 hour.

All three groups improved performance in both the short and long time trial with no statistical differences between the groups. In the short time trial the endurance group improved 3.9%, the sprint group improved 4.3% and the modified interval group improved 11.1%. In the long time trial the endurance group improved 7.5%, the sprint group improved 10.1%, and the modified interval group improved 8.8%. Figure 2 sums the changes in performance for all 3 groups in both short and long time trial.

Fig. 2: Changes in short and long time trial performance for 3 training groups

	Short Time Trial			Long Time Trial		
	Pre	Post	% Change	Pre	Post	% Change
Endurance Training	122 sec	128 sec	3.9%	60.2 min	65.0 min	7.5%
Sprint Training	113 sec	117 sec	4.3%	55.3 min	61.5 min	10.1%
Modified Intervals	116 sec	129 sec	11.1%	57.1 min	62.6 min	8.8%

Discussion

The results of these two research studies confirm the results of the initial study from this research team and raise questions about the distinctions between "aerobic" and "anaerobic" in endurance performance. The results of these

studies reveal that sprints positively affect endurance performance and improve endurance performance in events of up to at least an hour in length.

Considering the results of these studies in traditional terms of "aerobic" and "anaerobic" illustrates the following points. First, though "anaerobic" training and "aerobic" training may each produce distinct physiological adaptations the evidence from these studies show that "anaerobic" training is producing benefits that lead to improved "aerobic" performance. In effect, "anaerobic" training is producing "aerobic" results. The implication is that there is some overlap between the physiological adaptations that are produced by "aerobic" and "anaerobic" training; that the distinctions made by some training programs between "aerobic" and "anaerobic" may be artificial to some degree. Second, the fact that "anaerobic" sprints produced significant improvements in endurance performance shows that "anaerobic" training does not interfere with "aerobic" development, nor does it degrade "aerobic" performance, it increases "aerobic" capacity, in novice trainees at least.

These results naturally lead to the question of what is occurring at a physiological level that results in "anaerobic" training improving "aerobic" endurance performance. No answer is provided within the boundaries of traditional physiological explanations of "aerobic" and "anaerobic". In their initial study the researchers wrote, "We can only speculate on potential mechanisms responsible for the dramatic improvements in cycle endurance capacity..." They speculated that perhaps changes in oxygen utilization within the muscles accounted for the results, but noted that other studies on sprint training offered other equally plausible explanations.

If we set aside the distinction that "aerobic" and "anaerobic" performance are controlled by different factors it allows us to explore another possibility that does offer a reasonable explanation for the results of these studies. Changes in "aerobic" performance due to "anaerobic" training implies there is a common factor or factors at work in both "aerobic" and "anaerobic" events. What might these common factors be? Scientists have long known that muscle plays a primary role in "anaerobic" events. The amount of force the muscle fibers produce during contractions controls strength. Muscle fibers contraction rate controls speed. The amount of time a muscle fiber can contract prior to fatigue controls endurance and power. These and other muscle factors are the primary influencers of "anaerobic" events. Additionally, muscle is the common factor between "aerobic" and "anaerobic" events - the fibers used in the "anaerobic" cycle sprint are also employed during 1 hour of "aerobic" cycling. These facts point to the explanation that the muscle factors that control "anaerobic" performance are the same factors that control "aerobic" performance.

If the "muscle factor' explanation is correct, then logically any training that causes a positive adaptation in the muscle factors will likely produce both "aerobic" and "anaerobic" improvements. Supporting this idea are the results of the three sprints studies reviewed in this and my previous paper on the same topic. In all 3 cases, training adaptations from "anaerobic" training resulted in "aerobic"

endurance improvement. Furthermore, "aerobic" training up to 2 hours per day resulted in a significant improvement in the 2 minute time trial, an event which falls on the "anaerobic" end of the training spectrum. The specificity and nature of the training will likely influence performance at different events differently, i.e. we would expect "anaerobic" training to improve "anaerobic" performance more than "aerobic" performance and vice versa. The fact remains, however, that changes in common muscle factors would generally be expected to positively influence both "aerobic" and "anaerobic" performance. Even though one or the other might adapt to a greater magnitude, both would generally be affected.

Summary

Two follow-on research studies by the same research team that found significant improvements in endurance performance from sprint training confirm the findings of the initial study. The first follow-on study found significant improvements in endurance performance throughout 6 weeks of sprint training. The second follow-on study found that 30 second sprints, 60 second sprints, and 90-120 minutes of traditional endurance training all produced the same magnitude of improvement in a 2 minute time trial and a 1 hour time trial. These results challenge the belief that "aerobic" training and "anaerobic" training produce only distinct physiological and training adaptations. Instead, the results imply that the distinction between "aerobic" and "anaerobic" training may be artificial to some degree. The results further challenge the belief that "anaerobic" training interferes with "aerobic" development or causes a decline in "aerobic" capacity, at least in novice trainees. Traditional physiological beliefs of "aerobic" and "anaerobic" are unable to explain the results of these studies. The physiological model of shared "muscle factors" offers a logical alternative explanation for these results.

References:

1. Burgomaster K, Cermak N, Phillips S, Benton C, Bonen A, Gibala M. Rapid Increase in Human Muscle MCT1 and MCT4 Accompany Performance Improvements Induced by Sprint Interval Training, abstract presented to the Canadian Federation for Biological Sciences
2. Wilken G, Burgomaster K, van Essen M, Little J, Tarnopolsky M, Gibala M. Low Volume Sprint Interval Training Stimulates Performance Adaptations Comparable to Traditional Endurance Training, abstract presented to the Canadian Federation for Biological Sciences