How to Spend Your Money

As mentioned in *Why Do I Need a Coach?*, a study by Asker Jeukendrup and James Martin[i] examined the literature for the benefits of different interventions on time trial performance. The paper used a formula to predict the size of the effect of these interventions based on the results of studies published in peer reviewed literature. Those interested in the mathematics of the model should seek out the journal article. The authors separated riders into three categories: novice, well-trained and elite. The absolute savings for the better riders is less since they are going to be on the course for less time. The percentage improvement for the groups would be similar. The authors also chose the TT since a mass start race brings into play team tactics, skills, experience, etc that cannot be quantified. The TT, while involving some strategy and skill, is less "polluted" by these factors.

Studies show that well-trained cyclists ingesting a carbohydrate beverage improved 40km TT time by 2.3% compared to a placebo (in this case a beverage not containing carbs). Over a one hour period, average power would be increased by **at least** ~2%.[i]

According to a formula developed by one of the authors, a novice (N) cyclist would improved his/her 40km TT by 42 seconds; a well-trained (W) cyclist would improve by 36 seconds; and, an elite (E) cyclist would improve by 32 seconds.

The authors' analysis reviewed caffeine ingestion and determined that this intervention would increase power by 5% thus leading to an improvement in the 40km TT of 84, 63, and 55 seconds for the N,W and E cyclists, respectively.[i]

How about spending money on a lighter bike? Cyclists love to spend money on lighter and the latest parts. The authors examined the effect of reducing bike weight from 10kg (~22 pounds) to 7kg (~14.5 pounds) on 40km TT performance. The effect is the N, W, and E cyclist improves by 13, 7 and 5 seconds, respectively.[i] Along those lines, losing 3 kg of body weight would reduce drag area by 1.84%. This reduction would improve 40km TT performance by 25, 21, and 19 seconds for the N, W, and E cyclist respectively.

What about going uphill? Wouldn't a lighter bike and/or weighing less make a difference? Of course! It is nice when science supports what we think to be true. On a 3% grade on a 20km TT, the authors determined that reducing bike weight by 3kg would result in a time savings of 94, 42 and 29 seconds for the N, W, and E cyclists. Increasing the grade to 6% yields savings of 3:38, 1:52, and 1:15 for the N, W, and E cyclists, respectively. [i]

(Note: Since most athletes at a given level have the same equipment (and UCI rules set a minimum bike weight), once you get as light as you can, the advantage in terms of placement in competition diminishes. It could be argued that the lower category riders benefit more in terms of standings since they are more likely to be competing with athletes who have entry-level bikes. I doubt the weight of Lance's TT bike is all that different from his main competitors.)

How about spending some time in a wind tunnel to improve my TT performance? The authors report that optimizing aerodynamic position can lead to a performance improvement by 2 to 2.5 minutes compared to a "baseline" measure of the rider with elbows on TT handle bars.

Surely buying the latest aerodynamic frame would make me a World Champion. (Sarcastic comment: Only if you were the only athlete with one and only if you had the engine to become a World Champion!) The savings for N, W, and E cyclists with the aero frame compared to a conventional frame (steel round tube) was calculated to be 1;44, 1:26 and 1:17, respectively.

The chart[i] below summarizes the information above.

Time savings in Time Trial Performance. All are 40km TT except where noted. Time is expressed mm:ss.

	Novice Cyclist	Well-Trained Cyclist	Elite Cyclist
Carbohydrate Beverage Ingestion	0:42	0:36	0: 32
Caffeine	1:24	1:03	0:55
Lighter Bike (flat TT)	0:13	0:07	0:05
Lighter Bike (uphill TT 3% grade, 20km)	1:34	0:42	0:29
Lighter Bike (uphill TT 6% grade, 20km)	3:38	1:52	1:15
Aerodynamic Positioning	2:00-2:30	2:00-2:30	2:00-2:30
Aerodynamic Frame	1:44	1:26	1:17

How about training?

The authors report that 9 to 12 weeks of training leads to improvement in VO_{2max} by 20 to 38% in several studies using untrained subjects[i]. In moderately trained cyclists (average VO_{2max} 57 as $ml^{-1} \bullet kg^{-1} \bullet min^{-1}$) at the beginning of the season), the authors report on a study by Norris and Petersen of 8 weeks of training (5 sessions per week, 40 to 55 minutes per session). Within 4 weeks performance was improved; at the end of 8 weeks, VO_{2max} improved by 5% and 40km TT performance improved by 8.4%. The authors report other studies using a variety of training interventions that lead to a performance increase or an improvement in laboratory measurements. It should be noted that many factors go into the magnitude of the improvement such as VO_{2max} at the onset of training (the lower the value, the greater the potential increase) and the volume, intensity and duration of training involved.

Jeukendrup and Martin[i] estimate that N, W, and E cyclists can improve 40km TT performance by proper training; the table below from the Jeukendrup and Martin paper shows the estimated effect of training on 40km TT. The authors estimate that proper training including high intensity intervals and sustained endurance can improve novice performance in the TT by 5 to 10%; modifying the training program for well-trained riders yields a 2 to 4% improvement; elite cyclists, since they are already so highly trained, improve by 1 to 3%. Of course, a difference of 1% or less in the Olympics in a timed event is often the difference between a gold medal and 4th place and no medal.

The table provides absolute time improvements from the formula used by the authors.

Estimated improvements[i] in 40km TT time (mm:ss)

	40km time prior to training	Minimum	Maximum	Average
Novice	72:56	3:35	7:18	5:27
Well-Trained	58:35	1:10	2:20	1:45
Elite	52:02	0:32	1:33	1:02

Combining the chart detailing improvements from training and the other potential improvements described above into one table provides the table below.

	Novice Cyclist	Well-Trained Cyclist	Elite Cyclist
Carbohydrate Beverage Ingestion	0:42	0:36	0: 32
Caffeine	1:24	1:03	0:55
Lighter Bike (flat TT)	0:13	0:07	0:05
Lighter Bike (uphill TT 3% grade, 20km)	1:34	0:42	0:29
Lighter Bike (uphill TT 6% grade, 20km)	3:38	1:52	1:15
Aerodynamic Positioning	2:00-2:30	2:00-2:30	2:00-2:30
Aerodynamic Frame	1:44	1:26	1:17
Training (minimum)	3:35	1:10	0:32
Training (maximum)	7:18	2:20	1:33
Training (average)	5:27	1:45	1:02

For the novice cyclist, the clear winner in providing the largest benefit is proper training in all scenarios except the uphill TT on a 6% grade (and just how often does someone compete in that event?). And that is just using the minimum estimated gain from training. If you look at the average impact, training more than doubles the benefits from every scenario except that 6% uphill TT scenario. As the cyclist progresses in fitness, other factors provide larger potential benefits although proper training still has a strong impact.

Conclusion

First, it needs to be noted that the information presented comes from mathematical models and needs to be taken in that context. However, if one thinks about it, the general idea that training has the biggest impact makes sense. Regardless of the kind of bike, position, nutrition, etc, a novice rider should have less of a chance of out riding a well-trained rider much less an elite racer.

The model ignores other factors that a coach brings to the table for the athlete such as skill development, pacing strategy, sport psychology skills and other factors the coach is able to

develop in the athlete. Leaving road time trialing for a moment and examining cross country mountain bike racing where aerodynamics are practically meaningless and the training issue and skill development becomes even a higher priority.

Factoring in the skill, strategy and psychological benefits a coach can bring to the table and the case for hiring a coach to improve athlete performance is quite strong. USA Cycling encourages its license riders to contact a USA Cycling licensed coach about becoming a client. Information on coaching certification levels is available at www.usacycling.org. A listing of licensed coaches is also available at www.bicyclecoach.com (this can be linked from the USA Cycling website).

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[i] Jeukendrup, AE and Martin, J. Improving Cycling Performance: How Should We Spend Our Time and Resources. *Sports Medicine*, 31(7): 559-569, 2001.