# Drafting in triathlon

## Abstract

The aim of this small research was to find out the reduction of output power in triathlon while drafting in 8 meters, 12 meters and 20 meters distance behind a leading rider. Additionally the basebar-position and the position while drinking was compared with the normal position on the aero-bars.

## Introduction

The idea for this small research came from triathlon-coach Roy Hinnen. About the Draft-legal racing there are many discussions, especially in the field of the long-distance triathlon.

The current rules are as follows:

**Deutsche Triathlon Union (German Federation) – Sportordnung 2019 ( p.20, §26 Windschattenzone)**

- 12m behind athlets

- 15m behind motocycles

- 35m behind two-lane vehicle

https://www.dtu-info.de/

**Challenge Roth – Wettkampfbestimmungen 2019 (p. 15, 3.4 Windschattenfahren)**

- 12m behind athletes

https://www.challenge-roth.

**IRONMAN – Competition Rules 2020 (p. 18, Section 5.04 DRAFTING AND POSITION RULES)**

- 12m behind athletes

https://cdn4.sportngin.com/

**Challenge Family The Championship – 2018**

- 20m behind athletes

https://www.challenge-family.

In addition to the distance from athlete/vehicle to athlete, there exist also many other rules that regulate overtaking at the bike course.

It seems reasonable to assume that the drafting rules have an impact on the results and the tactics of the races as well professional athlets as agegrouper.

If there is an advantage although you stick to the rules we tried to find out in this research.

## Methods

The measurements took place at the Augsburg Velodrome, which is a wooden 200-meter indoor track. For each run power (SRM powermeter), speed (Sigma ANT+ Geschwindigkeits-Sender) and laptime (light barrier) were recorded by a Garmin 520/Raspberry Pi 3 for 6 to 20 rounds. The data was interpreted by a self-developed software. On a (short) track it is important to correct the speed measured on the wheels to the speed of the center of mass. The power has to be corrected due to drivetrain efficiency. After removing rolling resistance from the power data, the cdA-value of every run was calculated in respect to the changing micro-climate (temperature (avg. 25°C), humidity (avg. 63%), air pressure (avg. 960,7hPa)) which was tracked instantly.
Because of little variations of speed between the runs, we calculate the power of each run for the required speed using the weight of the rider, the drivetrain efficiency (depending on power output), the rolling-resistance-value of the tyres ($c_{rr}$ = 0,0030), the correction factor for a good tarmac surface (i = 1,4), the cdA-value of the ride and the air density of a “normal atmosphere” (pressure: 1013hPa, temperature: 20°C, dew point: 7°C). The system (including bike, helmet, clothing, etc.) weight of the drafting rider was 91,2kg.

## Measurements

***Drafting tests***

For the drafting tests the leading rider was a male athlete (1,84m, 77kg) on a 2020 Specialized Shiv TT, while the drafting athlete was 1,86m and had a weight of 80,0kg. He was riding a Simplon Mr. T2 with a Specialized Turbo Cotton front and Continental GP TT rear tyre both with a pressure of 8,0bar.
The drafting distance was marked with colored indications on the track. The athlete had two rounds for gaining the target speed, then the measurement started.

***Basebar test***

The basebar comparison consists of a measurement in aero-position and another one in basebar-position of an athlete (1,86m, 80,0kg).

***Drinking test***
For the drinking test one baseline measurement without drinking was done. In the next step the same rider (male, 1,84m, 77kg) took a few sips of the bottle on one straight (44,6 meters) each round.

## Results

All resulting power values include the tyre rolling-resistance for this rider (80,0kg, crr = 0,0038).

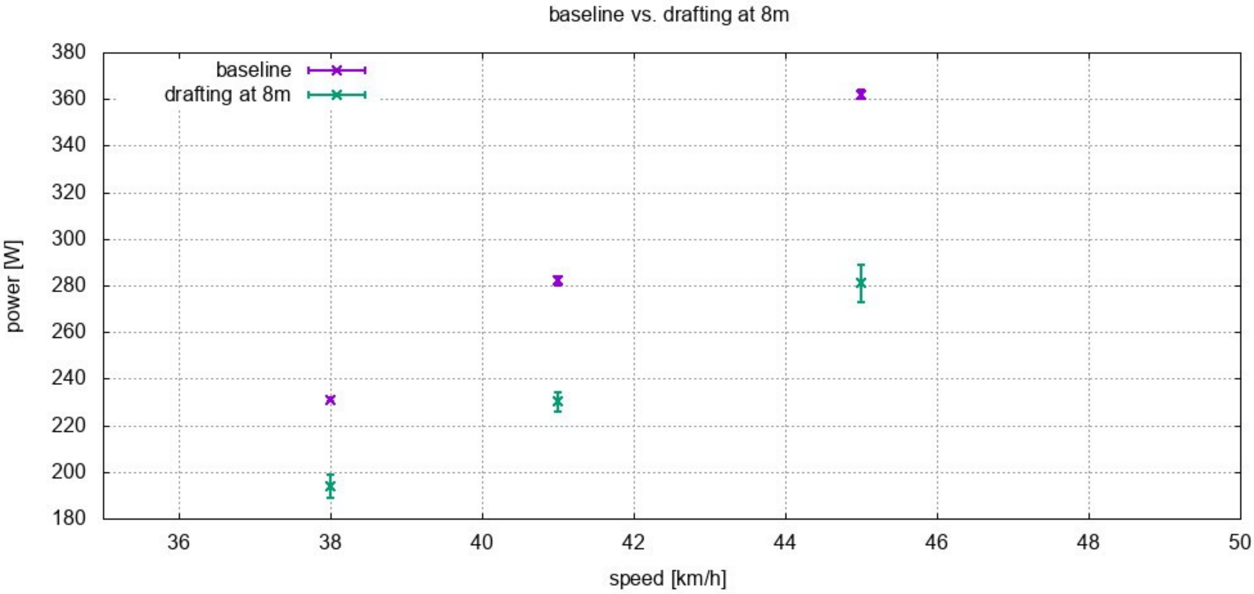
***Drafting tests***
The power value of the 38km/h run without drafting is measured, the other power data without drafting are calculated by the data of the riders baseline ride at 38km/h.
The results of the tests (+/- standard deviation) are the following:

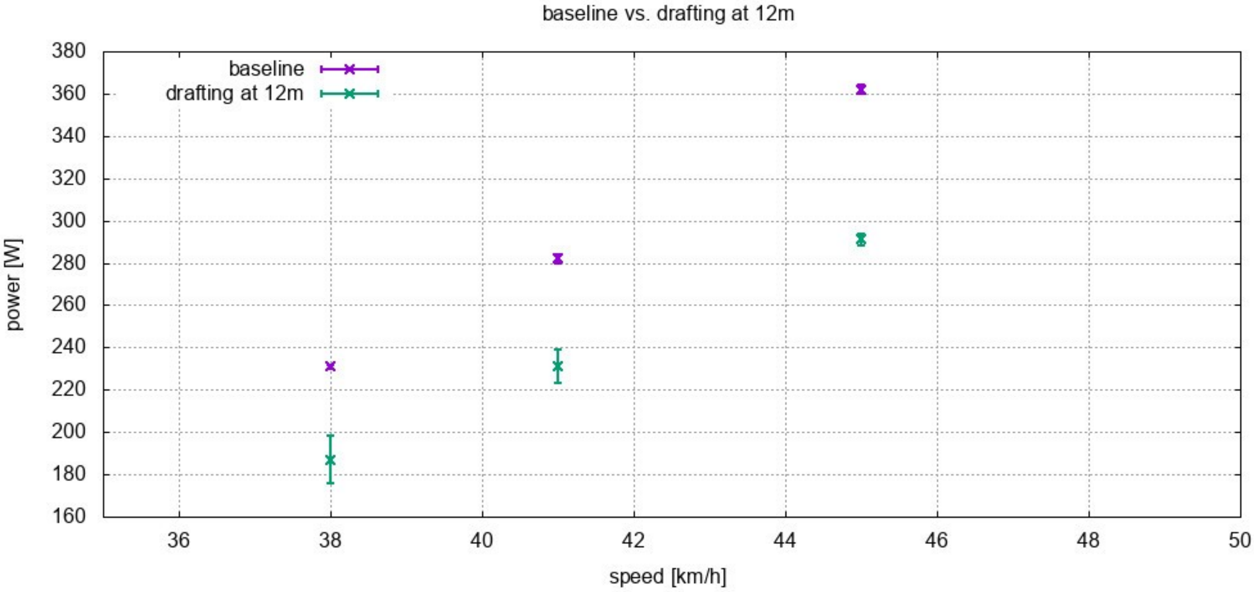
| **speed [km/h]** | **power without drafting [W]** | **power at 20m drafting distance [W]** | **power at 12m drafting distance [W]** | **power at 8m drafting distance [W]** |
|---|---|---|---|---|
| 38,0 | 231,0 +/- 1,6 | - | 187,1 +/- 11,4 | 194,1 +/- 5,5 |
| 41,0 | 282,1 +/- 2,0 | - | 231,0 +/- 8,8 | 230,3 +/- 4,6 |
| 45,0 | 362,0 +/- 2,6 | - | 291,0 +/- 3,9 | 281,5 +/- 8,7 |
| 50,0 | 482,6 +/- 3,6 | 427,9 +/- 18,7 | - | - |

It is obvious that at all drafting distances there is a reduction of required power for the drafting rider. Of course the saved wattage decreases, if the drafting distances increases. The relative power values also show that at the same drafting distance the saving is getting bigger at higher speed.

| **speed [km/h]** | **power without drafting [%]** | **power at 20m drafting distance [%]** | **power at 12m drafting distance [%]** | **power at 8m drafting distance [%]** |
|---|---|---|---|---|
| 38,0 | 100 | - | 81,0 | 84,0 |
| 41,0 | 100 | - | 81,9 | 81,6 |
| 45,0 | 100 | - | 80,4 | 77,8 |
| 50,0 | 100 | 88,7 | - | - |

The errorbars (+/- standard deviation) in the plot show that it is more difficult to get good data while drafting. The problem is that the riders need to control their speed accurately and hold the same line on the track.



***Basebar test***

The results for the average power of the tests at 38km/h are shown below:

| position | power [W] | relative power [%] |
|---|---|---|
| aero | 231,0 +/- 1,6 | 100 |
| basebar | 284,7 +/- 4,9 | 123,2 |

Changing the position from aero to basebar results in an increasing power output of 53,7 Watt at 38km/h.

***Drinking test***

At a velocity of 38km/h the following values were recorded:

| position | power [W] | relative power [%] |
|---|---|---|
| aero | 213,5 +/- 1,4 | 100 |
| drinking | 233,8 +/- 4,4 | 109,5 |

The difference in averaged power output is 20,3 Watt. The rider was just drinking for 44,6m of the 200m round. So his power output while drinking can be calculated:

$$P_{drinking}=\frac{P_{drinking}-P_{aero}\cdot\frac{d_{track}-d_{straigt}}{d_{track}}}{\frac{d_{straigt}}{d_{track}}}=\frac{233{,}8\,W-213{,}5\,W\cdot\frac{200\,m-44{,}6\,m}{200\,m}}{\frac{44{,}6\,m}{200\,m}}=311{,}2\,W$$

This results in an increased power output of 97,7 Watt needed for the drinking position to hold the speed at 38km/h.

If constant power output of 213,5 Watt is maintained while drinking, the speed will decrease from 38km/h to 33km/h. This means, each 100 meters of sustaining the drinking-position costs approximately 1,4 seconds in comparison to the aero-position.

## Discussion

All errors are standard deviations of the measured variables. For further investigation a complete error analysis is needed. The provided results are snapshots based on one run per measurement. The reader can see that for some runs the errorbars are very wide. For more accurate results the number of runs has to be increased and statistical analysis is needed.
A research posted by Swiss Side in 2017 presented CFD-simulations at 45km/h. They found out that at a drafting distance of 10m the aerodynamic drag was reduced by 13,4%. Subtracting the rolling resistance power from the values (8m and 12m drafting) in this study, the drag reduction is approximately in the range of 23% - 26%.
It would be interesting to see how riders of different position, height and weight influence the results. The effect of crosswinds would be very interesting but difficult to measure. In our opinion CFD-simulations could deliver new insights here. Different atmospheric conditions could play a key role for the results of this testing, too.

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