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Airia Running Performance Test

Background

The most important equipment in running (except for the incredible human body) is undoubtedly the shoes. There are several thousands of different models available for the shod runner and they are all unique. Below are just some of all the parameters that differ between shoes:

Weight of the sole	Weight of upper	Center of gravity of whole shoe	Heel to toe drop
Elastic properties of sole	Elastic properties of upper	Thickness of sole	Thickness of insole
Elastic properties of insole	Geometry of sole	Lacing	Heel cap width
Instep width	Breathability of upper	Breathability of sole	Flexibility/stiffness of sole
Outsole rubber quality	Geometry of sole	X?	Y?

All these differences between shoes add up to create the specific feeling that a runner gets while running in that shoe. We are convinced that these parameters also play a role in determining how well a certain runner performs in a certain shoe (how fast he or she can run on a certain distance).

The idea that a shoe can give a person performance benefits is somewhat controversial. Mainly (we believe) this is because running is considered a cheap, fair sport and that there has been no generally accepted test to distinguish performance differences between running shoe models. In cycling time trials for example it is well known that you can easily “buy” several minutes in performance by investing an extra 10000 USD on aero equipment (frame, bars, wheels, skin suit). Runner don’t want this to happen to their sport. But it already has and by ignoring the fact they miss out on a great opportunity to choose their shoes for best possible performance. Today it is almost impossible to buy a racing shoe for more than 200 USD but we believe that in the future the fastest running shoes might cost considerably more.

While developing our Airia shoes we wanted to devise a test that could measure if runners actually would run faster in our shoes, compared to other shoes, while trying to run as fast as possible for a certain distance. The classic scientific model for measuring running efficiency is based on running in slow fixed paces far from high lactate levels and far from the type of running involved in most races. The reason for this being that the physiological processes involved in high intensity running are still too complex (and includes big individual differences) for scientific modelling. We decided that “slow” testing was not an option for us because winning races and beating personal records is

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about pushing yourself and your equipment to the limit. We wanted the true racing process to be a part of our tests.

Why time trials?

We developed our test adhering to the wisdom of Timothy D. Noakes (MD, professor of the University of Cape Town and author of several books and scientific articles on running and physiology). In his book "Lore of Running" he punches a big hole in the myth of the VO2 Max test as the golden standard for testing running performance. He claims that performance on shorter time trials (up to 10k) is the best way to predict performance for any longer distance ("Why VO2 max doesn't Necessarily Predict Performancee" p 49; Predicting running performance p 64-66). We based our test protocol on shorter time trials which has been proven to be the best predictor of performance on longer races. To test how well a shoe works for a specific group we have developed a test protocol based on paired time trials conducted in an "as sterile as possible" running environment with only the shoes being the varying parameter.

Our tests

The test that we have found to be most reliable is the Double 5k all-out time trial performed indoors on a 200m banked track. The first test being run with one shoe type and the second test being run with another type. The tests are all conducted with one person running alone on the track. The test runners are encouraged to give it their best effort with the aim of achieving the fastest possible finishing time.

Before and in between tests the test runners are asked to come as equally prepared as possible, avoid alcohol and to communicate any changes they experience in the body, mood or other things that might influence the outcome. Tests where other parameters than the shoes have an obvious influence on the results are scratched from the protocol. For example:

- The test runner feels he was unable to give it his best during a time trial due to problems with his knee
- The maximum or average heart rate differs more than five beats (/min) between tests.
- The lactate level after the test differs with more than 3 mmol between tests or is lower than 4 mmol in either one of the tests.
- Alcohol consumption between tests.

The tests are randomized so that the same number of runners run their first test in shoe A and shoe B. The number of days between the two 5k trials are 2 to 4 depending on the level of the athlete (with the best trained athletes at the low end of this spectrum).

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During the tests we have been measuring heart rate, step frequency, stride length and lactate levels. However not always all of these parameters. During some developing stages this data has been used to get a better understanding of different shoe models and some of the data is important to make sure that the test was at a maximum effort by the runner. One test series usually includes at least 10 double tests. Our experience is that this is enough to see the difference on a group level between the two shoe models being compared.

Our test runners

The performance level of our runners on the 5k distance range between 16 and 25 minutes, with the majority of them running it in 19-21 minutes.

We have a big variety of stride patterns among our runners including forefoot-, midfoot- and heel strikers. More than 100 runners have been involved in our tests.

Statistical analysis methods

We have used the Paired Wilcoxon signed rank test to see if the average performance differences that we get from our tests are statistically significant, and the probability that these mean differences apply to a larger population is outlined in the results section below.

Testing the method

To be sure that there was no bias in the test method we conducted several double test series where Shoe A and Shoe B was exactly the same shoe. We treated this same shoe exactly as if it had been two different shoes, keeping track of Test A and Test B for each and every runner. The result was a difference of 0.05%. The probability that shoe A would repeat this 0,05% performance gain over shoe B across a larger population was 51,4%, which is very low.

We have also conducted several series of the same test to verify results, with the same outcome every time.
From this we concluded that our test method is showing actual performance differences between shoe models.

Some results

We have tested many different racing shoes for road running. With the exception of the first result in the table below, we only show tests conducted with shoes of a similar weight (within 10g difference /shoe). Among are shoes worn when breaking world records and well established “good” racing shoes. We do however not want to name the shoes we have been testing.

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Shoe X vs. Shoe X +110g added weight
Shoe X without added weight came out 1,87 % faster (21,6sec on 5k with a finishing time of 20min.) 99,9% probability that this is true for a larger population.

Airia Prototype 1 vs Shoe Z
Airia Prototype 1 came out 0,94 % faster (11,3 sec on 5k with a finishing time of 20min.) 99,5% probability that this is true for a larger population.

Shoe R vs Shoe X
Shoe X racer came out 0,89 % faster (10,7sec on 5k with a finishing time of 20min.) 95% probability that this is true for a larger population.

Airia Prototype 2 vs Shoe R
Airia Prototype 2 came out 2,16% faster (25,9sec on 5k with a finishing time of 20min.) 97% probability that this is true for a larger population.

Airia Prototype 2 vs Shoe X
Airia Prototype 2 came out 1,26 % faster (15,6sec on 5k with a finishing time of 20min.) 98,9% probability that this is true for a larger population.

Shoe X vs Shoe W
Shoe X came out 0,36 % faster (4,3 sec on 5k with a finishing time of 20min.) 80 % probability that this is true for a larger population.

Control test conducted to prove the method
Shoe X vs. Shoe X*
Shoe X came out 0,05 % faster (0,6sec on 5k with a finishing time of 20min.) 51,4% probability that this is true for a larger population. Proving that the shoes were equal.

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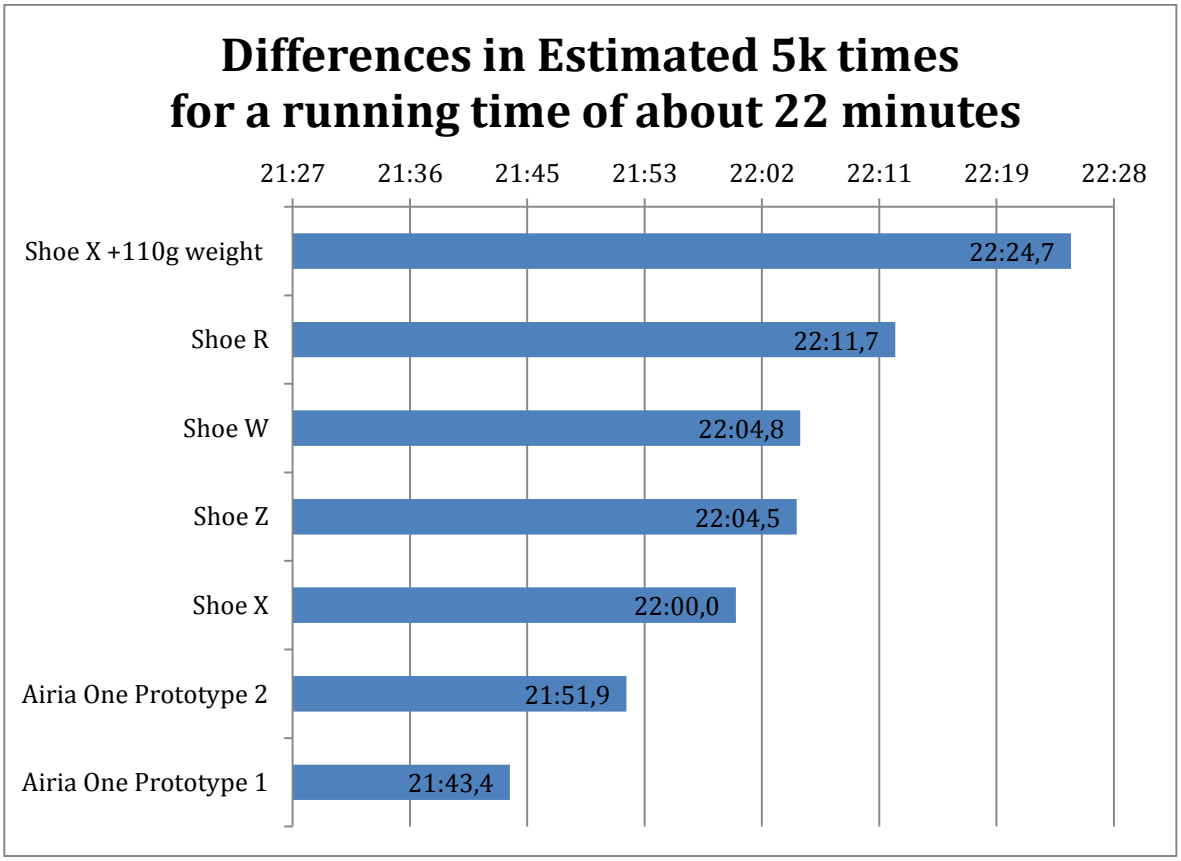

Conclusion

We set out to find a test that could help point our development in the right direction and help us measure how our prototypes performed in comparison to other shoe models. After testing several methods we found that the "Double 5k all out time trial" provided the most reliable answers. We found that this type of testing can be a very good tool for rating different shoe models in a way that has not been done before. Hopefully it can be used as a stepping stone towards gaining more knowledge about different running shoes; which shoes aid and/or hinder performance, and why.