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Running Power: Comparison of Myotest Solution with Commercially Available Products

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Abstract
This white paper aims at comparing Myotest's location-agnostic software solution to calculate Running Power with three commercially available solutions: Garmin with a pod on a waist belt, Polar watch on the wrist and Stryd with a pod on the shoe.

Keywords
Power — Running — Myotest — Garmin — Stryd — Polar

Contents

Introduction

We believe that Running Power has the potential to fundamentally change the way people run and train. However, there is no consensus yet on the Gold Standard[1] for Running Power so it is hard to say who is right and how accurately brands measure it [1] .

The aim of this paper is to compare Running Power calculated by Myotest's software and three commercially available products: Garmin with a pod on a waist belt, Polar watch on the wrist and Stryd with a pod on the shoe.

Running Power

Running Power is the amount of work produced over the running time (in Watt or Watt/kg). Measuring Running Power has the potential to transform running, in the same way that power measurement revolutionized cycling [2]. Below are three examples:

1. **Pacing.** Monitoring Power allows a runner to pace his/her race or to train much more accurately than using heart rate (HR) monitoring, pace measurement or perceived rate of exertion (PRE) since changes in Power occur instantly where HR change can be delayed (see Fig. 1). Pace measurements on a hilly course does not allow for appropriate effort management and PRE is only established at the end of the session. With Running Power you can define a target zone in order to run a certain distance under a specific amount of time whilst managing your energy supply and avoiding common mistakes such as starting a race too fast.

2. **FTP.** Power can be used to measure the Functional Threshold Power (FTP)[2] and then, guide the athlete for training specific energy systems, e.g. a tempo run is intended to increase mitochondrial enzymes and ability to store glycogen, a VO2 Max workout improves cardiac output, etc [3, 4, 5].

3. **Intensity.** Using Running Power as an indicator of intensity in conjunction with duration enables coaches and athletes to plan the workload from day to day, week to week and a whole season. The changes in maximal power outputs and FTP can also be tracked to monitor progress through various training regimen and improved running economy.

The general formula for Power is [6]:

$$\text{Power(t)} = \text{Force(t)} \times \text{Speed(t)}$$

While speed can be calculated, the overall force is open to interpretation, because there is no "Gold Standard" accepted in the industry. Myotest Running Power is calculated according to two components. Firstly, the vertical motion of the runner, which includes the vertical oscillation of the center of mass, as well as any uphill or downhill displacement during the run, secondly, the horizontal motion which includes mostly the anteroposterior motion (in the direction of travel) since the mediolateral motion (in the horizontal plane, perpendicular to the direction of travel) is not contributing significantly to the Power output.

[1] The gold standard is an agreed upon common external reference.

[2] FTP is defined as the average sustainable Power during an 1-hour running test.

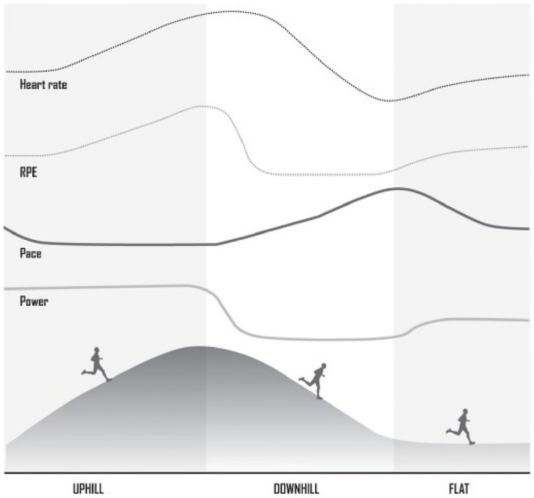

Figure 1. Heart rate, rating of perceived exertion, speed and power respond differently to change in the track. Only Power responds in real-time to the change of workload [3].

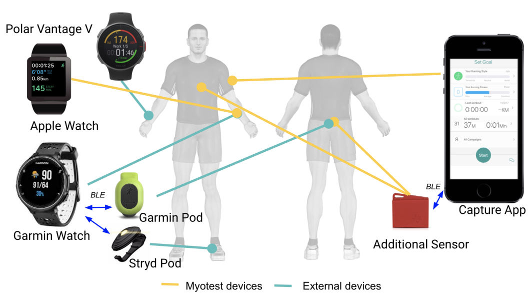

Figure 2. Each subject was wearing 7 devices: Garmin watch at left wrist, Polar Vantage V on the right wrist, Garmin pod on the waist belt, Stryd pod on the shoe, and for Myotest Apple watch on the left wrist, iPhone on the upper arm and two BLE accelerometers, one on the sacrum and one on the chest.

Study Methodology

The signals of Garmin, Stryd, Polar and Myotest were recorded simultaneously for a run on the same course by seven devices (see Fig. 2). Since Garmin and Polar solutions require the use of GPS, we chose an outdoor location. To cover all possible scenarios, we chose a course with flat, uphill and downhill parts. A total of 27 runners took part in this study. Out of those, 7 runners (6 males, 1 female, age: 27–52 years old, weight: 56–82 kg, height: 1.64–1.85 m) ran with the setup and protocol described below.

Runner Setup

For this study, each subject was equipped with a grand total of seven sensors: Garmin pod, Polar watch, Stryd pod and four sensors for the Myotest solution on different body locations.

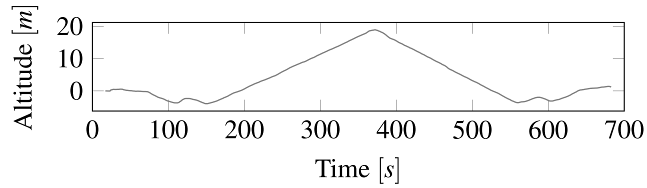

Figure 3. Illustration of the elevation profile of the course.

Data collection

The age, gender, height and weight was introduced in each device to allow the respective software to adjust with this data. For each run data was collected, aligned in time using date/time, GPS data and elevation profile as common references.

Protocol

Runners were asked to run at a self-selected pace during the workout. Each runner ran 2 km with a total elevation gain of 22.8 meters as follows (see Fig. 3):

- 500 meters on almost flat ground
- 500 meters uphill on a constant slope
- 500 meters downhill on a constant slope
- 500 meters on almost flat ground

Data analysis

All the data collected during the workouts was analyzed using Python Jupyter notebooks. Signals had to be re-sampled and mean normalized to be able to compute sample by sample differences between brands. This allowed for comparison of the mean relative error, the correlation and the mean absolute amplitude shift between Myotest and other brands.

Results

Overall visual comparison

We did a separate analysis for each runner. Firstly, we assessed visually the Power outputs for the four measurement systems to determine whether there was any major difference that could be noticed while running on the flat, uphill and downhill. For most of the runners, we noticed that despite an amplitude shift, the shape of the outputs and the presence of similar peaks are a clear evidence of the correlation between all four systems. You can see an example of such data in Fig. 4. We can also see that all brands are responsive to change in elevation (drop in Power at the uphill/downhill transition, increased Power in the uphill parts).

In order to show the correlation of the signals from the different devices, we analyzed the original Power signal (see Fig. 4 and Fig 5) and the mean normalized Power signal (see Fig. 6 and Fig. 7). As Polar and Myotest are both measuring Power from the wrist, it was expected that the original Power signals are closer to each other. However, when removing the constant shift in the signals by using a mean-normalization

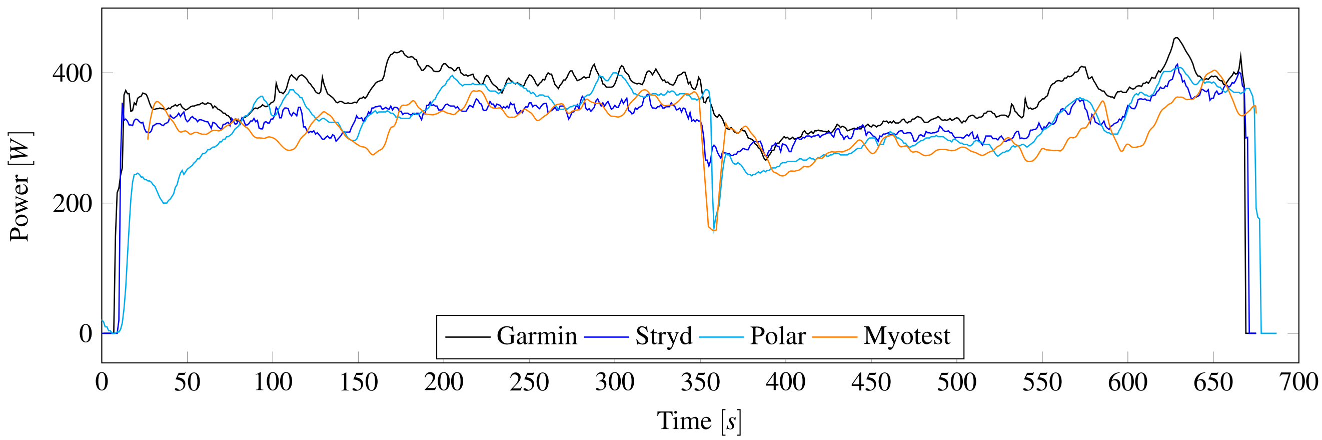

Figure 4. Representation of the power outputs of Garmin, Stryd, Polar and Myotest for one runner. We can clearly see the correlation with the overall shape, peaks and the transition with the uphill/downhill part.

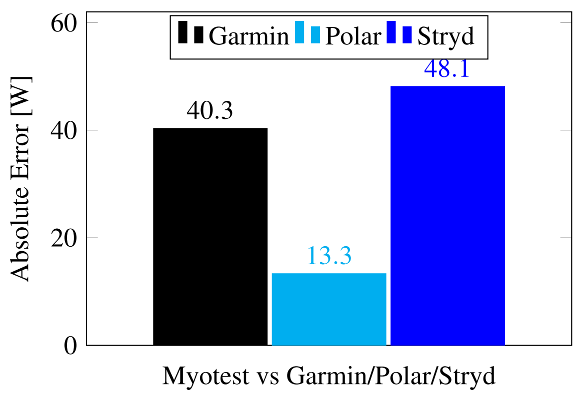

Figure 5. Bar graph of the absolute value difference in Running Power measurements between Myotest on the wrist and the three systems: Garmin, Polar and Stryd. These values represent the mean absolute amplitude shift of the signals for all runners.

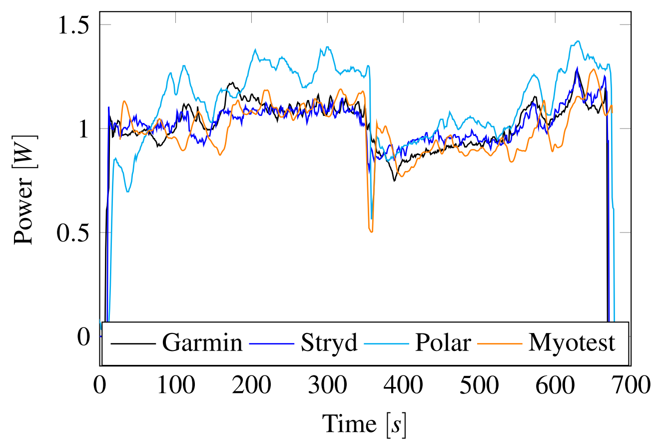

Figure 6. Illustration of the mean normalized power signal of Fig. 4 of Garmin, Stryd, Polar and Myotest for one runner.

method, we see that Myotest's Running Power is actually closer to Garmin's and Stryd's.

This indicates that despite being on the wrist Myotest's solution measures Running Power as accurately as Garmin and Stryd, which are worn on body location where the calculations are easier and considered as more accurate.

Myotest versus other brands

Secondly, we assessed the correlation between all brands signals to Myotest. For this purpose, we computed the differences between Myotest and all three brands signals that were re-sampled according to Myotest's sampling frequency and mean normalized in order to remove the amplitude difference. You can see the effect of the mean normalization in Fig. 6 for one runner.

The bar graph (see Fig. 7) representing the absolute relative error demonstrates that Myotest is consistently measuring values with a similar error rate versus Stryd and Garmin and a slightly bigger error rate versus Polar. One factor explaining the difference with Polar lies in the fact that it always takes in average about 100 seconds for their measurements to align with all the others. This is noticeable in Fig. 4 at the beginning where we clearly see the time the Polar signal needs to reach the other. All of this makes us believe that despite a shift in amplitude between signals, Myotest is reliably measuring Power as are Stryd, Polar and Garmin.

Consistency across body locations

Measuring accurately Power from different body locations is challenging. It requires to find a common reference frame to account for the different motion captured by the different devices. For example it is harder to measure from the wrist (a watch on the wrist or a phone in a hand) because of the arm swing. From the chest, sacrum or foot it is easier and usually gives more accurate results. Garmin measures from chest and belt, Stryd from the foot, Polar from the wrist. Myotest's software can calculate Power from the wrist, chest, belt and upper arm. Myotest's consistent Power outputs from different locations can be seen in Fig. 8. This is a unique

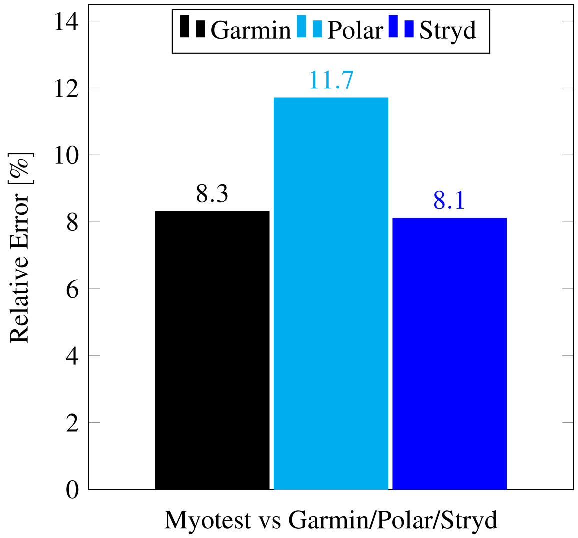

Figure 7. Bar graph of the absolute relative error difference in power measurements between Myotest at the wrist and the three systems after applying a mean-normalization. This normalization removes the impact of the constant amplitude shift and demonstrates the similarity of the shape of the signals.

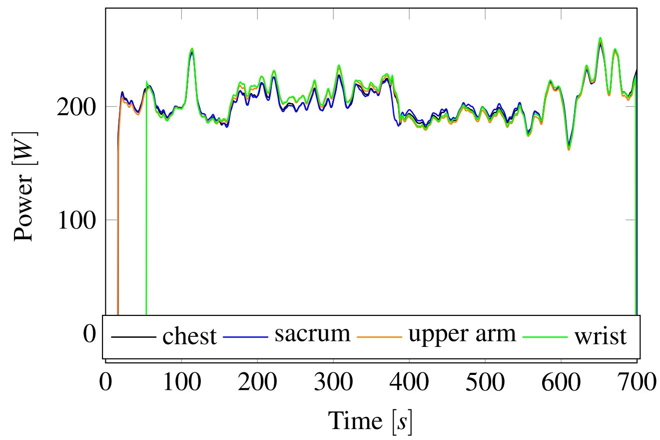

Figure 8. Power outputs of Myotest on the chest, sacrum, upper arm and wrist. We can clearly see that Myotest's Power output is consistent across every sensor location.

advantage of Myotest's technology that allows comparable measurements across several body locations, as we compute the biomechanics of the center of mass of the runner. That means that if we use a watch and a phone at the upper arm, the real-time Power measurements will be the same.

Conclusion

Running Power is new to the market and there is no consensus on the Gold Standard. It is therefore difficult to evaluate the accuracy of each brand. As a result, in this study, we did compare Myotest Running Power with other brands as relative and absolute differences.

While Garmin measures form the sacrum and Stryd from the shoes which require an extra costly accessory, both Polar and Myotest measure from a device at the wrist, without any external device, which reduces significantly the user friction and the cost.

Our study has shown that there is an amplitude offset between all four brands, most likely due to the differences in the vendors definitions of power. However when normalized, the common shape and peak occurrences are coherent between all systems, as shown in Fig. 6. Myotest is closer to Stryd and Garmin who are measuring Power at the foot and belt, where measurements should be more accurate. Despite the difference in calculating Power by each brand, this paper demonstrates a high degree of consistency in the shape of the Running Power when normalized as shown in Fig. 6. However, Myotest is the only solution designed to deliver consistent results on multiple locations, as shown in Fig. 8.

About Myotest

Myotest believes that sports - running in particular - should remain accessible, simple and safe. Myotest delivers smart software and services for wearable devices to help athletes achieve their goals confidently, improve their efficiency, and reduce the risk of injury. Wearable device manufacturers and app developers license Myotest software and services for their next-generation products. Founded in 2004, the company is a pioneer in the capture, analysis and interpretation of biomechanical metrics. The Myotest system has been used by over 20,000 professionals in sports and health. The Myotest patent portfolio includes more than 50 issued and pending patents. Learn more at `www.myotest.com`.

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