Marathon Pace Prediction

All marathoners, from fast to last, predict their race pace, usually by comparing shorter race times, time trials, previous marathons or “gut” feelings. But studies show that the best predictor of race performance may be submaximal performance. The importance of accurate prediction is more than a game — it can help monitor training progress, increase race confidence, provide an invaluable pacing strategy and even predict injury.

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MAF

Just after the 2016 U.S. Olympic Trials in Los Angeles, coach Alberto Salazar claimed that Galen Rupp (his star 10K runner and now marathon winner) had recently clocked a 20-mile training run at a 4:52 minutes per mile (min/mi) pace, with a heart rate of 150 beats per minute (BPM).

If this is true, Rupp would be the clear favorite to beat the East Africans at this summer's Olympic Games in Rio, Brazil. But the normally secretive Salazar rarely surrenders specifics about his athletes.

However, it must be considered that when running at any given heart rate (HR), the onset of fatigue causes later miles to be slower than earlier miles. If HR remains constant, pace drops. And if pace remains constant, HR rises. Therefore, it's highly unlikely that Rupp can perform a workout where the 1st and 20th mile are run at the same pace, while maintaining a constant submax HR.

Regardless, Salazar may have spilled the proverbial beans: Speed at an aerobic submax HR is highly predictive of marathon performance. Let's suppose that only Rupp's 1st mile was run at 4:52 min/mi, with a submax heart rate of 150 BPM. This time could predict that Rupp might not only win an Olympic medal in the marathon, but, on a fast course with cool temperatures, also could establish a new marathon record. He could potentially even break the 2-hour mark — the greatest remaining barrier in the sport since Sir Roger Bannister broke the 4-minute mile.

(In the book "1:59," I present the evidence and details for how a runner could break the two-hour marathon barrier: by improving submax performance to under 4:50 minutes per mile.)

For generations, marathoners and their coaches have pondered predictions of how fast athletes might run. Early estimations were notably based on instinct and intuition, or "gut" feelings, but the results were usually the same: the runner was either thrilled to achieve success or disappointed by the results. It's not much different today: Sometimes a well-run, properly-paced race leads some finishers to claim it seemed too easy — that they could have had a better time, had they only run faster earlier in the race. However, due to the body's physiological setup, that supposition is unlikely to be accurate. Later in the text, we discuss the reasons why.

Laboratory Testing

Since the 1970s, scientists have been trying to accurately predict marathon times in runners of all levels of talent. Methods of prediction are included but not limited to:

- The correlation of marathon performance with maximal oxygen consumption (VO2max) is a long-standing estimate, but not a very good one.
- A rather complex formula that includes the oxygen cost of running, VO_{2max}, and from the largest fraction of VO_{2max} that can be sustained throughout the race.
- Dr. Michael Joyner, who authored the first published scientific paper addressing the

possibility of a sub-two-hour marathon in 1991, used the following equation to predict marathon times:

- VO_{2max} x lactate threshold percentage x running efficiency = marathon time. (Joyner estimated an elite athlete could theoretically run the marathon in 1:57:58 based on this formula.)

- The maximal lactate steady state (MLSS) has also been used to predict marathon times. It is defined as the workload (MLSSw) at the highest blood lactate concentration that can be maintained over time without a continual blood lactate accumulation. Marathon average paces are just below this level.

For most runners, collecting this and other data required for marathon prediction requires lengthy evaluations in a laboratory facility with proper equipment and protocols. For progress to be monitored across time, it is necessary to perform regular testing. As a result, most runners — even elite athletes — do not utilize this approach due to these and other factors such as cost, availability, and often, inconvenience. As important as laboratory testing is, it may not be necessary: an easy and accurate test can be performed by anyone with a heart-rate monitor.

Submax Field Testing

A common feature of all sports lasting more than a few minutes is that higher aerobic submax capacity results in higher competitive performance. In the marathon, race paces are usually only seconds faster than submax training paces in runners of all abilities. This means that the faster one can run while maintaining a lower-intensity submax HR, the faster the race pace. (This phenomenon is applicable to all endurance sports.)

The Aerobic System

The *aerobic system* is the collection of various systems and processes that intake, transport, and utilize oxygen, in particular, to oxidize fat for fuel. Fat provides the body with a stable supply of long-term energy that complements glucose utilization and reduces training and racing fatigue while conserving glycogen.

In the marathon, about 99 percent of race energy is provided by the aerobic system. Unlike shorter endurance events such as the 5k, where intensity is closer to one's VO_{2max}, marathoners perform at lower intensities such as 80-85 percent of VO_{2max}. The intensity at which the marathon is run must remain relatively low. As exercise intensity increases, the percentage of energy provided by sugar increases, while the energy provided by fat decreases. The body's sugar stores are far too small to provide energy for the duration of such a long race. To the degree that an athlete relies too much on sugar as a primary source of fuel (due to an untrained or dysfunctional submax aerobic system), running a marathon will be an extremely stressful, challenging — and slower — endeavor.

This means that by developing *maximum aerobic function* — MAF — one can optimize both submax speed and race performance. In addition, studies show that submax tests are the best predictors of endurance performance in runners (and for other endurance athletes, such as cyclists and race walkers, as well as for untrained people). Measuring submax performance can be accomplished regularly through a simple field test using a heart-rate monitor on a reasonably flat running course, such as a track.

MAF HR and Test

The MAF HR is a submax intensity useful for both training and submax testing. It corresponds closely with physiological laboratory measures, including:

- Aerobic threshold (Aer T).
- Maximal lactate steady state (MLSS).
- Fatmax (the highest level of fat oxidation, which occurs during submax activity).

The MAF Test is a submax evaluation that measures pace at a given HR. For example, if an athlete can run one mile in 8 minutes while maintaining 140 HR, the MAF Test result is 8 minutes per mile. (Anyone can perform an MAF Test in his or her particular sport.)

Both the MAF HR and MAF Test were developed by the author in the early 1980s and are described in detail on my website. Monthly, measurable improvement in MAF Test scores (running faster at the same HR) is the most important measure of increasing health and fitness in an athlete.

These improvements should also correspond to improving performances (even in shorter endurance races). Figure 1 is an example of a runner's 18-month progress of MAF Tests with three corresponding marathons.

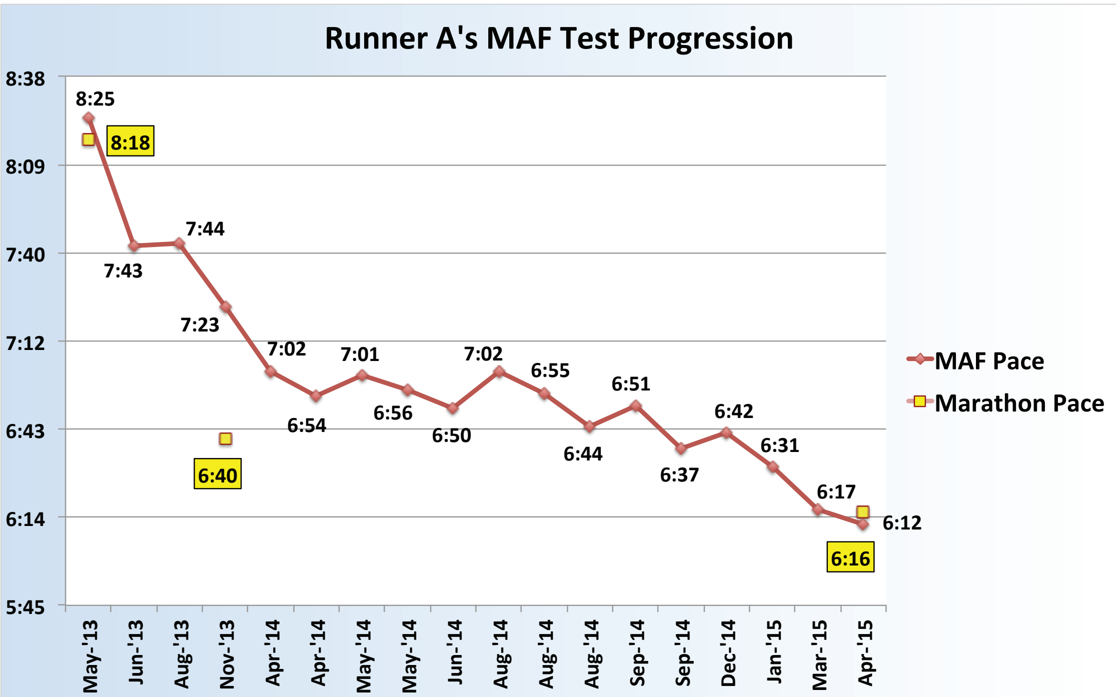

FIGURE 1. A graphical dipiction of an athlete's 18-month MAF Test first mile progress with results of three marathons (average pace). Marathon dates are aligned with their closest MAF test.

Time-Tested Results

Examples of elite runners comparing first mile MAF Test times and marathon paces:

- In the early 1980s when I put a heart monitor on Norwegian Grete Waitz, who would become a nine-time winner of the New York Marathon, she ran a 6:05 aerobic pace, which corresponded to her then 2:32 New York marathon — averaging 5:48 pace.

- A few years later, England's Priscilla Welsh developed her MAF HR pace to 6:00 minutes per mile, and ran a 2:30 marathon averaging 5:44 pace.

- Not long after his 2011 Boston Marathon 2:04:58 finish, a 4:46 pace, American Ryan Hall clocked a 5:07 MAF Test mile at altitude, estimated to be sub-5-minutes at sea level, which would correspond to his Boston finishing time.

Clinical observations by the author since the early 1980s demonstrated that in a healthy athlete running a typical 26.2-mile course (without significant changes in elevation, closer to sea level, and without excess weather stress such as higher temperatures or humidity, or increased winds), most could average about 15 seconds per mile faster than their MAF Test pace (within a range of 10 above and 10 below on average). This applied to age-group runners as well as elite marathoners.

Additional data was recently collected to assess the relationship between MAF Test and marathon race pace. The MAF Tests from seven female and 10 male runners of varying performance levels were analyzed. Results demonstrated that average marathon paces ranged from -17 sec/mi to +1 sec/mi, relative to 1st mile MAF paces, with a mean time of 4 seconds. This corresponds well with past clinical observations. It is possible that the slightly faster marathon pace relative to MAF Test times observed by the author is due in part to:

- Differences in marathon courses (elevation change) and weather.
- The author's use of physical therapies such as biofeedback to improve the athlete's muscle balance and gait immediately before races (in most but not all cases).
- Well-defined dietary recommendations (particularly no refined carbohydrates and lower overall carbohydrate intake).
- Combinations of these or other factors.

The Value of Prediction

Why is it important to predict marathon race times? Accurate prediction has real benefits for an individual athlete, including providing an important pacing strategy, as well as helping assess the balance of health and fitness.

Pacing Strategy

Lambert et al. (2004) defined pacing as the subjective competitive strategy in which an individual manipulates speed to achieve his or her performance goal. Pacing can help reduce fatigue and improve performance. Maintaining a consistent marathon pace throughout the race has been shown to be an effective performance strategy. (Pacing can be performed by the individual or with the help of another runner.)

Naturally, pacing strategy must consider the details of each particular course regarding elevation changes. For example, one would avoid running an average pace for a first mile that is significantly uphill; likewise, during a downhill mile pace may be faster than average.

By using the 1st mile of the MAF Test to predict average marathon race pace, one could create an optimal pacing strategy. This could help runners reduce their pace variability throughout the race. A lower pace variability than that observed in age-group runners is a hallmark of the elite runner. Even during championship marathons run exclusively by elite runners, top finishers showed a more even pace pattern than the less successful contenders.

Psychological and Physiological Factors

Adoption of optimal pacing strategies in a marathon is of such great importance that it could be said that the race is won in the first 5k rather than the last. In describing athletes who adopt effective pacing strategies St. Clair Gibson and Renfree (2013) write that runners who employ more even pacing throughout a race "will be able to record faster times and finish ahead of athletes with superior physiological capacities who paced themselves less effectively."

Most coaches, clinicians and athletes have known for decades that fast starts in most events from about 800 meters and longer can impair overall performance (similar situations exist in cycling, triathlon and others). Yet, most athletes run initial miles too fast for their ability, and relative to their personal best times, and must therefore slow down too much later in the race resulting in poor performance.

Subjective factors, especially those of a psychological nature, can interfere with a runner's ability to avoid faster, early paces. Whether in the lead or at the back of the pack, marathoners are more likely to follow other runners in the initial stages of the race and run too fast rather than follow their own perceived abilities. Sometimes referred to as "herd mentality," this is a social phenomenon seen not only in marathon runners but in other sports (and across all levels of society). Denes-Raj and Epstein (1994) describe this as "conflict between intuitive and rational processing: when people behave against their better judgment."

Pacing strategy is a decision-making issue which occurs long before the race begins. With an objective pace strategy plan based on submax testing, runners can follow their own inherent abilities — racing "within themselves" — rather than that of others. The result can be:

- What usually seems like a "too easy" first 5K.
- A "negative split" — a natural faster second half of the race — which is also associated with increased race success.
- The ability to run faster at the end.
- Performing at, near or above a personal best.

In the author's experience, pacing success appears to work best in healthy runners, including those who oxidize higher amounts of fats for race energy and those with better running economy.

Health and fitness

The close relationship of the MAF Test to a person's marathon pace can answer an important question about the balance of health and fitness. Average marathon race paces that are much slower or much faster than the relative MAF Test may be associated with a physiological imbalance:

- *Too slow* a race may be indicative of less than optimal fat oxidation with reduced long-term energy to maintain a fast pace, or an irregular gait (often due to neuromuscular imbalance) reducing running economy.

- *Too fast* a race could be an artificially inflated pace, commonly seen in the early stage of the overtraining syndrome where excess sympathetic tone creates artificial strength and speed.

The first indicators of worsening health and fitness may be observed in training as reductions in MAF Test speed (which sometimes initially appears as a lengthy plateau in monthly MAF Tests), with the potential of predicting various physical, biochemical or mental-emotional injuries. This often occurs even before the onset of pain, fatigue, mood changes, or other symptoms of poor recovery and physiological breakdown. Preventing this very common injury pattern may be Galen Rupp's biggest challenge.

Considering that Rupp's MAF HR may be 150, with the possibility that he can run a 4:52 MAF Test, it reflects great marathon potential. So, why didn't he run faster than a 5-minute mile — his average pace at the Olympic Trials? Perhaps his primary goal was to qualify for the U.S. Olympic Team. In addition, his relatively "slow" 2:11 winning time could easily be attributed to race-day conditions: temperatures reached 76°F by the time he crossed the finish line. A 50°F day could have improved Rupp's marathon time significantly — possibly by several minutes. Can he stay healthy, run his potential in Rio, break a world record on a faster course and flirt with 1:59?

Time will tell.

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