Can autonomic monitoring predict results in distance runners?

Massimo Pagani1,2 and Daniela Lucini1

1Dipartimento scienze cliniche L. Sacco, Centro Ricerca Terapia Neurovegetativa, University of Milano; and 2Ospedale L. Sacco, Unità Operativa Telemedicina e Medicina dello Sport, Milano, Italy

Running for Victory

Victory (victoria) was the last word uttered by Philippides, before collapsing, at the end of the ~42-km run from the fields of Marathon to Athens, where he had been sent to announce the victory against the Persians in 490 BC. In modern Olympic games, the marathon has been introduced as a ~42.2-km road run, with a 2008 world record of 2 h, 3 min, and 59 s. It has been said that winning the Olympic marathon remains the ultimate accomplishment for a long-distance runner and that this requires strength, courage, and endurance but also something else, something the skeptics might call the blessing of the gods (9). The marathon has also become renown as the typical elite long-distance race, with thousands of runners participating in very popular races (such as the New York Marathon), organized in almost every part of the world. Accordingly, the training techniques and tactics to prepare for a marathon go well beyond the field of an elite sport and also interest laypeople or at least whoever might think to run a marathon, including the handicapped.

Signs of the popularity of this specialty are easy to find. The marathon has been used to follow athletic training in other sport specialties, whom only RR intervals were measured. Autonomic assessment has been found to be a useful tool in marathon performance (12a), or the occurrence of symptoms. Winning performance likely requires a perfect interplay (12a) of training frequency, duration, and intensity with enough recovery to optimize the adaptation of both biological and psychological aspects. Overtraining (1) might induce a depression-like syndrome, inclusive of malaise and bodily symptoms, such as soreness that may guide in tailoring individual routines. It is also our experience in a different Olympic specialty (rowing) that subjective bodily symptoms observed before the competition might predict results in the subsequent race (7). In certain cases, the cortisol daily profile might help in assessing individual resilience to competitions stress, such as in pentathletes. In a sense, one might hypothesize that, like in everyday life, the stress of competing might be mirrored in functional parameters describing either subjective or objective elements of regulatory functions and notably the autonomic neural regulation of the cardiovascular system (11).

Indirect Autonomic Assessment

Only very few studies have focused on the autonomic nervous system and on its surrogate measures, such as RR or blood pressure variability in the context of marathon training. These indirect measures, however, might offer a means to obtain dose-response curves of the cardiovascular adaptations (8) or predict competition time (5) since maintaining a low level of sympathetic modulation to resistance vessels (4) might enable a fast performance. Conversely, an autonomic assessment might underscore the slow recovery from the elevated sympathetic drive of maximal effort, as shown years ago, e.g., by Furlan et al. (3) in trained or untrained healthy individuals in whom only RR intervals were measured. Autonomic assessment has been used to follow athletic training in other sport specialties, such as in rowing. Followed throughout an entire year, world-class athletes (6) changed from a vagal predominance (elevated high-frequency power of RR variability spectra and of baroreflex gain) during moderate levels of training load to sympathetic predominance (elevated low-frequency component and reduced baroreflex gain) at the time of increased, precompetition, training load. In nonathletes, the presence of indirect autonomic signs of resting sympathetic predominance is usually found in pathological conditions, such as in hypertension (10) or chronic stress (11).

A key issue might reflect the fundamental difference between signals and their meaning (13), in addition to the observation that indirect measures can only imperfectly reflect

Table: Predictors of Performance

<table>
<thead>
<tr>
<th>DOMAIN</th>
<th>FUNCTION</th>
<th>MEASURE</th>
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<tbody>
<tr>
<td>psychology</td>
<td>subjectivity</td>
<td>Stress &amp; Bodily symptoms</td>
</tr>
<tr>
<td>regulation</td>
<td>ANS</td>
<td>RR V, BRS</td>
</tr>
<tr>
<td>endurance</td>
<td>fitness</td>
<td>VO2 max, anaerobic threshold</td>
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Fig. 1. Schematic outline of the elements that might provide a guide to individualized prediction of athletic performance in marathon runners. The view of Manzi et al. (Ref. 12) corresponds to adding indirect autonomic markers [normalized spectral indexes of RR variability (RR V) and baroreflex gain (BRS)] to the matrix of result predictors. ANS, autonomic nervous system; VO2max, maximal oxygen consumption.
the underlying central neural regulation. A possible way to circumvent this inevitable limitation might be offered by the combined use of various autonomic indexes, providing an overall profile suggestive of regulation or dysregulation. It should also be mentioned that tonic and oscillatory autonomic indexes might carry different information (13). These two modalities might be dissociated by specific stimuli, such as by long-term bed rest, which reduces the former and leaves the latter ones largely unaffected (2).

In this sense, the study by Manzi et al. (12) appears unique as these authors attempt to provide, heuristically, a technique capable of monitoring training over time, while predicting future individual performance. Training levels were estimated by athlete by a measure of personal “biochemical” load, as quantified by an individualized Training IM Pulse method and correlated to indirect autonomic indexes. To enhance the information extraction, Manzi et al. employed the combination of baroreflex gain and of spectral indexes from RR variability, using a normalization procedure to facilitate the assessment of oscillatory properties (14).

This approach was also important for its capacity to provide reasonably strong conclusions even from a small number of subjects, a condition that sometimes is inevitable because of the difficulty of experimental protocols or conditions (16), as typically might happen with world-class athletes.

Suggestions for the Coach

Athletic competitions represent a unique opportunity to assess the quality of the “machine,” the resilience of the “subject,” and the perfection of their interaction. The coach’s main keys to success largely derive from experience and insight. However, the possibility of predicting individual results from subjective symptoms (7) and functional autonomic measures (12) opens the way to a new approach to athletic training. In the case of the marathon, we might surmise that the best bet requires athletes with low levels of symptoms and an elevated sympathetic drive on top of an optimal aerobic fitness (Fig. 1). However, different profiles might be applicable to other sport specialties. A similar multiparametric approach might provide a test bed for porting personalized training to a wider audience and might promote a structured introduction of exercise as treatment for clinical prevention in the global world.

GRANTS

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REFERENCES