Performance data: less is more?

Dr Andy Renfree presents a case that practitioners may be best served by focusing on overall subjective perceptions of the athlete as opposed to isolated physiological or performance variables.

Introduction

Sport and exercise scientists, as well as athletes and coaches, routinely collect a wide range of physiological and performance data to assist the decision-making process informing the design and monitoring of physical training programmes. Although a vast array of affordable laboratory-based and wearable technology is now available to collect this data, ultimately users must still interpret its meaning and decide how to act upon it. Given the complexity of the factors determining human performance, this is clearly no simple task. In this short opinion piece, I argue that in many circumstances, the decision-making process may be best served by focusing on overall "gestalt" sensations (a phenomenon whereby the mind integrates multiple sources of perceptual information to produce an overall summary), rather than being concerned with isolated variables. Through use of such an approach, it is acknowledged that in complex systems the characteristics of the whole system are often greater than the sum of its parts.

What could we measure?

So, assuming we want to collect data on something during training, what should be collected? The obvious answer to this is the various markers of "external load." So, things such as how far or long (volume), how fast or heavy (intensity), and details of interval sessions, etc. These are very simple to calculate and provide an accurate picture of what work has actually been done. However, in isolation these metrics clearly do not provide the full picture - the goal of training is not to go as far or fast as possible, but to provoke an adaptive response. This depends not on the external load as much as on the degree of physiological stress imposed by the session, or the "internal load." It is easy to see how the two can become disassociated. A 16 km run completed by a well-trained athlete in 60 minutes with a howling tail wind would be expected to produce a lower degree of physiological stress than doing the same run in 70 minutes in the opposite direction.

To give us some indication of the more important internal load, we need some way of measuring the degree of physiological stress experienced, and also the acute response to this exercise stress. There are now lots of relatively cheap ways of doing this, and commonly used methods include assessment of heart rate, heart rate variability, blood lactate, blood glucose and more. Elite level athletes may have access to more sophisticated technology allowing monitoring of endocrine and inflammatory markers amongst other things. However, despite the availability of this technology, my suggestions as to the most useful data to collect would relate to more subjective measures of internal load and its associated responses, such as ratings of perceived exertion (RPE), muscle soreness and psychological state (e.g. mood and motivation); data requiring no more than a pencil and paper to collect. Why?

The problem of complexity

You, I and everything else in biology are complex systems and we operate within various environments, each of which also represents a complex system. Essentially, a complex system is one that displays properties that cannot be predicted based on knowledge of its components. These properties are generated by the interactions between the various components of the system, meaning that examination of the various components in isolation cannot explain the behaviour of the system as a whole, which is therefore considered an "emergent" phenomenon (I have previously written about athletic races being best considered as complex systems with pacing behaviour being an emergent phenomenon - Renfree & Casado, 2018).

It is the issue of these interactions that presents a problem when trying to decide what to monitor relating to internal load and physiological strain. Consider what happens if you try to predict the path of the balls on a billiard table if someone was to strike them hard with a cue ball:

"If you know a set of basic parameters concerning the ball at rest, you can compute the resistance of the table (quite elementary), and can gauge the strength of the impact, then it is rather easy to predict what would happen at the first hit. The second impact becomes more complicated, but possible; you need to be more
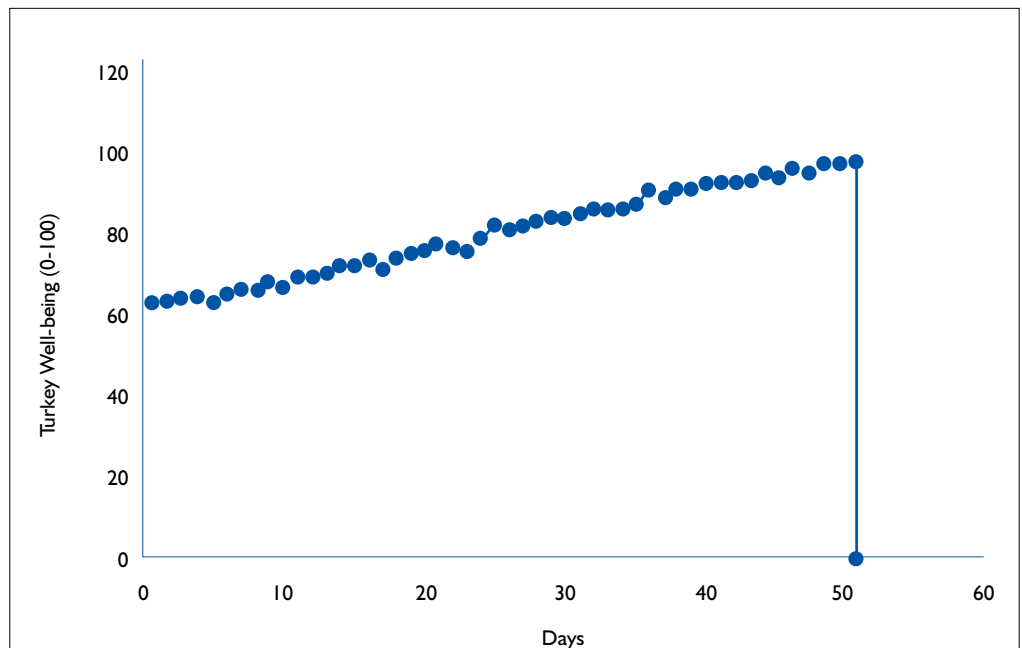

Figure 1. Well-being of a turkey over the 51 days after hatching. If you only collected data for the first 50 days of life, you may draw the (incorrect) conclusion that well-being increases with age.

This applied feature aims to address issues and areas that are often common in the real world, but are seldom covered by the usual learning mediums (university courses, journals, books, etc.). Please contact the editor if you have any ideas for future issues: editor@bases.org.uk

careful about your knowledge of the initial states, and more precision is called for. The problem is that to correctly compute the ninth impact, you need to take into account the gravitational pull of someone standing next to the table. And to compute the fifty-sixth impact, every single elementary particle of the universe needs to be present in your assumptions!" (Taleb, 2007, p. 178).

So, considering the difficulty in predicting the behaviour of balls hitting each other, consider how much more difficult it is to predict the behaviour of an individual consisting of billions of interacting cells. What this means is that if you want to be confident you are monitoring the relevant data you have to monitor everything. Of course, this is impossible, and we must also consider the possibility that there are crucial variables we have not yet discovered or appreciated the importance of. This is before we even get to the issue of understanding how the numerous components interact with each other. To paraphrase Donald Rumsfeld speaking at a 2002 news briefing - there are the known knowns, the known unknowns, but most importantly of all are the unknown unknowns.

In summary so far then, prediction in complex systems is exceptionally difficult, or even impossible, because of availability of incomplete information, large numbers of interacting variables combined with inability to measure them and likely measurement error. Even small errors in measurement of some variable may have dramatic impacts on predictions for the system as a whole. All of this means that measurement of only a handful of biological or performance markers is unlikely to give us the full picture with regards to how an individual is responding or is likely to respond to any training intervention.

Don't be a turkey

At this point somebody might say, "But by recording lots of data I can track progress and identify how things looked when things were going well," an argument that basically says you can see trends in the data. Imagine that you monitor any variable you can measure (variable x) and you notice over a period of a few weeks or months that as x decreases your ability to run a given distance quickly also improves. The obvious conclusion is that x is correlated with performance and is therefore worth measuring. However, you may also have fallen foul of the "Turkey Problem" (see Figure 1). Taleb (2007) talks of a turkey who for the first 50 days of his life associates the arrival of humans with the delivery of food, and therefore draws the conclusion that the humans have his well-being at heart. On day 51 though the turkey gets a nasty surprise!

Substitute "well-being" and "days" with for example, "performance" and "training volume" and you can see how similar errors may be made in interpreting training data. The other issue you have is that by collecting data over a relatively short timeframe you may miss out on the true pattern generating process - what looks linear may in reality only represent a small part of an oscillating pattern over the longer term.

Rules of thumb

If, as I argue, you cannot rationally decide what best to do based on measurement of isolated physiological variables, what can you do? In any situation where you have incomplete knowledge of options and likely outcomes (or a "large world" environment) then you need to rely on heuristics (Renfree et al., 2014). Heuristics are a method of decision-making that ignore much of the available data and allow humans to solve problems without relying on complex statistical analysis. Crucially, heuristics have been shown to allow individuals to make better quality decisions in complex environments. At the most basic level, heuristics are little more than "rules of thumb."

What rules of thumb should be used then? In my opinion, if the athlete isn't motivated to train on a particular day, then this tells me something isn't quite right "under the bonnet." I don't necessarily need to know exactly what but I can fall back on the old adage of "if in doubt, don't." Similarly, if an athlete has delayed onset of muscle soreness (DOMS), I do not need to know the exact

Above: Don't be a turkey

levels of Creatine Kinase in the blood to know they are not yet recovered from previous training. My preference then is to focus on the overall experience of the athlete, admittedly based on the assumption that this is reflective of physiological status. Surely this is preferable to making training decisions based on incomplete and not fully understood data?

Be careful

I argue that use of athletes' overall gestalt sensations may be superior to more complex data pertaining to isolated physiological or performance variables in informing future training or conditioning decisions. However, it is acknowledged that there are potential limitations to this approach, and that the suggestion is not to simply do whatever you feel like. What an athlete "feels like" is not necessarily what they "need." Additionally, there are potential negative emotional outcomes if a highly motivated athlete feels guilty about failure to adhere to a prescribed programme. However, just as an engine warning light on a car dashboard indicates a problem without identifying the specific nature of that problem, changes in an athlete's sensations of well-being or motivation can act in them same way and indicate when the time has come to collect more specific data that may help explain the "malfunction."

Summary

This article has argued that the monitoring of athletes' overall perceptual sensations is likely to be at least as effective as, if not better than, complex physiological or performance data in informing future conditioning decisions. Rather than being overly simplistic, such an approach may provide a more accurate overall summary of condition than information relating to isolated variables. ■

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References:

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