Sport Science: Progress, Hubris, and Humility

Sport science can mean a lot of different things. At one level, it can be the collation and transmission of scientific findings to coaches and athletes. At another, it can be the evaluation of athletes in the laboratory, intended to give the coach a venue free view of the current status and progress of the athlete toward training targets. At yet another, it can be the testing of hypotheses about the likely effects of changes in training program design, equipment modifications, or ergogenic aids, which may aid the coach in preparing athletes. Viewed from a longer perspective, it should be a lesson to sport scientists that they are (1) at best helpers to coaches, who understand their sport at a depth that is not attainable to most sport scientists, (2) subject to comparatively rapidly changing information about what data are important and how data should be interpreted, and (3) lessons in humility and cautions against the hubris that they “have the answers.” In essence, sport scientists should always remember that they are about as important as a good video camera, which helps the coach “see” their athlete better.

There is always the risk—since we have a jargon about physiology and biomechanics, and have the imprimatur of scientists who are “seeking truth,” and since coaches often have a quite different jargon, perhaps with simpler and more descriptive language—that we think that coaches as less schooled and understand things less profoundly. Traditionally, coaches do have less formal education and often speak in a simple, colorful, and very sport-specific jargon. Although it is becoming less common, many coaches are former elite athletes without formal academic training. So, it is easy to think of them as unschooled. But, as Stephen Seiler pointed out in a lecture some years ago, the scientific understanding of training is grounded on the 8- to 20-week randomized controlled trial, which is so much shorter than the yearly or often quadrennial-based training plans of coaches that the scientists do not really have an appreciation of the effects of long-term periodization and thus cannot really understand the important elements of the training response. The years of experience “in the field” have equipped most serious coaches with a breadth and depth of knowledge that simply is not attainable for those operating in the intentionally narrow world of experimental science.

Science is a “way of knowing,” comparable in some senses to the knowledge imparted by grandparents or by religious traditions. Uniquely, science is self-correcting, in that we recognize that “things that we know with certainty” will be out of date in 25 years and more likely just completely wrong. Even the scientific anchors on which we base our understanding will change. At a certain point in my career, the maximal oxygen uptake (VO2max) was everything.2 Athletes with big values for VO2max were destined for success; athletes with lower values were supposedly doomed to be second-tier performers.3 Someone forgot to tell that to Peter Snell and Frank Shorter, dominant athletes in their day, who only had VO2max values in the low 70 mL/kg range.4,5 I also recall, during my postdoctoral period at Ball State University, meeting Ed Coyle, who was an MS student at the same time. I was confused when Ed told me that he had a VO2max >80 mL/kg but had only run a 1-mile race in the range of 4:10. Clearly, VO2max, while important, was not the only important thing. In concert with the concept of a “big motor,” the classic papers by Joyner6 and di Prampero7 on the determinants of performance reinforced the importance of VO2max as a critical parameter for sports performance. If VO2max was not absolutely critical, perhaps something to do with lactate accumulation during exercise was the more important player.8–10 Indeed, I can recall testing athletes, developing a “lactate profile,” and telling them that their “ideal” training intensity was the power output or heart rate (HR) equivalent to a blood lactate concentration of 4 mmol/L. That worked fine, until Seiler11 and Esteve-Lanao et al12,13 made the simple observation that this seems to be a training intensity that athletes use very selectively, usually only 10% to 15% of training volume. If not VO2max, or lactate threshold or the economy of running,14–16 surely something that scientists could measure must provide the definitive answer that allows them to understand elite sport performance and give us the ability to tell coaches what everything really means. The candidate emerged in muscle-fiber composition. Surely, athletes who were more slow twitch or more fast twitch or who had higher respiratory enzymes in their muscle fibers, should have a competitive advantage.17–19 Although all of these laboratory-based measures were somewhat successful in terms of explaining sporting success, we really have failed to hit on a single measure that will let the scientists tell the coach what is really important.

Well, if physiological parameters are not the scientific answer that makes sport science valuable, maybe knowledge of the training response is. Coaches had long ago discovered for themselves the value of more training and harder training. Interval training had been created in the late 1930s with some very specific (run to HR = 180/recover to HR = 120) guidelines that were supposedly scientifically based, although, despite extensive correspondence, I cannot find anyone who knows why those particular values for HR were selected. Bannister’s group had evolved the concept of the Training Impulse in the 1990s, allowing integration of training intensity and duration.20 Seiler11 and Esteve-Lanao et al13 came up with the concept of training-intensity distribution using the conceptual format of Bannister. We came up with the session RPE (rating of perceived exertion) in the late 1990s, designed to simplify and augment the concept of training-intensity distribution by accounting for hard days and easy days,21–24 and training periodization,25 which are known to augment the training response.26,27 Mujika and Padilla28 and Hickson et al29 have documented the effect of taper on the training response, but we have yet to come up with a unified field theory that is of practical benefit to coaches trying to better understand the training response in their athletes. Important recent progress has been made in terms of differentiating the “internal” and “external” training loads,30 but the fact remains that our science is still less than ideally practical.

There has been progress with integrating the knowledge base of sport science into practical solutions that can be useful to coaches and athletes. In the early 1970s, the English marathon runner Ron Hill, who was trained as a PhD textile chemist, delved into some of the early studies of muscle glycogen storage and depletion from Sweden31,32 and came up with the basic outline for carbohydrate loading that was used by athletes for many years.33
Later work by Sherman et al.\textsuperscript{14} demonstrated that the prolonged period of glycogen depletion could be shortened without loss of effect. van Ingen Schenau et al.\textsuperscript{35} and de Koning et al.\textsuperscript{36} working from first principles of locomotion, developed the klapskate, which revolutionized speed-skating performances within a single year. My own best contribution was to take published results from Ivy et al.\textsuperscript{37} about the rapidity of muscle glycogen replacement after exercise to guide speed-skating coaches regarding how they should refuel their athletes between competitive events. So, translation of basic scientific understanding into strategies that are of practical use is possible, but it is done far too little.

So, sport science is important. But, its importance is probably less in the domain of evaluating athletes, where coaches already have access to competitions and standard training sessions. When we have tried to tie our recommendations to specific laboratory parameters, we have more often demonstrated our ignorance, indeed our hubris, than been really helpful. There is potential for an integrated understanding of the training response, but limited data and narrow ways of looking at data have prevented us from developing the unified field theory\textsuperscript{38} that would be of considerable use. Systematic review of the literature about ergogenic aids and/or equipment modifications holds promise but is too seldom accomplished. In any case, as practicing sport scientists, we are obligated to continually reexamine what our best role is in support of coaches and athletes.

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\section*{References}