How Elite Coaches' Experiential Knowledge Might Enhance Empirical Research on Sport Performance

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ABSTRACT
In sport science, much research has been aimed at developing empirical knowledge of performance and practice. While this body of work has led to significant advances in understanding, one source of information that has been under-represented is the analysis of experiential knowledge of high-level athletes and coaches. Using the run-up task in sport as an exemplar, we were interested in understanding the relationship between the experiential knowledge of elite coaches and empirical research findings to ascertain how a combination of these knowledge sources might enrich understanding of sport performance. For this purpose, fifteen interviews were conducted with elite coaches from three sports; track and field, gymnastics, and cricket. The qualitative data showed elite coaches intuitively expressed ideas consistent with recent scientific research in their design of training and learning programs. Key ideas expressed included perception-action coupling, the effects of interacting constraints on performance, and an approach to practice which was consistent with insights from nonlinear pedagogy. The data revealed how experiential knowledge of elite coaches might be used to support and enhance empirical research processes. Specific examples include providing direction for future research, assisting in the representative design of empirical research, and highlighting limitations of some empirical research protocols and findings. The coaches' comments suggested a need for more systematic and sustained efforts to explore how experiential knowledge might enrich understanding of sport performance.

Key words: Elite Sports Coaches, Experiential Knowledge, Nonlinear Pedagogy, Perception-Action Coupling, Run-Up Task, Sport Science Research

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INTRODUCTION

Much current understanding of performance in sport stems from theoretical knowledge derived from a number of scientific research methods [1]. While many empirical studies aim for designs which are representative of sport performance and learning contexts, the desire for scientific rigour, or limitations placed by data collection methodologies, sometimes require experimental research to take place under artificial or laboratory task constraints. Examples include a laboratory set-up to allow manipulation of the amount of light in the environment [2], artificially simulated conditions to allow analysis of gait [3], or a combination of environmental and task constraint manipulations, such as walking on a treadmill towards a projected image on a video screen [4]. In research studies, sport scientists attempt to generalise the results of their work to the ecological constraints under which individual athletes function [5]. Since the nature of the constraints designed in an experiment can directly influence the observed performance of participants [6], their effects need to be understood when making assumptions from the data. As limitations exist on the extent to which results of such studies can be extrapolated to performance settings, supplementary sources of data to support empirical research findings must be sought.

In seeking explanations of athlete performance, one source of information rarely explored is experiential knowledge of elite coaches and athletes. Elite coaches' knowledge is based on practice and performance experiences at various levels of competition spanning many years [7]. While sports scientists and elite coaches often hold common perceptions on the importance of applied research to enhance athletic performance [8], research tends to be dominated by empirical sport scientists. Some research has highlighted the complexity of coaches' knowledge structures [9], skills of the elite coach [10], and the developmental pathway of elite coaches [11], but empirical research which utilises experiential knowledge to support or enhance empirical research protocols or understand scientific results is lacking. Some previous work has sought coaches' views on scientific support [12], documented their attitudes or behaviour towards training programs [13], or presented their views on specific performance issues such as regulating run-ups in track and field [14], but these examples are limited. They form a small part of the knowledge base that exists within the coaching community at elite levels of sport [15], especially in coaches responsible for the employment of applied sport scientists [12].

It is not clear why sport science has neglected the knowledge of elite coaches as potential information sources to enhance theoretical understanding of athletic performance and training. Possible reasons could include the view that elite coaches' knowledge may not be formalised in theoretical concepts, may be considered subjective, and may be over-reliant on an individual's past history and the specific coaching methods they experienced as a performer [15]. However, coaches' experiential knowledge, gained through day-to-day immersion within specific performance contexts, might be useful to scientists as it is based on extensive experience [7] and an intuitive understanding of the influence of performance task constraints on athlete behaviours.

An interesting issue concerns the similarities between practical knowledge gained in sport performance and training contexts, and knowledge gained from controlled research experiments. Due to the large amount of practical experimentation that coaches undertake in the training of athletes, this type of experiential knowledge might be intuitively based on theory, although not formalised as conceptual knowledge from research studies. For example, the understanding of skill acquisition processes that elite coaches possess exists despite them not necessarily being aware of key theoretical ideas, vocabulary, and the implications that their knowledge has for scientific research. Elite coaches' technical vocabulary might sometimes be representative of a lack of formal science training, but does not necessarily reflect a lack of theoretical ideas being intuitively understood or applied. Elite coaches typically have an uneven exposure to sport science through the content of coaching syllabuses completed [16], and the career backgrounds from which they may originate: athlete, physical education teacher, or engineer, for example. Due to variations in access to these empirical knowledge sources, and the intermittent application of them, the recency of their empirical knowledge of learning and performance may also be a potential issue.

By analysing coaches' experiential knowledge of the run-up task across three different sports as an exemplar, we sought insights on how experiential knowledge could act as an important source of evidence to aid understanding of sport performance. By analysing experiential knowledge and its relationship with scientific theory, we wanted to understand how it could support and enhance research protocols and assist in the explanation of research findings.

METHODOLOGY TO ACCESS EXPERIENTIAL KNOWLEDGE

To gain insights into experiential knowledge, qualitative data were gathered from fifteen elite level coaches in three sport disciplines which rely on the run-up for performance outcomes: track and field jumps (n=5), gymnastics vaulting and tumbling (n=5), and cricket fast bowling (n=5). The coaches were currently, or had been, professionally involved at the international level and their credentials included running international and national coaching curricula, national team and institute training programs, and coaching Olympic and world cup champions and medallists.

All interviews were conducted by the lead author, who had experience as a sports science service provider at a national level in all three sports. Experience in dealing with elite coaches and athletes, and an understanding of the colloquial language of each sport, helped to establish a rapport with the interviewees and assisted in the interpretation of results [17]. The context of the study was explained as an investigation of run-ups in sport, with no mention of scientific approaches or current theories to ensure that responses were not biased from the outset. The discussions with participants sought to establish their experiential knowledge regarding the run-up in their specific sport discipline through a four-section interview. Section 1 probed the perceived importance of the run-up and key contributors to run-up performance success. Section 2 investigated current coaching practices, including learning philosophies, teaching strategies, and the design of practice environments. Section 3 looked at run-up specific knowledge, detailing successful approaches to the run-up and the key coaching tools used to guide athlete development. Section 4 examined sport-specific details of the run-up relative to the coaches' background and the context in which the run-up was placed. The interview was concluded with a broad summary question on the factors involved in successful and unsuccessful run-up performance as well as an offer for interviewees to add any additional information they felt had been left out during the interview. Throughout the interview, open-ended questions and elaboration probes were used to explore the experiential knowledge of the coaches. The conversational nature of the interviews allowed a semi-structured interview approach with variation in the ordering of questions depending on the responses of the participants [18]. Interview length allowed full exploration of the issues concerned and was between 30 and 70 minutes in duration. Interviews were recorded and transcribed verbatim by the lead author.

Sentence-by-sentence open coding was performed by the main researcher to draw out raw data themes, in the form of quotations, from each coach [19]. The quotations of elite coaches formed the units of data which were used for analysis. Coding was used to select, separate, and categorise themes which were constructed from the qualitative data [20]. Categories and sub-categories were created that captured the essence of the ideas or concepts discussed, with each quotation placed in a category or sub-category to which it best fit [19]. To ensure trustworthiness of the data, after initial thematic organisation by the lead author, the second author re-read the raw data to check and verify the correct categorisation of themes and ensure data was perceived within the correct context [21]. A triangulation consensus between the first two researchers and the third researcher, who was not involved in the initial analysis of data, was completed to ensure that the placement of raw data into general themes and higher-order categories was correct [22].

THE RUN-UP IN SPORTS

The run-up provides the foundation of performance in specific sports which culminate in nested actions, such as jumping in track and field, vaulting in gymnastics, or bowling in cricket. While the run-up is a sub-phase common to the three sports, experimental research has shown that the nature of the task nested at the end of the approach phase influences the performance of the run-up [23], and the successful execution of these tasks is highly dependent on the performance of the run-up phase [24]. Despite the regulation of step length when approaching surfaces and targets being a fundamental action in everyday life [25], and being highly practised in sport-specific training, there have been numerous examples in elite sport when athletes have had problems landing within designated target areas, often with disastrous performance results. This error rate, combined with its interceptive nature, has made the run-up an important movement model for investigating processes of perception and action in sport [25]. The run-up lends itself to explanation with a systems-oriented theory which proposes that action is predicated on the pick-up of specific information sources from the performance environment [26]. Also, the complex balance between stability and variability that exists within the run-up task has intrigued researchers and frustrated coaches in equal measure. This awareness of the challenging nature of regulating performance of run-ups in sport was summarised by one track and field coach from the current cohort:

> *"In horizontal jumping there is a component of the repeatable model that is important, but there is also the variable thing, and the variable part, for me, is still the part I still haven't come to terms with, and my jumpers still haven't come to terms with, and to me, nationally we haven't come to terms with as to how we are going to address this problem." (Track and Field Coach 2)*

The interest from sport scientists and coaches in the run-up task makes it a useful exemplar for examining common threads between experiential knowledge of coaches and empirical knowledge of sport scientists to enhance understanding of sport performance.

EXPERIENTIAL KNOWLEDGE IN THE SUPPORT AND ENRICHMENT OF EMPIRICAL RESEARCH

Elite coaches intuitively expressed ideas consistent with recent empirical knowledge in the design of training programs with athletes. A striking observation of the data was that there were numerous quotations which centred on the importance of the athlete-environment relationship. The focus of the coaches on the athlete-environment relationship reflected the athletes' reliance on the environment for perceptual information to guide their actions, and the use of actions to reveal information of the environment, in line with the constraints-led view of skill acquisition [27].

Coaches' intuitive understanding of the relevance of the athlete-environment interaction was clearly in line with recent theoretical advances in knowledge of perception-action coupling [25], the effects of task and environmental constraints on performance [28], and a nonlinear pedagogical approach [29]. Through exploration of coaches' experiential knowledge, each of these issues will be discussed with reference to experimental research and scientific understanding.

PERCEPTION-ACTION COUPLING IN THE RUN-UP

A continuous perception-action coupling during human locomotor pointing (i.e., running to place a foot on a target) has been demonstrated by athletes making adjustments to their foot positioning as and when needed throughout the entire run-up [30]. It was observed that gait adjustments were based on the perception of the athletes' current versus requisite positioning of the foot in relation to the target [25]. Experiential knowledge showed awareness of the athletes' perception of perceived versus ideal location of footfall placement, as explained succinctly by one gymnastics coach during a discussion on experience:

> *"Halfway through the vault you can notice that your footing is wrong, ten metres out you can say, it's no good. You can detect it, you just know in your mind." (Gymnastics Coach 4)*

Coaches noted the ability to perceive the difference between current and ideal footfall positioning as part of the skill set of elite athletes, which evolves through practice and experience. The following quotation from a track and field coach summarises experiential awareness of athletes' continual adjustment of step length to deal with their perception of current positioning:

> *"They know how to slightly adjust their run-up by the feel of their body positions and those sort of things. They know they will be short of the board, they know before they get there, whereas an untrained or developing athlete doesn't have that same concept or feeling." (Track and Field Coach 1)*

The ability to make continual performance adjustments gains importance in competitions when athletes are faced with changing environmental constraints, such as different venues, surfaces, and weather conditions. One example arose during a discussion on run-up length when a gymnastics coach highlighted the importance of gait adjustments due to environmental constraints:

> *"In different competitions you mark your run-up completely differently because your running changes. In a foreign gym because the table changes, the surface changes, and the spring from the floor changes it makes your running different." (Gymnastics Coach 3)*

Experimental research has suggested that the visual system is responsible for the continuous evaluation of the state of the movement system and in the adjustment of gait to reach the desired target [31]. Experiential knowledge of elite coaches shows agreement about the role that vision plays in the adjustments made by athletes during their run-up, as shown by the following comment by a track and field coach:

> *"So there will be a visual cue. In horizontal jumps athletes are very capable of making minor adjustments through visual cues prior to 6 or 7 strides (from the board). That will happen, and happens, naturally." (Track and Field Coach 3)*

This comment reflects an intuitive understanding that the use of perceptual information to drive action is a fundamental underpinning of skill acquisition and performance. For example, previous laboratory experiments have shown that a continuously visible target on the floor can be used to regulate gait [4]. This finding concurs with coaches' experiential knowledge who noted the sighting of the target to be influential in run-up tasks, especially in the long jump. The following insight is provided by a track and field coach discussing vision:

> *"All horizontal jumpers will sight the board. You have to be able to sight the board as you are approaching; you have to be able to use those visual cues."*
> *(Track and Field Coach 4)*

Experimental data have indicated that because adjustments in the run-up occur throughout the task, prior to the target on the floor being visible [25], additional environmental information can be used to regulate gait. This observation coincides with experimental findings which show that when available, multiple variables can be used to constrain locomotion [32]. Experiential knowledge reveals that, despite coaches being aware of athletes using sight of the take-off board to regulate gait, they also encourage performers to be open to other sources of environmental information that are available to guide their actions. A gymnastics coach highlights this point when discussing vision:

> *"When you run, you see the board, but you don't see much of the board because it is such a long way, (instead) you see the vaulting table." (Gymnastics Coach 4)*

Current empirical evidence suggests future research regarding visual control strategies during locomotor pointing tasks needs to examine possible perceptual variables that might guide visual regulation during the entire run-up [30]. Experiential knowledge of elite coaches and athletes may be able to assist in the identification of perceptual variables which might regulate action in the run up. A good example of this possibility emerged from the sample of cricket coaches where a number of individuals suggested that the positioning of the umpire was of key importance during the run-up when discussing training set-ups:

> *"A lot of the athletes I have been involved with use feel of the umpire ['s position]. It's like a feel and a vision, a sort of depth perception." (Cricket Coach 5)*

The idea that the positioning of the umpire might be a key perceptual variable to regulate gait during the run-up fits with current scientific research suggesting that a vertical reference point might provide a stable object at a constant velocity from which to gauge the distance to a target [4]. The close proximity of this vertical reference point to the take-off area suggests it may play a role as an important perceptual variable to regulate gait in the approach phase and warrants empirical investigation in the future to evaluate this proposition.

The coach's identification of several sources of information which regulate the control of the run-up is very perceptive since not all perceptual variables present in the environment can be used to regulate actions in a functional manner. Many of the perceptual variables present may be irrelevant or even distract performers in particular performance contexts. To understand the key perceptual variables that need to be included in learning design for athletes and experimental settings for researchers, an important task is to distinguish the *specifying* variables, the ones which affect performance, from the *non-specifying* variables, the ones which do not affect performance. Typically, this process has been based solely on data from previous empirical work through experimental designs which may, or may not, be representative of the performance environment. The coaches' comments suggest experiential knowledge of elite coaches can be instrumental as part of the identification of potential specifying variables for analysis by empirical research. This information demonstrates how a complementary relationship between experiential and empirical knowledge may provide a stronger base for understanding performance and learning of athletes.

TASK AND ENVIRONMENTAL CONSTRAINTS

The accurate replication of representative sporting scenarios in scientific research has been identified as a limitation of empirical research by both coaches, in their uptake of research results [8], and researchers, who seek representative scenarios in which to measure performance variables [6]. Both coaches and researchers agree that more research based in natural performance settings is needed [8]. The conceptual framework of ecological psychology [26] and representative task design [33] suggests that a shortcoming of many research studies in sport science is a failure to accurately sample the perceptual variables of performance environments in which skilled athletes operate [6]. Experiential knowledge demonstrates coaches have a sound awareness that athletes perform differently under various task, individual, and environmental constraints, and that these constraints interact with one another. Coaches revealed they were intuitively aware of, not only the different categories of constraints that shape run-up performance, but also their interactions with one another. The following cricket coach comment demonstrated the awareness of a task constraint (rhythm), an environmental constraint (a wet surface), and an individual constraint (fatigue) and their interactions with one another:

> *"It's just a matter of getting your rhythm on that particular day. You will bowl on fields where the run-up is flat but its been raining the previous week and the run-ups are very soggy and a bit soft, and at the end of a day, the last session is hard because your hammies are a bit tired, your quads are tired, and your ass is tired."*
> *(Cricket Coach 2)*

The varieties of constraints present during competition were noted in the experiential knowledge. Coaches' opinions on the use of training versus competition settings for practice, and the challenge of accurately reflecting the specific constraints of performance competition in training highlighted this, as the following quotation demonstrates:

> *"There is a change in performance from training to competition. Although we try to replicate competition in training both physically and in the mind, in the end it is still a training jump which they have done over and over again."*
> *(Track and Field Coach 2)*

Experiential knowledge concerning the differences between training and competition task constraints is important to sport scientists who often attempt to transpose their training-based performance analyses to competition. The following anecdote by a track and field coach reflected this:

> *"One long jumper, when he perfected his take-off on the board prior to competition, would move his run-up back 2 foot lengths as soon as the competition started, because he knew that the adrenaline pumping would push him over the board. Now I wouldn't recommend that for everyone, but it worked perfectly for him."*
> *(Track and Field Coach 4)*

Experiential knowledge of the constraints of competition environments, combined with the scientific knowledge of aspects of competition which lead to specific behaviours, such as emotional constraints on athletes and social constraints created by crowds [34], demonstrates the limitations of extending results beyond the context in which the data were collected. Future research should be shaped by awareness of environmental constraints and their effects on task performance. The concept of the environment in which the athlete performs is a constant issue for coaches as they seek to improve training methods, whilst conforming to workload and specificity issues. As a result their expertise could be sought by sport scientists to enhance the representative design of experimental task constraints. With contributions from experimental and experiential knowledge, a more complete understanding of the constraints influencing athletes in empirical research studies of sport behaviour could provide a richer understanding of performance.

NONLINEAR PEDAGOGY

Nonlinear pedagogy involves the application of the concepts and tools of nonlinear dynamics to athlete learning processes and athletic performance [29]. In this approach the athlete is viewed as exemplifying a nonlinear dynamical movement system, exhibiting typical characteristics such as an openness to surrounding information flows, capacity for transition, and capacity for self-organisation, allowing the emergence of creative and adaptive behaviours [35]. Nonlinear pedagogy involves the manipulation of key constraints, which are personal, task and environmental in nature, to facilitate the emergence of functional movement patterns within the athlete. The process of manipulation consists of, but is not limited to, the inclusion, exclusion or modification of key variables in the performance and learning environment. For example, implementing a long-term strength training program or changing the level of fatigue of the athlete prior to vaulting in a gymnastics training session demonstrates manipulation of personal constraints. Adjusting the size of the board, and therefore the accuracy required, or limiting the length of the run up within a long-jump training session are examples of task constraint manipulation. Practicing cricket bowling on different grounds with unique environmental features such as slopes or wind conditions are examples of manipulations of environmental constraints. Constraints manipulation facilitates the emergence of functional movement patterns and decision-making behaviours [29].

Nonlinear pedagogy promotes the creation of realistic learning experiences for individual athletes, presenting opportunities to search for unique performance solutions in diverse and authentic performance contexts [36, 37]. As distinct from more traditional approaches to coaching, which favour the provision of detailed verbal instructions and prescriptive explanations, nonlinear pedagogy facilitates athletes in finding their own performance solutions to satisfy unique constraints impinging on them. Instead of changing athlete behaviour through instructions, the coach becomes a facilitator, responsible for designing training and learning tasks to instigate functional changes in athlete behaviour. This approach was well summed up by a track and field coach when discussing coaching philosophies:

> *"We often don't give the athletes the skills to self learn, you need to develop that independence, and they have to learn to self correct. A coach shouldn't give too much input, they should let the athlete control themselves."*
> *(Track and Field Coach 3)*

This approach reflects elite coaches' awareness of the importance of task constraints in learning design. Their intuitive understanding, which is harmonious with principles of nonlinear pedagogy, focuses on specific performance-relevant perceptual variables when adapting key aspects of practice tasks. In cricket it was noted that when performing run-up intervention programs, the artificial 'netted' training environment created difficulties for the athletes and as a result coaches preferred to move to an 'open wicket' practice task design. This setting was believed to better represent perceptual variables and environmental constraints of a match. The following quote highlights the intuitive awareness of these perceptual variables:

> *"I find when dealing with no-ball problems an open centre wicket scenario works better than the netted environment. There are no distractions and you can focus on specific (match based) stuff." (Cricket Coach 1)*

The individual constraints of the athlete are an important consideration within nonlinear pedagogy. These constraints refer to the unique physical, physiological, cognitive, and emotional characteristics of the individual learners and place a large emphasis on how an athlete solves performance problems [37]. Each coach stressed the importance of individuality within the learning set-up and understood that individuals respond differently to various constraints faced. This was neatly summarised by one gymnastics coach when discussing athlete learning:

> *"You will never make all the girls have the same muscles and the same speed. In their running every girl is different, every body is different." (Gymnastics Coach 1)*

The concept of individuality extends beyond learning, to athletes achieving the goal of the current task. The concept of individual constraints implies a shift away from the assumption that there is a 'one size fits all' optimal movement pattern towards which all athletes are working. Instead, a more individualised approach, which encourages the emergence of unique performance solutions in order to achieve desired task goals is promoted. When discussing what makes an ideal run-up, this shift in philosophy was highlighted by an elite cricket coach:

> *"I think we have moved our thought process, which has been of an ideal model, to a more individual type action." (Cricket Coach 5)*

Performers have the potential to solve specific movement problems with a variety of methods, and if encouraged to, they will naturally seek out a solution which suits their individual constraints and the outcome required. The self-discovery process of searching for functional performance solutions during training creates an adaptable athlete better able to handle the unpredictable settings of performance environments [28].

Despite awareness of individual expression, and the existence of individual solutions to specific tasks within both experiential and experimental knowledge, many researchers still favour analysing group mean data in an attempt to generalise findings to wider populations. For example, presenting group mean data to look at gait properties at different walking speeds [38] has the potential to mask individual, intrinsic dynamics, which are especially important in the acquisition of skill [39]. Whilst this type of group analysis may have a place in scientific research, the role of individuality needs to be understood and given the emphasis it deserves to ensure scientific understanding of sport performance moves forward. This is especially significant in experimental studies with elite athletes, as by their very nature these participants have individually defining characteristics which separate them from both the general population and other athletes. The different perspective of elite coaches can highlight potential limitations of scientific research design and empirical findings, highlighting areas of improvement within empirical research and scientific analysis.

CONCLUSION

Elite coaches' experiential knowledge may play a useful role in enhancing understanding of sports performance. Discussions with elite coaches noted how their experience-based intuitions often complemented the empirical knowledge reported in research studies. In particular, an important observation to emerge reflected the athlete-environment relationship as the key focus for performance analysis. These insights suggest the value in accessing and integrating coaches' knowledge with current scientific research to support our understanding of human performance. Whilst experiential knowledge will never act as a surrogate for empirical knowledge gained from rigorous experimentation, it can clearly complement empirical knowledge to enrich our understanding of sport performance. It can enrich our understanding of athlete performance by providing direction for future research, assist in the design of empirical research, and highlight limitations of current research protocols and findings. Although there have been some isolated attempts to access coaches' experiential knowledge in the past, the results from the current study suggest the need for more long term, systematic, and sustained efforts to mine the rich data source captured in the practical expertise of elite coaches and athletes.

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