

From the Guest Editors: How Do Experts Learn?

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In this themed issue of the *Journal of Sport & Exercise Psychology*, we bring together an eclectic mix of papers focusing on how expert performers learn the skills needed to compete at the highest level in sport. In the preface, we highlight the value of adopting the *expert performance approach* as a systematic framework for the evaluation and development of expertise and expert performance in sport. We then place each of the empirical papers published in this issue into context and briefly outline their unique contributions to knowledge in this area. Finally, we highlight several potential avenues for future research in the hope of encouraging others to scientifically study how experts acquire the mechanisms mediating superior performance in sport and how coaches can draw on this knowledge to guide their athletes toward the most effective training activities.

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In recent decades an increasing number of researchers have attempted to identify the factors that contribute to expertise and expert performance in sport. An increase in research work is highlighted by the significant number of reference textbooks (e.g., Starks & Ericsson, 2003; Williams & Hodges, 2004), special issues of journals (e.g., Williams & Ericsson, 2007; Williams & Reilly, 2000), and meta-analyses (e.g., Mann, Williams, Ward, & Janelle, 2007) focusing on this or closely related themes. The growth in research activity is motivated by the assumption that knowledge and understanding of factors related to the attainment of the highest levels of athletic performance not only advance our understanding of elite sport performance, but also similar phenomena in the acquisition of expert performance in many other domains of expertise (Ericsson, 2003a, 2003b; Ericsson, Charness, Feltovich, & Hoffman, 2006; Williams & Ericsson, 2005).

Putting Things in Context: A Brief Historical Overview

As a result of the onset of this growth in interest around the late 1980s, and various perceived shortcomings in the dominant frameworks that existed at that time, Ericsson and Smith (1991) proposed the *expert performance approach* as a

guiding framework for those interested in furthering knowledge and understanding of expertise and expert performance. An empirical and inductive framework for the study of expert performance was proposed with three distinct phases or stages. The initial challenge is to identify the situations where superior performers excel in their domain of expertise and then develop representative tasks that allow this superior performance to be captured and reproduced under controlled conditions in the laboratory or field setting. Ideally, the tasks should allow measurement of the performance to be tracked over each phase of an athlete's development from introduction to the domain to attainment of expert levels. In the second stage, the aim is to assess the mediating mechanisms that account for superior performance on the representative tasks using process-tracing measures such as verbal protocol analysis and eye movement recordings. The identification of differences between the mediating processes of elite and less accomplished individuals have led scientists to identify specific mechanisms that can explain performance differences on the representative tasks and during athletic competitions. The final stage involves the examination of these critical mechanisms and an assessment of how they have been modified and even acquired by experience, learning, and practice, with obvious implications for effective coaching (for detailed reviews, see Ericsson 2003a, 2007a; Ericsson & Williams, 2007; Williams & Ericsson, 2005).

The expert performance approach has attracted significant research interest over the last two decades, although it has been argued that many have not fully embraced its underlying philosophy and methodology within the domain of sport psychology (Ericsson, 2003a, 2003b, 2007a, 2007b; Ericsson & Lehmann, 1996). Many psychologists with an interest in sport have attempted to develop representative tasks to capture expert performance in field and/or laboratory settings, albeit with varying degrees of success (see Müller & Abernethy, 2006; Vaeyens et al., 2007; Williams, Ward, Knowles, & Smeeton, 2002). A much smaller group of researchers has attempted to use process-tracing measures to identify the mechanisms underpinning superior performance on these representative tasks. Several of the early studies were motivated by methodological innovations rather than by rigorous hypotheses testing and theory building (see Williams & Ward, 2007), but recent more theoretically driven publications testify to the field's maturation.

It might seem surprising that the final stage of the expert performance approach has attracted so little empirical interest from sport psychologists when compared with research on the first two stages, especially given its relevance to improved training of elite athletes. However, research in the final stage of the expert performance approach requires that the critical mechanisms mediating superior performance have already been successfully identified; only then is it possible to systematically search for the practice activities that can account for the acquisition of those mechanisms. Unlike the original research on the acquisition of expert performance through deliberate practice in music (Ericsson, Krampe, & Tesch-Römer, 1993), researchers in sport have had difficulty in identifying and measuring specific aspects of performance and the associated deliberate practice and training activities that allow students to acquire and master the key skills. According to the deliberate-practice framework, an individual's level of attainment in a sport domain should be viewed as a sequence of improvements in particular aspects of performance as the result of maturation, deliberate practice activities, and other types of engagement in sport activities (Côté, Ericsson, &

Law, 2005; Ericsson, 2007a). Consequently, the mere accumulation of experience is not sufficient for attaining expertise. Learners must target improvements in particular aspects of performance with the availability of informative feedback, and repetitions with opportunities for error detection, corrections, and refinements crucial (Ericsson, 2006).

Due to the difficulties in identifying deliberate practice activities in most sports, especially team sports, researchers started to collect data on the estimated amount of individual and team practice accumulated in sport. Expert athletes have been shown to have accumulated more training and practice time in individual sports (Starkes et al., 1996; Hodge & Deakin, 1998) as well as in team sports (see Helsen, Starkes, & Hodges, 1998; Ward, Hodges, Williams, & Starkes, 2007) when compared with less expert counterparts. However, these studies have been criticized for focusing on the amount of training and practice rather than on identifying the microstructure of practice activities that best facilitate the acquisition of all aspects of expert performance (Abernethy, Farrow, & Berry, 2003; Ericsson, 2003a, 2003b, 2007a, 2007b). Several researchers have identified the need to examine in greater detail the specific types of practice activities in which athletes engage in, as well as how this interacts with the nature of the instruction provided by coaches (Deakin & Cobley, 2003; Singer & Janelle, 1999).

Many of the identified differences in accumulated training and practice hours have been confined to comparisons between expert and relatively novice performers (for exceptions, see Ward et al., 2007; Ford, Ward, Hodges, & Williams, 2006). To make further progress, we need to distinguish individuals that are performing at a comparable level and relate differences in various aspects of their performance to the amount and type of practice activities accumulated during their careers. This more fine grained analysis would help identify the specific activities that may lead to the adaptations and improvements necessary to reach the elite level. On the other hand, specific practice activities, such as hours of practice on shooting free kicks or on practicing putting in golf, may not be engaged in regularly each week and thus such quotas are difficult to recall and estimate, especially years or decades later. The data may be restricted to the recall of general blocks of activities, such as coach-led practice and unstructured play. To obtain more detailed records of different types of practice and playful sport interactions, it may be necessary to conduct longitudinal studies in which coaches and players recall recent practice activities using diaries.

The literature on motor learning provides another body of work that may contribute to our understanding of how experts acquire the skills needed for high-level performance. This area of study has a rather long history, dating back at least to the classic works of Bryan and Harter (1897, 1899) on the sending and receiving of Morse code messages (for a historical overview of this field of study, see Schmidt & Lee, 2005; Summers, 2004). However, despite its long history, there have been relatively few published reports in this field focusing specifically on “how experts learn.”

Laboratory scientists studying performance relevant to sports have largely tried to study general learning mechanisms rather than providing answers to research questions that may be of interest to those working directly with expert-level athletes in the field setting. This focus on fundamental rather than applied research has not permitted substantial contributions to our understanding on how

complex skills and expertise are acquired (Williams & Hodges, 2005). The prototypical approach has used traditional pre- to posttest experimental designs with novice rather than expert participants. Previous experience on the studied tasks is typically viewed as a potential source of unwanted variability, and, consequently, researchers have tended to select relatively novel tasks, with which participants have had limited or no experience (e.g., linear positioning or Bachman ladder tasks). As a consequence, the generalizability of findings based on research with novices has not been explicitly tested with expert-level performers and the relation between novice and expert learning has been based on assumptions and conjectures.

Our aim when setting up this themed issue was to encourage researchers to address these perceived shortcomings with the existing literature on how experts learn. We were hoping to attract manuscripts that focused on one of three broad themes or areas of research. First, we encouraged papers that examine the practice history profiles of elite athletes, preferably focusing on the microstructure of effective practice and its connection to changes in measured performance. Second, we hoped to attract experimental papers within the traditional pre- to posttest learning paradigm but using real-world sport tasks, expert performers, and longitudinal research paradigms as opposed to the more traditional approach of using novice performers, novel tasks, and short acquisition periods. Finally, we requested papers that examine the structure of the mechanisms mediating expert performance and the extent to which acquired skills are specific to a particular sport or domain. So, how did we fare?

Contributions to This Issue

Overall, the response to our published call for papers was modest, which may partly reflect the difficulties involved in undertaking systematic research in this area. A total of 11 manuscripts were submitted, and, after a rigorous review process, 6 of these were accepted for publication in this themed issue. Our perception is that these articles provide a good overview of the type of work currently being undertaken in this area.

In the first article, Weissensteiner, Abernethy, Farrow, and Müller examine engagement in sport activities that are associated with the development of anticipation skill in elite cricket batters. Participants completed a film-based anticipation test and a structured interview in which they estimated their accumulated hours of experience in organized and unorganized practice activities. The accumulated hours spent in organized cricket successfully discriminated players based on their age and skill level as well as the accuracy of predicting the type of ball delivered and its trajectory. An analysis of the exposure to a wide variety of sports did not uncover any advantage in the development of anticipation skill in cricket.

Berry, Abernethy, and Farrow address similar issues in their analyses of the practice activities that contribute to the development of decision-making skill in Australian Rules football. Professional players are grouped into expert or less skilled decision makers based on the ratings of a panel of expert coaches and a peer group of elite players and performance on representative laboratory tasks. The expert decision makers had accumulated more hours in coach-led, structured

practice in other invasion-type sports than had the less skilled decision makers. Moreover, the expert decision makers accumulated more hours in non-sport-specific deliberate play compared with their less skilled counterparts, supporting the hypothesis that engagement in other similar sports can facilitate the development of perceptual-cognitive skills.

The benefits of engagement in sports similar to the target sport for expertise attainment was studied by Ford and Williams. In this article, the authors compared the participation profiles of two groups of professional soccer players in Ireland who either had or had not played Gaelic football to an elite level in adolescence. The study was conducted within the theoretical framework of the developmental model of sport participation proposed by Côté, Baker, & Abernethy (2007). Some support for the model is presented, with both groups of players showing a reduction in the number of other sports and an increase in hours devoted to the primary sport between 6 and 18 years of age. However, the data from the two groups provided no support for the value of early diversification in developing elite soccer players. The two groups of players did not differ in the number of soccer-specific hours needed to achieve expert performance. The extended engagement in Gaelic football did not reduce the hours needed to achieve expert performance in soccer. Their findings suggest that expert performance in soccer is mainly developed through soccer-specific activities.

Keetch, Lee, and Schmidt examine the specificity of certain types of motor performance, such as free throw shots for expert basketball players. They report on studies in which they experimentally manipulate conditions for the free throw in basketball and find a reduced level of accuracy when the situations deviate from the standard conditions for free throws. They proposed that as a result of task-specific practice, expert basketball players develop very specific skills, termed *especial* skills, which may differ from other similar general skills due to the associated massive amounts of specific practice with the standard conditions. Findings are discussed in relation to the specificity and generality of skill learning in expert performers.

The remaining two articles in this issue followed slightly contrasting themes. Young, Medic, Weir, and Starkes examine how elite Master runners counteract the normal pattern of age-related decline by continual and extended engagement in deliberate practice. This study demonstrates how the typical decline in running performance with advancing age can be slowed when athletes maintain the same specificity and volume of practice. The importance of training specificity and volume in the development and maintenance of expertise is highlighted.

Finally, McPherson and MacMahon examine how tactical knowledge mediates expert performance in baseball. Verbal reports are gathered from baseball players and nonplayers as they view different film sequences of match action. The skilled players were found to use baseball-specific strategies to encode and retrieve pertinent game events and were able to effectively modify and adapt problem representations according to the demands of the task. In contrast, nonplayers used more general performance strategies. The authors illustrate the importance of sport-specific practice in developing expertise and make some recommendations for how best to facilitate the acquisition of tactical skills in baseball batters.

Advances and Future Challenges in Research on How Experts Learn

The traditional design in research on expert performers in sports is to identify expert athletes who are competing at national and international levels. In individual sports, such as running and swimming, there is an objective performance metric that reliably evaluates individual differences at all levels of competition. In the case of running, Young and his colleagues are able to build on a long tradition of laboratory research in which the link between changes in training and resulting changes in physiological adaptations and performance are relatively well understood. Their work can thus extend our knowledge about the effects of training and deliberate practice and show its ability to counteract the effects associated with normal aging. Additional efforts to measure the intensity of training, such as running speed and heart rate monitoring, might provide further insights into the factors influencing the acquisition and maintenance of endurance performance.

All the other articles in this issue study competitive team sports, where athletes confront individual tasks, such as free throw shooting in basketball (Keetch et al.) or face a single opponent, such as a bowler in cricket (Weissensteiner et al.) or a pitcher in baseball (MacPherson & MacMahon), or a group of opponents as in open play in soccer (Ford & Williams) and Australian rules football (Berry et al.). Two of the articles focused on factors influencing overall performance in a particular sport. Ford and Williams demonstrate that any benefit provided by engaging in another related team sport is too small to be detected with their available samples of soccer players. MacPherson and MacMahon identify qualitative differences in the thought processes of elite baseball players and nonplayers when they experience representative situations in baseball games.

From the perspective of the expert-performance approach, it would be interesting to focus on one or more specific aspects of performance that could be captured with representative tasks under controlled conditions that would differentiate the expert and less accomplished athletes. It is likely that it would be easier to trace the improvements of these aspects of performance on the representative tasks during development. It is more likely that investigators would be able to identify the quality and quantity of engagement in various practice activities that are associated with superior performance even among expert athletes. Although the attainment of an elite level in overall achievement in a sport might require sport-specific engagement of thousands of hours, the improvement of a specific aspect of that performance may only require deliberate practice for a few dozens to a few hundred hours.

The free throw task studied by Keetch and colleagues provides an interesting example of such a particular aspect of basketball performance that lends itself to detailed analysis of its structure and development. As with any interesting research, this study generates a number of new and intriguing questions for future study. For example, would a longitudinal study of adolescent basketball players' shooting accuracy reveal especial skill in spite of the maturational variability in height as well as changes in the regulation of the height of the basket from junior high school to high school? How closely is the specific skill of free throw shooting a function of past free throw performance as well as past and current specific practice on free throw shooting and other types of training in basketball shooting?

The studies by Weissensteiner et al. and Berry et al. demonstrate the possibility of capturing aspects of high levels of skill in anticipation and decision making. In both studies, the authors develop representative tasks and are able to reproduce differences between expert performers in the laboratory. It is always a challenge to design a collection of representative situations that can capture and measure individual differences in skill with high reliability and validity. When the proportions of variance in captured skill correspond to effect sizes that are medium to low (cf. Weissensteiner et al.), it is difficult to identify individual differences in performance that can be predicted either by differences in training history or basic ability measures. Additional work in refining proposed measurement tasks for anticipation and decision making should increase the reliable variance and allow the identification of the detailed mechanisms that mediate associated superior performance by tracing the cognitive processes through eye movement recording and retrospective verbal reports. Once we are able to specify and measure individual differences in the crucial mechanisms, it would be possible to start measuring their development as well as specifying the most correlated deliberate practice activities to better understand the adaptive learning and explicit acquisition processes that lead to expert performance. Such approaches would provide a wealth of information that may help explain the effectiveness of different types of practice activities. Clearly, we need to examine not only the *what*, but also the *why* and *how* of practice.

Another avenue for future work would be for researchers to more accurately examine how engagement in specific types of practice activities, or the use of different performance strategies by athletes, lead to measurable changes in performance. Thus far, the primary focus has been on describing these practice activities, and to a lesser extent the performance strategies adopted, whereas there have been limited attempts to examine the effects of increases in certain practice activities on quantifiable changes in performance. The article by Young and colleagues in this issue illustrates the value of this approach, as does a recent paper by Hodges and colleagues (2004) that examined the relationship between practice engagement and improvements in performance times in triathlon. This relationship can be examined relatively easily in sports where performance can be accurately measured by changes in time (e.g., running, swimming), average scores (e.g., baseball or cricket batting) or valid and reliable ratings by judges (e.g., gymnastics, high-diving).

Similar advances in the study of team sports such as soccer, basketball, and rugby are likely to require further development of valid measurements of performance components using representative situations. It may be that significant progress will depend on the successful development of a battery of representative tests of various aspects of performance (see Carling, Reilly, & Williams, 2008). The degree to which these aspects will have similar parallel developmental trajectories or depend on prior acquisition of requisite skills can only be verified through well-conducted scientific research. Furthermore, it is likely that skill development will differ as a function of the particular position of a player in a team (see Williams, Ward, Smeeton, & Ward, 2008).

With the ongoing development of valid representative tests of expert performance, we would like to see research that addresses the central question: Does learning, and the underlying performance strategy, change as a function of

increasing performance and, if so, how does it change? If the field of motor learning is to make a more substantive contribution to our understanding of how experts learn, a radical change is needed—one in which scientists attempt to answer the type of questions that those working with elite athletes ask themselves everyday in practice. From the research on expert performance in other domains of expertise, such as music, chess, and medicine (Ericsson et al., 2006), we know that expert performers neither benefit from instruction nor engage in deliberate practice in the same manner as novices. Questions about how world-class athletes focus their attention during practice, how they practice (types of practice schedules, durations, and selections of practice activities), and how they seek feedback are rarely addressed in contemporary literature. Yet answers to such questions are essential if the field of motor learning is to provide a stronger scientific basis for those working at the elite level in sport.

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