



Talent development in sport: A critical review of pathways to expert performance

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Abstract

This review aims to examine the most significant research regarding the development of talent in sport, with a focus on the quantity and type of practice necessary for the attainment of expertise. A total of 54 peer-reviewed empirical articles were collected and analysed for their content. The literature reveals considerable evidence demonstrating that both early specialization and early diversification can lead to expertise development. However, the contrasting views of deliberate practice and deliberate play do not provide a sufficient spectrum of different learning activities for talent development. Furthermore, the content analysis highlights some inconsistencies in the criteria used to characterize different types of learning activities, pointing to the need for a more rigorous and detailed characterization of activities that affect talent development throughout the lifespan. Finally, this review underscores the need for different methodological approaches to complement athletes' perceptions of their past practice experiences gathered from retrospective interviews. The potential value of using systematic observations to provide a detailed examination of the microstructure of different learning activities is discussed.

Keywords

Deliberate play, deliberate practice, Developmental Model of Sport Participation, early diversification, early specialization, expertise

Introduction

In recent decades, expertise has been explored by several researchers from many different fields ranging from music, art and education to mathematics, science, poetry, and, of course, sport.^{1–6} Here, the achievement of such outstanding performances, often at the limits of human capability, holds the attention of several researchers seeking specific answers about how excellence in sport is achieved.^{4,7} Research addressing the acquisition and development of sport expertise comprises the study of how athletes reach and stay at the pinnacle of their sport as well as what particular attributes or components of performance are key contributors to the expert's performance advantage in sport.⁸ Sport scientists have examined the development of expertise in sport through different lenses, focusing their attention on either environmental (nurture) or genetic (nature) contributions (for a review, see Davids and Baker⁹). Regarding the environmental factors, several studies have examined athletes' sport participation from a developmental perspective in order to understand what could influence the development of expert performance (e.g. parental support, peer influence, coach behaviours, birthdate and birthplace effects, etc.).^{10–15} The examination of sport activities

throughout the athletes' development has specifically provided important insights into what constitutes an optimal environment for athletic development.

Several review articles focusing on the developmental activities of elite athletes have been published in the past few years,^{9,16–19} which have provided a current understanding of the existing knowledge and have identified possible directions for future research. The key messages of published literature reviews indicate that (1) the amount of deliberate practice (i.e. relevant, effortful activities done with the specific goal of improving performance)¹ is a key factor in distinguishing performers at different skill levels; (2) deliberate play

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(i.e. intrinsically motivating activities that provide immediate gratification and are designed to maximize enjoyment)^{19,20} is also an important early learning activity in the development of expertise in sport; (3) both early specialization (i.e. investment in one activity and in deliberate practice from a young age) and early diversification (early participation in a wide variety of sports with high levels of deliberate play and low levels of deliberate practice) are suitable pathways to reach expertise in sport.^{9,19,21–23} Despite the important contributions of these reviews, there still lacks a critical view about key conceptual frameworks and methodological problems in this research field. For instance, the analysis of deliberate practice and deliberate play as two opposing and contrasting activities coexisting on a continuum^{19,20,24} only provides a small example of the panoply of different learning activities that take place in athletes' sport involvement. Other relevant learning activities take place in the course of an athlete's development and should, therefore, be considered in further research to obtain a more complete and realistic characterization of the development of expertise in sport.²⁰ Furthermore, empirical studies have demonstrated some inconsistencies in the criteria used to define key variables in the athlete development literature, namely the definitions of type of practice and expert athlete.^{4,9,18,25} The difficulty researchers have faced in attempting to find sport-related activities that adhere completely to the strict definition of 'deliberate practice' has led to the interchangeable use of this term with other 'sport-specific practices',²⁶ when they are in fact different concepts. Likewise, the criteria used to define the characteristics that comprise an expert athlete have been inconsistent across sport studies, which can easily lead to misinterpretations. For instance, the athletes' competitive level has been used interchangeably as one of the core criteria to define an expert athlete, and it can vary from the adult national level^{27–29} to adult or adolescent international level with regard to high performing athletes (some of them Olympic athletes).^{30–33} Expert coaches' opinion,^{27,34} the competitive results achieved^{35,36} and the number of years of practice^{28,37} are also common criteria used by researchers to select what they consider to be expert athletes. Therefore, all these inconsistencies can bias our understanding and consequently limit the identification of important gaps in this research field. Additionally, although retrospective methodologies have significantly contributed to advancing the knowledge in this field, the information gathered from retrospective interviews or questionnaires only provides a rough approximation of what athletes actually did during their development. There is a need to reinforce retrospective data with other methodologies such as the use of systematic observation of the microstructure of practice (i.e. real-

time observations of the athletes' practice across several training sessions with video recordings and detailed assessments of activities) so as to obtain a more in-depth understanding of the specific contributions of different learning activities to sport expertise.^{38,39}

Thus, the main purpose of this article is to review the role of developmental activities and participation trends in the acquisition of expert performance and talent development. Specifically, this paper will contribute to the literature by critically reviewing a broad range of concepts related to talent development, highlighting important gaps in the literature, and, therefore, giving insights into future research. The results emerged from the systematic review are organised into two major sections. The first section aims to review the main conceptual frameworks in athlete development research, namely the developmental sport activities and the models that have been proposed to explain how athletes develop in sport. In this section, we provide a critical analysis of these concepts, identifying some gaps that should be considered in future research. The objective of the second section is to examine the empirical research developed around the theoretical frameworks mentioned in the first section of this paper, highlighting what we know and proposing new directions for future research.

Method

The procedure of data collection and data analysis followed the guidelines of systematic reviews previously developed in the sport psychology research field.^{40–43} In order to achieve the purposes of the study and to ensure the scientific quality of the work reviewed, peer-reviewed journal articles formed the basis of the review. Database searches were conducted in *PubMed*, *Web of Science*, *Scopus*, *EBSCO* and *SPORTDiscus*. Searches were also conducted using Google Scholar. All databases were searched using combinations of the following keywords: 'youth development', 'deliberate play', 'deliberate practice', 'practice', 'practice history', 'early specialization', 'early diversification', 'practice structure', 'practice organization', 'skill acquisition', 'learning', 'expertise', 'excellence', 'elite', 'performance', 'high level', 'peak performance', 'talent' and 'talent development'. The scope of terms led to articles in several scientific fields; thus, we restricted our search to include '*sport*' and '*athlete*' to reduce and specify the results obtained. We also scanned reference lists in these publications in order to find other important articles for this review.

The criteria for including a study in this review were as follows: (1) the article had to focus on athlete development, talent development, developmental pathways, learning activities or athlete development models, (2) the article had to be written in English, and

(3) the article had to be published in a peer-reviewed journal. There were no restrictions regarding study design or publication year. We did not exclude studies on the basis of participants' age or skill level. Studies focusing on talent development in a research field other than sport were excluded. Also excluded were studies published in a language other than English as well as those published in non-peer-reviewed journals. With

these inclusion and exclusion criteria in mind, we found 54 articles published in 23 scientific peer-reviewed journals. Figure 1 shows the flow chart for paper selection. The first author screened titles, abstracts and full text reports of all studies identified by the search strategy and excluded studies that were classified according to reason for exclusion. The first and second authors cross-checked this process

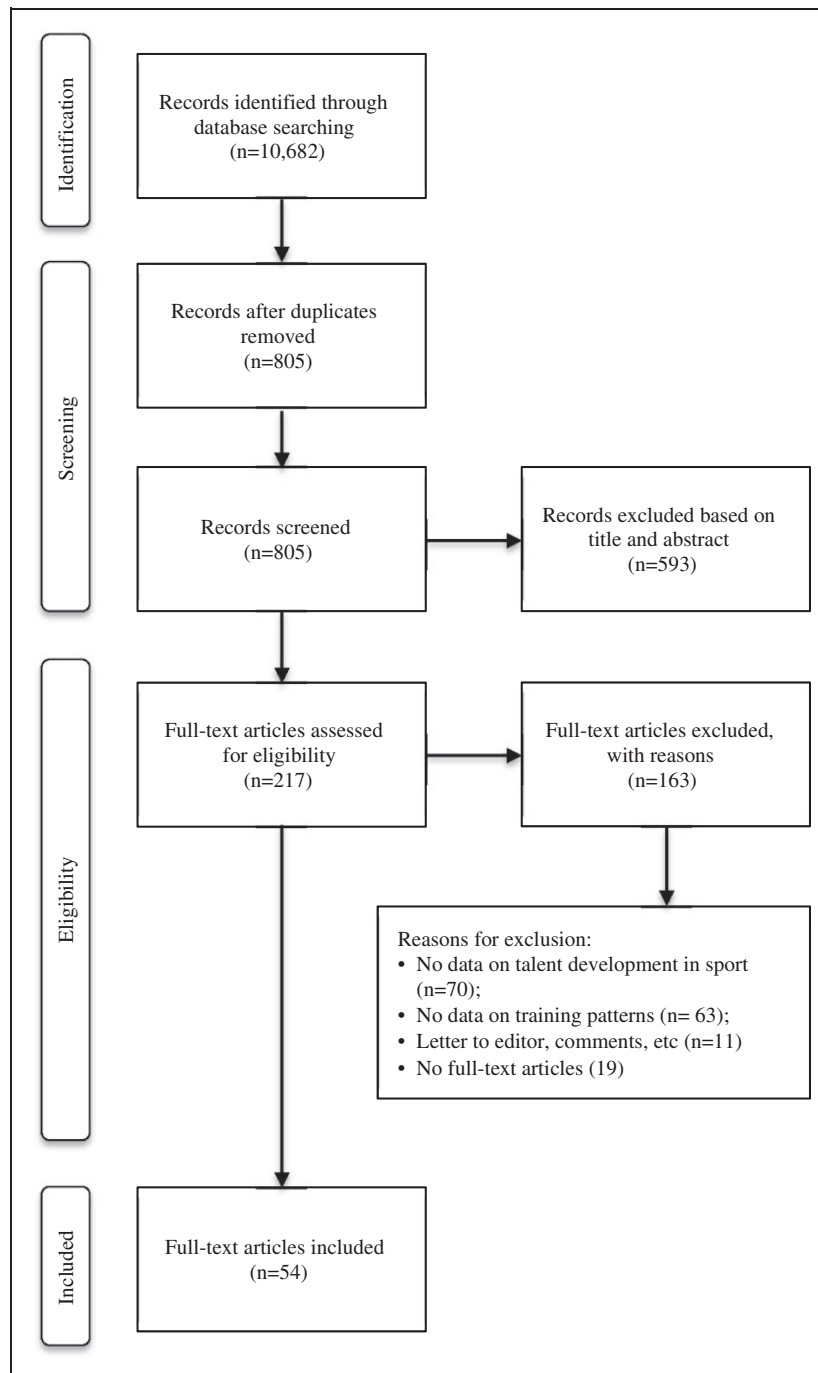


Figure 1. Flow diagram of the literature search and study inclusion.

independently and determined the inclusion or exclusion of the studies. All the authors examined the findings and decided the structure of this review article.

Results

Theoretical background in talent development research

The role of developmental activities in talent development. The developmental activities undertaken by children in specific learning environments are important contributors for skill development and should be explored when examining early talent development programmes in sport. Bronfenbrenner⁴⁴ suggested that human development and human behaviour are the materialisation of person–context interactions and that a network of nested systems which are in constant interaction with each other result in specific developmental outcomes. Accordingly, when the development of learning activities for children in sport is considered, many personal and environmental factors interact to determine an individual's talent development trajectory.²⁰ Therefore, understanding what facilitates sports participation may contribute to the development and implementation of effective programmes that increase involvement in sport activities, thereby enhancing physical, social and psychological wellness in children.^{20,45} Ericsson et al.¹ studied the role of practice in the learning and skill acquisition of pianists and violinists and concluded that the most effective learning occurs through involvement in *deliberate practice* activities. Accordingly, *deliberate practice* is defined as 'a highly structured activity, the explicit goal of which is to improve performance; requires effort and is not inherently enjoyable' (see Ericsson et al.,¹ p. 368). The main focus of deliberate practice is to foster skill development and performance enhancement; hence it is not simply training per se that is necessary for the attainment of expertise, but the engagement in specific forms of practice. The emphasis of deliberate practice is therefore placed on factors such as concentration, effort, motivation and relevance. According to Ericsson et al.,¹ optimal learning and improvement of performance occur when involved in activities that lead the individual to focus on, persist in, and tolerate high levels of specific, appropriate and pertinent practice, wherein they 'are motivated to practice because practice improves performance' (p. 368). Therefore, deliberate practice activities are specific developed 'to overcome weaknesses and performance is carefully monitored to provide cues for ways to improve it further' (see Ericsson et al.,¹ p. 368). On a more practical level, we could identify as an example of deliberate practice activities a specific offensive tactical task in volleyball

with the main goal of improving the coordination between setters and hitters and, consequently, the efficacy in the attack, or, a specific task for work on technique in gymnastic. Accordingly, Ericsson et al.¹ claimed that 'individuals who start early and practice at the higher levels will have a higher level of performance throughout development than those who practice equally hard but start later' (p. 392). The concept of deliberate practice as the prototype activity that lead to elite performance in sport suggests that young athletes who are involved in high amounts of deliberate practice early will have a better chance to develop into elite performers.

The early specialisation approach to talent development in sport includes an early start age in one sport and an early investment in focused intensive training such as deliberate practice.^{16,17,46} According to the original study of Ericsson et al.,¹ the best group of violinists with estimated prospects for an international solo had accumulated an average of over 10,000 hours at age 20, suggesting the existence of a monotonic relationship between the number of hours of deliberate practice and the performance level achieved. Similarly, a relationship between the engagement in high quantities of sport specific practice (deliberate practice) and the achievement of expertise has been found in sport studies.^{18,27,35,47–49} However, Ericsson⁵⁰ recently clarified that 'there is nothing magical about exactly 10,000 hours' (p. 534), as several researchers had misconstrued the alleged need for 10,000 hours to become an expert. Indeed, research in sport has shown that expert athletes have usually accumulated between 4000 to 6000 hours of sport-specific practice before reaching an expert level of performance.^{35,48,51,52} For instance, Baker et al.²⁷ found that Australian athletes achieved national team selection after only 4000 hours of sport-specific practice. Similarly, soccer players⁵² and wrestlers⁵³ went on to achieve international selection after accumulating approximately 4000 and 6000 hours of sport-specific practice, respectively. Therefore, it seems that there are other important activities and experiences other than just the quantity of deliberate practice that contribute to the development of expertise in sport.

As previously discussed, the quantity of deliberate practice throughout development has been the focus of several studies in sport; similarly, the subjective experience that defines deliberate practice has been examined in various sport studies. The subjective experience that differentiates deliberate practice from other sport activities consists of a series of tenets related to the effort and enjoyment of deliberate practice.¹ In general, the original tenets that characterise deliberate practice, including a high level of effort and low level of enjoyment, have received mixed support in sport

studies.⁵⁴ For instance, sport studies consistently report positive ratings of enjoyment for practice activities that require effort and are relevant to improved performance.^{18,30,47,55} Furthermore, a focus on specialised training during the early stages of development has been associated with several negative consequences.^{16,17,56} Evidence suggests that intensive training during early periods of development can increase an athlete's risk of specific types of injury as well as decrease sport enjoyment^{36,56} and stifle psychosocial development by reducing the number of opportunities for growth in these areas.^{46,57} Moreover, reducing our understanding of the talent development process by only considering the involvement in a single form of activity (i.e. deliberate practice) fails to acknowledge the important role of other activities in the acquisition of expert performance.²¹ For instance, informal free-play activities of infancy and childhood as well as structured (and less structured) practice activities typical of organised sport and practice activities that are inherently enjoyable are equally relevant to the development of sport expertise.²⁴

The concept of *deliberate play* proposed by Côté⁵⁸ as 'early developmental activities that are intrinsically motivating, provide immediate gratification, and are specifically designed to maximize enjoyment' (see Côté et al.,²⁰ p. 10) has been postulated as an essential activity in the early involvement of athletes in sport. A considerable amount of evidence has demonstrated that athletes who had a diversified early sport experience and engaged in deliberate play during childhood could achieve an elite level of performance in sport.^{5,15,28,59,60} Early diversification is based on the notion that children 'sample' a wide range of sporting activities that involve high levels of deliberate play and low levels of deliberate practice.^{19,21,24} Early diversification typically occurs during childhood before a gradual decrease in the number of activities and the 'investment' in one sport during mid to late adolescence.^{24,57,58} Participating in a variety of sports allows children to experience a number of different physical, cognitive, affective and psychosocial environments.^{21,57,61} Therefore, early diversification is thought to lead to sport expertise because of the intrinsic motivation that stems from the fun, enjoyment and competence children experience through their sporting involvement.^{19,57,62} It has also been suggested that the skills and physiological conditioning developed through a diversified childhood sport involvement may be transferable to the sport in which the athlete later specialises.^{35,63} However, Côté and colleagues^{19,24} suggested that as the athlete progresses in sport, there is a marked shift from activities focused on pleasurable participation and play to a focus on activities designed to optimise performance improvements through practice. Despite the benefits of early diversification for

talent development, there are some questions that remained unanswered. For example, little is known about the possible transfer of learning across different sport activities experienced in the early stages of development and its contribution to sport expertise. Moreover, research is yet not clear about whether early diversification and the development of expertise are a result of a delayed start in deliberate practice in the primary sport, the child's intention to have fun during the early sport experiences, diversification across several sports or a greater amount of time spent in child-led activities compared to adult-led activities. These potential gaps in literature are worthy avenues to explore in future research.

Although the theoretical framework for early specialisation/deliberate practice and early diversification/deliberate play has been important in guiding research about athletes' development research in the last several years, empirical evidence has demonstrated that deliberate practice and deliberate play are not exclusive activities within expertise development.²⁰ Retrospective studies examining the development of elite athletes suggest that sport participation includes involvement in a number of other types of activities that differ from deliberate practice and deliberate play.^{35,64} Côté et al.²⁰ suggested three additional types of activities that can be included on the continuum between deliberate practice and deliberate play: (1) play practice, (2) spontaneous practice and (3) organized competition. The *play practice* activities share most of the characteristics of deliberate practice (i.e. prescribed by an adult and designed to improve performance), however, emphasise fun and games. This type of activities typically represents the games played by young people and is designed to keep them motivated. *Spontaneous practice* constitutes a form of informal learning and is organised by children in their free time (as deliberate play); nevertheless, it is structured with the main goal of improving aspects of athletes' sport skills. An example of this activity is when a child decides to practice a specific skill (e.g. a basketball shot) on her own without being told to and without being monitored by an adult. Finally, *organized competition* is generally considered an activity that is highly enjoyable and not specifically structured to improve performance, though it requires concentration and effort and is led by adults.^{18,20} Côté et al.²⁰ acknowledged that

Deliberate practice, play practice, spontaneous practice, deliberate, and organized competition do not constitute a complete and exhaustive list of all the activities in youth sport; however, [they] are a representation of the typical characteristics of different types of involvement of children in sport. (p. 11)

For instance, despite the importance of deliberate play and spontaneous practice for motivation and learning,^{6,19,20,60} little attention has been given to these types of activity and their role in talent development. Furthermore, despite the obvious advantages of deliberate practice, it is unclear whether the benefits of this structured practice are superior to the benefits gained from the engagement in unstructured activities such as deliberate play and spontaneous practice.²⁰ In addition to this, although organised competition has been recognised as a relevant and helpful activity for the development of specific skills in sport,^{20,27,35} the value of this learning activity, as well as its role in the development of expertise, has been overlooked.

Overall, considering that both early specialisation and early diversification can lead to talent and expertise development, it is currently unclear in which sports a decision to choose a specialised or diversified pathway is more appropriate or suitable for children's sport development and why this is. There is a need to understand which specific parameters of early specialisation and early diversification are associated with positive or negative youth sport outcomes, and how personal factors (such as motivation) are affected by different types of developmental activities. Beyond this, it is uncertain what amount of specific practice is necessary for the attainment of expertise in sport and whether this quantity of practice is determined by the characteristics of different sports. Researchers have argued that the quality of practice may be more important than the quantity in facilitating the progression toward a superior level of performance,^{18,20,38,39} stressing the need to examine in greater detail the microstructure of the sport environments of athletes of all ages. Therefore, future research attempting to understand the development of talent in sport should consider the need to include various learning activities and their analyses in greater detail in order to understand what ultimately promotes long-term development and commitment to sport.^{20,65,66}

Athlete development models. In the past few decades, there has been an observable increase in the number of theoretical models devoted to understanding how athletes develop in sport. Based on an analytical research synthesis technique (citation network analysis), Bruner et al.⁶⁷ sought to unveil the empirical evidence behind several athlete development models^{2,58,68-72} as well as how they were connected. Two different perspectives emerged from this analysis that conceptualise athlete development from either a *talent development* perspective or a *career transitions* perspective, with very little connection between these two lines of research.⁶⁷ This apparent disconnect is obviously unfavourable for building a systematic and cohesive body of knowledge about athletes' development in sport.

Talent development models^{2,58,68,71,72} divide athletic careers into several stages and describe the changes in athletes and in their social environment. The study by Bloom² has strongly influenced the conceptualisation of talent development models in sport. From retrospective reports of talented individuals in disciplines such as mathematics, art, science and sport, a general pattern of development was inferred and three stages were suggested: (1) initiation stage, (2) development stage and (3) perfection stage. In Salmela's model,⁶⁸ these three stages were included; however, an additional stage titled discontinuation (i.e. when athletes stop participating at a high level, but continue sport participation for recreational purposes) was also considered. The model proposed by Abbot and Collins⁷¹ recognises that multiple interactive and compensatory processes take place within and between innate capabilities, environmental conditions and psychological behaviours. Likewise, Bailey and Morley⁷² suggested that current performance is a poor indicator of ability since other influences such as training, support, parental investment and social values can play an important role in talent development. The authors also contended that talent development needs to be viewed as a multi-dimensional construct because wide ranges of abilities including interpersonal, intrapersonal, cognitive, and creative ability are important contributors within this complex process.^{9,21,60,73,74}

Despite the meaningful contribution of these theoretical frameworks to athlete development research, the majority of these models fail to provide testable concepts that can enhance the understanding of athlete development.²¹ For instance, there is a lack of information related to quantifiable components that characterise each stage of development, and some of the variables are difficult to test, such as psychosocial behaviours⁷¹ or an athlete's potential.⁷² Moreover, the qualitative stages considered in many of the stage-based models are difficult to define, particularly because of the lack of clarity regarding indicators that track transitions between stages.

Recently, Gulbin et al.⁷⁵ proposed a new sport and athlete development framework known as Foundations, Talent, Elite, Mastery (FTEM). This model comprises 10 highly differentiated developmental stages of elite performance in order to better understand athlete transitions, thereby establishing a continuum between participation and elite. The intent of FTEM is to provide a new practitioner-generated development framework that is specific to sport and athlete development and that addresses a number of gaps within current theory and practice. However, given that 'development in sport is idiosyncratic, non-linear and dynamic',⁷⁶ cautions should be taken when this process is examined by such specific and

discriminative stages. For instance, the simplistic perspective under covering talent identification in this model may be limited and based upon the assessment of potential that occurs earlier in the process, which may deselect talented athletes who were not given the opportunity to mature.⁷⁶ The FTEM framework is also significantly delimited in scope by its descriptive focus on stages and phases and the use of a very specific sample group (i.e. Australian athletes working in a national institute), which limits its application to other sports and cultures, therefore reflecting the same limitations of other existing models.⁷⁵

The developmental model of sport participation (DMSP)^{19,24,58} is a conceptual framework that has attempted to address some of the aforementioned limitations. Considered to be the most prominent conceptualisation of athletes' development within the sport literature,⁶⁷ this talent development model has been developed and refined over the last 10 years,²¹ and it has presented a set of quantifiable and testable concepts and variables regarding the development of athletes. Three sport participation trajectories are given consideration in the DMSP: (1) recreational participation through early diversification and deliberate play; (2) elite performance through early diversification and deliberate play; and (3) elite performance through early specialization and deliberate practice.^{19,21} The different trajectories are based on changes in the type and quantity of involvement in sport, deliberate play and deliberate practice and have specific outcomes for athlete development.^{19,21} In contrast to other athlete development models, the main advantage of the DMSP is the identification of clear indicators for each stage that are consistent with theories of child and adolescent development.²¹ Nevertheless, MacNamara and Collins⁷⁶ have recently highlighted the need of moving beyond prescriptive models of talent development towards a consideration of features of best practice and process markers of development together with robust guidelines about the implementation of these in applied practice.

Career transition models^{69,70} differ from talent development models because they describe and explain the reasons and demands, coping processes, factors that influence coping, outcomes, and later consequences of a transition in sport. Thus, Stambulova's⁶⁹ and Wylleman and Lavallee's⁷⁰ models were not only elaborated to characterise the different stages of athlete development, but also to depict key transitions between these stages. The athlete development model suggested by Stambulova⁶⁹ divided the athletic career into five stages: (1) preparatory stage, (2) beginning of specialization, (3) intensive training in chosen sport, (4) culmination stage and (5) the final stage followed by discontinuation. Wylleman and Lavallee's⁷⁰

developmental model included the same stages of Salmela's model⁶⁸ (i.e. initiation, development, perfection and discontinuation), but they also added three levels of development termed psychological, psychosocial and academic-vocation, in order to challenge researchers to consider an athlete's demands and transition outside the sport environment.

Taking into account that the two different conceptual approaches (talent development models versus career transitions models) operate under the aim of building a solid body of knowledge around the phenomena and process of athlete development, their pervasive disconnect in the literature is surprising. Bruner et al.⁶⁷ highlighted the multi-disciplinary nature of the athlete and expertise development research field as a possible justification for the lack of discourse occurring between researchers of career transition and talent development. However, as a consequence of this segregation, there is little development, growth or networking of perspective between the two research groups, which may limit the development of knowledge in this research field. Taking into account the minimal knowledge transfer between these two different conceptual perspectives (and schools of thoughts), researchers may be hindering the understanding of the phenomenon of athlete development.⁶⁷ By considering a holistic perspective that integrates knowledge on both talent development and sport transitions, researchers are able to gather a more complete and detailed understanding of the relationships between the other existing factors within the continuous process of athlete development, therefore providing important insights for the design, implementation and intervention of such long-term programmes. Hence, further athlete development research should avoid this theoretical isolation, and the integration of knowledge should be viewed as a potential avenue to explore in further research.

Empirical research: Critical analysis and insights for future research

Developmental pathways: the need of a complementary and holistic view. From the analysis of empirical evidence, a pattern relating to the type of learning activities during the early years of sport development and the age of peak performance in a specific sport seems to emerge. Elite performance through early specialisation and deliberate practice has been more common in sports where peak performance is achieved before adulthood, such as in gymnastic³⁶ and figure skating.⁵⁵ On the other hand, elite performance through early diversification and deliberate play has been frequently observed in sports where peak performance is achieved during adulthood, such as in triathlon,^{59,77} rowing⁵⁸ and tennis,^{58,78} and in a large number of team sports

including ice-hockey,^{51,79} field hockey and netball,⁴⁸ basketball,^{29,37,48} baseball,⁸⁰ cricket,^{81,82} Australian Rules football,³⁵ football^{6,49,64} and volleyball.^{14,28,37} The age of peak performance in all these sports usually occurs after the athlete has fully matured, generally in the late 20s or early 30s.^{21,57} Thus, specialisation in these sports occurs around the ages of 13–15 years and the investment in the athlete's training around the age of 16 years, which allows the athletes to sample a variety of sports before specialising in his or her main sport.

The concepts of early specialisation–deliberate practice and early diversification–deliberate play have been commonly associated in athlete development research.^{34,35,64,83} While early specialisation and early diversification focus on the number of sports practiced at an early age, deliberate practice and deliberate play refer to the type of learning activities that athletes have experienced in their development. Although previously outlined in the literature as independent but interacting variables,^{1,58} researchers have sometimes misinterpreted these concepts and considered early specialisation as a synonym of deliberate practice and, likewise, early diversification as a synonym of deliberate play. This potential lack of clarity appears as a limiting factor for better understanding athletes' early involvement in sport. It can result in misleading research findings that fail to acknowledge that apparently opposing concepts (i.e. early specialization and deliberate play) may coexist. Somewhat echoing this point, findings from the work developed by Ford et al.⁶⁴ showed that youth soccer players engaged in early specialization in soccer while participating in high levels of play (deliberate play).

In further examining the intricacies regarding how expertise is achieved, research has problematized the 'one fits all' approach. As a result, research has been suggested the use of different pathways in the achievement of expertise.^{66,84} The targeting of talent development hotspots could be a suitable procedure to better understand what particular factors contributed to the achievement of expert performance in a specific context. This encompasses a more holistic ecological approach⁸⁵ by examining the broader developmental context or environment in which athlete development takes place rather than focusing solely on the individual athlete (for instance, understanding why Rift Valley, Kenya, is a hotspot for long distance running athletes or why some Brazilian schools of soccer have developed such outstanding players). In this case, the study of the uniqueness of a specific talent development environment is the main purpose of this approach, thereby allowing a deeper understanding of the idiosyncrasies that have contributed to the achievement of high levels of performance in that specific context. The value of this approach is highlighted in the recent studies of Henriksen et al.^{85–87} The authors have examined a

Danish sailing team,⁸⁵ a track and field Swedish club⁸⁶ and a Norwegian flat-water kayak team,⁸⁷ characterizing them with strong organisational culture, promoting values of open co-operation and individual responsibility and having a focus on performance process.

Other concerns to be considered in future research are the long-term implications of involvement in high-performance sport. To date, little is known about the relationship between participation as elite or professional athletes and arguably ultimate health outcome (i.e. longevity).⁸⁸ In this context, factors such as competitive level (i.e. elite vs. sub-elite vs. recreational), type of sport (e.g. individual, team) and the athlete's positions/roles on a team can prove very relevant to further understand the impact of such practices on health-related issues.⁸⁸ Beyond the sport experiences, research should also consider other relevant factors that may influence athletes' health profiles. Considering that expertise is a multi-factorial construct,^{3,18,89} future studies should integrate physical, social and cultural factors that may affect the athlete's health, such as socioeconomic status, social factors, involvement in preventive health behaviours or psychological factors.⁸⁸ Understanding the influence of all this factors might shed important light on the long-term implications of involvement in high-performance sport while providing useful information to guide the designs of sport developmental programmes.

The need for forensic detailed examinations of the microstructure of different learning activities. Based on athletes' retrospective reports, several studies have examined the pathways to expertise in sport by examining the accumulated amount and type of learning activities.^{28,35,48,54} Although retrospective interviews have provided relevant information, this tool cannot assess the specificities of the learning activities and the particular adaptations that characterize expert performance, thereby presenting a superficial and imprecise characterisation of practice.^{21,47} The overemphasis on time and effort of sport-specific activities could ultimately provide only a superficial explanation for success in sport.²⁶ In addition to athletes' retrospective reports, the systematic observations of practice activities may provide a detailed examination of the microstructure of practice and could be a valuable resource for understanding what best facilitates the acquisition of expert performance.^{57,90} For instance, recent studies examining the microstructure of practice activities performed by team sport players have suggested that the involvement in learning activities that replicate the similar underlying structure to the competition activity (i.e. 'playing form' activities) may facilitate greater transfer of perceptual, cognitive and motor skills to

performance in competition rather than other 'decontextualised' practice activities (i.e. 'training form' activities).^{25,38,39,91} Despite offering considerable insight, these studies have only considered two broad categories to classify the learning activities that players engaged in (i.e. playing form and training form), which could be insufficient to include the wide range of learning activities that take place during a training session. A possible avenue for future research could be the analysis of the microstructure of practice with consideration of more specific settings of practice and play such as deliberate practice, play practice, spontaneous practice and deliberate play as suggested by Côté et al.²⁰ Accordingly, there is a need to examine the microstructure of not only practice activities but also play activities in a number of different sports to reveal the extent to which youth athletes are engaging in activities that match (or not) the principles derived from research in the areas of motor learning and sport psychology. In addition to these issues, future studies should also consider the complexity of the context, wherein these practice activities take place in order to understand the interacting constraints that influence skills acquisition in athletes.^{92,93} Here, the constraints-led approach could be a sound framework to apply in further studies.^{94,95} This approach views influential factor within the learning environment as interacting constraints (i.e. organismic, environmental and task constraints) that guide and facilitate the acquisition of skills and consequent learning in sport.⁹² Therefore, by studying the influence of these constraints, researchers are able to better understand their role in skill acquisition and expertise development.⁹⁶

The unclear definition of what constitutes an expert sports performer. The concept of expert sports performer is controversial and restricted by the differences in outcomes that expert athletes display.⁹⁷ Taking into account that expertise is multi-factorial,^{74,98} the criteria used to define an expert athlete should consider different factors, such as contextual characteristics (i.e. cultural, social, economic status) as well as sport-specific features. Hence, the big challenge in the talent development research field is to provide specific and detailed criteria of what constitutes an expert sports performer so as to contextualise their overall development, understand the degree of their achievements and avoid misinterpretations and bias when findings of different studies are compared.

Sport studies have used different and inconsistent criteria to define what is an expert athlete.^{15,27,35,93,97,99} The expert-novice approach, also known as 'the relative approach',¹⁰⁰ is the one most typically employed by researchers. The main goal of this approach is to understand how experts developed so that others can learn to

become more skilled and knowledgeable. Expert and non-expert athletes have mostly been distinguished by the level of playing proficiency attained.^{27,35,48,59,64} Additional research reported other criteria such as playing in the highest division,^{28,39} being part of the national team^{28,52,60,101} or competitive results achieved.^{34-36,59,99,101} The judgement of national team coaches to select the best athletes in a specific sport domain is also a common criterion used by researchers.^{27,28,37,48,60} On the other hand, the non-expert athletes are usually selected based on failure to meet the expert athletes criteria.^{18,28,99,101,102} In addition to this limitation, the existing variability in the level of participants of each study as well as the high context-dependency of these criteria (i.e. the sport level) make it difficult to compare and synthesise findings across studies and sports.²⁵

A related difficulty likewise arises when the terminology applied in this research field differs from one study to another. For instance, studies have analysed expert/non-expert,^{34,48} skilled/novice,¹⁰³⁻¹⁰⁵ or even elite/sub-elite or recreational-level^{64,99} athletes. Even with detailed descriptions of what characterises each one of these groups, researchers should reflect about their meaning and whether we can generalise conclusions obtained from studies with different terminology. A working definition of the concept of expert should be fostered in order to establish a considerable and consistent conception of expert athlete. Additionally, the study of expert athletes is limited by the fact that the number of experts is, by definition, small, rendering the establishment of large sample sizes with strong statistical power extremely difficult. Although several studies have proposed an increase in sample size,^{60,64,106} this could lead to huge variability. Consequently, it could be regarded as noise in the data rather than as a potentially functional aspect in the study of expertise. A possible alternative to this problem is the use of the 'absolute approach',¹⁰⁰ which involves the study of a smaller sample of truly extraordinary athletes and has the aim of determining how they perform successfully in their chosen sport. However, such approaches are still not widely embraced within the research literature because very few of these individuals exist and, consequently, this constraint may necessitate the use of single-participant designs or multiple case study approaches.²⁵

Given all this, precautions should be taken within the definition of expert and non-expert athletes to avoid inappropriate considerations and, consequently, inaccurate results. What seems particularly important for future research is the existence of detailed descriptions of the criteria used to define the athlete's level of expertise as well as the context features in order to get a better understanding of who is considered an expert.

Moreover, the triangulation of several factors (for example, level of playing proficiency attained, competitive level, participation in national teams and competitive results achieved) could be a helpful way to characterise and select the best athletes rather than focusing solely on one of these factors.

New challenges in methodological procedures. The development of expert athletes has been mostly studied through cross-sectional designs and the longitudinal retrospective perceptions of athletes. Here, several methods to collect retrospective data, ranging from open-ended interviews^{15,99} to fixed-response questionnaires^{29,55,107} and structured interview procedures¹⁰⁸ have been used to examine the past activities of expert and less expert athletes. Consequently, the use of retrospective methods is a potential limitation of this research field because of the inaccuracy with which individuals can recall, for example, the time spent in activities undertaken up to one or two decades earlier.^{26,108} To reduce retrospective bias, it is important for studies to take extra measures to assess the reliability and validity of the data collected.¹⁰⁸ The triangulation of data sources (e.g. parents, coaches), administration of the same interviews or questionnaires to the same sample [test-retest reliability^{108,109}] as well as the convergence of estimated concurrent level of domain-related activity and diaries of weekly practice^{27,52,108} could also be valuable options used to assess data reliability.

Although retrospective interviews represent an imperfect tool in this research field, their validity is highly acknowledged.^{109,110} Retrospective interview studies allow an examination of experience through the athlete's eyes, which may at times be quite different from what an outside observer thinks he or she is seeing. What seems important to acknowledge is not whether we need to use the method of retrospective interview in the study of expertise, but, rather, how best to use the method.¹¹¹ Indeed, there is an excessive dependence on retrospective reports from expert athletes providing only a 'faraway' perception about the athletes' previous practice histories. However, it is important to complement it with the information provided by prospective athletes, since they could offer a more accurate and objective data about their current sport learning activities, therefore enabling a deeper examination of their sport involvement.

Recently, authors have suggested extending the methods for collecting data in the athlete development research field.¹⁸ In an attempt to provide a step further, recent studies^{38,39,91} have conducted systematic observations and examination of practice activities providing a detailed characterisation of practice (not based on athletes' perceptions) and a more detailed view of the athletes' sport involvement (for instance, coach

behaviours and instruction). Notwithstanding, there is a need to move towards a more contextual examination of practice in order to examine in greater detail not only the specifics of practice activities, but also the effect of other relevant factors in the course of that practice. For example, the analysis of coaches' behaviours (i.e. support, encouragement, feedback, questioning, instruction within the nature and goals of the practice and also athletes' responses to those behaviours) and peer/teammate characteristics (i.e. height, strength, etc.) within different types of sport activities could be a worthy avenue to explore in future research since these features can affect the athlete's sport experiences and contribute differently to the development of expertise in sport.¹¹²⁻¹¹⁴

Studies aimed to longitudinally tracking the sport developmental process are also encouraged since they could provide a more complete and understandable view of the factors that may influence athletes' sport involvement. Although several researchers highlight the difficulties of employing longitudinal designs,^{15,53,115} large-scale longitudinal studies (i.e. extensive duration that could last weeks, months or years) may provide a good opportunity to move forward in this research field. Longitudinal studies allow researchers to gather real and more accurate data of their developmental process as opposed to subjective perceptions of events commonly observed in cross-sectional studies. By tracing the same athletes over time, longitudinal data enable researchers to study changes over a certain period, therefore providing the opportunity to consider the effect of time to understand causal relations and inferences.^{116,117} Additionally, longitudinal studies allow researchers to identify not only interindividual but also intraindividual changes in several determinants (e.g. quantity and quality of practice, injuries, growth, etc.) as well as to understand the specific nature and direction of its relationships.^{116,118}

Most of the research intended to study athlete and talent development has used quantitative analysis to identify patterns of sport involvement and pathways to reach sport expertise. The majority of these studies have used statistical methods like ANOVA or ANCOVA to compare the differences between group means providing, therefore, a linear and non-dynamic analysis of the athlete's development process. Despite the importance of these research designs, they are somewhat limited since can only provide a general idea of sport developmental patterns oversimplifying the understanding of a panoply of other factors (e.g. contextual influences) that contribute to the achievement of high levels of performance. Baker et al.⁸⁸ have recently acknowledged the need of superior study designs that incorporate other important variables (e.g. socioeconomic status and sex). This will require more advanced

statistical approaches such as multi-level and/or structural equation modelling in addition to the established methods mentioned above. Such approaches have generally not been used in this type of research previously and may allow the development of more interactive and dynamic models of athlete and talent development providing useful insights for the development of long-term athlete development programmes. In addition to quantitative analysis of athlete and talent development process, there is a need to move forward with this research and consider qualitative methodologies as a valuable means for *in-depth* analysis and for *interpreting* the processes within athlete and talent development. Subsequent studies that incorporate multi-method research approaches¹¹⁹ could be an avenue for future research and will likely advance the understanding of the complex process of expertise development. Although this approach could comprise several different designs,^{120,121,122} one specific example could be the combination of a quantitative set of data to gather patterns of sport activities undertaken throughout athletes' development and qualitative data intended to explore the meaning that athletes place on events, processes and structures within that specific experiences. Such an approach allows a more complete and deeper analysis of athletes' pathway in sport by taking advantage of the strengths of each method (both quantitative and qualitative).

Conclusion

In this review, we intended to provide a critical overview of research in talent development, identifying important gaps in the literature and highlighting constructive insights into future research. Evidence has demonstrated that early specialization is not the only pathway to reaching expertise, and early diversification can also lead to elite performance and provide important benefits for continued sport participation and personal development. Moreover, the prevailed opposing perspectives about deliberate practice and deliberate play provide unrealistic portraits of children's experiences in sport. The development of talent during childhood should be assessed by taking into consideration the whole spectrum of distinctive learning activities (i.e. deliberate practice, play practice, spontaneous practice and deliberate play) in order to enhance understanding about the contribution of different learning contexts to talent development. Furthermore, the characterisation of past sport experiences based on athletes' perceptions is somewhat restricted, thus highlighting the need for longitudinal research that examines the microstructure of different learning activities. In order to assess a deeper characterisation of the microstructure of activities, the athletes' retrospective reports should be

supplemented with real-time systematic observations of athletes' sport involvement in practice and play activities. Also, a more suitable and context-specific definition of the common criteria used to define an expert athlete should be proposed in future studies. Ultimately, the relevance of these issues should embrace the need to consider a sport-specific examination of the factors that could lead to expert performance (rather than the search for a generalisable model of athlete development) so as to design long-term athlete development programmes that could meet the needs of each sport context.

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