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Effective Practice and Instruction: A Skill Acquisition Framework for Excellence (SAFE)

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RUNNING HEAD: Effective practice

Abstract

We revisit an agenda that was outlined in a previous paper in this journal focusing on the importance of skill acquisition research in enhancing practice and instruction in sport (Williams & Hodges, 2005). In this current narrative review, we reflect on progress made since our original attempt to highlight several potential myths that appeared to exist in coaching, implying the existence of a theory-practice divide. Most notably, we present five action points that would impact positively on coaches and practitioners working to improve skill learning across sports, as well as suggesting directions for research. We discuss the importance of practice quality in enhancing learning and relate this concept to notions of optimising challenge. We discuss how best to assess learning, the right balance between repetition and practice that is specific to competition, the relationship between practice conditions, instructions, and individual differences, and why a more 'hands-off' approach to instruction may have advantages over more 'hands-on' methods. These action points are considered as a broad framework for advancing skill acquisition for excellence (SAFE) in applied practice. We conclude by arguing the need for increased collaboration between researchers, coaches, and other sport practitioners.

Key words: motor skill learning; challenge points; specificity; individual differences; repetition.

Introduction

We previously co-authored a narrative review in this journal that looked at what appeared to be the common behaviours and strategies used by coaches, particularly those working in football, in designing and delivering practice sessions (Williams & Hodges, 2005). We intimated that many of the coach behaviours employed at that time were driven by what we termed "myths", that were perpetuated by tradition, emulation, and historical precedence within the sport, rather than by research evidence. These myths are summarised in Table 1. Our intention in writing the original paper was to raise awareness amongst practitioners of how these apparent myths were driving applied practice. Although the original article was specifically targeted at football, it was likely that these same myths perpetuated across sports, highlighting the widespread existence of a theory-to-practice divide in sport coaching. The paper has subsequently been cited 822 times (Google Scholar, 6th, July 2023). In view of the paper's popularity and increasing awareness of the need for improved coach education, we felt it was appropriate to revisit the agenda set in the original paper, as well as to extend the discussion beyond football.

Insert Table 1 about here.

We start the current paper by looking back through the proverbial 'rear-view mirror' to ascertain whether anything has changed over the last two decades. Did we collectively as a field manage to have translational impact and help facilitate a change in coach behaviours at any, or all, levels within sport? Our reflections on this issue will be somewhat inferential and anecdotal, but where possible, we draw on empirical data to substantiate claims. However, the main intention in writing an updated paper is not so much to look back at progress, but rather to look forward through the front windscreen, so to speak, to ascertain what direction the field is now travelling and what are the things we could be doing next to help coaches and practitioners design and deliver more effective practice sessions. The focus is specifically directed towards those working in high-performance sport, across adult and youth levels, albeit the material should resonate at all levels of participation.

Our approach in this paper is to be more constructive than in the preceding article by considering positive action points, rather than highlighting things to avoid doing. These action points are intended to enhance long-term skill acquisition and to help optimise the return from every hour invested in practice. While there has been extensive dialogue around the question of ‘how much practice is enough?’, prompted by research on deliberate practice (Ericsson, 2020), the question of what quality practice looks like in the long-term development of sports skills is arguably less well-debated. What might be an acceptable level of return regarding improvements in learning for every hour of practice undertaken? How can we measure the level of transfer from practice to competition to infer quality? How might we ensure that the least amount of practice time possible is wasted? This paper is intended to be of interest to researchers in skill acquisition and related fields and equally to coaches, coach educators, athletes, and practitioners working to enhance performance by applying principles emerging from the field of skill acquisition. The dialogue emanates from our own discussions and interactions with academic colleagues, as well as with coaches and practitioners. By sharing thoughts and reflections, we hope to highlight the importance of skill acquisition in the process of developing elite athletes, promote better communication and collaboration between scientists, coaches, and other practitioners, and provide guidance and direction as to how this agenda can be progressed.

The state of play: Have we made progress?

We believe that progress has been made regarding the translation of skill acquisition knowledge into practice, albeit arguably less than what may have been hoped for almost two decades ago.

There is increasing dialogue between academics and coaches, collaborations with sport governing bodies, and sharing of information through social media outlets, such as Twitter, LinkedIn, podcasts, and blog posts. Also, there appears to be an increased appetite from those working in professional and federal sport organisations to seek out guidance from individuals who specialise in skill acquisition. However, there remain very few examples of sports that have positions, full- or part-time, dedicated specifically to skill acquisition. People employed by professional sports organisations with a skill acquisition background are typically hired based on additional skills or knowledge related to biomechanics and movement analysis, data analytics, strength and conditioning or applied/clinical sport psychology. Moreover, skill acquisition specialists are not typically part of athlete-coach support teams and there are no programmes directly dedicated to the development of the profession.

Over the last decade, there have been an increasing number of books aimed to help educate practitioners about skill acquisition, with varying emphasis on research and application. At the more research heavy end, our first edited book on skill acquisition in sport (Williams & Hodges) was published in 2004 and is now in its 3rd edition (Hodges & Williams, 2020), in addition to other edited academic volumes on sport expertise (e.g., Baker & Farrow, 2015; Farrow et al., 2013; Renshaw et al., 2019; Williams & Jackson, 2019). At the more application-focused end, there have been popular science books written by academics, including “Peak” (Ericsson & Pool, 2016), “The Best” (Williams & Wigmore, 2021), “How we Learn to Move” (Gray, 2021) and “The Tyranny of Talent” (Baker, 2022). There is some evidence that these books and other outlets have impacted the actual behaviours employed by coaches in the field. Published reports suggest that in some sports, there have been meaningful changes in coaching practice, with increasing use of game-related activities (i.e., playing form) and guided-discovery focused methods of instruction, as well as reduced feedback provision (e.g., Ford & Whelan, 2016; O'Connor et al., 2018; Roca & Ford, 2020). Moreover, the increasing popularity of constraints-based and ecological dynamics approaches to motor skill acquisition, spurred by a growth in podcasts advocating this approach, has provided a potential framework by which coaches can become more 'hands-off' rather than 'hands-on' in the coaching process (e.g., Renshaw et al., 2019; Woods et al., 2020).

In the rest of this paper, we try and stimulate further growth and application of skill acquisition research by highlighting five action points that are intended to encourage reflection from researchers and practitioners regarding how best to facilitate effective skill learning. We present these action points as a working framework for enhancing skill acquisition practice in sport, which we term SAFE – Skill Acquisition Framework for Excellence. This is not a conceptually-driven framework, but rather a guiding "framework" containing 'a series of rules, ideas, or beliefs' (Cambridge Dictionary; https://dictionary.cambridge.org/), which coaches can use to help them plan and make decisions. The framework could be considered meta-theoretical, drawing on knowledge from different conceptual approaches and phenomenological explanations. As such, the framework has broad application, somewhat independent of the reader's theoretical bias. The list of action points is not intended to be exhaustive, or overly specific, but rather to provide pointers and evidence-informed ideas that could facilitate more substantive progress and provide some rubric for defining good practice in applied settings.

Skill Acquisition Framework for Excellence (SAFE)

Action Point 1 – Find the right balance in practice between focusing on long-term learning and short-term performance

When developing athletes, the main aim of practice should generally be to promote long-term learning rather than short-term performance. Although the relative importance of short-term performance versus long-term learning goals may differ across various levels of sport, with performance often gaining precedence at the highest levels of competition, the distinction between learning and performance is important at every level of sport. Performance is observed behaviour, typically within any one practice session (Schmidt & Lee, 2019). It is transient, short-term, and the result of what the coach and athlete are doing in that practice session. As such, it is subject to the impact of how much instruction and guidance are provided, the number and type of skill repetitions employed, and the temporary physiological or psychological state of the athlete. In contrast, learning is a relatively permanent change in the capability for skilled behaviour (Schmidt & Lee, 2019). Learning can only be inferred from changes in performance over time when the temporary effects of the practice environment, coach-athlete interaction, and physiological/psychological state have dissipated and processes related to memory consolidation have had time to work (Mang et al., 2019). To evaluate learning, one must firstly ascertain that any change in performance is retained after a period of rest and secondly, that it transfers to novel variations of that practice activity and ultimately to competition (Schmidt & Lee, 2019).

Why is the distinction between performance and learning important? An extensive body of research indicates that different types of interventions influence performance and learning in distinct ways (e.g., see Guadagnoli & Lee, 2004; Kantak & Winstein, 2012). Generally, one can conclude that if coaches provide high levels of instruction, facilitate repetitive, blocked practice of a single skill, and increase the amount and frequency of feedback provision, performance during the practice session is better when compared to the reverse conditions, that is, low levels of instruction, variable and random practice conditions, and low levels of feedback. In contrast, and importantly, these latter conditions lead to better retention and transfer of skill, that is learning (Williams & Hodges, 2005; for detailed and recent reviews of this body of work, see Anderson et al., 2020; Farrow & Buszard, 2017; Petancevski et al., 2022; Wright & Kim, 2020). Therefore, coaches do not always "see what they get"; observed behaviour (e.g., good performance) during practice can create a false sense of security that learning is being facilitated and vice versa, poor performance does not imply that no learning is taking place.

Another challenge for practitioners is how to measure performance within and across practice sessions to make inferences about learning. In sports, where time and distance are the principal measures of success (such as swimming and athletics), performance is easier to evaluate, but in many ball games and team sports, it is harder to quantify. The outcome of a competition presents a very coarse overview of which athlete or team performed better. Performance is based on the execution of several successful tasks and processes, making it difficult to objectively evaluate. In team ball sports, one can measure sub-components of skill that may be related to overall performance, such as passes completed, tackles won and lost, and distance covered. Yet, these team or individual player metrics do not translate in a simple formulaic manner into a measure of performance. Moreover, these measures are subject to variables unrelated to the player's learning, such as the level of the opposition, the performance of teammates, and the environmental conditions during play. Standardised skills tests present an alternative, or complimentary, means of assessing performance under relatively objective conditions, but there are concerns regarding their external validity (Carling et al., 2008). Subjective assessments of performance across time can also be made by coaches and athletes. Provided these subjective assessments are continuous and not based just on performance during, or at the end of, a single practice session and focused on the specific aspects of performance that are being addressed in practice, these appraisals can help in assessing learning.

In the motor learning literature, retention tests are generally carried out after a period of rest, typically the next day at a minimum, so that the rest period involves sleep. For example, delayed retention tests give a better measure of learning than within practice assessments related to rate of improvement. In practical settings, changes in performance need to be retained over prolonged periods of time, months, and years rather than hours or days, so knowledge about motor memory processes over time is important. The science of retention is evolving, and researchers are learning more about how rest, sleep, and activity impacts the retention of movement-related skills (e.g., Walker & Stickgold, 2006). This work on long term memory processes is studied under the umbrella term of motor memory consolidation (see Mang et al., 2019; Schmid et al., 2020; Wanner et al., 2020). In general, sleep can boost the retention of simple motor skills if it occurs in close succession to actual practice, otherwise there are decays over the ensuing hours. However, if sleep follows the decay, initial gains seen from immediate sleep are restored (Cellini & McDevitt, 2015; Nettersheim et al., 2015).

There is generally a lack of evidence regarding the relationship between the practice of sport-related skills and long-term retention and forgetting. The research on consolidation of motor memory has been restricted to manual aiming and sequencing skills. However, there is evidence that napping for two hours after practicing juggling aids later performance (Morita et al, 2012) and that sleep right after learning to ride an inverse steering bicycle, stabilises and improves performance in an adult sample compared to a period of wakefulness (Bothe et al., 2019, 2020).

Scientists have also explored memory interference when moving between tasks and skills that share similar features (e.g., Krakauer & Shedmehr, 2006). Practicing tasks thought to be more cognitive/verbal (such as team tactics) interferes with the retention of more procedural/motor skills when completed in relatively close succession (e.g., Brown & Robertson, 2007). This work highlights the importance of post-practice activities in planning practice sessions and facilitating learning. From a research lens, questions remain regarding the relative degree of skill atrophy over time due to interference associated with the learning of other skills, a lack of practice, or physical/physiological changes due to variations in fitness through training. How much forgetting should be expected in the absence of practice (and how quickly) and what components of skills deteriorate more quickly or slowly than others? While the retention/forgetting of motor skills has been well-reported, with findings suggesting that continuous, cyclical skills (such as swimming, cycling) are better retained than discrete tasks focusing on spatial accuracy (such as archery) (e.g., Ammons et al., 1958; Fleishman & Parker, 1962), the findings have yet to be translated into practice. Clearer guidelines about the timing or periodisation of skill practice for maximising learning (avoiding long-term forgetting) are needed across, albeit some recent efforts are noted (e.g., see Farrow & Robertson, 2017; Lohse & Hodges, 2015). Farrow and Robertson (2017) proposed a framework based on a physical training periodisation acronym guide called SPORT (Specificity, Progression, Overload, Reversibility and Tedium; Grout & Long, 2009). The "Reversability" item is particularly relevant to questions regarding skill atrophy and when to retrain (reverse forgetting), based on measures of skill decline (see Figure 4, Farrow & Robertson, 2017).

As per the difficulties associated with measuring retention, evaluating transfer is no easy feat and the level of transfer that occurs sits on a continuum (Gray, 2020). Skills seemingly acquired in practice may transfer fully, partially, or not at all to novel scenarios. Transfer of skills can be viewed as being "near" (e.g., to other situations highly related to the skill/context of the practice activity), "medium" (e.g., to some transfer settings, such as in practice scrimmages or competitive matches) or "far" (e.g., to various in-game scenarios and potentially to other sports) (Schmidt & Lee, 2019). Scientists are often guilty of creating transfer tests where they evaluate how much the skill has been learnt under "near" and relatively decontextualized situations (Williams, 2020). For example, evaluations of practise throwing to one target distance will be evaluated by measuring transfer to new unpractised distances; although admittedly such small variations have often been designed to answer theoretical questions (e.g., van Rossum, 1990). It is less common for transfer situations to include stressors such as anxiety or fatigue or to assess how prior practice on different skills influences the learning of new skills; yet there are exceptions (e.g., Kim et al., 2018; Lam et al., 2009; Ong et al., 2010; Smeeton et al., 2005). Such transfer tests help to ensure that the conditions that yield the best performance on tests of retention are robust to conditions where contextual factors can interfere. There is widespread consensus amongst researchers that transfer is best when the conditions of practice maintain the important sensory information constraining skills in competition and that include the emotional and thought (i.e., plans and decisions) processes needed during competition (e.g., Button et al., 2020; Hodges & Lohse, 2022; Pinder et al., 2011; Proteau et al., 1992).

Another important issue to consider is that most evaluations of learning are based on an assessment of performance effectiveness. That is, was the goal outcome achieved; did the pass get to its intended destination in basketball, did the ball land in the service court in tennis, was the ball close to the hole in golf? The question of whether practice impacts on performance efficiency has rarely been examined (Williams et al., 2017), although there is an increasing interest in this question, particularly as it relates to injury prevention and burnout (e.g., Benjaminse et al., 2015). Was less energy expended in throwing the discus or striking the golf ball or less attention or fewer cognitive resources used in passing or serving the ball? Similarly, did decision accuracy improve over time in addition to the speed of the decision and how do trade-offs in speed and accuracy impact performance (Du et al., 2020)? Learning may not necessarily manifest itself as a change in effectiveness but rather in terms of increased efficiency in how the outcome was attained, such as enhanced motor coordination, a movement pattern more resilient to injury, decreased metabolic cost, increased speed and/or reduced cognitive load. Therefore, both measures of efficiency and effectiveness are needed evaluate changes in performance.

The challenge for practitioners and researchers is that measuring, or even defining, efficiency is no easy feat and what may be viewed as an increase in "efficiency" means different things to scientists from diverse disciplinary backgrounds (e.g., for a discussion of the challenges involved in measuring efficiency in cognitive neuroscience, see Poldrack, 2015). Skill acquisition specialists have used secondary task measures to infer changes in 'efficiency' related to attentional resources, such as assessments of dribbling speed in football or ice hockey when players are simultaneously counting backwards or trying to memorise spatial positions (e.g., Beilock & Carr, 2001; Ford et al., 2005; Runswick et al., 2018.). Self-report scales such as the RSME (e.g., Broadbent et al., 2019) or the NASA-TLX (e.g., Staiano et al., 2023) have also been employed to index mental effort. Also, process-tracing measures such as the recording of gaze behaviours (e.g., Williams et al., 2002), as well as psychophysiological markers such as heart rate or pupil dilation (e.g., Hosseini et al., 2017) or muscle activation (e.g., Marchant et al., 2009), have been used to infer changes in efficiency. In biomechanics, video analysis is a powerful and economical tool to determine changes in movement form (e.g., Williams et al., 2002). With the onset of marker-less motion capture through phone apps (e.g., openCap, https://www.opencap.ai/), assessment of movement kinematics associated with efficiency is becoming far less labour intensive (such as decreased accelerations/jerkiness in movements). In exercise physiology, metabolic markers are commonly used as markers of efficiency (e.g., Bangsbo, 1993), whereas in neuroscience, mobile EEG systems may help to evaluate the cognitive effort associated with various actions (e.g., Krigolson et al., 2021).

Certainly, there are clear implications for coaches and researchers regarding measures of performance, learning, and transfer. Periods of rest are necessary to best evaluate learning over time and under conditions that represent the relevant sensory, emotional, and cognitive states of the potential transfer environment. An evaluation of learning based on the rate of acquisition within a practice drill or athlete performance at the end a practice session is rarely accurate. Moreover, an evaluation of learning effectiveness solely without efforts to ascertain accompanying changes in movement efficiency could similarly lead to misleading conclusions about the effectiveness of various interventions. Scientists should re-double their efforts to evaluate both components of performance/learning. It may be difficult for coaches to develop easy to administer measures of performance efficiency in applied settings, but validated self-report measures, video analysis or psychophysiological measurement might prove to be relatively easy to use as cost-effective proxies of continued learning.

Action Point 2 – Focus on the quality rather than merely the quantity of practice

Gladwell (2008), in his popular science book ‘Outliers’, first coined the idea of a “10,000-hour rule” for expertise, crediting the phrase incorrectly to eminent Swedish psychologist Anders Ericsson. In numerous publications over a few decades, Ericsson certainly placed a strong emphasis on the importance of accumulating substantive hours of practice in the intended domain of expertise, but he did not propose the existence of a ‘rule’ per se (e.g., Ericsson et al., 1993; Ericsson, 2007; Ericsson, 2020). Several authors have subsequently reported that expert athletes accumulate more hours in sport-specific practice than their less-expert counterparts (e.g., Baker & Young, 2014; Ford et al., 2015; Williams et al., 2018). In some instances, the quantity of hours accumulated by athletes when they reach the elite level is much higher than the original figure suggested by Gladwell, whereas in other sports, this figure is much lower (e.g., Ford et al., 2015; Hopwood et al., 2016). The number of hours needed to reach the elite level is likely to be specific to each sport but the variability in these hours reflects difficulties associated with accurately capturing time spent in quality, deliberate practice (Ericsson, 2020). This latter observation may explain, at least in part, the high standard deviations that have often been reported in the hours of practice accumulated when looking across groups of experts within the same sport (e.g., see Ford et al., 2015, 2020). If one presumes that the quality of each practice hour accumulated by every athlete is consistent, it will be detrimental to end up with a ‘practice deficit’ relative to the hours accumulated by competitors. Yet, at the same time, accumulating significantly more hours than one’s competitors may not be helpful if this practice is not of the quality of that engaged in by competitors.

According to Ericsson (1996, 2016, 2020), if athletes passively accumulate practice by doing the same thing repeatedly, without increasing the level of difficulty, then improvements will be limited; what he referred to as ‘arrested development’, as shown in Figure 1. Ericsson (2020) differentiated between maintenance practice, where already well-learned skills continue to be practiced and deliberate or purposeful practice, which are activities designed with the intention of improving some specific aspect of performance. The key challenge from Ericsson’s perspective is to create practice sessions where athletes are encouraged and supported to enhance existing skills and develop new ones. Thus, every hour of practice is not necessarily equal in facilitating learning. Figure 1 presents a classical learning curve with performance on the vertical axis and amount of practice accumulated on the horizontal axis. The specific component of performance that needs to be improved is identified and then practice is designed to enable that component of performance to be developed. Practice needs to be deliberately structured and engaged in by the athlete, to encourage growth and progression along the learning curve (Ericsson, 2020). If athletes spend all their time practicing components of performance that are already well-developed, or practice is not set at the appropriate level of challenge, the benefits of practice are significantly reduced and arrested development can occur.

Insert Figure 1 about here.

Some important ideas regarding the quality of practice are captured in the challenge point framework and its recent extension (Guadagnoli & Lee, 2004; Hodges & Lohse, 2022). Guadagnoli and Lee (2004) noted that environments that were high in the potential for new information relative to an individual's capabilities (conceptualized as challenging) were best for learning and growth. These environments present uncertainty and variability, encouraging the search for new information to act as a stimulus for learning. If the challenge is too low, it may be that no learning occurs, if the challenge is too high, the individual could similarly be overwhelmed. The challenge is to engage specific perceptual-cognitive processes that are critical to improved performance on task. The optimal point or zone for challenge is hypothesised to be where the difficulty is just beyond that of current capabilities, analogous in some ways to the ideas of progressive overload in weight training. If the goal is to improve beyond current capabilities, challenges are needed to encourage change and stimulate learning. Accordingly, the point where learning is optimal with respect to the level of task difficulty or challenge, is the point when performance is believed to be sub-optimal. Short-term performance is traded-off for long-term learning. In this challenge zone, there will be the expectation of errors and high concentration and as such it will be limited in duration due to the mental (and perhaps physical) demands as well as potential motivational costs (Hodges & Lohse, 2022).

The main evidence used to support the challenge-point framework stems from research on contextual interference and variability of practice, showing support for conditions of practice that involved within and between task variability (for recent discussions, see Czyz, 2021; Farrow & Buszard, 2017; Wright & Kim, 2020). The variability can be created by the types of experiences (such as throwing from different distances) and the order that skills are practiced. In the former case, experience of various conditions under which skills could be performed would promote both robust retention and the ability to transfer to new situations, compared to more constant, repetitive conditions. In the latter case, regular switching between skills (i.e., random or interleaved practice), promotes effortful cognitive processes associated with long-term benefits for skill retention. In the challenge-point framework, evidence relating to provision of feedback was also considered, whereby more challenging conditions resulting in less (or less immediate) instructional guidance from a coach were best for learning, but not short-term performance (Guadagnoli & Lee, 2004).

A task may be made more difficult in meaningful ways by increasing the sport-specific perceptual-cognitive demands to promote an optimal challenge zone for learning. For example, increasing the number of players (or number of players in attack if defending), decreasing the amount of time available to interpret a context, or speeding up play would elevate task difficulty (to different degrees dependent on the athlete’s capabilities; termed “functional” task difficulty;

Guadagnoli & Lee, 2004). Alternatively, task difficulty can be manipulated by varying various instructional systems design components of the task such as instruction, practice scheduling, and feedback, as well as the level of stress imposed. For example, providing high levels of instruction, blocked and repetitive practice, copious feedback, and requiring athletes to perform the task under low stress conditions all reduce levels of task difficulty. In contrast, providing minimal instruction, presenting tasks under random and variable practice conditions, decreasing the amount of feedback provided, and requiring athletes to perform under physical or mental stress will increase task difficulty.

It is possible to conceptualise deliberate practice as representing activity within a zone of optimal challenge, promoting what we have termed “growth practice”. This growth practice designed for learning is contrasted to “maintenance practice”, where already well mastered skills are repeatedly practiced. We illustrate this distinction in Figure 2. The maintenance zone is on the left of the continuum, where learning is low or unlikely. The growth zone, where learning is highly likely, is on the right side, with practice being purposeful, deliberate, and challenging. Practicing without any clear goals (naïve practice), has a low likelihood of significant improvements and learning (Ericsson, 2020; Ericsson & Pool, 2016). It is likely that within a practice session, each athlete is in a somewhat different place on the continuum between maintenance and growth practice. Where a learner sits on this continuum during any given practice session impacts the benefits gained from each hour of practice.

Insert Figure 2 about here.

There are some challenges involved in putting ideas of deliberate practice and the challenge point framework into practice. There is the problem of identifying what components of practice need to be improved and verifying these with objective data, as well as determining an appropriate level of difficulty to bring about learning. This second point is especially challenging given that it needs to be ascertained for each individual and continually adjusted as skills are refined. Moreover, there are many ways to manipulate task difficulty and there are no specific guidelines as to the best way to vary task difficulty. A couple of applied frameworks have recently been proposed to help coaches consider how to enact a more deliberate approach to practice. Ford and Coughlan (2020) developed the acronym ASPIRE (Analyze, Select, Practice, Individualize, Repetition, Evaluate), to help guide the application of deliberate practice in practical contexts, as illustrated in Figure 3. Performance is first analyzed (A), ideally using empirical data where possible, to select (S) the key aspect of performance to be improved. Practice (P) sessions are then designed to improve the selected key aspect of performance involving individualisation (I) of processes and feedback, along with repetition (R) of the aspect in an environment representative of the conditions to be faced in competition. Finally, performance is re-evaluated (E) to determine the amount of improvement in the key aspect, with further practice bouts designed as necessary.

Insert Figure 3 about here.

A second framework for considering how to bring quality into practice is labelled EXPERTS (Eccles et al., 2022). The authors suggest that deliberate practice should occur in domains and for skills where established (E) and effective training techniques exist. It involves improvement of existing (X) individual skills through step-by-step processes designed to ‘push (P) the envelope’ to enhance skills beyond the current level. They argue that deliberate practice is intended to enhance (E) mental representations to better guide future performance (e.g., North et al. 2011). Improvement occurs by obtaining and responding (R) to individualised feedback from instructors. When engaging in deliberate practice, the athlete should give their full attention, that is total (T) application, with continual focus on specific (S) goals for improvement.

The above frameworks were designed with the goals of providing practical advice about how best to implement deliberate practice in applied settings, through individualised and skill-specific practice. However, neither framework has been tested empirically in applied settings, including the collection of longitudinal data to monitor adherence and evaluate the benefits compared to existing approaches. There have been some isolated attempts to capture change in key components of skill under controlled settings, coupled with short-term interventions designed to encourage deliberate practice (e.g., Coughlan et al., 2014, 2019). In these studies, repeated measurements were gathered relating to perceptions of mental and physical effort to help evaluate the quality of practice. Partnerships between coaches and skill acquisition specialists are needed to progress towards a more data-driven approach to identifying and designing high quality practice. Such an approach could generate exceptionally large data sets, but recent advances in data analytics, machine learning, and Artificial Intelligence (AI) have significant potential to facilitate this process (e.g., Richter et al., 2020).

Action Point 3 – Create practice conditions that are specific to competition

An ongoing debate exists about the importance of specific versus general skills in the development of expertise (e.g., see Gray, 2020; Kalén et al., 2021), with the dominant position being that expertise develops through adaptations that are specific to the unique performance or practice environment (Williams & Ericsson, 2008). We refer to specificity as the degree of similarity (in processes, context, and perception- action linkages) between practice and competition. For example, in performance environments, where multiple skills are performed in highly variable and dynamic ways, practice should be structured in a manner that recreates the same demands in practice, matching the level of variability apparent in competition (e.g., Hall et al. 1994). Specificity of practice should not be confused with constant practice or practice that is limited to a range of practice experiences (i.e., specific practice). The argument favouring the importance of competition specificity in practice for effective retention and transfer of motor skills is strong and has a long history (e.g., Lee & Hirota, 1980; Tulving & Thomson, 1973). The more practice looks and feels like competition the more likely transfer will occur (e.g., Godden & Baddeley, 1975, 1980; Lee, 1988; Proteau et al., 1992). The role of context specificity in facilitating effective retrieval has been brought to the fore in recent theoretical models of motor learning (Heald et al., 2021), as well as emphasised through ecological-dynamics and the concept of representative task design (e.g., Dicks et al., 2009; Pinder et al., 2015; Renshaw et al., 2019).

The importance of specificity of practice conditions for transfer does not mean that transfer does not occur across different sports, but most existing date supports the importance of specificity. Scientific evidence relating to the extent of any transfer, what could transfer, and how much engagement in other sports is necessary to facilitate transfer is generally limited (*cf*., Gullich et al., 2022; Müller & Rosalie, 2019). Certainly, insufficient evidence exists to create a training program where general transfer is emphasized beyond specificity. There has been some evidence that multi-sport engagement in childhood is preferable to specific practice in the main sport for later elite success as an adult (e.g., Barth et al., 2022; Gullich et al., 2022), but the mechanisms upon which such transfer may occur is unclear, and the relative amount of time practicing other sports remains comparatively low relative to the hours invested in play and practice in the target sport for expertise (Williams et al., 2018). How many other sports should one participate in for transfer to occur, at what age and for how many hours per week? Do skills transfer differently with age and experience? What are the primary mechanisms underpinning effective transfer and how can they be best promoted? Transfer may well occur, whether facilitated implicitly or explicitly, but the extent of this transfer is unlikely to be the determining factor in achieving expertise in the primary sport.

If we accept the importance of specificity in skill development, questions remain about how specific practice should be relative to competition. How should coaches design practice with specificity to competition in mind? It could be argued that a very specific training environment is one where the demands of practice match almost faithfully that of competition. The demands of practice should ideally be at a level that is at least similar technically, tactically, physiologically, and psychologically to that of competition. For example, there is considerable evidence showing that athletes process information differently under high levels of anxiety, mental fatigue, and physical workload, which are relevant to competition, with changes noted in gaze behaviours and in the emphases placed on different sources of information (e.g., Casanova et al., 2013; Cocks et al., 2016; Moore et al., 2012; Wilson et al., 2009). If athletes practice under conditions involving low pressure, concerns emerge concerning the degree of transfer to competition (Alder et al., 2016; Oudejans & Pijpers, 2010). The challenge remains how best to recreate the demands of high-performance sport in practice; the conditions faced at the Superbowl, the World Cup, or playing the final 9 holes in the US Masters are difficult to replicate in practice.

In performance environments where multiple skills are often performed in highly variable and dynamic ways, practice should be structured in a manner that recreates the same demands in practice, matching the level of variability apparent in competition. However, specificity rests on a continuum and there may be trade-offs between competition similarity and practice quantity or repetition. For example, consider a coach in football that wishes to work on the decision-making skills of a wide midfield player. Practice activity can be designed in a grid or a confined area where a limited number of players (e.g., 3 vs 3) can make lots of decisions in short periods of time. In such conditions, the opportunity for repetition is high, but specificity regarding the tactical demands of actual match-play may be low. Moreover, the types of decisions will be different to a full 11-a-side game, the perceptual cues will differ (impacting perception-action linkages), and there will likely be reduced realism to the actual game (where performance pressure is high). Alternatively, the coach may develop a phase-play practice session, perhaps isolated to one side of the field, that may involve more players (e.g., 5 defenders vs. 6 attackers). Specificity will be closer to the game by virtue of the involvement of more players and the use of pitch markings/areas, but the opportunity for repetition is now reduced (i.e., how often would the wide player receive the ball compared to in 3 vs. 3 situations?). How does a coach or athlete decide how much time should be spent in these various types of activities and to what extent is specificity to competition more important than high repetition? While it may be easy to cast a vote in favour of high repetition, which may partly be why drill and grid-based practices have historically proven popular with coaches, there are concerns associated with spending time on activities that have lower resemblance to the competition environment. If there is limited specificity, what, if anything, is being learnt that will transfer to competition?

The importance of specificity of practice matched to the goals of practice, such as maintenance and growth, has been detailed in the extended challenge point framework, as shown in Figure 4 (Hodges & Lohse, 2022). Low levels of specificity to the game environment is hypothesised to hinder transfer, relative to more moderate or high specificity, as highlighted by the “avoid” zone on the left of Figure 4. For maintenance practice, individualized “functional” challenges will be low relative to the athlete’s current capabilities, as the athlete will be practicing within a zone where he/she can already function well (what is shown in the bottom right). If the purpose of practice is particularly focused on transfer to an upcoming competition, there may be a greater need to recreate situations that are expected in competition, such as performing under increased time pressures, when fatigued, or when there are significant consequences for errors (i.e., moving along the specificity continuum). Also, there will be more need to test existing skills under contexts and demands that are matched to the opposition strengths and environmental conditions (such as style of play, climate, playing surface). When challenges are designed to bring about learning, then the individual is in this hypothesised growth zone, with specificity to competition necessarily being on the medium to high end, dependent on current capabilities and impending transfer goals. Notably, a second "avoid" zone exists at the top right of the figure, which denotes the place where challenges are too high for a performer's given skill set. This latter state is referred to as the "punishing zone" (Hodges & Lohse, 2022). It is here that challenges exceed current resources and capacities, where information is uninterpretable and/or unusable. Scaling specificity in this zone would likely just compound processing demand issues.

Insert Figure 4 about here.

While coaches are invariably aware of the need to achieve the best balance between repetition and specificity, how can researchers best support them in making these judgements? Some researchers have used video-based, time-use analysis to measure what activities coaches are asking players to engage in during practice (see Ford et al., 2010; Partington & Cushion, 2011). However, there is no work comparing practice sessions with varying levels of practice specificity and different amounts of repetition and how these factors impact on skill development across different age and skill groupings. There has been some success in using virtual reality (VR) to create more competition-specific training environments (e.g., Gray, 2019) and this body of work is likely to grow as the use of simulators, VR and AR (augmented reality) become more widespread (see Neumann et al., 2018; Williams, 2020).

In the extended challenge point framework, suggestions are made for scaling specificity depending on goals for maintenance, learning and competition transfer, which may offer some general guidance to coaches (Hodges & Lohse, 2022). However, we need a better understanding of what specificity means in the context of different sports, perhaps by making greater use of data analytics and traditional task analysis, to identify the demands of each sport and how these vary across age and skill groupings. As our understanding and the application of AI and machine learning continue to improve these new methods of analysing competition and practice data may offer some new approaches to identify the nature of specificity in sport and potentially, could help us to develop practice sessions where level of difficulty is manipulated in optimal ways depending on the competition performance profile for each athlete.

Similar methods are needed to quantify how effective coaches are in creating practice activities that mimic or exceed the demands of competition. While sports have been successful in measuring the physiological demands of training and match play (e.g., using HR and GPS data), limited, if any, progress has been made in evaluating the technical or tactical load of practice and competition to aid in quantification of practice specificity. At the very least, coaching sessions should routinely be filmed and analysed to ascertain the level of specificity and opportunity for repetition relative to age- and skill-specific competition. If we could better quantify the demands of competition at each age and skill level, it would enable us to begin to model what type of activities mimic the technical and tactical skills needed in match play and how one should manipulate practice to achieve the optimal balance between repetition and specificity.

Action Point 4 – Consider individual differences in how learners respond to different interventions

A substantive literature base exists focusing on how best to provide instruction/feedback and structure practice for optimal learning, going back at least fifty years. However, this body of work is not without its limitations, including a predominant focus on novice learners acquiring novel and unusual tasks and short periods of practice, with very limited research involving the modification of already well-learned skills among experts (*cf*., Williams et al., 2017; Vecchione et al., 2022). Although knowing how people learn new skills over short periods of time has value, in most instructional settings in sport, coaches are dealing with athletes that have some prior experience of the skill, are trying to further refine these skills, and often they have been engaging in this process for months, if not years (Williams et al., 2017). As a field, more research is needed focusing on how elite athletes learn real-world skills under realistic practice conditions (for some notable exceptions, see Buszard et al., 2017a; Coughlan et al., 2014, 2019; Pinder et al., 2009).

Paradoxically, while researchers have become proficient at controlling everything to examine how generally a single factor impacts on performance and learning, we have largely turned a blind eye to individual differences that exist between learners, except for participant age or experience (Anderson et al., 2021). The classical approach in motor learning research is to select novel tasks for study where there is an assumption that participants are matched for experience and then randomly allocated to groups, sometimes with constraints on age and/or gender. The assumption of this approach is that homogenous groups are created such that responses to different types of interventions are relatively uniform. Therefore, our knowledge of how individual differences in aptitude or personality characteristics impact on the effectiveness of different types of interventions is only just emerging (Anderson et al., 2021). Scientists have generally studied how groups of individuals respond to different interventions. As suggested earlier, published reports suggest that low levels of instruction, high practice variability, and low feedback facilitates skill learning better than the reverse conditions, but do these generalisations apply to all learners even after accounting for individual differences related to skill and experience (Guadagnoli & Lee, 2004)? Are these conclusions consistent across age or gender or psychological characteristics such as, self-confidence, locus of control, resilience, grit, mental toughness, perfectionism, or ‘coachability’?

With respect to the study of individual difference a few areas of research have alerted us to potential factors that underlie responsiveness to practice variables and instruction. The first is with respect to what has been termed “reinvestment”, which is defined as the ‘manipulation of conscious, explicit, rule-based knowledge, by working memory, to control the mechanics of one's movements during motor output’ (p. 208; Masters & Maxwell, 2004). Reinvestment scales have been developed to capture individual differences in propensity to reinvest; including scales for conscious movement processing and self-consciousness about movement execution (Masters et al., 2005; see also Masters & Maxwell, 2008). This propensity discriminated individuals most likely to perform poorly under pressure-inducing situations, when cognitive demands were high (e.g., Chell et al., 2003; Masters et al., 1993). However, much of the evidence supporting the validity of the movement reinvestment scale is related to populations where injury or disease has caused movement issues (such as people with Parkinson’s, post-stroke populations or the elderly after having fallen; Masters et al., 2007, Orrell et al., 2009; Wong et al., 2008). A second, somewhat related variable to reinvestment, concerns the ability of an individual to deal with explicit information, captured by measures of working memory capacity. Although there is not much evidence regarding the influence of working memory on motor learning, in a recent study of learning the basketball free-throw shot in children, where detailed explicit instructions were provided, working memory capacity distinguished across good and poor learners (Buszard et al., 2017b; see also Anguera et al., 2010; Bo & Seidler, 2009).

The challenge point framework can help us to evaluate how the interactions between conditions of practice and instruction vary with individual differences (Guadagnoli & Lee, 2004). The framework emphasizes the individualised nature of practice challenges and how difficulty should be considered based on the experiences and capabilities of an individual to optimize challenge and ultimately learning. For novel skills or for novice performers, the potential to bring challenges and new information into the environment is high and so an optimal challenge point will be relatively lower than for a more experienced performer.

Another individual difference variable considered in the extended challenge point framework is motivation and its interaction with task difficulty (Hodges & Lohse, 2022). If performance designed to improve learning comes with increased evidence of errors and task failures, challenging practice has the potential to impact motivation through self-confidence (for recent work showing confidence being moderated by the type of feedback, see Kok et al., 2020). Questions have been raised concerning the optimal balance between success and failure for learning or phrased differently, how does one find the right balance between the need for information and motivation (Hodges & Lohse, 2022)? At the high end, it is suggested that 70-85% of practice of a particular skill should be successful, with the idea that the performer is just outside a zone of comfort, is obviously able to perform, but not failing all the time (Wilson et al., 2019; Yan et al., 2019). The ability to cope with failures, or more errors in performance, may equally be an individual difference variable that impacts learning potential. Published reports suggest that motives related to achievement, affiliation and power differentially impact how individuals respond to incentives related to competition and task difficulty (e.g., Müller & Caňal-Bruland, 2023; Wegner & Teubel, 2014).

There may be other factors, beyond motivation, that impact on the ability to optimize challenge in practice and spend more time in growth versus maintenance practice, such as grit or resilience (e.g., Larkin et al., 2016; Tedesqui & Young, 2017). Questions concerning the stability of factors such as grit and whether differences exist early in an athlete's engagement in sport or can be developed and facilitated over time remain important for research? It may be that for individuals, who are low in self-confidence and potentially grit, time in challenging practice, or in a "growth zone" should be limited, sandwiched between periods of maintenance practice that help reinforce current abilities. Others may be better able to thrive in an environment where there are failures, particularly if there is later evidence that these periods of challenge promoted learning. The importance of sustained performance assessment across multiple sessions is critical, particularly for individuals who are lacking self-confidence. Clearly, there is considerable scope for scientists and coaches to work together on these issues and to explore the best methods to measure task difficulty and determine what is an optimal zone for learning and what psychological characteristics influence the positioning of this zone.

The absence of any pre-practice and longitudinal data on individual difference characteristics makes it difficult to offer concrete advice to coaches and practitioners. However, as a positive trend, there has been some work directed to studying individual difference variables that might predict engagement in practice over the long-term. Wilson et al. (2019) have been studying how measures of self-regulation among individuals correlate with practice amounts, whereas Larkin and colleagues (2023) have explored the impact of grit on practice adherence.

There have been initial efforts to design a questionnaire that probes individual differences in readiness to engage in deliberate practice (i.e., the CEPP, Challenge, Effort and Purposeful Practice questionnaire), to see whether this measure covaries with skill and practice behaviours and aligns with other psychological variables related to grit and competitiveness (Peters et al., 2022).

A difficulty perhaps in measuring various psychological characteristics such as grit, resilience, mental toughness, perfectionism and then using these measures as independent variables to examine how these factors impact on instruction, practice scheduling, task difficulty, feedback, and so on, is there is almost an infinite number of characteristics and variables that can be measured. So, we may end up in the proverbial situation of looking for a ‘needle in a haystack’ or the never-ending search for a ‘holy grail’ that predicts a sufficiently high proportion of the variance in skill learning to have predictive utility (Williams et al., 2020). Scientists need to present parsimonious explanations as to why some variables were measured or manipulated over others. We acknowledge that much exploratory and correlational work may initially be needed, but we believe that this is a crucial area for future work to enhance understanding of how people learn differently.

Action Point 5 – Facilitate learning during practice rather than dictate or abdicate

Historically, coaches were thought of as conveyors of knowledge, with one of their key roles being to dictate wisdom to athletes (Williams & Hodges, 2005). A culture prevailed where the provision of detailed augmented information through demonstrations, verbal instruction, and feedback became the bedrock of ‘successful’ coaching. This emphasis on explicit, prescriptive (“how to”) instruction was evidenced in systematic observations of coaching behaviours (e.g., Cushion et al., 2012; Ford et al., 2010; Partington & Cushion, 2011). There has since been reason to doubt the efficacy of such a heavily prescriptive, “hands-on” approach, first evidenced in work on augmented feedback and dependencies that develop and hinder retention when too much or too frequent “guiding” information is provided (e.g., Schmidt et al., 1989). Also, discovery-based approaches to motor learning begun to show some promise as an effective means for learning, when compared to more prescriptive “how to” instructional methods (e.g., Hodges & Lee, 1999; Verijken & Whiting, 1990). There was also evidence that when skills were acquired in a less explicit manner (termed implicit motor learning), that they were more resilient to forgetting and the negative impacts of competitive pressures (e.g., Masters, 1992; Maxwell et al., 2000).

As a result of these diverse lines of research and other frameworks as detailed below, recommendations have been made for the coach to be viewed as a catalyst or a facilitator of change, rather than as a dictator of change (Hodges & Franks, 2002; Otte et al., 2020; Williams & Hodges, 2005). The challenge for the coach is one of deciding when and how much instruction /information is beneficial for learners at each stage of development and whether there are alternative methods to bring about the same change in behaviour without prescriptive instruction. Stated another way, what is the least amount of instruction needed to stimulate positive change?

A couple of conceptual approaches to motor learning espouse the benefits of a more “hands-off” approach to coaching. The first is OPTIMAL theory (Wulf & Lewthwaite, 2016), which is based on research on the attentional focus promoted by instructions and feedback, as well as the role of motivational variables related to autonomy, competence, and relatedness in designing effective practice. OPTIMAL is an acronym which stands for Optimizing Performance through Intrinsic Motivation and Attention for Learning. There is a general agreement that instructions that focus attention onto an external action effect, rather than internal body-related cues, facilitate both short-term performance and longer-term learning (for reviews see Chua et al., 2021; Wulf, 2013). The provision of externally focused instruction is generally less prescriptive and information heavy than body-focused, internal instructions; such as focusing on kicking through the ball (external) rather than focus on the rotation of the hip during the kick (internal).

Moreover, the OPTIMAL framework highlights the importance of autonomy for motor learning and the benefits associated with athletes being agents of control over practice activities and decisions (within constraints). For example, having control over the structure of practice or when and how much instruction or feedback to receive, have mostly been shown to be positive for motor learning, or at least not hinder learning relative to more "teacher"-directed approaches (for reviews, see Sanli et al., 2013; Ste-Marie et al., 2019). This work is congruent with a more 'hands-off' approach to coaching, where the learner is instead an active decision maker, determining when coach guidance is needed to reinforce or shape skill development. Work on self-directed practice also aligns with research on adaptive practice environments, where feedback or instruction is given based on performance bandwidths, sparingly and when needed, and often to reinforce current good performance rather than alert to relatively poorer performance (e.g., Chiviacowsky & Wulf, 2007; Choi et al., 2008).

A hands-off approach to instruction is further epitomized by the constraints-based approach to coaching (e.g., Renshaw et al., 2019; Woods et al., 2020). This approach presents a framework for creating change in behaviour through the manipulation of various constraints that are often enacted through a change in, for example, the rules or through equipment modifications (e.g., Brocken et al., 2020). The difficulty with such an approach is in determining what constraint should be manipulated and whether this change is sufficient to bring about learning in a timely manner (once the constraint has been removed). While there are numerous ongoing updates to this framework with efforts to help coaches determine how and when to apply such methods, much more empirical work is needed to guide applied practice (e.g., Otte et al., 2020).

The challenges faced by coaches around the specifics of how, what, and when to provide instruction and feedback are dependent on many interacting factors (Williams & Hodges, 2005). It is well appreciated that while skill acquisition research can inform coaching practice, coaching is not akin to following a cook-book recipe. Significant craft knowledge and intuition are needed to decide the best approach at that time with each athlete. Moreover, instructions per se are not bad, merely the default application of instructions is to be cautioned, especially when they prescribe more than describe and undermine the athlete's role in the learning process. Although there will be situations when explicit instructions are necessary (e.g., as has been shown in the acquisition of certain decision-making skills in expert learners; Richards et al, 2012), defaulting to this method of telling the athlete what to do should be cautioned.

The future: how do we facilitate collaboration?

We have presented a Skill Acquisition Framework for Excellence (SAFE), which includes five action points for coaches as summarised in Table 2. These points speak to the evaluation of performance and learning, designing practice with quality interventions for learning in mind, and with a premium on competition specificity. Also, we urge consideration of individual difference variables that interact with practice variables, particularly those related to experience, reinvestment, motivation, confidence and grit, as well as the role of the coach as a facilitator of change rather than a conveyor of knowledge. This framework is proposed to help extend the impact of skill acquisition research in applied contexts. Although these action points are directed at coaches, in our discussions of each action point, suggestions for research where articulated, by asking questions and alerting the reader to areas where knowledge is missing or still in development. The ideas or beliefs expressed in SAFE are not intended to be prescriptive, but merely to provide some guiding principles for practitioners involved in skill acquisition. We encourage coaches, coach educators, and practitioners to question the extent to which they are employing the action points presented by SAFE in their current practice, while encouraging researchers to evaluate and further refine these action points.

Insert Table 2 about here.

We close by focusing on how more progress can be made in integrating and applying research on skill acquisition and highlight what may be some of the barriers to progress. We believe that the affinity between scientists and coaches is growing, particularly as younger generations of scientists are becoming more aware of the need to demonstrate translational impact (driven in part by social media). Certainly, in some regions of the globe, such as Europe, Canada, and Australasia, there is a greater awareness of the value of evidence-based practice in sports. The phrase 'pracademics', has been coined, originally emanating from the field of political science (McDonald & Mooney, 2011), and more recently applied to sport (Collins & Collins, 2019), which refers to the trend for academics to be more driven by real-world problems. While we are not advocating for a move away from basic "discovery" science, there remains an equal need for research that is directed to applied problems and these endeavours should not be mutually exclusive. We should encourage engagement in both basic and applied research, with the strengths of each positively impacting the other.

Good coach education, relating to the principles of skill acquisition, is essential if positive change is to be facilitated. Skill acquisition seems so central to coach education and athlete development, yet more efforts is needed to integrate concepts into coach education. There is a relative absence of on-going support to coaches from skill acquisition practitioners and scientists beyond the prevails of short classroom exposures on certification course. Coaches receive a relatively small amount of ongoing mentoring post certification; consider, for example, the hours needed to become an elite athlete relative to an elite coach in most sports (Young et al., 2009). Clearly, athletes accumulate substantive hours in coach-led practice, while ironically, coaches learn mostly on the job without much direct supervision.

As a field, we need to do more to facilitate awareness and be more active in forging relevant links with national governing bodies and those with influence in leadership roles. It would help if the role of the skill acquisition specialist within elite sport could be more clearly outlined. While the coach remains the dominant individual within most sporting hierarchies, certainly outside the boardroom, the need to have well-qualified fitness and conditioning staff, performance analysts, diet and nutrition specialists, and sports psychologist are now widely accepted in professional sport. Yet, rather surprisingly, there remain very few roles for skill acquisition specialists. Perhaps one difficulty is the inaccurate perceptions that coaches are skill acquisition specialists or that skill acquisition specialists are coaches. Coaches generally do not have the specific knowledge and understanding of the science underpinning effective learning possessed by skill acquisition specialists, whereas, in contrast, the latter by and large do not have the level of craft and sport-specific knowledge possessed by coaches. These roles are not in competition, they should be facilitative and collaborative; the two inform each other and expedite knowledge creation. Perhaps the relative absence of examples or models where skill acquisition specialists have worked successfully with coaches in sports settings has hindered progress. Certainly, more effort is needed to better identify what the role of a skill acquisition practitioner in high-performance sport could be and what are the systems and processes that needed to increase awareness of this potential role and to facilitate change.

In summary, we have focused our attention on the field of skill acquisition to promote its visibility and importance. Progress appears to have been made in developing awareness and understanding of this field over the last decade or so, but there remains work to be done. By drawing on our recent experiences with high-performance sports, we highlighted five action points that could help extend the impact of skill acquisition research in applied contexts, as well as scientific understanding of how people learn. We pulled these action points together into a 'Skill Acquisition Framework for Excellence' (SAFE). The role of a skill acquisition specialist is not to dictate knowledge, not least because there are many gaps in current understanding, but rather to work with coaches and athletes to stimulate ideas as to how best to promote skill learning. To facilitate further progress, we need to be more successful in getting scientists, coaches, and other key stakeholders in sport (such as governments and professional sports organisations) to collaborate and engage in meaningful conversations around how knowledge and understanding of skill acquisition can be facilitated and integrated into daily practice. An agenda focusing on how to optimise the return on practice and facilitate skill acquisition is the bedrock for developing future generations of elite athletes.

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Figure 1. Two types of performance curves as a function of accumulated hours in practice. The bottom curve shows what Ericsson referred to as "arrested development" and the top "expertise". We have superimposed on the expertise curve ideas concerning deliberate practice and how this type of practice leads to notable improvements in performance (i.e., from pre- to post-practice), without stagnation. In contrast, maintenance type practice results in little gain from practice and hence is more likely to define arrested development (adapted from Ericsson, 2008).

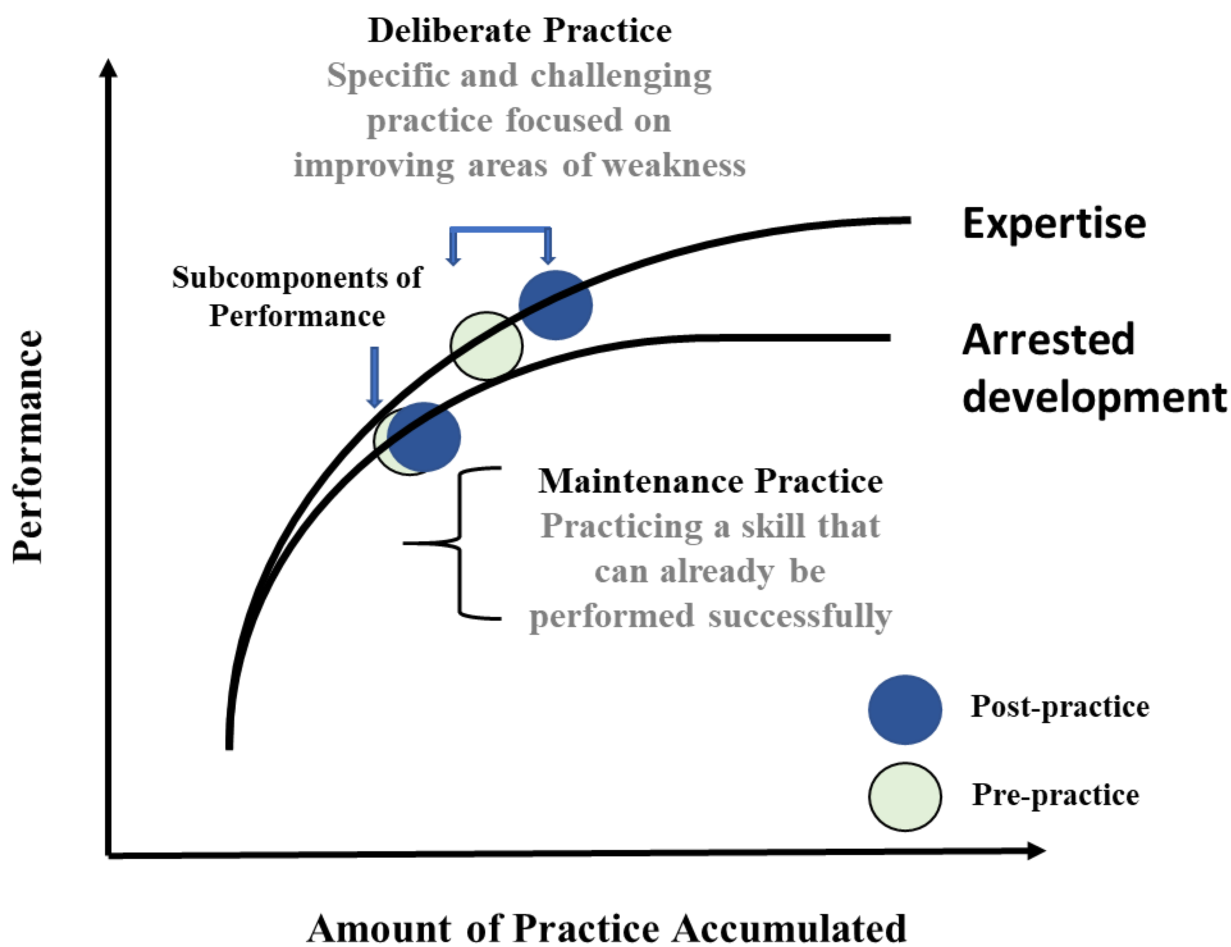

Figure 2. A continuum of practice activities ranging from those that serve to maintain current performance, termed a maintenance zone, to those where growth is likely to happen and where there's a high likelihood of learning and improvement, termed a growth zone.

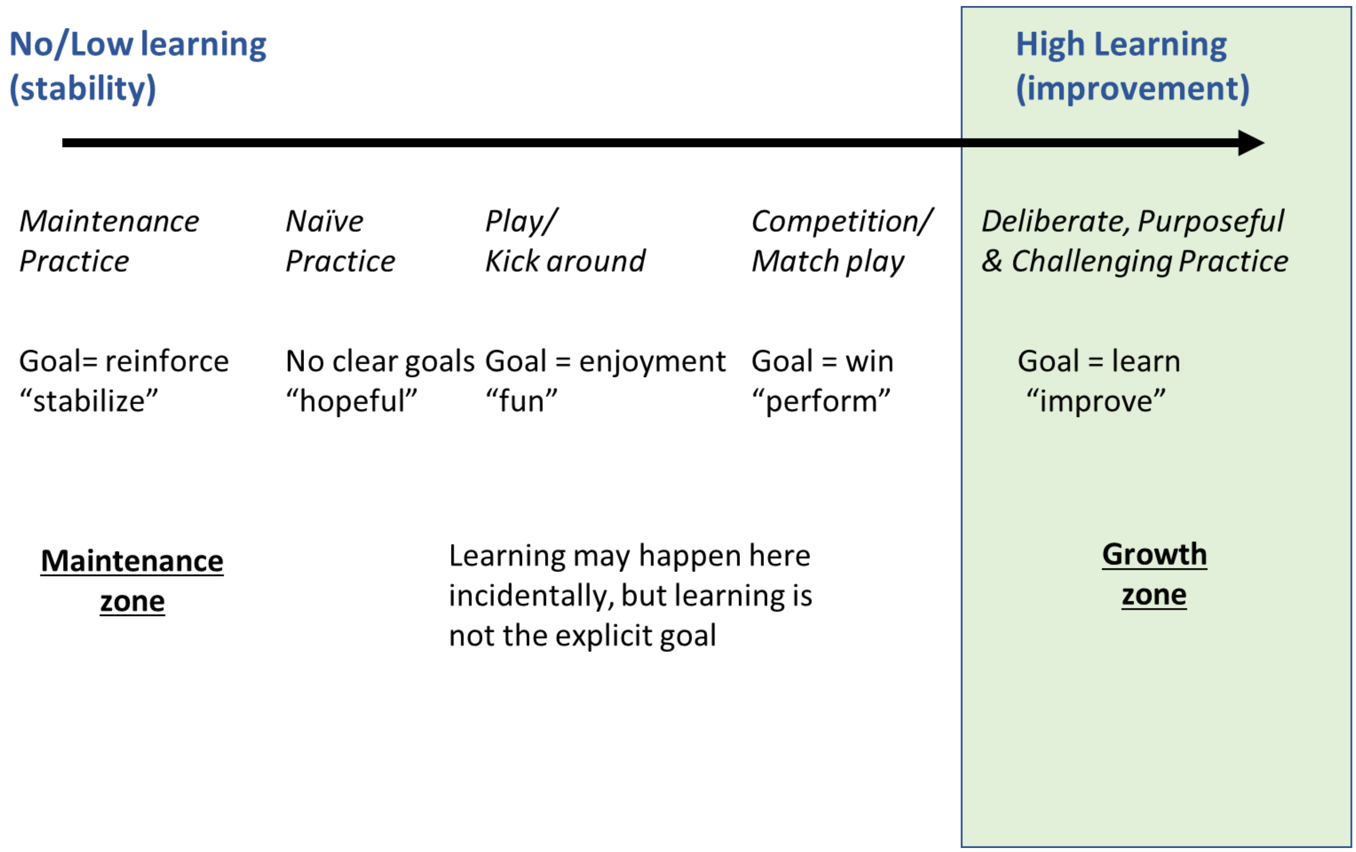

Figure 3. The ASPIRE (Analyze, Select, Practice, Include feedback, Repeat and Evaluate) framework designed to facilitate deliberate practice in applied environments (adapted from Ford & Coughlan, 2020).

Figure 4. Practice design can be considered with respect to two dimensions, namely, specificity to competition and level of challenge. When specificity to competition is low, there will be little transfer to competition, so we want to stay out of this "avoid" zone. At higher levels of specificity, transfer is expected, and coaches can manipulate the level of difficulty depending on the goals of practice. If it is about maintaining current performance, the difficulties will be functionally low for that individual. They will be performing within a "maintenance" zone (lower right box). To bring about learning, challenges need to be designed to take people beyond their current level, into this overload "growth zone" (middle right box). Challenges bring new information into the environment for the athlete, to stimulate learning and improvement. However, too much challenge should be avoided (top right "avoid" zone), even if specific to the transfer environment. Challenges within the maintenance and growth zones will be specific to competition dependent on the goals of transfer, but never low in specificity (adapted from Hodges & Lohse, 2022).

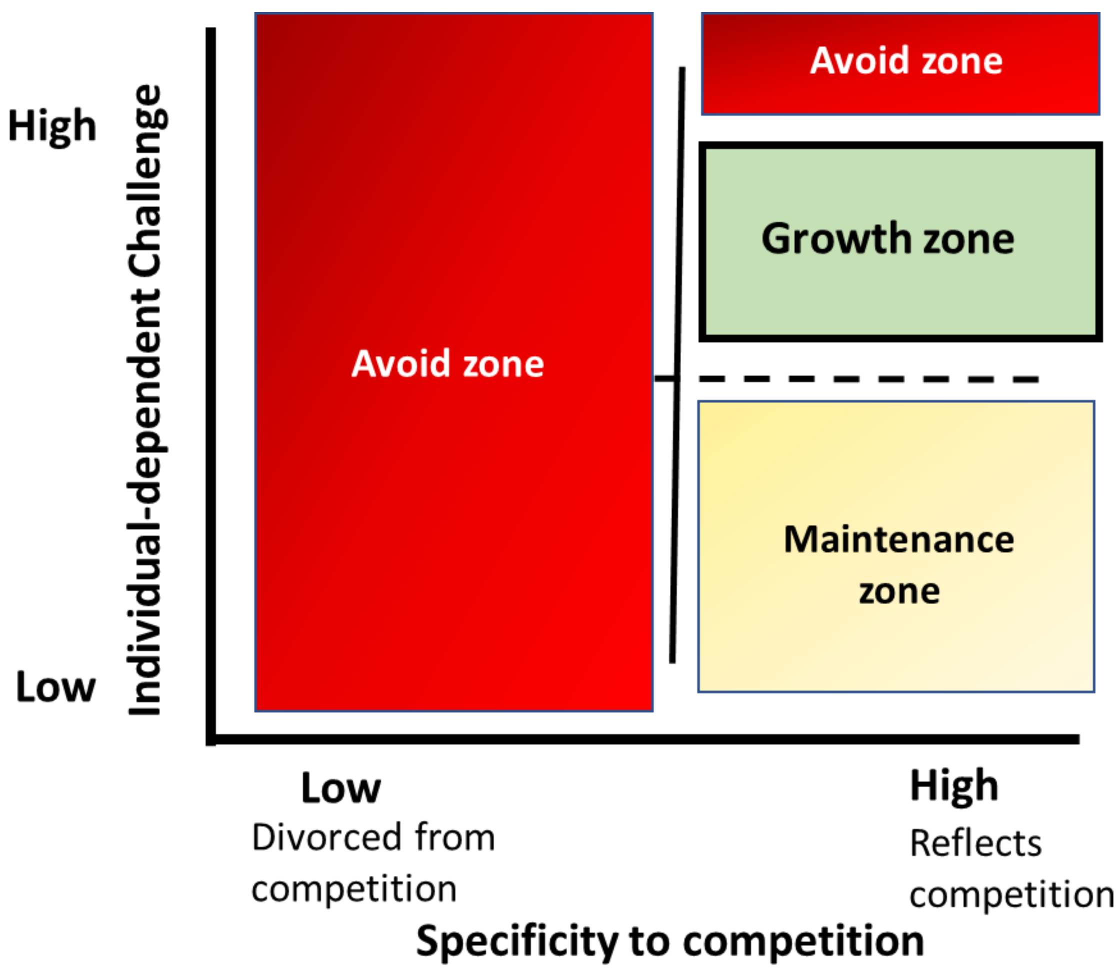

Table 1. The five skill acquisition myths that were considered to perpetuate football coaching practice early in the millennium (Williams & Hodges, 2005).

	Some Potential Myths in Coaching Practice
Myth 1	Demonstrations are always effective in conveying information to the learner.
Myth 2	Specific, blocked practice of a single skill is essential for skill learning.
Myth 3	Augmented feedback from a coach should be frequent, detailed and provided as soon as possible after the skill has been performed.
Myth 4	Prescriptive coaching is always better for skill acquisition than instructional approaches based on learning by guided discovery.
Myth 5	Game intelligence skills are not amenable to practice and instruction.

Table 2. Some key action points to facilitate optimal skill learning. The Skill Acquisition Framework for Excellence (SAFE).

	Skill Acquisition Framework for Excellence (SAFE)
Action Point 1	Find the right balance in practice between focusing on long-term learning and short-term performance
Action Point 2	Focus on the quality of practice, rather than merely on practice quantity
Action Point 3	Create practice conditions that are specific to the competition setting
Action Point 4	Consider individual differences in how learners respond to different interventions
Action Point 5	Facilitate learning during practice rather than dictate or abdicate