Skill execution errors

Skill execution errors: An 'it depends' perspective on their role, type and use when coaching for player development in sport

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Abstract

Decades of motor learning research has challenged the role of errors; it seems that for the same reason some authors promote using errors, others demote them. In this discursive article, we propose that the role of errors in the sports coaching context is more complex than a binary error avoidance or promotion approach. Accordingly, we present a novel 'it depends' perspective, which suggests that when equipped with effective decision-making skills, coaches can use errors strategically, manipulating their frequency to align with an athlete's performance context (i.e., skill level, aspirations, competitive schedule) and achieve interdisciplinary learning outcomes (i.e., technical, physical, psychological). In doing so, the article discusses the psycho-motor, psycho-behavioural and psycho-social considerations for error implementation, presents alternative and emerging perspectives on error usage, and emphasises the importance of coaches' decision-making skills for implementing a nuanced error-based approach. Such ideas have the potential to positively impact on the quality of applied coaching practice within the field of motor learning and player development, but more research is required to establish how this is, and could be, operationalised with practitioners in the field.

Keywords: Biopsychosocial, Challenge point hypothesis, Desirable difficulties, Motor Learning, Practical Coaching, Psychological characteristics of developing excellence

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A sport coach's primary role is to develop and optimise the performance of individuals and teams (Cruickshank & Collins, 2015). In this regard, the additive value of interdisciplinary considerations is increasingly recognised within contemporary sports coaching literature to achieve these fundamental objectives (Barker et al., 2022; Carson & Collins, 2017; North, 2017; Siwik et al., 2015). Accordingly, this paper extends the rationale for interdisciplinarity in the context of how a coach should interpret physical, technical or movement, errors. Specifically, we suggest that errors can be used to draw attention to *and* develop the psycho-motor, psycho-behavioural and psycho-social skills that have been identified as necessary for long-term player development (Collins et al., 2016; Hill et al., 2019). Additionally, the paper explains the crucial role of coaches' professional judgement and decision-making skills when implementing an interdisciplinary-informed, error-based approach. Specifically, regarding the implications of when, how, where and with whom errors are purposefully utilised in training.

The beneficial role of *challenge* as a necessity for learning and skill development has long been recognised within the motor learning and player development literature (e.g., Adams, 1971; Collins & MacNamara, 2012; Guadagnoli & Lee, 2004; Orlick & Partington, 1998). Indeed, just as Guadagnoli and Lee's (2004) Challenge Point Framework suggests optimal motor learning occurs when players' performance is slightly impaired (i.e., they experience *some* errors), Collins and MacNamara (2012) propose that failure (i.e., errors) provides opportunities for psycho-behavioural development that assists performers to negotiate future challenge. In this way, we propose that errors are a commonality between

44 physical and mental skills that coaches can utilise on a day-to-day basis to facilitate motor
45 *learning* and psycho-behavioural *development*.
46 The way in which practitioners should interpret and utilise errors to support learning
47 and skill development also aligns with contemporary literature regarding coaching expertise
48 that promotes a nuanced 'it depends' perspective (Collins et al., 2022). In summary, the 'it
49 depends' perspective provides a pragmatic approach to finding solutions for complex human
50 problems, in alignment with previously discussed 'interpretative' coaching approaches
51 (Barker et al., 2022; Kinnerk et al., 2021). Reflecting the diverse factors and considerations
52 across different participants' performance contexts, situational demands and personal
53 needs, the perspective advocates the 'conditionality' of knowledge and practice as being
54 appropriate, as opposed to those that seek one universal 'truth'. Therefore, effective
55 coaching practice accepts that there are no universal or permanent 'right answers', rather,
56 only temporary, contextually-driven solutions that align with dynamic situational demands
57 and the practitioner's intention for impact (Collins et al., 2022). In relation to errors, this
58 perspective encourages coaches to implement a range of error-based strategies (e.g.,
59 promotion or avoidance) depending on players' participatory context and the associated
60 motoric and psychological skill development priorities.
61 Of course, coaches should always critically interpret literature. In this case, the
62 existing 'universal' or 'permanent' error-based motor learning strategies might best be seen
63 as *temporary* tools that can be implemented and withdrawn or replaced when most
64 appropriate for a player's participatory context. By recognising such conditionality, this
65 approach is appropriate when addressing the complexity of performer development and,
66 uniquely, encourages coaches to make pragmatic, contextually informed decisions regarding
67 error usage. Accordingly, this article contributes to the literature by extending the

perspective's application to the role of errors in learning and offers coaches a means by which to encourage holistic skill learning and development in performers.

To fill this important gap, this paper first introduces and discusses biopsychosocial interactions when implementing errors through a focus on psycho-motor, psycho-behavioural and psycho-social factors. Secondly, a contrast is provided with several alternative motor learning perspectives to demonstrate how coaches' adopted perspective can be used to reinterpret existing data and recommendations within the field. Finally, a discussion of how an 'it depends' perspective towards errors is coherent with contemporary coach education research and practice concludes the paper.

Part One: A Biopsychosocial Conceptualisation

The 'biopsychosocial' model has become an increasingly popular way to conceptualise the complex integration of factors that underpin participant development in sport (Carson & Collins, 2017; Taylor et al., 2018). It posits that the dynamic interaction between physical or movement attributes ('the 'bio'), psychological skills and attitudes (the 'psycho') and the environment in which a player participates (the 'social') produces a more powerful explanation of coaching and learning effects than when addressing these factors in isolation (Bailey et al., 2010; Collins & MacNamara, 2018). Given its consideration towards a wide range of domains (i.e., sport), contextual and individual factors, the 'it depends' understanding of player development and coaching expertise aligns with the biopsychosocial model (Collins et al., 2022; Taylor et al., 2023) and, as such, we consider these multi-factorial considerations as fundamental to utilising errors for holistic development in sport. Accordingly, we will now expand upon the biopsychosocial considerations for error exploitation during in-session, micro-level, coaching interactions.

Psycho-Motor Considerations

As indicated previously within the context of sports coaching, the 'bio' factor of the biopsychosocial model refers to the physical movement aspects of player development. It is now widely recognised within motor learning research that movement outputs interact with and are moderated by associated mental processes (Habay et al., 2021; Nicholls et al., 2016). For example, a player being able to 'feel' (i.e., perceive) the difference between one technique and another, at least during learning, determines their ability to execute distinct movements. This interaction between mental and physical, termed 'psycho-motor' learning, can be enhanced by training associated mental skills (Fortes et al., 2019). Motor imagery is a common example of a psycho-motor skill in which the objective is to mentally simulate the expected execution experience, which informs the activation of motor structures involved in the execution (Frank et al., 2023; Schuster et al., 2011). Accordingly, for sports performance and, in turn, effective coaching, psycho-motor skill development is crucial (Paul et al., 2012).

During this process of psycho-motor skill development, there is a seeming inevitability of errors as players learn what the correct, functional or desirable sensations would be like, and there is extensive research that suggests these mistakes serve to benefit players in the long-term. Adams (1971) and Schmidt (1976) were the first to discuss the importance of errors regarding feedback for skill acquisition. Adams' (1971) closed loop theory proposed that by comparing intrinsic feedback ('this is what I did') to a correct template ('this is what I should do'), performers could identify errors to inform corrections. Schmidt (1976) developed the idea to account for the problem of performers not having an accurate perception of what 'correct' means when the level of experience is low/non-existent, which is one reason why the evidence for using motor imagery is not as strong for novices than it is for experts. Schema theory proposes that performers generate movement programmes based on feedback from their lived experience (i.e., 'where is the soccer goal?',

116 'how fast do I need to do this?'). These generalised motor programmes are then improved in
117 response to sensory feedback that occurs when an error is experienced in order to more
118 effectively meet future and novel task demands. Accordingly, whilst performers do not
119 possess a reference of correctness, they do possess a general capacity to produce and
120 develop a movement, thus overcoming the problem of novelty/uncertainty.
121 Importantly, both Adams (1971) and Schmidt (1976) place errors at the centre of
122 psycho-motor learning. For Adams, identifying errors provides the stimulus for subsequent
123 corrections and, although through different mechanisms, Schmidt also utilises errors for the
124 development from generalised motor programmes to more efficacious task-specific ones.
125 Utilising errors as a learning mechanism is addressed more extensively within verbal and
126 cognitive learning literature (Schmidt & Bjork, 1992; Wong & Lim, 2022); therefore, we now
127 draw from these sources to extend the discussion *for* errors during motor learning.
128 Coined the 'desirable difficulties' approach, this research is predicated on the idea
129 that effective learning should be demanding and, consequently, lead to short-term errors in
130 performance, yet lead to better long-term learning through improved retention (i.e.,
131 remembering following a period of no practice) and transfer (i.e., application of the learnt
132 skill in a different context or modification of the skill itself). Indeed, forgetting information
133 during practice is considered to be a desirable difficulty because it "trigger[s] the encoding
134 and retrieval processes that support learning, comprehension and remembering" (Bjork &
135 Bjork, 2020, p. 476). Hence, the distinction between performance versus learning is critical.
136 For decades, researchers failed to distinguish between these outcomes and, as such, better
137 performance was perceived to equate to better learning (and coaching) at the time of
138 practice or acquisition (e.g., Digman, 1959; Hanley, 1937). More recently, however, the
139 desirable difficulties literature has highlighted those profound differences when evaluating

long-term retention and transfer of skills that are beneficial within sport (i.e., learning; Bjork et al., 2013; Salmoni et al., 1984; Schmidt & Bjork, 1992). Specifically, the extent to which a performer cognitively engages with the to-be-learnt content (dictated in part by the difficulty level) alters how this content is organised and accessed within long-term memory. Notably, large improvements in performance can be achieved when the mental resources required are relatively low because there is less self-regulatory demand during recall of the skill from long-term to short-term working memory (Soderstrom & Bjork, 2015). An example of this is the frequent provision of prescriptive feedback and expert demonstration (i.e., "do it like this, not like that") (Williams & Hodges, 2005). Furthermore, coaches may prescribe practice conditions that aim to consolidate short-term performance enhancements; for example, using blocked practice where one skill is repeatedly practised for an extended number of repetitions or length of time before moving on to the next skill. In summary, the idea is to limit erroneous repetitions and the need to retrieve information from long-term memory whilst building confidence in the short-term ability to execute skills (Kantak & Winstein, 2012).

Conversely, the methods by which to promote longer, more-sustained improvements can delay, sometimes even impair, short-term performance due to their more testing and cognitively demanding nature on long-term memory recall processes (Soderstrom & Bjork, 2015). Furthermore, such methods may involve reduced, bandwidth, or summary feedback from the coach, which results in the performer solving the problem more independently with less external support. Importantly, this strategy encourages more active and personally meaningful memory storage and retrieval strategies; indeed, a coach might even ask performers questions to enhance the utility of intrinsic feedback mechanisms before and following skill execution (e.g., "what was the difference there? Or 'what do you think is

causing that to happen?'). Similarly, practice methods that challenge retrieval strategies and promote long-term learning include interleaving (e.g., a golfer practising full swing technique, followed by a period of putting to 'forget', before then returning to the full swing to 'remember') and self-testing (e.g., challenging a tennis player to make a number of consecutive first serves beyond what they are usually capable). The opposite of blocked practice, interleaved practice involves mixing different skills and techniques within the same session. With each change in skill, the performer must forget some distinct elements in order to adapt to the following task (i.e., contextual interference; see Wright & Kim, 2019). Therefore, when performers repeat a task, they must retrieve information about how to execute the skill from memory, which strengthens retrieval strength the next time that skill is needed (Bjork & Bjork, 2011). Self-testing is another method by which retrieval strength can be trained. Bjork et al. (2013) discuss the value of self-testing as a method of real-time self-evaluation and learning because realising what you do not know enhances the quality of focus on subsequent practice or study. Importantly, this metacognitive approach yields slower progress but more significant long-term benefits of retention and transfer (i.e., learning). Oppici et al. (2021) substantiate such contention by proposing that performers benefit most from knowing both *what* they are doing and *why* they are doing it; thereby offering a macro- as well as meta-cognitive recommendation.

Indeed, the theories discussed in this section demonstrate the potentially beneficial role of errors when promoting psycho-motor skill development within sports coaching and provide the basis for key coaching decisions regarding why, when and how to utilise errors in practice. However, if the beneficial effects of experiencing errors are to be fully realised, we must also consider other contributing factors within the biopsychosocial model.

Psycho-Behavioural Considerations

In the biopsychosocial model, the 'psycho' relates to psychological factors that impact upon participant development. In the context of this paper, it is crucial to recognise and develop a performer's psycho-behavioural responses to errors. This includes how performers perceive and observably react to errors (Savage et al., 2022). Without possessing necessary psycho-behavioural skills to cope with errors, we suggest that the psycho-motor benefits can be mitigated or removed altogether. Indeed, Collins et al. (2016) found that possessing and deploying psycho-behavioural skills in response to significant developmental challenges was a key discriminating factor between similarly 'talented' athletes who 'make it' at the highest level of their sport (e.g., sustained periods of time at the highest level in their sport, Olympic/world champions) and those who fall short of their potential (e.g., fail to transition from junior to senior international competition). Therefore, understanding and addressing a performer's psychological and behavioural responses to errors is vital for their successful implementation and exploitation.

Building upon the earlier work of Orlick and Partington (1998), MacNamara and colleagues (Hill et al., 2019; MacNamara et al., 2010) proposed a specific psycho-behavioural skillset aimed at developing sporting talent, termed the Psychological Characteristics of Developing Excellence. These characteristics include commonly employed mental skills such as imagery and goal setting, as well as attitudes, goal setting, commitment, planning and organising, seeking social support, focus and distraction control (Collins & MacNamara, 2017). MacNamara et al. (2010) suggest that player development programmes should proactively emphasise the development of these psycho-behavioural skills alongside motor learning practice activities. In order to develop these skills that underpin sporting success, Collins and MacNamara (2012) highlight the importance of challenge within the learning pathway. Specifically, training needs to offer a *degree* of challenge to proactively realise and

deploy the Psychological Characteristics of Developing Excellence. In this way, there is a potentially positive reciprocal relationship between motoric errors and psycho-behavioural skills; motoric errors create opportunities for the deployment of psycho-behavioural skills and psycho-behavioural skills allow performers to benefit from motoric errors. By adopting an 'it depends' perspective, we propose that coaches can strategically take advantage of this relationship by utilising in-session errors to promote the psycho-behavioural skills that underpin psycho-motoric development and, therefore, learning.

However, it would be remiss to ignore the complex challenge of balancing both motor and psycho-behavioural skills within a long-term developmental plan alongside performers' short-term performance expectations. This complexity is precisely why we view expert sports coaching through a decision-making lens; deciding what to do, when, why and how to do it is a puzzle that coaches must frequently solve and is something we will return to in the coming sections of this article.

Psycho-Social Considerations

The biopsychosocial model encompasses a final critical consideration for coaches, which involves the socio-cultural environment in which the player exists (Bailey et al., 2010). This is based on the premise that, like any other social phenomenon, an individual's response to errors is shaped by the social structures, power relationships and social norms and, subsequently, contributes towards emerging social patterns (Lyle & Cushion, 2016). Similar to psycho-behavioural skills, we posit that a dysfunctional socio-cultural environment can also negate the psycho-motor advantages provided by errors; this is because errors may be interpreted negatively within a specific social group or context. In turn, this interpretation may create a social pressure that influences a player's ability to deploy, or even attain, the psycho-behavioural skills necessary for psycho-motor development (Cassidy et al., 2015).

This suggestion is in line with existing literature on the sociology of sports coaching, which reports that coach and athlete behaviour is influenced by broad societal structures such as the cultural perspective on errors *and* narrow interpersonal relationships such as those between coach and player, or senior and junior squad member (Jones & Potrac, 2010; Mills & Denison, 2018). So, depending on *who* is present when an error is made needs considering when designing practice conditions.

Accordingly, we suggest that coaches are aware of and demonstrate sensitivity to the player's socio-cultural environment when making decisions regarding error utilisation. Anecdotally, in practice, this awareness may be developed by observing how peers or parents respond to a player's mistakes, and displaying sensitivity to these social influences may be subtly demonstrated by designing reduced-error practice activities or, more directly, by explicitly 'selling' the potential beneficial role of errors as part of a player analysis process (e.g., Carson & Collins, 2016).

In this section, we have reviewed theory from motor learning, talent development, sports coaching and performance psychology to provide the rationale for our proposed 'it depends' perspective when interpreting errors. We have sought to exemplify the complex psycho-motor, psycho-behavioural and psycho-social considerations concerning error utilisation in order to highlight the inherent decision-making demands on expert coaching practice. We suggest that for errors to be interpreted and utilised from a nuanced, 'it depends', perspective, coaches must make decisions within and between these interdisciplinary considerations. That is, practitioners must decide upon an appropriate psycho-motor strategy (e.g., compare and contrast), psycho-behavioural outcome (e.g., challenge or reinforce) and psycho-social environment (e.g., who is involved and where and

when to intervene), considering how each decision interacts with the others to create practice conditions that align with the intended outcome.

Part Two: Alternative Perspectives

So far, we have sought to demonstrate the complexity of coach decision-making within the biopsychosocial model. In doing so, we have adopted the fundamental position that errors serve to benefit motor and psycho-behavioural learning. However, this has been and continues to be, an area of contention within fundamental research literature.

In contrast to the evidence presented above which advocates the use of errors, reinvestment theory explains that processing verbal knowledge or declarative 'rules' about movements is bad for learning. Specifically, such knowledge affords the risk of later de-automating the skill under conditions of competitive pressure through self-focused attention in an attempt to over-control the situation (Masters & Maxwell, 2008), a condition known more commonly as 'choking'. According to research on reinvestment theory, when errors are frequent in practice, this encourages rumination and hypothesis testing to understand why the errors occur in relation to the movement execution process (Poolton & Zachry, 2007) As such, a coaching recommendation from the reinvestment literature is to reduce errors during practice, supress declarative knowledge accrual, the potential to consciously retrieve skills from long-term memory and, thereby prevent choking (Masters & Maxwell, 2008). Indeed, this approach challenges traditional explicit-to-implicit control transitions during learning by implementing a single stage of automatic control with little-to-no conscious thought towards the movement (Anderson, 1982; Fitts & Posner, 1967). Notably, reinvestment theory's challenge to Fitts and Posner's (1967) traditional three-stage learning model contends that declarative knowledge of the skill facilitates the breakdown of automated skill execution under both physical and psychological pressure in individuals with

283 a high propensity for reinvestment (Masters & Maxwell, 2008). For example, studies have
284 reported skill execution breakdown under conditions of physical fatigue (Davidow et al.,
285 2020) and when performing for monetary rewards (DeCaro et al., 2011). Accordingly,
286 Masters and Maxwell (2004) suggested that if performers were to bypass the cognitive and
287 associative phases—characterised by the accrual and sense-making of explicit, declarative
288 knowledge—it would be possible to learn the skill execution implicitly, which resembles that
289 of the autonomous stage of learning. In turn, implicit learning would lead to a greater
290 immunity toward reinvesting under pressure. This perspective is operationalised by
291 'errorless learning' practice designs, which is suggested to promote implicit learning and can
292 be a particularly useful coaching tool for athletes with a higher tendency towards
293 reinvestment (Malhotra et al., 2022), thus removing the rationale to develop verbal
294 knowledge about one's skill.
295 Maxwell et al. (2001) used golf putting performance to evaluate differences between
296 implicitly and explicitly trained novice performers. During the putting trials, implicit learners
297 were exposed to an errorless learning condition in which the task difficulty gradually
298 increased from easy to difficult by systematically moving further away from the hole.
299 Conversely, the explicit learners were exposed to an errorful learning condition in which task
300 difficulty progressed from difficult to easy by initially putting at further distances from the
301 hole. This study found that whilst errorless learners performed better than their errorful
302 counterparts during a retention test and under a secondary loading transfer task that
303 occupied working memory (i.e., repeating words or phrases unrelated to the putting task,
304 therefore distracting them from the movement process), each group reported a similar
305 amount of explicit knowledge at and above moderate task difficulty, which refutes the
306 notion that errorless training protocols and implicit learning are inherently connected.

However, what can be discerned from this study is that errorless learning does encourage implicit processes for *less complex* task conditions.

Whilst implicit learning contributes to an interesting scholarly debate, its application within a biopsychosocial approach to sports coaching has some significant and, so far, unresolved challenges. Indeed, from a motoric perspective, researchers have expressed concern regarding the investigative designs used to evaluate implicit methods, the efficacy of implicit mechanisms for complex whole-body movement learning (i.e., sport) and, significantly for coaches, the practical feasibility of implementing implicit strategies such as errorless learning given the complexity of manipulating task difficulty in dynamic real-world environments (Collins et al., 2023). Furthermore, the implicit learning literature is yet to address psycho-behavioural and psycho-social interactions, which we suggest significantly limits its application within sports coaching.

So far in this discussion, the literature on this topic has assumed that errors can be generally categorised as either positive or negative occurrences. However, such categorisation may be neither practical nor even possible. For now, it is also worth considering how a different, yet emerging, paradigm within the motor skill acquisition literature *might* interpret the use of errors since it is increasingly contributing to the sports coaching domain (e.g., Yearby et al., 2022)

The Ecological Dynamics perspective conceptualises humans and their environments as complex, dynamic and interactional systems. Accordingly, system components constantly exchange information under temporarily self-organised states. Movements emerge based on affordances, or opportunities for action, that are dynamically created between the performer, environment and task characteristics (Immonen et al., 2022). Such complexity and need to adapt means a prescriptive, correct or even modelled technique within sport is

not considered and is even discouraged within coaching practice (Araújo et al., 2006; Immonen et al., 2022). Accordingly, within a coaching context, this motor control perspective stresses the necessity for exploratory behaviours when learning to enable flexible solutions to inherently novel performance problems (termed "movement degeneracy"; Seifert et al., 2014). For instance, consider a golfer learning to adapt their swing mechanics to different situational demands, such as playing from sand or accounting for slopes in the fairway. Movement degeneracy would involve encouraging the player to explore different techniques to develop a repertoire of playing skills that enable them to consistently achieve successful outcomes despite facing diverse performance environments. In this way, functional movement variability, whereby performers' movement patterns have a level of variation that allows them to adapt to novel performance environments whilst maintaining consistent outcomes, is an essential aspect of motor learning and coaching (Barris et al., 2014). However, it is important to stress that functional variation has mainly, if not exclusively, been addressed in terms of the movement patterns rather than other outcomes (cf., choked vs. successful performances). Given this novel, variable and complex worldview, it would presumably be near impossible to determine what an error would consist of *a priori* or categorise any skill execution as wholly unsuccessful. As yet, however, we are not aware of any research from this perspective that has directly addressed how coaching might utilise errors in training and for what specific purpose(s); we do, however welcome such commentary.

In addressing these alternative perspectives on errors, we hope to have explained some of the complexity that coaches face when making decisions regarding error utilisation. Indeed, despite many decades of research into the role of errors in motor learning (e.g., Adams, 1971; Sanli & Lee, 2014), researchers are mixed in their advice regarding their value,

355 which is potentially confusing for practitioners. However, given the considerable practical
356 limitations of implicit learning and the lack of research addressing errors from the
357 perspective of ecological dynamics, we are of the view that errors are an essential
358 component of learning. Furthermore, by adopting an 'it depends' perspective, we believe
359 coaches are enabled to utilise an interdisciplinary understanding of errors' impact and value
360 their use with performers for different purposes.

361 **Part Three: Decision-Making as Fundamental to Expert Coaching**

362 Whilst we align with the idea that errors are beneficial for learning, it is important to
363 recognise that learning is not always the intended coaching outcome, which gives a potential
364 new utility to some of the error-avoidance strategies advocated within 'implicit learning'
365 research. For example, during the warm-up before a competitive performance, coaches may
366 consider using an errorless practice design (i.e., incrementally increasing difficulty to
367 encourage successful, confidence-building repetitions) to prepare a player for short-term
368 performance. Anecdotally, this practice design is commonly used within golf as a
369 competitive putting practice game between players where the winner is decided by who can
370 hole the most putts consecutively. This kind of practice game, where players can either work
371 together or compete against each other, has been suggested to encourage social
372 development and friendship through sport (Martin, 2014), which reflects the psycho-social
373 considerations discussed earlier. This provides the practical rationale for adopting an 'it
374 depends' perspective towards errors and, once again, places a decision-making
375 responsibility onto coaches to decide when and where error implementation is appropriate;
376 that is, when it aligns with the intended coaching outcome (i.e., long-term learning or short-
377 term performance).

Our discussion has led to the proposal that errors are a coaching tool to achieve desired outcomes and can be designed by the coach with appropriate auditing processes in place to continually inform decision-making (e.g., monitoring the player's behavioural response, self-evaluation and social interaction). In fact, ongoing decision-making is recognised as a crucial component of the coaching process and a hallmark of coaching expertise when appropriately adapted to meet the complex demands and contexts presented. Against this backdrop, Professional Judgement and Decision-Making (PJDM) is a systematic approach that examines and synergises the complex pedagogical skills associated with coaching practices (Collins & Collins, 2016). Broadly, PJDM enables coaches to effectively utilise their skillset by designing, implementing and refining teaching strategies that are responsive to the dynamic and interpersonal coaching milieu (Collins & Collins, 2015). Reflecting this, the 'it depends' perspective promotes a flexible pedagogical approach within coaching that changes to support the nature of practice strategies employed. That is, given our suggestion that coaches may opt to encourage *and* avoid errors at different times during practice, we contend that their pedagogical approach inherently needs to align with the desired learning or performance outcome (Mosston & Ashworth, 1990). For example, when encouraging errorful practice for *learning*, coaches may adopt features of an athlete-centred or positive pedagogy whereby mistakes are accepted as an essential aspect of learning and players are allowed to continue making them as they formulate, test and evaluate solutions to problems (Light & Harvey, 2017). On the other hand, employing an error avoidance strategy such as errorless learning to enhance *performance* may encourage coaches to align more with a linear pedagogy as they assert more control over a player's physical and psychological experience (i.e., strictly controlled practice activities for the minimisation of explicit knowledge accrual; Masters & Maxwell, 2004). In this way, we

contend that practice design and pedagogical approach are fundamentally connected, and when utilising various practice methodologies, as 'it depends' proposes coaches may, the underpinning pedagogy is inherently flexible within a spectrum of teaching styles (Mosston & Ashworth, 1990)

Researchers have proposed that PJDM operates on three levels of planning for performer development: macro, meso and micro (Martindale & Collins, 2012). These levels describe different conceptualisations of the problem to be solved by coaches; that is, from the broadest perspective of a performer's development (i.e., how to progress Player A from national to Olympic level over the next 4 years) to the narrowest (i.e., what does a player need to complete training today). Accordingly, coaches may opt to strategically incorporate and operationalise errors in practice to align with desired short-, medium- and long-term technical and psychological outcomes. That is, to periodically prioritise learning or performance by adjusting the frequency of error in practice as part of a systematic developmental process which accommodates for externally-dictated contextual factors (e.g., competition schedule).

Summary and Conclusion

Throughout this article, we have cited several bodies of literature to provide context for and explain the rationale for proposing an 'it depends' perspective on error usage during player development in sport. From this, we conclude that effective sports coaching enables performers to develop a comprehensive skillset that facilitates meeting the demands of their chosen sport, participatory context and individual needs.

In brief, we have proposed that a binary approach towards errors (i.e., always yes or no) does not accurately reflect the realities of, nor optimally encourages, player development in sport. Instead, we have made the case for coaching that utilises different

error-based strategies to align with dynamic individual circumstances and presents *challenges* that yield holistic learning and skill development opportunities. Accordingly, we suggest that coaches' decision-making skills regarding when, where, why and with whom these challenges are presented are fundamental for the successful implementation of the 'it depends' perspective on errors. Indeed, this is a highly demanding approach for coaches to implement, necessitating continuous professional development and engagement with research, which may be a limitation of this approach. Accordingly, future research should investigate coaches' interest in and familiarity with 'it depends' and error-based learning to inform how the approach can be disseminated and operationalised within applied settings.

This article has sought to develop the debate on the role of errors in player development toward a more nuanced and applied perspective. We hope that by interpreting errors in this new way, coaches can evaluate the existing literature against their applied realities and implement error-based strategies in practically meaningful ways, elevating the standard of their coaching practice and the scope of performer outcomes.

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