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Constraints of the constraints-led approach in American football and comments on Yearby et al. (2022)

Ray Bobrownicki [a], Howie J. Carson [a], Alan C. MacPherson [a] and Dave Collins [a,b]

[a]Institute for Sport, Physical Education and Health Sciences, University of Edinburgh, St. Leonard's Land; Holyrood Road, Edinburgh EH8 8AQ, UK; [b]Grey Matters Performance Ltd, Stratford upon Avon, UK

ABSTRACT

In recent literature, constraints-led approaches have been promoted for practice design to coaches of American football. While we agree that this approach would represent a useful tool, we put forward that ecological approaches alone are insufficient to address the complexity and diversity of real-world sporting contexts, so coaches must carefully consider how constraints-led approaches might fit within the total coaching process and associated challenges. With this in mind, this paper explores the implications and challenges of constraints-led approaches within the American football environment. In doing this, we consider the context and constraints of the game and their implications for both coaching practice and the implementation of ecological principles. To conclude, we also propose the need for pragmatic balance and consideration of approaches as part of a professional judgement and decision-making process by coaches.

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Ecological psychology; nonlinear pedagogy; cognition; sport coaching; biopsychosocial

Over the past few decades, there has been increasing interest in the application of ecological approaches within real-world sport settings. According to these approaches, coaches are encouraged to become "learning environment designers" (Woods, Rothwell, Rudd, Robertson, & Davids, 2021) that promote or constrain athlete opportunities for action, thereby shaping the emergence of functional movement patterns. In this process, such dynamically self-organised, coordinated movement and functional control are realised through the continuous interaction of perception and action. Due to the non-linear relationships between the innumerable variables involved in performance, accurately predicting the specific demands within performance environments is argued to be complex, rendering uniform training

CONTACT Ray Bobrownicki ray.bobrownicki@ed.ac.uk Human Performance Science Research Group; Institute for Sport, Physical Education and Health Sciences; University of Edinburgh, St. Leonard's Land 3.26; Holyrood Road, Edinburgh EH8 8AQ

Author NoteRay Bobrownicki @bobrownickiHowie J. CarsonDave Collins: @DCGreyMattersUK

strategies and predetermined technique inappropriate (Araújo & Davids, 2009). As such, ecological and constraints-led approaches eschew concepts such as internal representations and knowledge structures as central constructs of movement control (Araújo, Hristovski, Seifert, Carvalho, & Davids, 2019) and are, therefore, commonly explained as incompatible with cognitive or constructivist approaches to learning and development (Glazier & Lamb, 2018; Renshaw et al., 2016; but see Ramos, Davids, Coutinho, & Mesquita, 2022 for contradictory developments). Instead, according to Araújo and Davids (2011), skill development – and subsequently expertise – is characterised by functional interactions between the athlete and the environment as performers increasingly attune to relevant perceptual information and calibrate their movements in accordance. For this reason, the athlete–environment relationship, inspired by the work of Gibson (1979) and Newell (1986), represents an essential consideration when operating within a constraints-led framework (Araújo & Davids, 2011). As performance is considered contextually situated, proponents of ecological approaches advocate the design and organisation of representative tasks – through the manipulation of organismic, task, and environmental constraints – that mirror the behavioural and performance environments in which the skills would apply (Araújo & Davids, 2011).

Reflecting these contentions, a recent paper by Yearby, Myszka, Roberts, Woods, and Davids (2022) argued that the best way forward for coaching practice in the sport of American Football (AF) was to implement the constraints-led approach to facilitate athlete–environment interactions. In short, these authors encouraged the promotion of attunement, adaptation, and skill development and the abandonment of coach-centred practices aligned with cognitive approaches that emphasise internal representations, unopposed drills and isolated movements. Under their promoted approach, athlete–environment interactions should focus on "representative learning design" to promote greater action fidelity and encourage athletes to "solve football problems that vary in complexity" (Yearby et al., 2022, p. 8). Although we agree that many of these principles are relevant and useful for AF, in addition to other sports, we contend that there remains room for other approaches, informed by competing theoretical perspectives, to provide beneficial practical and explanatory guidance. Indeed, such a variety of approaches is not only the norm in many sports, but an essential component if performance is to be optimised. Notably, such ideas have received limited attention from Yearby et al. and other proponents of ecological approaches (e.g., constraints-led, ecological dynamics, etc.). For us, a significant issue when translating motor learning scholarship is strict adherence to any *one* theoretical stance to inform specific facets of practice (see Ashford, Abraham, & Poolton, 2021) rather than consideration of how such issues will fit within the complexities of the wider coaching process.

Ironically, an approach that espouses catering for complexity and variability often seems to prescribe simplistic and rigid solutions! Coaching not only involves motor learning and development but also demands the knowledge and skills to pull together diverse areas of knowledge (e.g., team dynamics, organisational psychology, etc.) as part of a professional judgement and decision-making process (PJDM; Abraham & Collins, 2011a; Martindale & Collins, 2005). For this reason, at least, the suitability and implementation of ecological-based approaches, which purport to best represent the problems that players must solve on the field, should be considered against the full backdrop that is the complex, dynamic, and challenging reality of coaching delivery and athletic performance. With this in mind, this paper responds to Yearby et al. (2022) and aims to further develop recent ideas towards the application of ecological methods by coaches in AF as a sport of recent interest within the domain. To do this, we first set out key contextual factors pertaining to AF before examining stages of planning and execution relevant to the sport's coaching process and the implications and challenges for ecological approaches within these. As part of this, we also propose a schematic for achieving appropriate and pragmatic balance between cognition and perception that weighs up skill development needs within the wider context of the sport.

The AF context

Although it shares common roots with other football codes (e.g., association football, rugby union, rugby league, etc.), AF at the highest levels has developed uniquely into a sport that combines fast-moving, open and dynamic environments for short duration with strategy-focused and game-like planning and decision-making during frequent stoppages of play over 60 min. Teams, whether in possession of the ball (offence) or trying to recover it (defence), have limited time to plan and execute their plays (i.e., their strategy or tactics) due to the play clock (40 s at the professional level). Moreover, dozens of games each week at the university and professional levels may be played in stadia holding 75,000 fans (Hicks et al., 2019), which may evoke pressure and impact performance.

For these reasons, perhaps even as a well-evolved tradition, tactics and strategy represent prominent features of the coaching process with head coaches renowned for late nights and high workloads to gain any advantage (Peters, 2006; van Walkenburg, 2013). With the large team sizes consisting of three units (i.e., offence, defence, and special teams), coaching staff in AF take responsibility for managing the coordination of movement by providing external direction during the game (e.g., play call, substitutions, and time outs), limiting the autonomy of individual players. Consequently, applications of motor control theory must be able to account for these

realities or practices or demonstrate how such practices are erroneous or better catered for by the approach being promoted. This underlying context is important to set forth in order to better understand where ecological approaches may fit in sports such as AF (e.g., with respect to other responsibilities of the coach) and the challenges to implementing such approaches for movement acquisition, decision-making, team coordination, and beyond. With this in mind, we next explore the interdependent stages of planning (which we have termed pre^3-, pre^2-, and pre-planning) and execution (e.g., in-game play calling and running of play) within the sport's coaching process.

Pre-Pre-Pre planning (P^3)

At the professional level, in the months leading towards the start of the season, the plays are reviewed and analysed based on the previous season and then shaped, (re)designed, and/or removed as needed in off-field meeting rooms and then practised at pre-season training camps (Pompei, 2004, p. 50). The master playbooks of National Football League (NFL) head coaches can contain around 1,000 plays that are rooted in coaching staff's knowledge about the sport1979 and their core philosophies, commonly called schemes, that will ultimately characterise the teams' style of play, such as general offensive and defensive strategies, play design, and play calling (Kirwan & Seigerman, 2011). Notably, for new head coaches, introducing and refining their philosophy and associated processes will also represent primary objectives when starting with new teams (D. Collins, Collins, & Carson, 2016). Options for problem solving in AF are, therefore, varied and require tailoring to contexts and situational demands to search for functional and effective solutions. Based on this, player positions and roles may differ depending on the selected schemes, leaving the coaching staff to align the team's players with its scheme (or vice versa) such that player strengths are maximised while limitations are minimised (Nguyen, 2022). Moreover, due to fitness, injury, or strategy, players may be frequently substituted from play to play, so multiple players must be able to seamlessly step in with clear understanding of their specific roles and duties. Importantly, these plans are externally imposed then learnt and executed, thereby representing a combination of Standard Operating Procedures ("if they do this, you do that") and Shared Mental Models ("under these circumstances we tend to do this"; D. Collins & Collins, 2011). The most successful coaches will design (or select) their schemes so that players are assigned clear, specific, and achievable processes and goals rather than ask players to fulfil every possible role within their position, which perhaps only the most elite players might be able to do (see Cottrell, 2017). This planning is arduous and cognitively demanding, with legendary coach Vince

Lombardi reputed to have remarked that he only ever added a play to his playbook when he could visualise successful execution from each position (Farrar, 2017).

These practices reflect the formal management and decision-making hierarchies that typify AF teams (e.g., head coach > offensive/defensive/special teams coordinators > position coaches > assistants to position coaches > players) with field management structures clearly delineated (Braddock, Smith, & Dawkins, 2012). Crucially, this means that the players' movements and decision-making must operate within a specified range of possibilities to ensure orderly communication, execution, and coordination amongst large teams (54 players per team with 11 on the field at any one time). In the modern NFL, where the throwing time once the ball is snapped (i.e., when the play starts) is less than 3 seconds on average (Clark, 2018), it is critical for players to *understand* what they are doing, where they are going, and why. With such challenging time constraints, reliance on environmental information alone to plan and then execute their skills would be disadvantageous for AF players. The playbook and scheme design in this P^3 phase allow the coaches to design around these issues in advance and tailor the playbook to the players on the team.

While Yearby et al. (2022) advocated shifting from these carefully planned plays and practices towards ongoing athlete–environment interactions, we contend that this alternative approach would be unfavourable, suboptimal, and potentially injurious. Even *if* playing together over time would equip players with "shared affordances" (and we have yet to see an explanation for how this works and how it improves upon Shared Mental Models), it would be back to square one every time players are substituted! As such, pre-scripted plays, understanding, internal representations, and scenario-based practice constitute key factors that players and coaches use to overcome time, space, information, and cognitive constraints on the field to coordinate their plays, movement, and decision-making (e.g., because QBs will know in advance where wide receivers will go for a pass, while the defence does not; see Figure 1 for example play). This element is critical because the main responsibility for problem solving is not delegated to on-field players who typically must operate within specific parameters based on team strategy and the task constraints imposed by the AF rulebook (e.g., linemen are ineligible receivers, only one offensive player may be in motion before the ball is snapped, etc.).

Although Yearby et al. (2022) questioned the practising of "unopposed plays with defined, predictable start and endpoints" (p. 4), task constraints in the form of AF rules explicitly limit the contact that defences can apply to particular positions, such as wide receivers (i.e., the players whose role is traditionally to receive passes from the quarterback; QB), until they have touched the football. This means that the QB and receivers practising these

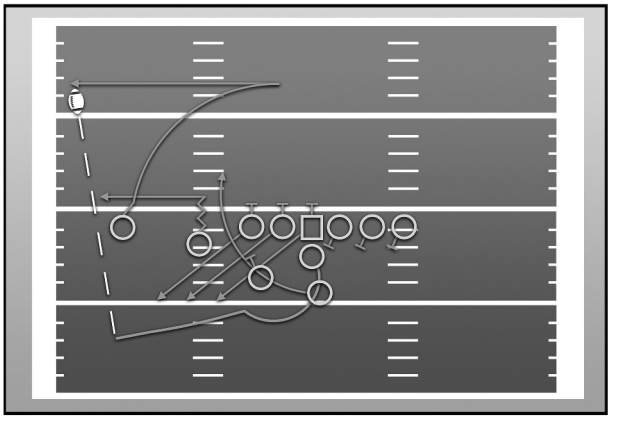

Figure 1. Pictorial display of example American football passing play for offensive team inspired by hand-drawn schematic from Hall-of-Fame and Super Bowl-winning coach Bill Walsh (Walsh & Dickey, 1990). To coordinate the players and successfully execute these plays, coaches will typically utilise myriad tools to establish and embed player positioning, responsibilities, timing, contingencies, and more.

plays to establish and then embed the preferred timing, route, and placement of the ball (i.e., where the ball will be thrown) could still represent meaningful practice, even in the absence of a defence (see Carson & Collins, 2016). Moreover, even if we were to accept that unopposed drills and walkthroughs did, in fact, limit skill acquisition specifically, there may yet be other skills, attributes, or factors that these unopposed drills promote, such as confidence, communication, and rhythm, that will be useful for teams, coaches, and players if player development is considered more holistically within the coaching context. At this planning stage, the sporting demands lend greater support for employing a cognitive approach to develop shared understanding about the macro-level characteristics of the team and its strategy for the upcoming season.

Pre-Pre planning (P^2)

As the season progresses, teams will transition to the P^2 stage which focuses on devising and tailoring game plans to counter or exploit upcoming opponents each week. Part of this process will involve coaches extensively scouting and preparing to maximise their own team's strengths and opportunities for success (Cottrell, 2017), while exploiting the weaknesses and limiting the advantages of the opponents. In doing this, the coaches will prepare sets of plays ready to deploy "for every conceivable down and distance and from every location on the field" (Pompei, 2004, p. 50) including a pre-scripted first offensive series of plays.

With the practices at the P^3 and P^2 stages, which are driven by the tactical and technical constraints of the game and the hierarchical decision-making, players' problem-solving and movement possibilities are minimised. While Yearby et al. (2022) attributed the development of *football speed* (i.e., moving fast specifically in the game context) to the coupling of perception-action, we contend that this may be more parsimoniously explained by the thorough preparation of players. Rather than an abstract development of organismic constraints or refined attunement, *football speed* may be facilitated by knowing exactly where to go without having to wait for or act on contextual cues. Through the preparation stages, coaches can implement and simulate schemes, plays, and tactics that ask players to operate within a defined set of parameters, which facilitates faster and more confident execution (Hays, Maynard, Maynard, & Bawden, 2009; Hays, Maynard, Thomas, & Bawden, 2007). Research in association football also suggests that contextual prior knowledge can enhance anticipation and movement response time (Broadbent, Gredin, Rye, Williams, & Bishop, 2019), so the common study of opponent tendencies on offence and defence is advantageous.

Opponent preparation and simulation may offer representative practice as Yearby et al. (2022) proffer, but it may also help facilitate player understanding of opponents' tendencies and promote confidence in acting upon these. This may be particularly important, as opposing teams may look to disguise plays and formations (e.g., bluffing incoming blitzes or running plays) so that the available information is misleading. This means that coaches must consider how to train or develop perception, decision-making, and skill execution potentially through scenario-based training and/or deliberate consideration of potential options (see R. Collins, Collins, & Carson, 2022). Based on this, we contend that ecological approaches alone are insufficient to meet these challenges and a more progressive approach is needed to optimise aspects of direct and indirect perception within performance (Carson & Collins, 2020).

Pre-planning (P^1)

After the P^2 planning, which involves opponent preparation, the next stage is in-game tactical, which is more responsive to on-field events during AF games. For instance, coaches may make adjustments to counter injury, fitness, or anticipated opponent strategy. Key decisions, however, are still taken by the coaching staff prior to the snap and while the ball is not in play. With the 11 on-field players, who may be substituted from play to play, it remains critical that the coaches oversee how these pieces fit together collectively to ensure coherent and organised execution. Indeed, the coaching staff may have access to valuable information that the players on the

field will not (e.g., offensive and defensive coordinators may operate from coaching booths, offering a birds-eye viewpoint of opposition actions, strengths, and weaknesses). Coaches can then compare, reconcile, or take decisions based upon their contextual prior knowledge (e.g., playbook, opponent strategy, etc.) and in-game contextual information (down, time remaining, field position, etc.; Gredin, Bishop, Williams, & Broadbent, 2020). At the professional level, these decisions are increasingly informed by analysts who provide evidence-based support to the coaching staff (McManus, 2018). In this way, in-game tactical processes are clearly *not* based on direct perception (cf. Araújo et al., 2019), but better reflect cognitive auditing processes (D. Collins et al., 2016) with coaches providing an overarching influence.

From play call to the snap

Once the play call is decided, the call is communicated to the QB (typically by substitute players, visual signals, or radio communications at high school, college, and NFL levels, respectively; Hicks et al., 2019; Pompei, 2004). In some cases, players are provided scope to override the play call to run an alternative play (i.e., calling an audible) depending on what they see prior to the snap (e.g., defence has anticipated the play or opportunity to exploit defence is presented). This requires the players, typically the QB, to compare the presenting information from the defence against prior knowledge of the offence's playbook and the defence's tendencies. To communicate and implement any changes in time-constrained and distracting environments, players then must draw upon trained simulations of adaptive practice which includes changing of roles or responsibilities within the play.

In fact, decision makers on the field in AF are likely to operate on a continuum from called play to perceived affordance. To make decisions (i.e., I can see a better option) and countermand externally called plays, QBs must surely consider what might happen under each option. How is this to be done without an internal representation, some cognition and a "what if" mental simulation? Recent research with rugby players indicates that priming for contextual information can assist in informing active play, anticipating opponent behaviours, and expediting decision-making (see also Recognition-Primed Decision-Making; Klein, 1993; R. Collins et al., 2022). As such, this stage continues to involve and heavily rely upon understanding, internal representations, and cognition to govern decision-making, although real-time perceptual information is beginning to become increasingly salient as time progresses towards the snap (see Figure 2 for their proposed relative contributions across the stages of preparation and play).

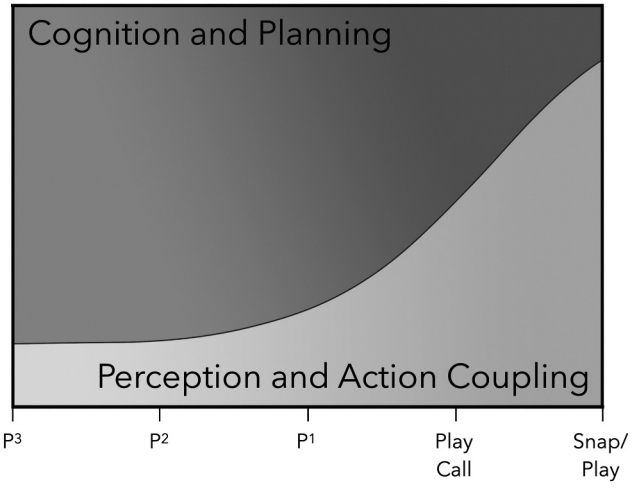

Figure 2. This figure displays proposed balance between the relative contributions of cognition and planning against perception-coupled action across the stages of American football preparation and execution.

The play itself

In a typical NFL game, teams may execute approximately 125 offensive plays (Kirwan & Seigerman, 2011) – alongside a corresponding number of defensive play calls – with all deliberately selected, previously practised, and underpinned by cognitive and analytical processes. During play, evidence from skilled rugby players suggests that players may still rely on cognition (e.g., consideration of what to do and what *not* to do) with lower-level or fundamental movements operating below conscious awareness (R. Collins et al., 2022) which could be explained several ways (e.g., ecological approach vs cognitive or meshed control theories). As such, taking a direct perception perspective, this would seem logical provided the play does not deviate from expectations and, therefore, require reinterpretation against the plan. Functional movement variability, by means of small adjustments in movement, clearly cannot be planned and thought through amidst action execution within dynamic environments. Consequently, we suggest that these aspects of play *are* supported by self-organising concepts as proposed by ecological approaches. In essence, at this stage, we concur with many suggestions by Yearby et al. (2022) concerning movement execution processes within AF, but still contend it is not only direct perception that is relevant for players.

Implications and concluding remarks

Traditionally, proponents of ecological approaches, we suggest, have underestimated or ignored the contribution of knowledge and understanding for

informing action execution in play. While the purpose of this paper was not to present theoretical developments, the pre-planning structure above hopefully demonstrates the need for greater mechanistic *integration* of approaches to explain real-world sporting contexts. Beyond the potential positive offerings of ecological approaches for skill execution, we put forward that they are insufficient to guide effective talent development and coaching practice in their entirety (e.g., player understanding, confidence, or communication). In short, we contend that ecological approaches are *not* the whole answer for coaching and instead represent useful tools to be deployed within coaching practice. Indeed, ecological approaches represent theories of human movement, not of coaching and performance (see Araújo & Davids, 2009). From here, it would be useful for research to take a more multi-level and integrated approach to study design (e.g., motor, psychological, and neural processes) when investigating applied practice. In this regard, there is need for experimental studies with more representative comparisons exploring the utility and appropriateness of these approaches for real-world practice (cf. Gray, 2018). This will lead not only to theoretical advances but also higher quality guidance for coaches that can, in turn, enhance the support and outcomes for athletes. This should surely be the primary aim for research presented in applied journals! Moreover, research should investigate the balance of ecological relevance across different coaching scenarios given the complexity and diversity that characterise sport and coaching (e.g., psychosocial and psychobehavioural factors and outcomes). Nevertheless, within a coaching toolbox or PJDM perspective, we put forward that constraints-led approaches offer useful tools and strategies for motor skill acquisition and refinement that coaches could utilise as part of a pragmatic or eclectic approach (see Carson & Collins, 2015; Poczwardowski, Sherman, & Ravizza, 2004).

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Ray Bobrownicki http://orcid.org/0000-0003-4529-8085
Howie J. Carson http://orcid.org/0000-0002-3785-606X
Dave Collins http://orcid.org/0000-0002-7601-0454

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