A Communal Language for Decision-Making in Team Invasion Sports

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Abstract

Invasion team sports coaches are faced with the problem of developing players that in any given situation can make decisions that lead to successful outcomes. Research into human decision-making has established three widely accepted perspectives, which sports coaching has used to understand player decision-making and inform practice; *information processing*, *ecological psychology* and *naturalistic decision-making*. As a result, coaches are challenged with perspective-specific terminology and having to draw connections amongst similar findings that are explained in quite different ways. This conceptual paper presents a plainer account of player decision-making by proposing a communal language within a conceptual framework for decision-making in invasion team sports. It is hoped that the proposed language and framework will together facilitate knowledge exchange between researchers and coaches for the betterment of player development.

Keywords

Introduction

A necessary challenge for coaches of invasion team sports is to develop players that in any given situation select the option that will most likely progress the team towards their overarching aim - 'to score more points/goals than their opponent' (Richards, Collins, & Mascarenhas, 2012, 2017). The importance of player decision-making is highlighted by the volume of research dedicated to better understanding it (Araújo et al., 2019; Raab & Araújo, 2019; Toner, Montero, & Moran, 2015; Williams & Jackson, 2019). Despite the rigour and impact of this empirical work there is no single view on how players make decisions (Araújo et al., 2019; Raab & Araújo, 2019; A. M. Williams & Jackson, 2019) instead, three, supposedly distinct, research perspectives have emerged; *information processing*, *ecological psychology* and *naturalistic decision-making*.

Often researchers are deeply rooted in one philosophical camp that interpretation of empirical data presents just one side of the argument (this is nicely illustrated by recent review articles, (Araújo et al., 2019; Raab et al., 2019; Williams & Jackson, 2019). As a result, the well-intended coach is forced to first understand and then draw connections among findings that are explained in quite different ways. The challenge is heightened by the establishment of perspective-specific lexicon, which offers different terms for similar concepts, and is compounded by the sharing of ideas via social media, which can result in nuanced misinterpretations of empirical evidence and perspectives (MacNamara & Collins, 2015). Thus, a coach's engagement with research can lead to bewilderment, conceptual blind spots and convoluted solutions to an intricate practical problem. To deliver some clarity, this paper aims to provide a plainer account of decision-making in invasion team sports by adopting a neutral stance. We do not intend to be critical, address methodological concerns or suggest that a certain perspective holds more weight than another. Instead, we take a mediating position to develop a communal language that is housed by a unified conceptual

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framework for team player decision-making. In doing so, we hope this paper provides an aide memoire to make potentially valuable research more accessible to coaches.

Three research perspectives on player decision-making

The crux of the difference between the three perspectives is the role of cognition in decision making (Raab & Araújo, 2019). From an information processing perspective, certain competitive situations demand a conscious interaction with task specific information to avoid performance errors (Toner et al., 2015; Toner & Moran, 2015):

> experts must be able to deliberately access and strategically re-route any semi-automated routines in order to facilitate "continuous improvement" (Montero, 2010; Breivik, 2013). (Toner & Moran, 2015; p2)

In contrast, the ecological dynamics perspective proposes that decisions are made through an automated process where perception and action are coupled through the information available in the environment (Gibbs, 2006; Araújo, Davids, & Hristovski, 2006):

> This theoretical rationale proposes that the most relevant informational constraints for decision-making and controlling action in dynamic environments such as a rugby match are those that emerge during on-going performer-environment interactions, not information from past experiences stored in the brain. (Passos et al., 2008; p. 131)

Since each perspective disputes the way decisions are processed, at this point it is pertinent to clarify each view. Those schooled in information processing tend to present decision making as a conscious process of selection, in which expert players excel in their capability to extract and process cues from the environment (Müller, Abernethy, & Farrow, 2006), recognise and interpret familiar patterns of play (Lorains, Ball, & MacMahon, 2013; Tenenbaum & Summers, 1997; A Mark Williams & Ward, 2007) and form expectations by computing situational probability (Abernethy et al., 2001; Farrow &

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Reid, 2012; Loffing & Hagemann, 2014). This process of selection is viewed as a conscious agent between what a player perceives (perception) and how a player responds (action) to the play unfolding about them (Johnstone & Morrison, 2016; Macquet, 2009; Macquet & Kragba, 2015). For example, a centre in netball receives the ball with two options to pass forwards to the goal attack or the goal shooter. The centre processes the cues available, which indicate that the goal shooter is being well marked by the goalkeeper, whereas the goal attack has lost their defender and is free in open space. As such the familiarity associated with this situation leads the player to the judgment that the risk is too high to pass to the goal shooter and instead decides to pass to the goal attack.

In contrast, the school of ecological dynamics describes how behaviour emerges because of an ongoing reciprocal relationship between *perception* of information, which constrains movement, and *action*, which creates information (Greenwood, Davids & Renshaw, 2016; Kelso, 1995; Warren, 2006; Williams & Davids, 1998). The coupling of perception and action can be captured as opportunities for action (or options), known as *affordances* (Fajen, Riley, & Turvey, 2008; or *perceiver effectivities* within action-specific perception theory, Witt & Riley, 2014[1]), which are defined relative to the task goal, structure of the environment and the action capabilities of the performer. For example, a rugby player would only perceive the affordance to run through a gap between defenders if they had the requisite physical stature and speed to do so (Fajen et al., 2008; Gibson, 1979). Fajen et al's idea of affordances (2008) was extended to explain how individuals within a team coordinate their behaviours (Silva et al., 2013). The concept of *shared affordances* describes a collective perception of what is possible within the constraints of a context (Silva et al., 2013). For example, a rugby player is only afforded the opportunity to chip the ball into space beyond the defence if their teammate

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[1] Witt & Riley's (2014) review paper attempts to reconcile the ecological approach with action-specific perception theory.

is perceived to be able to outrun the defenders and evade the onrushing fullback. Therefore, the kicker must factor in the perceived action capabilities of a range of external agents (i.e., the receiver, the defenders and the fullback), whist the receiver must perceive the technical capability of her teammate to execute the kick and 'read' the situation.

An intermediary view, *naturalistic decision-making*, (Zsambok & Klein, 1996; Klein, Calderwood, & Clinton-Cirocco, 2010) argues that in highly pressurised, time constrained situations decisions are made through a *recognition primed* process (RPD) where a person's interaction with information varies from automated to conscious depending on the decision maker's familiarity with the situation (visual, auditory, olfactory etc.) and their requisite knowledge base (Klein et al., 1986; Klein et al., 2010). The decision-making process is formed of three levels; i) simple match, ii) diagnose the situation and iii) evaluate a course of action (Klein et al., 1986, 2010). *Simple match* represents a case in which a player perceives the situation as typical, as the information that is available to the player matches their initial expectations of the situation, leading to an automated decision response. *Diagnose the situation* represents a case where the information available is not typical (Zsambok & Klein, 1996). The decision maker must clarify the goals, cues and expectations of the situation through a process of diagnosis to restore typicality and arrive at a decision (Zsambok & Klein, 1997). *Evaluate a course of action* represents a more complex scenario where the information available (goals, cues and expectations) demands a deliberate assessment of possible options and the difficulties that may emerge in taking each approach. To do this, the decision maker runs mental simulations to test, disregard and select an appropriate course of action.

The only distinct difference between each perspective centres on the presence of memory representations to facilitate the selection of a course of action. Recently, Raab and Araujo (2019) explored the presence of memory within the decision-making process through the lens of the *information processing* (Raab) and *ecological psychology* (Araujo) perspective.

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They concluded that no 'single' theoretical perspective captures player decision-making in its entirety. Instead, they proposed that the presence of memory representations is dependent on the lens one looks through. Such a verdict suggests that a framework to facilitate the assimilation of knowledge borne from each perspective would help progress collective understanding of player decision-making in invasion team sports (e.g., Ribeiro et al., 2019; Bourbousson, Feigian & Seiler, 2019; Hoffman et al., 2013). We next present an attempt to construct a unified framework that encompasses a communal language for decision-making in team sports.

A unified conceptual framework for player decision-making in invasion team sports

Decision-making in invasion team sports can be compartmentalised into three facets: *the game*; *the player*; and *the coach*. The facets are not mutually exclusive, as each interacts with the other (Richards, Collins & Mascerenhas, 2017; Passos et al., 2008). *The game* sits at the centre of the framework presented in Figure 1, as the goal and rules of *the game* interact to create problems that both *the player* and *the coach* need to solve. *The player* interacts directly with both *the game* and *the coach*. The player serves as the coach's agent by acting out shared solutions to the problems *the game* presents. Each of the three research perspectives contribute to our understanding of how the game, the player and the coach interact. It is our view that the knowledge generated can be unified and expressed as a communal language for decision-making in invasion team sports.

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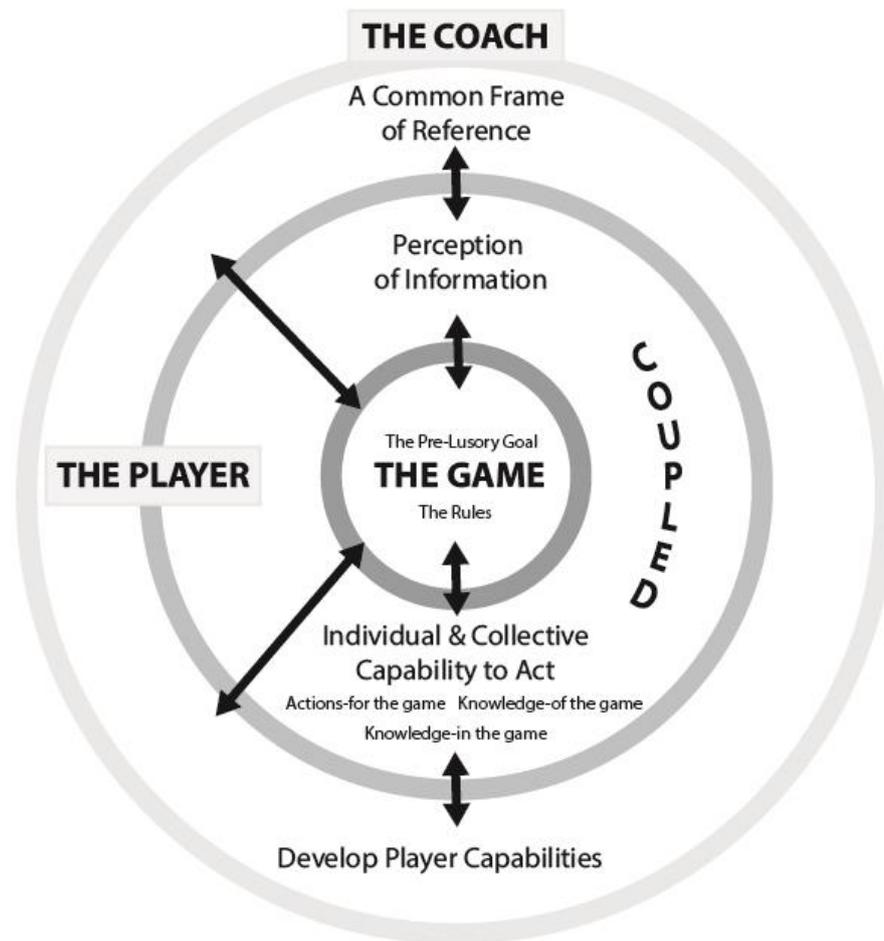
Figure 1: A unified conceptual framework for player decision-making in invasion team sports

A Communal Language for Decision-Making in Invasion Team Sports

The Game

Invasion games present an 'uncertain' performance environment, however, the options available to a player are directly governed by two overarching concepts, the pre-lusory goal and the rules of the game (Suits, 1978). The pre-lusory goal describes the overarching aim of a sport, which in the case of an invasion game is 'to score more points/goals than your opponent'. The rules prohibit a team from winning through more efficient means - that is,

cheating (Grehaigne, Godbout, & Bouthier, 1999) - by specifying the area of play and acceptable actions within it. The interaction between a sport's pre-lusory goal and the rules shape the internal logic of a game (Grehaigne et al., 1999; Suits, 1978) and the game-specific information that players must act upon. Continual interaction with the rules allows players to refine their suite of options for a specific moment in the game (Silva et al., 2013).

The Player

Perception of Information

Advocates of ecological dynamics suggest that perception is 'of affordances' which are the invitations for action specified by the game rules and the actions of those around the decision-maker, e.g. a gap to run through (Araújo et al., 2019). The information processing perspective suggests that skilled players better identify information through salient (McPherson & Vickers, 2004), predictive (McRobert et al., 2011), global cues (Johnston & Morrison, 2016) within the context of their intended goal. Whilst, naturalistic decision-making argues that *patterns* of a *typical* and *familiar* nature are *recognised* through the perception of *relevant* information:

> The RPD model suggests that people can assess the given situation by recognizing its typicality. The decision maker recognizes the situation through salient features that experience has shown to be useful. Recognition has four by-products: (a) expectancies, (b) relevant cues, (c) plausible goals, and (d) typical action. (Macquet, 2009; p. 66)

Therefore, each perspective similarly expresses the notion that the *perception of information* actuates the decision-making process (Correia et al., 2012; Johnston & Morrison, 2016; Macquet, 2009; McRobert et al., 2011; Poplu et al., 2008).

Further exploration of *perception of information* reveals that it is task dependent, that is, player's visual fixations and verbal descriptions change in line with changes in the demands of the task, presumably as they search for means to a successful outcome (Roca et al., 2011;

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Roca et al., 2013; Roca, Williams, & Ford, 2012). Moreover, expert players develop an improved connection to the information the performance environment offers over time (Abernethy, Zawi, & Jackson, 2008; Araújo et al., 2019; Esteves et al., 2012; Williams & Jackson, 2019). For instance, Jackson, Warren and Abernethy (2006) found that skilled rugby players can see through the deceptive acts of their opponents:

> skilled players are better able to detect and respond appropriately to advance deceptive visual information, highlighting an additional characteristic of anticipation skill. (Jackson, Warren & Abernethy, 2006; p. 368)

Finally, conditioning of skilled players to information that best leads to successful outcomes is more commonly known in ecological psychology as *perceptual attunement* (Esteves et al., 2012). In total therefore, terms that capture the perceptual element of goal-based decision-making, such as *perceptual attunement*, *familiarity*, t*ypicality*, *affordances* and *cues* - of a *salient*, *global*, *relevant*, *anticipatory* or *deceptive nature* – adopted by each perspective can be much more simply termed the *perception of information*[2].

Individual and collective capability to act

Ecological psychology argues that players have an inherent perception of what is *technically* and *physically* possible (*action capabilities*) in the context of the intended goal (Cordovil et al., 2009). Empirical data supports the idea that a player's *physical* (e.g., speed) (Passos et al., 2012a) and *technical* (Paterson et al., 2013) attributes directly influence the action taken. In turn, the information a player perceives cannot be separated from the capabilities they possess, as their capabilities are what guide them to the information to perceive in the first instance (Davids, 2008). For example, a rugby player who is strong,

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[2] Perception is not only of visual information, but also refers to the information a player can hear (acoustic) and feel (haptic).

powerful and fast with the ball in hand is likely to perceive more gaps to run through than a slower, less powerful player. However, it is important to note that players, and perhaps coaches, tend to overestimate their capabilities which can lead to mistakes (when overestimating) or passive play (when underestimating). The implication for the coach in this example would be to develop appropriate capabilities for the demands of the game e.g. speed, power, strength and technical proficiency (Wilson et al., 2019). By doing this a coach would develop the players *actions-for the game.*

Alternatively, the information processing view would suggest a player's capability to act is moulded from a richer pool of task specific declarative knowledge (Afonso et al., 2012; Evans et al., 2012; Lex et al., 2015; McPherson & Vickers, 2004; Roca et al., 2011; Roca et al., 2013) stored as mental representations (Afonso et al., 2012; McPherson & Vickers, 2004; McRobert et al., 2011). It is presumed that mental representations afford the rapid selection of suitable *action plan profiles* that allow experts to effectively operate in dynamic game environments (Evans et al., 2012). For instance, Johnstone and Morrison (2016) found that expert rugby league players were capable to verbally report the reason *why* they acted the way they did; "I can't see the fullback so the kick would be an option" (Johnstone & Morrison, 2016; p. 404). Players who have a deeper knowledge of their sport possess the capability to understand why an action would be more appropriate in one situation than another (Johnston & Morrison, 2016; McPherson & Vickers, 2004; Poplu et al., 2008) and they are therefore, maybe, more likely to explore the boundaries of their action capabilities. Considering this, a player's *knowledge-of* the game increases their capability to act.

Naturalistic decision-making argues that a player's use of knowledge and memory is dependent on their recognition of a situation (Klein et al., 2010; Macquet, 2009; Macquet & Kragba, 2015). Jackson et al (2006) conclude that skilled players use heuristic-based judgments when the perceptual information is highly typical. Heuristics become established by the

repetition of an action in response to information that proves to be successful over time (Kahneman et al., 1982). For example, a basketball player forms a heuristic about how to get through a defender's screen, preferring to go over the top rather than below, leading to preference towards a flare cut response. Yet, as players recognise less typicality in a situation, they are required to *make sense* of the information as their heuristic-based-judgements would no longer lead to a satisfactory action (Macquet & Kragba, 2015).

The idea of making sense implies that a player is recurrently perceiving information in consultation with their knowledge of the game (Macquet & Kragba, 2015). Yet, if new information arises, such as an opposing player showing unexpected (or atypical) behaviour, their situation-specific knowledge would need to be updated in game (McPherson & Vickers, 2004). Ecological psychologists would describe this as *perceptual calibration* between context-specific information and actions for the game, resulting in a more refined capability to act to the given situation (Araújo et al., 2019; Esteves et al., 2012). Information processors would describe this as a *current event profile* where a player frequently updates competitive information within their memory during performance (e.g. an opponent's strengths) (MacMahon & McPherson, 2009; McPherson & Vickers, 2004). Whether its players making sense, calibrating, or using a current event profile, players are not only required to have *knowledge-of* the game but are also required to update their *knowledge-in* the game in order to adapt to sudden changes to the perception of information.

In sum, a player's *actions-for*, *knowledge-of* and *knowledge-in the game* shape their *individual and collective capability to act*. However, capability to act is inherently dependent on the interaction of **the player** with perceptual information born out of **the game**. Consequently, the perception of information is always *coupled with* a player's and teams individual and collective capability to act.

The Coach

A common frame of reference

Invasion games require players to mutually coordinate their *perception of information* and their individual and collective *capability to act* (Steiner, Macquet, & Seiler, 2017). This concept has been captured by *shared mental models* (Richards, Collins, & Mascarenhas, 2012; Richards, Collins, & Mascarenhas, 2017) and *shared affordances* (Passos et al., 2012; Silva et al., 2013). Richards and colleagues (Richards et al., 2012, 2017) argued that a shared mental model:

> enables players and teams to attend to information that is significant in the display, prioritise and then order this information so that the correct course of action can be determined. (Richards, Collins & Mascarenhas, 2012; p. 409)

A shared mental model is typically developed by the coach as an ideal vision of what performance would look like before being impressed on the coaching staff and players to create a mutual shared view (mental representation) of success. A critical by-product of a shared mental model is the development of a *common language,* which supports the agreed perception of roles, responsibilities and success (Richards et al., 2012). For example, a defender within rugby union may signal that the attacking team have an overlap using a *word* that stimulates a coordinated action from the team.

Ecological psychology contends that coordination of behaviour relies on a collective perception of information (Duarte et al., 2012a; Duarte et al., 2012b; Passos et al., 2008), "by perceiving and using affordances for and affordances of others, players can share affordances, and this helps to explain how teammates are able to control their actions in a coordinated way." (Silva et al., 2013; pp. 768-769). For example, a supporting basketball player perceives that a defender is blocking their teammates route to the basket. The player in possession of the ball also perceives this information. In a coordinated act the supporting player uses their body to screen the defender, leaving a gap for the teammate to dribble towards the basket (Ruano et al., 2015). Regardless of differences in terminology and underlying ontological views, shared

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mental models and shared affordances both suggest that by establishing a *common frame of reference* coaches can affect their players' *perception of information* and their *individual and collective capability to act*.

Develop player capabilities

It is the role and responsibility of coaches to work with players to develop their capacity to solve tactical problems within competitive situations. From an ecological psychology perspective, coaches who seek to develop their players perception of information and *actions-for the game* should acknowledge the non-linear nature of learning; that is, accept that a player's rate of progression towards a criterion is not predictable (Chow, 2013; Chow, Davids & Button, 2015). Advocates of non-linear pedagogy argue that learning environments should be designed to mirror real game contexts (Chow, 2013; Passos et al, 2008; Dicks et al, 2009). The principle of *representativeness* compels players to interact directly with game-specific information. It is claimed that this appropriately educates players' perception of information (Fajen, Riley & Turvey, 2008) and positively influences the development of both technical (Travassos et al, 2012) and physical capability (Esteves, de Oliveira & Araujo, 2011; Wilson et al, 2018). Crucially, contextualised learning activities must contain the functional *perception-action* relationships (*coupling*) that coaches want their learners to discover, so that players learn to recognise the personal (Fajen, Riley & Turvey, 2008) and shared (Silva et al, 2013) affordances offered by the game. Therefore, from an ecological psychology perspective, the role of the coach is to design practice activities that facilitate the search for tactical and technical solutions to real-game problems (Chow, 2013). This is done by the purposeful *manipulation of constraints*, such as practice space, rules, equipment and players (Chow et al, 2013; 2006; 2007).

From the information processing and naturalistic decision-making perspective, the development of player capabilities centres on *knowledge-of the game* (McPherson & Vickers,

2004). Macquet and Kragba (2015) suggest that this rests on players developing a shared understanding of *why* certain decisions are more appropriate in specific situations than others, which allows players to evaluate and make sense of the information available; that is, develop a *common frame of reference* or playbook (Macquet & Kragba, 2015; Richards, Collins & Mascarenhas, 2012). Richards and colleagues (2009; 2012; 2017) recommend coaches use *slow deliberate environments (off-field)* to build *knowledge-of the game*. Off-field environments should encourage players to reflect-*on*-action, in order to strategise and plan for the *perception of information* and the appropriate *action* in response to it (Richards et al, 2009; 2012; 2017). Reflection-*on*-action can be stimulated by video and notational analysis, which allow players to see the moment of the game from an external point of view and review information that was available but perhaps not perceived in-action (Richards, Collins & Mascerenhas, 2017).

The variable nature of invasion team sports necessitates the development of players capability to adapt to perturbations to perceptual information. Richards and her colleagues (2017) argue that the development of *knowledge-in the game* requires the design of *applied knowledge (on field)* environments that encourage players to reflect-*in*-action. The practice should draw the attention of players toward the perception of information, whilst other players and the coach provide specific feedback.

Simon (1965) suggested that decision-making may best be understood by considering the context in which the decision is made. Bar-Eli, Plessner and Raab (2011) argue that when the perception of information is complex - higher number of options and more time – it is better to plan *intentional decision-making training* (explicit learning) environments, such as the use of coach-led if-then rules of thumb (*heuristics*; McPherson et al., 1999; 2004). That is, players should be encouraged to explicitly connect their *perception of information* to their *knowledge-of the game*. In contrast, *incidental decision-making training* (implicit learning) was deemed to be more appropriate when the perception of information is simpler – fewer options and less

time (Bar-Eli, Plessner & Raab, 2011). Incidental decision-making training conforms to the design principles advocated by non-linear pedagogy (Chow, 2013) in that practice provides frequent exposure to the perception of information in order to identify invariances between the information perceived and the action planned (Bar-Eli, Plessner & Raab, 2001).

Implications for the use of the unified framework for researchers and practitioners

Karl Popper (1968) argued that the purpose of research is the search for truth and that truth can never be proven, but research can contribute knowledge that can be applied to make sense of a problem (Veronesi, 2014). The aim of this paper was to create a communal language for decision-making in invasion games that assists the acquisition and application of knowledge. To this end, a unified conceptual framework is presented that, independent of viewpoint, encapsulates player decision-making process in invasion team sports. Table 1 provides a glossary of perspective-specific terminology aligned to the communal language developed within this paper. It is our hope that the table can provide an aide memoire for coaches and researchers to better facilitate the exchange of knowledge.

From a research perspective, future investigations should focus on the specific interactions between *the game*, the *player* and *the coach*. Research into the interaction between *the game* and *the player* could consider how players adapt their decision-making following rule/law changes, both behaviourally (e.g. tackles, carries, rucks, ball in play time; Van den Gerg & Malan, 2012) and cognitively. Likewise, the rule/law change to *the game* might have implications for *the coach*, such as the revision to the common frame of reference they impose on their team (Richards et al., 2017). Furthermore, the work of Raab (2003) and Bar Eli, Plessner & Raab (2011) could be extended by exploring the impact on *the player* of moments in *the game* that vary in complexity and the time to decide. Finally, research should study how the demands of *the game* are perceived and captured by *the coach* and impressed onto *players*.

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Does the *thinking* and *doing* of coaches align to the *theory* and *practice* principles offered by researchers?

From a practical perspective, high-level coaches can struggle to bring coherence to their thoughts (Abraham, Collins and Martindale, 2006), whereas, serial winning coaches are excellent at creating a vision of what performance should look like (Lara-Bercial & Mallett, 2016). Reference to the unified framework might help coaches across performance levels achieve clarity of thought on both the process of player decision-making and what, specifically, the coach can affect (Richards et al., 2009; 2012; 2017). The coach can then use their practice informed knowledge to design learning environments to accelerate the development of specific individual and collective capabilities to act and to educate the perception of information. It may be found that the balance and blend of intentional (explicit) and incidental (implicit) decision making training activities used are inextricably linked to the context within which the decision is made in competition (Raab, 2003; Bar-Eli, Plessner & Raab, 2011). Moreover, it is hoped that reference to the unified framework makes valuable research accessible to coaches; bolstering both their own professional development and the decision-making of the players in their charge.

Table 1: A communal language for player decision-making in invasion team sports (quotation marks denote the communal language terminology)

The Game			The Player			The Coach	
	Perspective	"Perception of information"	"Individual & collective capability to act"			"A common frame of reference"	"Develop player capabilities"
			"Actions-for the game"	"Knowledge-of the game"	"Knowledge-in the game"		
The pre-lusory goal & The rules	Information processing	Salient cues		Mental Representations		Shared mental model	Intentional decision-making training (explicit)
		Global cues		Declarative knowledge			Incidental decision-making training (implicit)
		Predictive cues		Long term working memory		Common language	
		Anticipatory cues		Action plan profile			Planning & strategising
	Naturalistic decision-making	Pattern recognition		Evaluation	Current event profile	Shared mental model	Slow deliberate environment (off field)
		Relevant cues			Heuristics		
		Typicality			Diagnosis	Common language	Applied knowledge environment (on field)
		Familiarity			Procedural knowledge		
	Ecological Psychology	Affordances	Action capabilities		Perceptual calibration	Shared affordances	Non-linear pedagogy
		Shared affordances	Physical				Representativeness
		Perceptual attunement	Technical			Intention	Manipulation of constraints
							Perception-action coupling

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