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Coaches' Decision Making

John Lyle and Bob Muir

Introduction

Coaches' decision making has been identified as a key element of coaches' practice (Coutts, 2017; Till, Muir, Abraham, Piggott & Tee, 2018). Indeed, there have been suggestions that decision making may be considered the defining feature of coaching expertise (e.g. Abraham & Collins, 2011, Lyle & Vergeer, 2013). Nevertheless, attempts at a theoretical underpinning as a legitimate basis for empirical work is a relatively recent part of coaching science and reflects a greater attention to the cognitive aspects of expertise (Nash & Collins, 2006; North, 2017). Decision making may be defined as 'making discretionary judgements', which Beckett (1996) identifies as the distinguishing feature of professional activity, or 'committing oneself to a course of action' (Lipshitz, Klein, Orasanu & Salas, 2001). The relevance of decision making to practice is something that is likely to resonate with sport coaches. This is evident in, for example, team selection, managing competition performance, devising strategy, managing the delivery of interventions, planning, responding to crises, providing appropriate feedback and interacting with athletes (Lyle, 1999).

Decisions are classified in a number of ways, depending on immediacy and automacy. Kahneman (2012) identifies type-1 decisions as fast and instinctive, and type-2 decisions as more deliberative and analytical. Svenson (1996) offers four categories: automatic and unconscious decisions, those exhibiting no compelling issues, those in which conflicting goals are attached to outcomes, and decisions in which neither the alternatives or the attributes are fixed. Goldstein and Weber (1995) also propose four types of decision: non-deliberative, associative, rule-based and schema-based. These are categorised by the way in

which knowledge is accessed to evaluate alternatives. Klein and Weick (2000) distinguish between rational, intuitive, and experiential decision making. The generalised distinction between decisions with clearly identified alternatives and objectives, and those associated with more dynamic environments is redolent of the contrast between the experimental approach characteristic of judgement and decision making research in psychology and experience-dependent Naturalistic Decision Making (Lipshitz, Klein, Orasanu & Salas, 2001; Mosier, Fischer, Hoffman & Klein, 2018; Teigen, 1996). Lyle (2010) identifies the serial nature of decision making as significant in sport coaching, having relevance for an intervention process in which decisions are interconnected and interdependent (e.g., delivering training sessions or managing competition) (Harvey, Lyle & Muir, 2015; Jones, Bowes & Kingston, 2010). He suggests a semi-deliberative decision process would be the most apt descriptor (Lyle 2002).

It is important to acknowledge that the study of coaches' decision making, although there may be some commonalities, is distinguished from the dynamic decision making of sport performers (see Belling, Suss & Ward [2015] for a review of relevant research). Further, the academic literature can be divided into a focus on 'how' decisions are made (decision processes) and decisions relevant to specific aspects of coaching (decision policies). Clearly, the latter category is wide ranging; examples of this breadth can be found in overtraining (Pope, Penny & Smith, 2018), selection policies (Bradbury & Forsyth, 2012), and 'return to play' decision making (Shrier, Safai & Charland, 2014). In this chapter, we chart the emergence of coaches' decision making in the academic literature, review the research conducted, and consider the impact of decision making research on coach education and development.

Historical development

Research in the 1970s and 80s was characteristically focused on coaches' individual dispositions (Hendry, 1972) and on descriptive observation of coaches' behaviour, with the development of a wide range of behavioural recording and analysis instruments (Anshel, 1987). The scope of the research was limited by the, largely North American, emphasis on the organisational role of the high school and collegiate coach and analyses of teacher/coach episodic sessional behaviour (Kahan, 1999). Much of the research consisted of behavioural profiles of coaches and the manipulation of the sites of enquiry or coaches' competition records (e.g., Claxton, 1988; Lacy & Darst, 1985).

There was little or no direct attention to coaches' decision making, either process or policy. However, coaches' decision styles, derived from the degree of participation in decision making by the performer, were incorporated into the Leadership Scale for Coaches (Chelladurai & Salah, 1980). Coaches' behaviours were classified as autocratic, consultative, participative or delegative, but there was no attention to how coaches made decisions, or the basis on which they made them. Decision styles were at the heart of a very substantial research literature at that time (e.g., Chelladurai & Arnott, 1985; Terry, 1984) (Gilbert & Trudel, 2004). The distinction between autocratic and democratic decision styles of coaching continues to be evident in research, particularly in youth sport (e.g., Bartholomew, Ntoumanis, & Thøgersen-Ntoumani, 2010; Erickson & Côté, 2015; Sullivan, Paquette, Holt & Bloom, 2012; Vella, Oades & Crowe, 2012). The extent of athletes' engagement in decision making remains central to the discourse on athletes' empowerment (Kidman, 2005; Nash, 2015; Purdy, 2018) and autonomy in relation to internal motivation based on self-determination theory (Amorose & Anderson-Butcher, 2007; Mageau & Vallerand, 2003; Mallett, 2005).

As early as 1970, Cratty (1970) had identified the potential of psychology for understanding coaches' decision making but acknowledged that there was as yet no relevant

research to support such a contribution. The quantitative experimental tradition associated with behavioural science, largely via questionnaire and observation, was ill-equipped to address the decision making process, although the behaviour modification research of Smith and Smoll (1978; 1979) had some impact on coaching in youth sport. At that time, research associated with the cognitive science of judgement and decision making did not address complex problems (Hastie, 2001), and the contribution of the heuristics and biases research of Tversky and Kahneman (1974) had not yet been recognised in coaching studies. Perhaps more significantly, research to this point did not suit the nascent emergence of the coaching process as a focus for study (Lyle, 1984; 1986). Martens (1987), recognising the dilemma, called for greater attention to experiential knowledge and a move away from ‘orthodox science’, particularly laboratory studies.

Throughout the 1990s, research continued to focus on decision policies and decision styles. However, by the second half of the decade, a greater emphasis on the cognitive aspects of coaches’ behaviour and the establishment of coaching as an interactive process (Gilbert, Trudel & Haughian, 1999; Jones, Housner & Kornspan, 1997) had presaged a gradual move towards the ‘how’ of decision making. Throughout the 90s, policy research into specific issues in coaching practice attempted to demonstrate good practice (Dennis & Carron, 1999; Duke & Corlett, 1992; Flint & Weiss, 1992; Ransone & Dunn-Bennett, 1999; Vergeer & Hogg, 1999). These studies employed questionnaires and simulation/scenarios to evaluate coaches’ responses to alternative choices and to identify factors (e.g., competition proximity, age/stage, location, performance standard) that influenced decision choices. However, there was little, if any, field-based research. The absence of *in situ* research designs resulted in more manageable and reproducible studies but failed to address the coaches’ prior knowledge of the actors and context, the processual nature of serial decision making, and the interdependence of goals and decision options.

Nevertheless, a number of papers throughout the 90s began to identify cognitive features associated with coaches' decision making. Lyle (1992) investigated the degree of systematic practice by 30 coaches across three sports. He found that coaches amended their plans using a decision making process dependent on intuition and the triggering of crisis thresholds. He emphasised the coach's knowledge-in-practice and introduced Schön's (1987) work on reflection-in-action as a potential explanatory framework. The often-cited study of gymnastics coaches by Côté, Salmela, Trudel, Baria and Russell (1995) established that coaches' behaviour was characterised by an integration of performer, performance, and contextual factors. The authors introduced the notion of mental models, through which coaches organised their knowledge. Although there was no attempt to identify the 'how' of decision making, the study provided a basis for further studies, particularly their speculation that the coaches' mental models were continually modified.

Abraham and Collins' (1998) exploration of coaches' expertise did not deal directly with decision making but employed cognitive psychology literature to substantiate a view on coaches' cognitive organisation. Their emphasis on declarative and propositional knowledge would later be elaborated in the decision making literature. Saury and Durand's (1998) study of Olympic sailing coaches demonstrated that coaches were dependent on their previous experience for managing their coaching interactions with athletes. In order to assist coaches to 'make sense' of the coaching environment, they used their experience to create stories and scenarios, and relied upon contextual repertoires of potential actions to guide their decision making.

A review of the literature and a consolidation of the evidence to that point in time was provided by Lyle (1999). He identified a number of features of coaches' decision making that would subsequently become part of the research agenda in this field, and an overview of decision making practice. For example, non-deliberative decision making was equated with

the time-constrained interventions of coaches, often with incomplete information and significant levels of uncertainty. He emphasised the need to address the serial nature of context-dependent decision making and the challenges for research of apparently intuitive decisions and largely tacit knowledge. Despite this, coaches do cope with complexity and uncertainty, and perhaps the most prescient contribution of the work is the introduction of Naturalistic Decision Making (elaborated later) as a mechanism through which to understand and operationalise decision making in dynamic micro moments of coaching intervention. Lyle acknowledges the need to distinguish, and account for, the complementarity of rational intention and apparently intuitive implementation (1999, p. 215). He draws upon the ‘dual cognitive architecture’ of Boreham (1988; 1994) and his research on the match coaching decisions of volleyball coaches to propose four models of decision making (schema, script schema, case script and slow interactive script) that coaches employ to cope with non-deliberative decision making. In the schema model, (expert and experienced) coaches’ pattern recognition of situations triggers a match against stored repertoires of situations with similar features and prompts solutions that match previous tried and tested outcomes. With higher levels of uncertainty, optimal solutions may need to be further modified. A specific version of this is the case script, in which a greater familiarity with the actors and circumstances can be matched to almost synonymous previous instances of ‘what works and when’.

The script schema applies in circumstances in which there is an ‘unfolding situation’ (e.g., in-game coaching). Continuous scanning of the environment alerts the coach to potential action (both planned and emergent). The coach uses stored examples of previous scripts to create a contemporary ‘story’ that anticipates a likely course of action and, at the same time, the likely outcomes of decisions that might be taken. Lyle speculates that, in the absence of rule-based heuristics, coaches create a personal repertoire of ‘if ... then’ propositions that enable them to speedily match potential decisions against likely outcomes.

However, the type of decision that most closely addresses the coach's intervention practice (that is, the coach's design, delivery and management of goal-derived and planned activities to improve performance) was the slow interactive script model. This might be best described as 'semi-deliberative'. This mode of decision making acknowledges that many coaching decisions are made in circumstances that, despite an element of time pressure and incomplete information (plus the vagaries of human dispositions and emotions), there is less need for an immediate recognition-response decision but an opportunity for some deliberation (including intentional delay). The coach will not evaluate all possible alternative actions but continuous situational analysis and recourse to stored schemata will reduce the alternatives and provide the coach with a measure of control of the intervention.

By the turn of the century, decision making had been firmly established as part of the coaching science literature. Decision styles and decision policy research would remain a constant feature of the literature, but greater attention to the cognitive aspects of coaches' expertise was beginning to generate academic interest in the decision making processes that would best characterise coaches' interactive, context-dependent, complex, and multi-variable practice. It was accepted that much of coaches' knowledge was tacit and that experience-based knowledge was being accessed to enable coaches to cope with such practice. Despite this, there was no evidence that the academic literature had impact on coach education and development.

Expansion and diversity

The first decade of the new millennium was characterised by a continuation of research using decision styles as a variable and isolated examples of decision policies. Over this period there was a gradual incorporation of Naturalistic Decision Making assumptions into academic writing, and a move, albeit gradual, away from questionnaire-based research designs to a more varied diet of enquiry methods. While accepting that there would be examples of non-

time pressured decision making by coaches, experience-based decision models began to assume some greater significance as the coaching literature acknowledged the role of interactive decision making in the micro-management of training sessions, competitions and interpersonal communication between coach and athlete. Although much of the North American literature continued to focus on youth sport (see Camiré, 2014), the coaching-related academic literature began to give the performance domain a greater significance (e.g., Erickson & Côté, 2007; Mallett & Côté, 2006, Rynne, Mallett & Tinning 2006).

Decision styles research across more varying domains and roles remained prominent (Hatamleh, Abu Al-Ruz & Hindawi, 2008; Giske, Benested, Haraldstad & Høigaard, 2013; Loughhead & Hardy, 2005) but it began to be used by other ‘schools’ of research as a marker for more- and less-appropriate approaches to coaching practice. Evidence had accumulated over the years that athletes’ preferences and satisfaction was dependent on domain, gender, and sport. In general, youth sport participants preferred a ‘democratic’ leadership style with shared decision making. However, older and more mature athletes, males and those in interactive team sports preferred more autocratic (decisions by the coach) styles (Crust & Lawrence, 2006; Horn, 2002). Although decision styles had been used rather uncritically as a marker for coaches’ behaviour, they became associated with a number of fields of study in coaching science, in which decision style was one of a pattern of behaviours, and shared decision making was associated with positive outcomes. In research on Teaching Games for Understanding and other similar pedagogical approaches, the absence of directive decision making by the coach or teacher was associated with players’ capacity for tactical decision making and understanding (Croad & Vinson, 2018; Práxedes, Del Villar, Pazarro & Moreno, 2018). The absence of shared decision making was also a feature of emotional abuse, particularly with female athletes (Stirling & Kerr, 2009); coaches taking decisions was also considered ‘objectionable’, as an example of athletes being treated as a ‘means to an end’

(Fry, 2000). The locus of decision making forms part of research into the quality and efficacy of interpersonal relationships between coach and athlete (Hampson & Jowett, 2014), and is part of a profile of behaviours leading to more or less autonomy-supportive coaching practice (Mageau & Vallerand, 2003; Ahlberg, Mallett & Tinning, 2008).

A further and substantial school of academic writing has adopted a critical stance on sport coaching as a site of social enquiry (Jones, Potrac, Cushion & Ronglan, 2011). The extent to which coaches exert 'control' over athletes is partly determined by the locus of decision making. Athletes are thought to be disenfranchised by their lack of decision making power in performance development. These studies seek to empower athletes through more participative and athlete-centred practice (Denison, Mills & Konoval, 2017).

There was also a continuation and further development of policy research, that is, identifying appropriate decision outcomes in coaching practice. Not surprisingly, these are evident, not in emergent interactive decisions, but in 'choice of alternatives' studies in which there is an element of deliberation. An interesting development has been an examination of coaching decisions taken in competition. These are generally examples of statistical support to enable more-informed decisions by coaches. For example, Sackrowitz (2000) examined the decisions taken by American Football coaches about whether to opt for one or two point additions when scoring a touchdown. A similar study in that sport considered the relative advantages of punting or passing on 'fourth down' (Romer, 2002). Ferrera, Volossovitch and Sampaio (2014) conducted an investigation into the impact of game critical moments on decision making in basketball, and the use of substitutes in soccer (Silva & Swartz, 2016) and the timing of time-outs in volleyball (Abreu, Fernández-Echeverría, González-Silva, Claver, Conejero & Moreno, 2017) has also been studied. In an interesting paper, Ni and McGarrity (no date) showed that coaches' decisions in basketball were more effective than those made by players. An example of statistical support for player selection was proposed by Trninić,

Papić, Trninić and Vukičević (2008). The use of technology to collect personal and performance data (e.g., weight, medical condition, performance analysis and projection) has been interpreted as ‘intrusive surveillance’, leading to athlete passivity and compliance (Johns, D.P. & Johns, J.S., 2000). Williams and Manley (2016) suggest that reliance on such technology and statistical data can lead to a lack of trust in interpersonal relationships and in decision making. However, Collins, Carson and Cruikshank (2015) point out that the use of performance analysis is both a necessary and common feature of planning for improvement in sport performance and appropriate use of technology and data, in concert with transparency and player involvement, can be a positive feature of performance coaching.

Despite the continuation of research on decision styles and policies, there was little initial progress on the decision making process itself – how coaches make decisions. Lyle (1999; 2002) had introduced the potential of Naturalistic Decision Making to describe and explain the decision making of experienced sport coaches, but it was some time before this paradigm found its way onto the research agenda. The academic literature had become heavily influenced by the extensive work of Robyn Jones. It was he and his co-writers who criticised a conception of coaching as a linear, rational, and systematic process and, along with this critique, behavioural research assumptions. The coaching process became accepted as a complex, dynamic interaction between athlete and coach, heavily contingent on the social milieu, and with the management and delivery of the intervention process subject to negotiation between coach and athlete (Bowes & Jones, 2006; Jones & Wallace, 2006; Jones, Bowes & Kingston, 2010). Despite some criticism over the balance between structured improvisation and instrumental accommodation, and an emphasis on interpersonal relationships to the exclusion of performance-related decisions (Lyle, 2007; Lyle & Cushion, 2017), the weight of academic writing was moving gradually away from behavioural assumptions and methods to qualitative enquiry into social and cognitive issues (Abraham &

Collins, 2011; Gilbert & Trudel, 2004; Lyle & Cushion, 2017; North, 2017). In the context of a need for explanations for storing and accessing knowledge, it became accepted that the operationalization of sport coaching interventions relied a great deal on tacit knowledge (Nash & Collins, 2006), and that coaches' expertise demanded an efficient and effective interactive collaboration between knowledge structures and retrieval. It was this emerging vacuum in coaching science that was the catalyst for more varied research methods and a more domain-specific understanding of coaches' decision making.

A dominant research paradigm throughout the period covered in this paper is Judgement and Decision Making (JDM). It would be difficult to summarise almost 50 years of research since Simon's (1955) concept of 'bounded rationality' was the catalyst for research on why human beings do not make rational decisions in everyday situations (Kahneman, 2012). Nevertheless, the research can be characterised as largely taking place in laboratory or controlled conditions, with specified objectives and identifiable alternatives, and often with research subjects with no domain-specific knowledge; the principal purpose has been to explain the 'flaws' in human decision making, most often through experimentation and testable hypotheses. Raab (2018) provides a detailed overview of this research field as it applies to sport, although the account is notable for the absence of any reference to coaches' decision making. Raab (2012) confirms that classical Judgement and Decision Making research is ill-equipped to address fully the needs of sport research. He cites the rich information environment, time constraints, limited information processing capacity, the complexity of objectives, and the absence of testable outcomes in sport as reasons for the absence of rational decision making and the relative paucity of sport-related research.

There will undoubtedly be circumstances in which coaches take deliberative decisions, and, in which, the alternative options are relatively clearly identified. Even in such circumstances, however, it is often forgotten that performance outcomes, to which most

decisions will ultimately be directed, are also subject to the decision making strategies and intended outcomes of opposing coaches. Performance sport is a contested arena and information is deliberately withheld or obfuscated, leading to a lack of control in the decision environment by the coach, and, although to some extent sport-specific, what may appear to be option choices are subject to a multi-layered hierarchy of goals (Abraham & Collins, 2011; North, 2017).

The domain-specific decision making process in sport coaching to which attention needed to be directed were the relatively time-pressured interventions in training and competition – an emergent, dynamic, serial and ‘nested’ (Abraham & Collins, 2011) practice. In Judgement and Decision Making (JDM), making decisions in circumstances of uncertainty and/or time constraints makes computational or option scanning strategies less workable (Kahneman, 2012). This is evident in coaches’ management of games in which the time between rallies and the opposition coach’s tactics require less-deliberative decision making. Decision making is made feasible by the use of heuristics, which are cognitive shortcuts or ‘rules of thumb’ that permit selective decision strategies (Kahneman, 2012). The use of heuristics, such as ‘taking the first option’ or ‘choosing an option that reinforces a previous decision’, are recognised to have limitations and militate against maximal decision choices (best of all options) in favour of ‘satisficing’ options, that is, optimal in the current circumstances (Gigerenzer, & Gaissmaier, 2011). For example, coaches may make a substitution in a team sport as a means of ‘buying time’ to confirm their interpretation of the situation, but be aware that further action is likely. The coaches will recognise that the action taken may not maximise their potential response but it is a compromise between sufficient impact on the problem and not wishing to limit further options. Despite its lack of relevance for serial decision making and criticism that it pays insufficient attention to emotional and social influences (Bruch & Feinberg, 2017), JDM has been used as a paradigm for research

on stakeholders in sport, principally athlete decision making (Bar-Eli, Plessner & Raab, 2011; Farrow & Raab, 2013). It is instructive, however, that in Raab's (2012) brief section on coaches' decision making, the examples given generally involve options and cues that are clearly defined, and the tenor of the paper is that researchers should 'test' the relative validities of different decision models, rather than inform coaches' practice.

Raab (2012) proposes that the decision making process should be made more efficient through the use of simple or 'fast and frugal' heuristics (Bobadilla-Suarez & Love, 2018; Raab & Gigerenzer, 2015). This approach accepts the 'trade-off' between time and accuracy. The largely experimental approach of JDM, which accompanies this 'trade off', is more complicated in coaches' decision making in which there are few 'accurate' responses – perhaps none in some situations, leading to novel actions or problem-reducing strategies. Nevertheless, there are two interesting contributions from this paper. The first is that Raab proposes that the focus should not merely be on the 'correctness' of the selection of alternative options but on the 'building blocks' to produce the decision – the search process, the strategy for stopping the search, and thereafter, the decision process. In the context of multiple cues and dynamic goals, sport coaches are faced with a recognition and time-pressured situational analysis challenge. Second, one of the recent research fields to which he refers is 'hot hands' research (a basketball analogy) (Bar-Eli, Avugos & Raab, 2011; Raab, Gula & Gigerenzer, 2011). This refers to decisions about team selection and tactical reliance on individual players as a result of an assumption that players are more likely to produce a successful 'play', immediately following a previous successful play, although the evidence is contested. The emphasis on scanning, recognition, and situational analysis will be shown to be part of current discourse, and the 'hot hands' research hints at a coach's interactive decision making during competition.

The heuristics and biases processes are categorised as intuitive thinking, which is an accepted component of current discourse on coaches' decision making (Collins, Collins & Carson, 2016; Lyle, 2010). In sport coaching research to date, intuition has been interpreted in a rather simplistic and unidimensional way, despite being shown to be domain-specific (Dane, Rackham & Pratt, 2012), and would benefit from a more in-depth critique (Glöckner & Witterman, 2010).

Naturalistic decision making and methods of enquiry

Increasingly, coaches' practice is acknowledged to exhibit features such as tacit knowledge, apparently intuitive decision making based on accumulated experience, and a balance of deliberative and less-deliberative decision making and reasoning. It became necessary, therefore to adopt a decision making paradigm that offered a plausible explanation for this expert behaviour. Naturalistic Decision Making (NDM) is a branch of cognitive psychology that focuses on how people make decisions in real-world domains with which they are familiar (Lipshitz et al., 2001; Ross, Shafer & Klein, 2006); the emphasis is on how decisions are made, rather than how they 'should' be made. In comparison to JDM, it focuses on matching rather than choosing alternatives, on process rather than outcome, and is more context dependent (Klein, 2015). Nevertheless, Kahneman and Klein (2009) find some measure of correspondence in their respective fields. The paradigm is applied in decision making contexts with ill-structured problems, uncertain dynamic environments, time constraints and multiple goals (Orasanu & Connolly, 1993). The basic premise is that, in such circumstances, decisions emerge from a subconscious process involving a scanning of the environment and recognition of the decision problem, without explicitly reasoned consideration of alternative options, and by recourse to knowledge stored as mental models or knowledge frames.

Of the many descriptive models representing the NDM process, Klein's (1993) Recognition Primed Decision (RPD) model is the most widely cited. It is important to note that, in subsequent elaborations, the element of enhanced diagnosis and reconsideration is emphasised. In other words, as the most optimum decision emerges, there is a moment of, 'is this likely to work'. This provides an opportunity for forward reflection (what Lyle [1999] terms, anticipatory reflection) and amendment. NDM research has further developed from an emphasis on recognition primed decision making to macrocognition, with attention given to sensemaking, coordination, and planning (Klein & Wright, 2016).

Although introduced into the coaching literature by Lyle (1999; 2002; 2003), NDM has not generated an extensive body of research on coaches' decision making. This may be attributed to the more general absence of field-based studies, the methodological challenges, and the suitability of NDM assumptions to the continuous and serial nature of coaches' intervention behaviour. The subsequent extensive review by Lyle (2010) examined the correspondence between NDM and sport coaching, but was able to draw upon relatively few published research studies. Not surprisingly, given the significance of tactical decision making in game play, there have been a number of studies on the decision making of playmakers in team sports (Johnston & Morrison, 2016; Kermarrec & Bossard, 2014; Macquet, 2009; Macquet & Fleurance, 2007; Macquet & Kragba, 2015).

In a study of experienced volleyball coaches, Lyle (1999; 2003) found that an NDM framework was the most appropriate foundation for a slow interactive script model that most appropriately represented coaches' decision making in interactive intervention practice, with an emphasis on situational assessment, anticipatory modelling/simulation, and a desire to 'control' (or at least mitigate) the element of uncertainty. It was also acknowledged that the range of action decisions was constrained by game structures; for example, the availability of substitutions, time-outs and tactical options. Debanne and colleagues have generated a

significant body of field-based work that investigates the cognitive strategies employed by coaches and their relationship to environmental factors, drawing to some extent on NDM assumptions (Debanne & Fontayne, 2009; Debanne, Angel & Fontayne, 2014; Debanne, T., Fontayne & Bourbousson, 2014; Debanne & Chauvin, 2014; Debanne & Laffaye, 2015). The coaches' cognitions rely on a balance of analysis/reflection and recognition-derived decisions. For example, Debanne and Chauvin (2014) found that handball coaches exhibited a reactive, routine-based approach when attempting to maintain a winning position; in a negative position they displayed 'anticipatory cognitive control' – that is, greater deliberation. Although focused on coaches' cognitive processes, this work could also be categorised as contributing to decision policies (see also, Prieto, Gomez, Volossovitch & Sampaio, 2016).

Based on a set of assumptions that underpin NDM, coaches' decision making in time-pressured intervention practice (for example, micro-managing training drills or responding to negative game situations) can be summarised in this way: coaches will scan and attend to key attractors (domain-specific stimuli that have particular 'weight' as catalysts for action) in the continuously unfolding environment (athletes, scores, opposition, crises). This may lead to a problem-framing response if a threshold of goal challenge is breached, otherwise routine activity (or inactivity) will continue. A speedy situational analysis matches the problem with a potential course of action. In practice, a mix of story telling and forward simulation reduces the options to one that most appropriately addresses relevant needs. The scale of reflection and reconsideration is dependent on the problem context. Central to this process are mental models; these are a metaphor for the organised storage of domain-specific knowledge, scenarios and 'what-ifs' that the coach has developed over time. Experts and novices differ in the complexity of their mental models. For example, Vergeer & Lyle (2009) found that more-experienced coaches exhibited more-comprehensive decision policies and took more

variables into account in ‘framing a problem’, particularly competition-related factors, when making decisions about injured gymnasts. Lyle and Cushion (2017) suggest that it is helpful to distinguish between three models – goal (in which a continually evolving framework of long-, medium- and short-term goals forms a backdrop for decision making and a reference point for staying ‘on track’), performance (which, based on performance analysis and expectations commensurate with age and stage, provides details of current and projected status and is the basis for performance planning), and simulation (which represents the expected course of events in specific training or competition episodes, significant deviation from which may provide cause for action). Although it is helpful to isolate these models to aid understanding, in practice they operate in concert. Nevertheless, the notion of mental models remains a useful metaphor rather than a subject of research and coach education. This is also the case for the skills that accompany this element of expertise: scanning, pattern recognition, situational awareness, problem framing, sensemaking, and story telling.

Harvey, Lyle and Muir (2015) tested the aptness of the NDM paradigm for sport coaches in the context of serial decision making. They constructed a conceptual framework and conducted stimulated recall interviews with coaches of three team sports in training sessions and competition. The authors concluded that NDM was a useful paradigm for investigating coaches’ decision making, in particular confirming the role of problem framing and evaluating thresholds for decisions. Also valuable was the identification of a number of key attractors – goals threatened, quality of player activity, and momentum shifts in games. They recommended further study into an element of conservatism that emanated from the coaches’ attempts to maintain control of developing situations and to reinforce perceptions of their expertise. The coaches in the study were at pains to maintain momentum towards their goals but responded to the problem of ‘second guessing’ the opposition by employing decisions that did not limit future action. It is important to acknowledge that goals provide a

central ‘driver’ and reference point against which decisions making may be evaluated (sometimes without conscious deliberation), and provide a catalyst to action when threatened. This is implicit in the notion of ‘nested goals’ (Abraham & Collins, 2011), and is not unlike other ‘treatment professions’ in which the vicissitudes arising from the need for moment-to-moment decisions requires an umbrella standard against which the practitioner/professional can evaluate both need and appropriateness.

Research into cognitive processes brings with it methodological challenges. No identifiable trends can be discerned in sport coaching science’s research into decision making, perhaps because of the reliance on interviews and the absence of field studies. What is not clear is whether the methodology is simply underdeveloped in coaching research, or the methods of enquiry into cognitive processes are difficult to conduct. It is evident that sites of enquiry (specific sports and coaching domains) are chosen to suit the epistemological assumptions inherent in each investigation. Lyle and Vergeer (2013) identify the problem:

Any claim that coaches take decisions without reference to context is a parody of coaching practice. The expertise element of decision making is about how the coach learns to deal with the decision complexity that is implicit. Simply saying that the processes are tacit and intuitive does not address the issue of developing this expertise. (2013, p. 123).

The experimental reduction of JDM research deals with outcome, rather than process, and fails to account adequately for social, emotional, and performance and goal-related complexity. However, perhaps in response to the problem of maintaining process and context validity, NDM researchers have had recourse to a wide range of enquiry methods. A recent compilation of NDM research papers utilises this catalogue of methods: after-action reviews, Cognitive Task Analysis, simulation exercises, depth interviews, argumentation analysis, functional analysis, induction, observation and ethnography (Gore, Flin, Stanton & Wong, 2015)

Lyle and Vergeer (2013) provide an overview of sport coaches' decision making research from 1990-2010. The methods employed were categorised as, first, 'decision policy capture by questionnaire', in which, typically, coaches were asked to respond to practice scenarios. Second, the use of stimulated recall of video footage (Lyle, 2003). This is generally augmented by interviews with coaches. There are limitations with this method (e.g. Demers & Tousignant, 1998; Gilbert, Trudel & Haughian, 1999) but it is an attempt to situate coaches' cognitions in training or competition practice. The third approach, largely in the context of 'game decisions' is to present controlled video/computer scenarios (Austin, Sparrow & Sherman, 2007; Schorer, Baker & Strauss, 2007; Hagemann, Strauss & Büsch, 2008). As with other methods, there are limitations to the transmission of appropriate (and necessary) contextual information. The final method is to conduct interviews with coaches. Each of the methods that investigate the coach's personal practice involves a retrospective account of some kind. Subsequent research has continued these research methods: for example, stimulated recall (Harvey et al, 2015), and interviews (Collins, Collins & Grecic, 2015). Debanne and colleagues have employed interviews, stimulated recall and analysis of verbal communications (Debanne & Fontayne, 2009; Debanne & Chauvin, 2014). In these studies, there is generally a statistical analysis of decision outcomes/game factors. In many of the interview-based studies, in-action recollections bear resemblance to a critical incident technique.

The paucity of field-based studies is matched by the rather limited scope and variety of the methods employed. In relation to in-action decisions, stimulated recall has, thus far, been the most common method for retrospective analysis of decisions taken. Harvey et al. (2015) would appear to be the only study to apply an NDM conceptual framework to the design of the research.

Where are we now?

Current academic writing is dominated by the prolific work of L. Collins, D. Collins and colleagues, and their scaffolding of a Professional Judgement Decision Making (PJDM) model, largely applied to adventure sports (e.g., Collins & Collins, 2015). In an encyclopedia entry such as this, it is inevitable that research in existing fields will continue to be published (e.g., in policy research, Gomez, Silva, Lorenzo, Kreivyte, & Sampaio, 2017; Allain, Bloom & Gilbert, 2018) and new perspectives developed beyond those that can be accommodated at a particular stage in the evolution of the field. Jones and Corsby (2015) is an important paper for reminding coaching science scholars of the social dimension in decision making. This is an erudite and compelling argument, which identifies limitations in classical, NDM, and PJDM approaches, and places the emphasis not simply on the cognitive but also on social processes. The authors remind us that decisions are founded in social interaction, and, without due care, may replicate a taken-for-granted ‘official’ stance on appropriate responses.

Naturally, the paper reflects a particular ontological and epistemological understanding of sport coaching, but, stripped of a distinctive terminology, the emphasis on the importance of past decisions and sensemaking is redolent of similar cognitive perspectives. Why would it be assumed that coaches would ignore social cues and past reflection in their problem framing and sensemaking? The criticism of a certainty of outcome is at odds with coaches’ appreciation of the challenge of contested complexity, but the reminder of the limited range of potential actions is helpful. The ‘social’ perspective on decision making can seem remote from practice, and the absence of a performance perspective is evident in the authors’ use of examples, c.f. differentiated attention, and group and individual communication. Nevertheless, this is a useful contribution, which emphasises social context and interaction.

Abraham and Collins (2011) (and the earlier work of Martindale & Collins [2007; 2013] with sport psychologists) make the case for Classical Decision Making (CDM) and

NDM each having its limitations and identify PJDM as an integrated model of decision making that explains and facilitates the diverse decision making behaviour of sport coaches. The claim, although hardly novel, is that coaches make decisions along a continuum from logical and rational option choices, with deliberative analysis, to intuitive experience-based decision making in conditions of uncertainty. They argue that there are relatively few recognition-based non-deliberative decisions and that, in this context of semi-deliberative decision making (Lyle, 1999), extreme NDM models are helpful but not the complete solution. It is argued that there is an element of deliberation in most decision making, other than immediate crises, and that reflection, involving story telling, simulation and recourse to declarative knowledge, facilitates an effective decision making process. The PJDM model (Collins & Collins, 2013) is an aggregation of the continuum of deliberative and analytical to intuitive decision making within a (nested) series of levels: macro- (social-political, goal setting), meso- (targets and environment), and micro- (intervention). Decision making is guided by an 'epistemological chain' (Grecic & Collins, 2013), which is a manifestation of the coach's beliefs and knowledge (in some ways akin to a mental model).

There is a wealth of position papers (e.g., Collins & Collins, 2013; Collins, Carson & Collins, 2016) and research publications. What follows is a brief summary of a small selection of these. Through semi-structured interviews with adventure sports coaches, Collins and Collins (2015) demonstrate that coaches have strategies through which to engineer 'time for reflection'. By manipulating the 'span of control', they create opportunities for observation and reflection, thus enhancing the quality of their decision making. Much of their behaviour would be thought to represent sound pedagogical practice. Collins, Collins and Grecic (2014) interviewed seven adventure sport instructors, finding that these practitioners were able to articulate the value structures that guided their practice. They exhibited a 'consistent, logical relationship between philosophy, modus operandi, aims and session

content'. Collins, Collins and Carson (2016) found that adventure sport coaches and rugby union coaches were able to distinguish their analytical and intuitive modes of decision making, and when these might be utilised. Examining the role of adaptability and creativity in PJDM, Collins and Collins (2015) found that adventure sport coaches were adept at 'managing' the interdependence of context, content and individual needs.

PJDM is a repackaging of existing constructs in decision making. The scale and weight of research in the area is not a challenge to the extensive body of research scaffolding the NDM paradigm. However, its importance lies in its application to sport coaching. There is no doubt that the work on PJDM has added greatly to the discourse on decision making in sport coaching. Investigating the practitioner's active control over cognitive process through metacognition, reflectivity, adaptability and flexibility has created a worthwhile research agenda. Thus far, the weight of research has been conducted with adventure sport coaches, with attendant features of risk, environment, and coach participation. The contextual siting of client groups, sessions, and non-related episodes is redolent of episodic instruction and there is a need to demonstrate the insights gained from the research in other, competition and serial, sporting domains. Nonetheless, there has been some recent branching out into other sports (Crowther, Collins, Holder, 2018). The investigative methods employed have been restricted to interviews, with some unarticulated stimulated recall. The coaches' practice is, therefore, largely based on self-reported behaviour and cognitions are inferred from coaches' responses. Thus far there has been no attempted correspondence with coaching outcomes (athlete behaviour and performance), as the data generated is coach-centric. This said, there is no doubt that this is a welcome re-energising of decision making research in sport coaching.

This encyclopedia entry has focused on substantive and developed ideas in decision making in the context of sport coaches' practice. However, there are alternative approaches to the study of decision making that have not yet made an impact of this specific behaviour. In

contrast to the use of self-reported and indirect methods of enquiry into the ‘how’ of decision making, neuroscience offers an understanding of how brain function is related to decision making (e.g., Rudorf & Hare, 2014). The application of findings from neuroscience to fields of study such as economics, consumer behaviour and addiction is well established but have not yet found their way into the coaching science literature. An interesting paper by Costa et al. (2018) demonstrates the use of indirect means of measuring brain function, but, despite the title, the study focused on tactical knowledge rather than decision making. The challenge of investigating brain function in the context of field-based coaching practice is one that will be left to future scholars. A similar situation can be found in the application of a bio-ecological paradigm in sport. This finds expression in the ‘constraints-led’ approach to enhancing sport performance (Araujo, Davids & Hristovski, 2006). This approach displays the same challenge of devising *in situ* research designs as other approaches (Travassos, Araújo, Davids, O’Hara, Leitão & Cortinhas, 2013) and has been applied to athletes’ performance rather than coaches’ decision making, although the attention to ‘practice design’ is relevant (Renshaw, Davids, Newcombe & Roberts, 2019).

Conclusion

Research into sport coaches’ decision making has progressed substantially from earlier role-related policy research. Studies on decision styles were prolific but became relevant when they were subsequently utilised to situate more-specific behaviour and practice-related concepts. The gradual move to processes that facilitate decision making in the micromanagement of interventions has mirrored the greater attention to and sophistication of our understanding of the coaching process and coaches’ expertise. Coaching policy research - the ‘what’ of decision making – will continue to be relevant; not as decision rules, but as indicators of the strategic and tactical level principles that can be absorbed into coaches’ mental models and thereafter applied in context. Naturalistic Decision Making

offered a paradigm that would appear to contribute to the experience-based decision making of coaches in circumstances of uncertainty and time pressure. Its value lies in the provision of a language and a set of constructs rather than a direct application to the dynamic and serial nature of much of coaching intervention. Lyle's (1999) semi-deliberative decision making and Collins and Collins (2015) demonstration that coaches could control the decision environment to facilitate more-considered decision making are crucial and now need to be expanded into more extensive domains and sports.

In addition to being contested, having multiple goals, and being understood only in the contextual particularity of practice, coaching decisions are 'negotiated, have ethical and value parameters, are influenced by personal bias, have historicity and domain specificity' (Lyle & Vergeer, 2013: p. 124). This creates an enormous methodological challenge for researchers. Thus far, the methods employed have been safe and conservative, with the result that cognitive mechanisms are inferred from retrospective and self-reported accounts of practice. There is tremendous scope for more innovative, field-based studies with greater correspondence to athlete performance and behaviour established.

An understanding of coaches' decision making is subjective, not only in its individuality and particularity, but in the ontological and epistemological lens through which it is observed. This may be one of those (relative rare) occasions in the evolution of an academic field of study in which the insights offered by coaching practitioner scholars may add positively to the insights that competing metaphors can offer. It would be true to say that, at this stage, the combination of contextual complexity and competing paradigms has provided some working models but that, in the absence of more fundamental research, these remain somewhat speculative.

There is no doubt that the PJDM work and the steady number of research publications have established a research agenda. The acceptance of decision making within the academic

discourse on sport coaching and the acknowledgement of its importance by practitioners has been more successful than the insinuation of decision making expertise into coach education and development. The emerging language of decision making skills - for example, sensemaking, situational awareness, cues and thresholds, simulation, reflection, mental models – has been identified, but the mechanisms for researching these are, as yet, underdeveloped and translation into education and development strategies has yet to be given its deserved prominence.

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