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1 **Developing team decision making: A holistic framework integrating both on-field and**

2 **off-field pedagogical coaching processes.**

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Abstract

This paper explores the complexity of developing decision-making skills in team sports. Research from the domains of motor control, perception and pedagogy (Teaching Games for Understanding and Game Sense) has significantly enhanced our knowledge of decision-making in sport. However, such studies although contributing knowledge, have explored elements of decision-making in isolation and many have failed to consider the naturalistic context in which decisions are made. Additionally research has often ignored the complexity of exploring decision-making within a team setting. Using the Naturalistic Decision Making paradigm, this paper proposes two interconnected models designed to develop individual/team decision making. Model 1 presents a layering approach where performer's cognitions, situational factors and the performance setting are explored. Model 2 places this framework in the context of on-field and off-field training/competitive environments. It is envisaged that this paper will open discussions as to how researchers and practitioners develop decision-making skills in team sports.

Keywords: reflective practice; team sports; tactical; mental models; team development

Introduction

It has been well documented that perception is vital to the development of decision making (hereafter DM) in team sports (Williams, 2009). Unfortunately, limited consideration has been directed towards exploring the influence of the playing context in which such decisions are made (cf. Bar-Eli, Plessner, & Raab, 2011) and the significant role of the player's own subjective, cognitively-based perception relating to these situations. Consequently, coaches need to appreciate how the playing context influences what information players perceive, attend to and prioritise whilst playing.

Our point here is that 'mainstream' sport science research seems to have addressed too narrow a band of the factors which, through complex interplay, enable the DM process to take place in high pressure, time limited settings. Moreover this is often performed with initially disparate groups of players in ways that seek to gain their commitment, buy-in and, eventually cognitive investment to build a shared understanding. For example, perceptual elements are clearly crucial, and a substantial literature has addressed this in sports settings. There is a comparative dearth of research however, which shows how individual perceptions can be made more similar and, even more crucially, how these more common perceptions can be used to generate common but effective DM strategies and outcomes. Simply put, coaches seem to be waiting for science to address what is a central but neglected concern.

Of course, DM in team sports is much more than a collection of separate activities (Williams, 2009). Rather, it requires a complex and dynamic integration of several elements and processes, which simultaneously and dynamically interact. These processes include the interaction between situational/tactical aspects (e.g., teammates, opposition, area of the pitch) and strategic factors (team philosophy and match objectives), both of which must be similarly applied by all team members, often without any overt in-game communication, through the

77 development and application of a Shared Mental Model or SMM (Richards, Collins, &

78 Mascarenhas*, 2012).

79 *Developing team DM: What do we know and what do we need?*

80 Confusion still exists amongst practitioners and researchers with regard to the precise

81 mechanisms which should be used to develop expert decision makers within applied sporting

82 contexts. Williams (2009) recognises the valuable contribution of existing research in the area

83 of DM, but suggests that investigating perceptual skills in isolation of the performance setting

84 may have inflated the contribution these make in competition.

85   Of course, we acknowledge that the motoric and perceptual elements of technique are

86 fundamental to the development of DM skills in team sports. A significant amount of research

87 has identified the perceptual cognitive skills which are essential to the DM process (Starkes &

88 Ericson, 2003; Williams, 2009). Such research informs us about a wide range of factors,

89 including what cues skilled performers use to assess the opposition's movements (Williams,

90 2009), what stimuli are identified in recognising play patterns (Klein, 1993; Williams 2009)

91 and at what stage this information is attended to in dynamic play situations (North &

92 Williams, 2008). In addition, research has highlighted the importance of visual search

93 behaviours in skilled performers (Williams, 2009) and the need to use cue identification and

94 anticipation to inform DM (Caserta, Young, & Janelle, 2005; Williams, 2009). Other crucial

95 elements have been comparatively neglected, such as how commonality of perception is

96 encouraged and how this information, once established, can best be used to generate optimum

97 styles of DM through essential cognitive processes, both within individuals and across teams.

98 As a vital next step therefore, practitioners need to take responsibility for understanding and

99 designing training environments that integrate the player's subjective cognitive perceptions of

100 the situations within the context of the performance setting.

101   The development of high quality team decision makers therefore appears to be more

102   complex than just facilitating a perceptual recognition or problem solving approach in training

103   environments (although both of these significantly enhance our understanding of the process).

104   Numerous theories relating to DM exist (see Bar-Eli et al., 2011) but only a limited number

105   explore the process of DM in the sporting context. Each of these theories provides a valuable

106   contribution to our understanding of the DM process in sport. However, most explore an

107   aspect of DM in isolation and ignore the complexity of the dynamic competitive situations in

108   which several components interact.

109   We propose that the nature of DM in invasion sports lends itself to the Naturalistic

110   Decision Making (NDM) paradigm, where decisions in sport are performed in complex and

111   often unpredictable conditions, in pressurised situations and with extreme time constraints

112   (Klein, 2008). NDM researchers seek to investigate how experts perform tasks in dynamic

113   environments which have ill-structured problems, shifting and changing objectives, time

114   constraints, include multiple players and are influenced by organisational goals. All these

115   characteristics are representative of high performance team sport environments.

116   Unfortunately, such a real world approach, heavily laden with contextual information, has

117   often been neglected in perception-action research where such information has a bidirectional

118   link between perceptions and actions (Beilock, 2009). Accordingly, this paper will explore the

119   specific NDM theories of Recognition Primed Decision making (RPD), Situational

120   Awareness (SA) and sensemaking (Klein, Phillips, Rall & Peluso, 2007) in context of the

121   proposed framework (see Figure 1 and 2). Each approach makes a valuable and distinctive

122   contribution individually but when collectively integrated, they provide a comprehensive

123   justification of the possible mechanisms through which DM might be developed in sport.

124   Supporting our integration of these constructs within a single framework, Bar-EIi et al. (2011)

125   proposed that our understanding of the DM process will only be improved by applying

126   theories directly into the sporting environment. The authors suggest that specific situations

127 may require the development of specialised models that can be applied to the dynamic context

128 of the sporting setting (Richards et al, 2012).

129 As applied practitioners working with elite sports teams developing DM skills, we propose

130 that there are three factors that are worthy of consideration. Firstly, in examining the context

131 of the situation, we need to be cognisant of the unique characteristics of the team, such as

132 tactical plans and the team's philosophy; such aspects guide the application of the team

133 developing a SMM (Richards et al., 2009, 2012). Secondly, presuming that team players are

134 attending to, perceiving and valuing elements of the performance display in a similar fashion,

135 then subsequently such team philosophy and game plans will shape players' actions thus

136 directing what information players then attend to. Thirdly the literature needs to present, test

137 and refine DM models and explore how DM characteristics can best be developed in team

138 players. This paper proposes that team DM is developed by layering information (Figure 1)

139 using two dual processes (Figure 2) which illustrates the interaction between an off-field

140 reflective environment and the on-field in action training and competitive environments.

141 The framework highlights how individual cognitive thought processes can be collectively

142 developed in a progressive manner to establish a collective mind set (Weick & Roberts, 1993)

143 and develop shared mental models (Oranasanu & Salas, 1993) of performance which can then

144 be effectively communicated on the field of play.   The complexity of developing team

145 decision making is too dynamic and multifactorial to be illustrated singularly in one simple

146 diagram. The framework proposed in this paper consists of two interconnected models. We

147 believe it is only when elements relating to DM are explored holistically in a connected

148 manner can we truly understand the process of developing team DM. The holistic elements

149 manifest themselves in several ways. For the moment, consider the importance of combining

150 perceptual and decision making elements of motor control, the social support generated

151 within a team by self-constructed elements such as key terms and the integration of these

152 within a practical and effective model. All these elements are combined in the approach we

153 describe, leading to the use of the term holistic as a hopefully justifiable description. The

154 reader is referred to Richards et al (2012) for an illustrated example of the framework being

155 applied to an international netball team.

156 **The two model process – How each contributes**

157   Model 1 illustrates the psychomotor processes which are required to develop a shared team

158 cognitive thought process, which itself is positioned within the context of the team's playing

159 philosophy. We advocate that developing team DM skills requires pedagogical process to

160 extend beyond enhancing individual cognitions to integrate the development of shared team

161 cognitions (Oranasanu & Salas, 1993) and the development of a connected thought process

162 (Weick & Roberts, 1993). Such processes require information to be seen and valued in the

163 same way by all team members, resulting in the construction of SMMs of performance.

164 Player's individual cognitive thought process are collectively co-ordinated through the

165 pedagogical process of layering information outlined in Model 1, which facilitates members

166 of the team valuing, perceiving and interpreting information in the same connected manner.

167 The ability of all team members to perceive and value dynamic playing situations in the same

168 way, facilitates key information being more effectively attended to and communicated.

169 Model 1 therefore outlines the concepts which necessitate the development of five layers of

170 information which are required to develop team DM (see Figure 1 – *what to coach*). Each of

171 the layers involves feedback and feed-forward mechanisms, facilitating a cyclical process for

172 continual learning and development of playing constructs. Although illustrated separately to

173 provide clarification for the reader, the five phases continually interact and define each other.

174 Through the process of player empowerment, each of the layers addresses the development of

175 cognitive structures (RPD), mental models (MM) and shared mental models (SMM) and the

176 contextualisation of these structures in the specific environmental situations (Situational

177 Awareness).

178   Model 2 in the second section of the paper illustrates the pedagogical process involved in

179   co-ordinating individual perceptual representations of playing situations, so a collective team

180   cognitive thought process can be obtained. The second model (Figure 2 – *how to coach*)

181   demonstrates an empirically tested framework that illustrates the interaction between the slow

182   deliberate reflective off-field environment and the rapid on-field competitive environment

183   with the focus of developing team DM. We argue that team DM is developed through a

184   combination of two very different DM paradigms. A slow deliberate reflective off-field

185   training context (more akin to Classical Decision Making; CDM) where mental models are

186   constructed and which simultaneously connects to the in-action high pressurised on-field

187   environment (aligned more with the NDM theoretical approach; see Klein et al, 2007); where

188   mental models are applied and used to inform in action decisions collectively as a team

189   (Merola & Richards, 2010; Richards et al., 2012). It is proposed that team decision making

190   requires the complex interaction of psychomotor (e.g. technical execution, cue identification,

191   interpretation of situational information and physical movement etc.) and psychosocial

192   processes (e.g. creating of a shared vision and common language amongst coaches and

193   players within the context of shared team philosophy). The creation of pedagogical processes

194   which address psychomotor and psychosocial mechanisms are outlined in Model 1 and 2 and

195   results in the effective identification, interpretation and communication of key information in

196   competitive situations, eventuating in successful team play.

197   **Model 1- Developing decision-making in team sports: Cognitive layering and**

198   **contextualisation**

199   Model 1 proposes that the complexity of improving and developing DM skills in team sports

200   demands that we consider the integration of three components; the technical skills required to be

201   executed, the tactical understanding of the play when performed in real-time; and the co-

202   ordination of all of these aspects by players collectively as a team; all within the particular

203   context of the situation in which the decision is framed (Richards et al., 2012).

[INSERT FIGURE 1 HERE]

205 *Developing a performance vision: Layer 1.*

206 The initial phase of the model (Figure 1) involves the establishment of the performance vision

207 (which includes team trademarks and generation of concepts) which contribute to the team's

208 playing philosophy. The establishment of the team's concepts is crucial as these provide the

209 framework that will direct attentional focus and determine how knowledge is clustered (Merola

210 & Richards, 2010). Constructing these concepts in this early phase is initially shaped by the

211 coach's vision of what the 'ideal' performance will ultimately look like for this particular set of

212 players (an *alpha version* of the performance vision, see Richards et al., 2012). Only when this

213 alpha version of performance is established can it be divided into small aspects of play: for

214 example, an attacking centre pass in netball or an attacking pattern of play in hockey.

215   During the sporting programme, the coach's vision of performance is reshaped as players are

216 actively encouraged and empowered to contribute to the performance vision (Bate & Richards,

217 2011; Merola & Richards, 2010). The incorporation of the player's perspective (bottom-up

218 approach; Richards et al., 2009; 2012) reshapes the coach's initial vision (alpha version) and

219 results in the construction of the new final *beta version*. This refinement process is crucial in

220 gaining buy-in from players and will facilitate a deeper and more meaningful engagement with

221 the DM process. The outcome of which is the establishment of a shared team perception, shared

222 language and collective thinking; players are genuinely empowered as they are working within a

223 structure which they helped to create.

224   This collective performance vision (beta version) results in the construction of MMs that

225 represent key aspects of performance. Mental models have been simply defined as '... internal

226 representations of the external world… [which] represent the experts understanding of the

227 situation' (Serfaty, MacMillan, Entin, & Entin, 1997, p.235). They provide information about a

228 situation to initially direct attention, then rapidly classify the information and interpret meaning

229 from it (Rouse et al., 1992). MMs are only valuable to the individuals who construct them

230 (Westbrook, 2006) so it is important that coaches facilitate opportunities for players (both

231 individually and collectively) to contribute to the development of MMs and subsequently SMMs

232 (Eccles & Tenenbaum, 2004). The development of a team specific, SMM would demonstrate a

233 collective understanding of a situation in which players are able to execute the specific roles in a

234 coordinated manner to achieve the same perceived outcome (Richards et al., 2009).

235 Serfaty et al. (1997) elaborate on the concepts of MMs stating that '...expert memory

236 consists of an array of patterns with information items grouped and indexed by their relevance

237 for problem solving in the domain of expertise' (p. 235). This perhaps accounts for the

238 difference between the tactical MMs of an advanced sport performer and those of a novice.

239 The creation of such cognitive internalised structures by players (Richards et al., 2009)

240 provides a framework to structure, order and prioritise relevant information, thus facilitating

241 correct decisions. The formulation of these MMs also enables individuals to learn and

242 comprehend the nature of the situation more quickly (Ross, Battaglia, Phillips, Domeshek, &

243 Lussier, 2003).

244 The establishment of the shared performance vision enables information to be transferred and

245 integrated from a top-down knowledge process (alpha performance vision) and a bottom-up

246 knowledge process (MMs and SMMs – developed by players and coaches) simultaneously

247 (Richards et al., 2009). It is these two interactive processes, which are instrumental in shaping the

248 development of DM.

249 The top-down knowledge process provides the framework in which the beta version of

250 performance can be subdivided into relevant playing aspects. This division enables aspects of

251 performance to be identified and split into more manageable chunks and priorities (e.g., attacking

252 play patterns might be a priority). These key aspects of performance (each one relating to the

253 performance vision) are then rebuilt through the bottom-up knowledge process. Such MMs

254 incorporate players' skill sets, individual roles, team principles of play and recognition of

255 situational factors. This process enables players to cluster information and construct internalised

256 plans (Bates & Richards, 2011; Richards et al., 2012), which facilitate improved DM at an

257 individual, unit and team level.

258 ***Perceptual drive and technical execution: Layer 2.***

259 Technical executions have a direct link to both tactical and strategic layers of the DM process.

260 There is a complex exchange of knowledge and information across the respective knowledge

261 layers, which dictate that several cognitive processes are occurring simultaneously. Shared MMs

262 are driving a top-down approach, influencing cue identification. In this process, players'

263 commonly agree a weighting scale for which factors in any display are the most pertinent.

264 Simultaneously, perceptions of environmental cues (bottom-up) are governing the recognition of

265 tactical patterns (utilising experience), which, in turn are determining what technique will be

266 executed by the player. This process is complex but of relevance here, as the process by which

267 cues are recognised and interpreted determines the action (preparatory movement) taken by

268 individual players prior to the execution of technical skills, therefore resulting in superior skill

269 execution. Notably, Starkes, and Ericsson (2003) confirmed that the way in which technical and

270 tactical skills interact is complex and not well understood.

271 Importantly, the development of sport skills requires two-stages (Dunn, 2006). This includes

272 the player acquiring a range of technical skills, as well as an established link to where and when

273 in the game context they would be used. Dunn (2006) also proposed that the level of tactical

274 knowledge in novice performers and their DM ability could exceed their technical ability to

275 execute these skills in a performance context. This further reinforces the importance of technical

276 skills, which are continually emphasized by elite coaches. Indeed, we would suggest that the

277 limited ability to execute skills influences the tactical options taken within a playing context. For

278 example in field hockey, a player without the technical ability to produce an aerial pass would

279 remove that tactical option; in short, they would not look for it so hardly ever see it. Similarly,

280 the limited technical ability to pass using either hand in netball/basketball determines the tactical

281 decision that is made. The way in which this technical deficiency impacts on DM has yet to be

282 discerned although, anecdotally at least, it seems that players without a particular skill fail even

283 to consider, let alone see the options related to their weakness. Unsurprisingly therefore, French,

284 Spurgeon and Nevett, (1995) concluded that technical skill was a distinguishing factor in

285 determining a player's performance level.

286 It therefore appears that the layering approach outlined in this paper presents a possible

287 rationale for building decision-making knowledge (technical, tactical and strategic) as a

288 mechanism to develop DM capabilities. Furthermore, the layering of information must consider

289 the technical component performed within the tactical situation, so that both are contextualised

290 within the performance vision (objective). In light of this, we propose that different theories

291 located within the NDM paradigm could collectively (rather than singly) provide the best

292 possible framework for developing team DM.

293 Pertinent to such challenges, RPD (Klein, 1998) proposes a dual system, which integrates

294 intuition and subjective analysis of the situation. The application of RPD (see also Klein, 1993)

295 to team sports enables us to gain an understanding of what cues are attended to, together with

296 how they are prioritised and used to inform and influence decisions. In field hockey for example,

297 at a basic level the cues from where an attacker is carrying the ball and the angle of the stick will

298 inform the defender of potential moves that the attacking player might take. Hence, these cues

299 facilitate decisions as to what actions the defender might initiate, such as which technique for

300 tackling will be implemented. At a more complex level these technical cues, combined with

301 identified elements from the tactical environment (thus combining layers 2 and 3 of the DM

302 process), would inform what decisions might be taken at an individual level and collectively at a

303 defensive team level (action involving multiple players). By contrast, a reliance on a cue-only

304 driven approach (bottom-up) would often result in DM errors such as defending the option being

305 'shown' by the attacker but permitting a pass which carries greater threat to the team. Clearly,

306 reliance on intuition alone is too risky as pattern matching can generate flaws in perception

307 (Klein, 2008).

308   Klein's (1993) cue based RPD model incorporates both intuition and analysis of situations

309 (Klein, 2008) and can be used to some extent but not solely, to explain basic DM in sport.

310 However, as proposed in the first model (Figure 1) there also needs to be an established link of

311 technical skill proficiency to the competitive context (Bock-Jonathon, Venter, & Bressen, 2007).

312 This lends additional support to the layering of technical, tactical and strategic approaches as

313 proposed in this paper.

Tactical and situational awareness development: Layer 3.

315 This third layer of the model indicates the development of cognitive knowledge structures (MMs

316 and eventually SMMs) relating to tactical play, which incorporate situational factors and visual

317 cues. DM at the expert level requires both individuals and teams to adapt their knowledge to the

318 complexity of the situation in which they are playing (termed macro-cognition; see Klein 2008).

319 Making effective decisions requires MMs to be constructed that are unique to specific situations

320 (e.g., attacking play from the left defense). The nature of the situation (for example attacking

321 verses defensive situations) will require a different DM engagement.   Such cognitive

322 representations are driven by the experience of the player and the playing philosophy established

323 by the team (utilising top-down knowledge processing). This process occurs simultaneously, as

324 the player is actively perceiving their current performance context (location on field, position of

325 teammate and opposition, plus other contextual factors); making sense of the current performance

326 situation they are participating in (bottom-up knowledge processing) within the context of the

327 team playing philosophy (top-down knowledge processing). To gain an understanding of these

328 concepts within the performance context warrants the additional inclusion of a situational

329 awareness framework as a theoretical approach to justify the importance of the environment in

330 which decisions are made.

331 Situational Awareness (SA) proposes a hierarchical model (Endsley & Garland, 2008)

332 consisting of three levels. Level 1 involves the perception of important cues. Level 2 is

333 concerned with the comprehension of these cues and level 3 allow individuals to predict future

334 situations by integrating past experience to the situation. Caserta and Singer (2007) proposed that

335 level 3 Situational awareness distinguishes elite from non-elite performers in any domain.

336 Pertinently for applied practice, this paper proposes that such situational specific knowledge

337 structures (MMs/SMMs) are developed through the combined interaction of off-field, slow

338 reflective deliberate environments (team meetings etc.) and on-field dynamic training/matches

339 environment (see Figure 2). The development of MMs for specific situations enables players and

340 teams to attend to information that is agreed as being significant. Players then prioritise and order

341 this information so that the correct course of action can be followed (Bate & Richards, 2011;

342 Thevenot, 2009).

343 As a further element, combining the contributions of RPD and SA, Klein et al's (2007)

344 concept of sensemaking makes a valuable contribution to enhancing our understanding of

345 how MMs are developed. Sensemaking goes beyond the comprehension of environmental

346 cues and the reader is encouraged to read Klein et al, (2007) for a comprehensive account of

347 The Data-Frame Sensemaking Theory. Sensemaking proposes an approach in which the

348 experience of the individual (we propose also the experience of the team) can be used to

349 'frame' (comprehend) a playing situation. As the players and team collectively 'frame' the

350 situation (place it in context of previous experiences), data points (performance cues) in

351 competition can be interpreted and collectively responded to. Sensemaking facilitates the

352 performer (we argue also the team) establishing connections and relationships between

353 environmental cues. Such visual perceptions are contextualised within previous playing

354 experience (individual/team). The construction of slow, deliberate, learning situations,

355 whereby individuals are empowered to reflect and contribute to providing a solution (Figure

356 2), results in the content of these situations being internalised and stored by players/teams

357 (Richards et al., 2009, 2012). This produces an increasingly robust mental model where, in

358 future situations, information perceived in the environment is matched, enabling rapid

359 execution of technical and tactical skills (Bate & Richards, 2011).

360 While we await investigation of sensemaking in sport, the implication for coaches is that the

361 information necessary to formulate MMs and SMMs requires development in a progressive and

362 logical manner. This will incorporate the perception of the situation together with cue

363 recognition. As generations of the playing concepts develop, both in variation (specific to

364 situations) and detail, the playing philosophy of the team moves from providing the simplest

365 answer to a more complex, strategy-based approach as multi-play patterns are developed. In this

366 regard, the update of information we gain relating to MMs enables the models to be modified and

367 refined in light of new experiences (Kessler, Duwe, & Strohmer, 1999). The engagement in slow

368 deliberate reflective processes during off-field team meetings not only updates team MM/SMMs

369 but creates a simulation environment where solutions are discussed which relate to future playing

370 situations. This team simulation process (Klein, 2008) contributes to an improvement in the

371 consistency of team decision in a competitive context. It is a crucial facet through which SMMs

372 are developed as genuinely shared, rather than just a conglomeration or averaging of different

373 individuals viewpoints. In short, what is developed is a real shared vision – a team vision –

374 rather than some political compromise. The team parameters which impact on shaping the

375 development of a team's vision are multifactorial (see Richards et al 2009) and include

376 player/team maturity, empowerment process and experience to mention only a few.

377 *Strategic development: Layer 4.*

378 In the fourth stage of the model, team members are perceiving the situation (perceptual cues,

379 knowledge structures) in the same way by placing the same value on key markers (cues) in the

380 environment. Through having a common perception, the team can now generate a reduced

15

381 number of plausible options (playing actions) by having a commonly agreed assessment of the

382 situation. Where an obvious playing option has been perceived this will be taken. Difficulty

383 arises when several options present themselves which all relate to achieving the same team

384 outcome. In such situations we would argue that the agreed team SMM (players perceiving the

385 situations the same) results in the team intuitively considering perhaps only one or two possible

386 options. Notably, however, this intuitive understanding has arisen from the slow deliberate

387 reflective team meetings and associated discussion. Thus, through 'satisficing' (see Simons,

388 1957), the team collectively takes an option, which will produce a successful outcome.

389 The final challenge for sports coaches developing DM skills in a team context is the

390 construction of communication and coordination processes. The success of team performance is

391 reliant on tasks being simultaneously performed by multiple or cooperating individuals.

392 Therefore, individual's tasks, language, thinking and schema need to be coordinated and

393 integrated (Eccles & Tenenbaum, 2004). In team sport, success will frequently be determined,

394 not only by the contribution of the team member's skill-sets (layer 2) but also through the

395 coordinated and integrated manner in which the perception, decisions and actions of the team are

396 executed. In order for the team to perform in this coordinated manner, members must share a

397 common perception of the objectives of the task (game plan) and the approaches required to

398 achieve success (team principles of play). This shared approach or common way of thinking is

399 developed through SMMs and represents the highest strategic level of DM required at the elite

400 levels in team sports.

401 Although SMMs have been recognised as a method for studying skilled performance in teams

402 (Cannon-Bowers, Salas, & Converse, 1990), the exploration of SMMs in a sporting context has

403 been limited. Yet it seems logical that the integration of multiple tasks and roles of individuals

404 need to be communicated and coordinated in environments where the dynamic nature and speed

405 of task execution limits discussions. At the same time, situations must be similarly perceived if

406 they are to be collectively responded to in order to achieve the team's objective. Bridging this

407 apparent conundrum, SMMs provide a structure for teams to share a common perception of the

408 expected outcome of a situation (winning a game) and the process required to achieve this

409 (understanding of the coordination of individuals' roles). SMMs also act to speed-up and ease

410 communication. For example, Heath (1991), working with a baseball team, highlighted how

411 developing SMMs reduced the need for prolonged and explicated communication within the

412 team.

413 *Beta vision of performance: Layer 5.*

414 When collectively performed, the development of the SMM at the strategic level results in

415 delivery of the beta-version of performance in the competitive setting (Richards et al, 2009). This

416 will, in theory, consistently produce the 'ideal' performance. Of course, this vision of

417 performance is continually being reshaped and developed by coaches and players throughout the

418 duration of the team's life cycle. The extent to which this final stage is successful is very much

419 influenced by the quality of the previous layers of tactical recognition, technical execution of

420 skills and the development of shared cognitive frameworks. In practical terms, some would

421 propose that it is rarely, if ever, achieved. However, pursuit of this ideal through the methods

422 described above is arguably the best way in which high levels of performance can be realised.

423 **Model 2 – Developing rapid high-pressure decision-making through slow deliberation**

424 Figure 2 presents a dual process model in which rapid, high-pressured, team DM can be

425 developed in dynamic competitive situations, through slow deliberate conscious off-field learning

426 combined with on field experience in games and training. The model has been empirically tested

427 and proved successful in field-hockey (Richards et al., 2009); football (Bate & Richards, 2011;

428 Merola & Richards, 2010) and netball (see Richards et al., 2012). The model proposes that, in

429 order to develop team DM skills, practitioners need to develop dual learning systems which

430 incorporate a slow deliberate reflective environment (off-field) and a dynamic performance

431 environment (on-field) where applied experience and knowledge is ascertained and 'automated'.

432 Both of these environments integrate the knowledge structures presented in the first section of

433 this paper.

434   Such dual processes draw parallels and relevance to other DM research situated outside of

435 sport in two respects. Firstly, there is considerable evidence that people make decisions by

436 utilising their previous experiences (Klein, 2008; Lipshitz, 1993). The recognition that an

437 individual uses previous experiences to make decisions in real-world situations is reliant on both

438 their perception and recognition of the situation. Secondly, the proposal that DM requires dual

439 systems, which are responsible for directing attentional focus has been substantially investigated

440 (Epstein, 1994; Evans 2008). Examples include Kahneman (2003) proposing his System 1 and

441 System 2; and perhaps more significantly in context of this paper, the work by Eysenck,

442 Derkshan, Santos and Calvo (2007) on Attentional Control Theory. Both of these approaches

443 propose that decisions cannot be made solely on the intuitive instincts of an individual. The

444 process ideally involves both intuitions and analysis of the situation (a dual system).

445   Eysenck et al. (2007) also made reference to a dual system and proposed that individuals have

446 a goal-directed attentional system and a stimulus driven system. In pressurised situations,

447 according to Eysenck et al. (2007), there is less reliance on the goal-directed attention system

448 (our equivalent of the top-down system) and more reliance on the cue driven system (cf. Bishop,

449 Duncan, Brett, & Lawrence, 2004) to shape decisions (our bottom-up approach). This would

450 explain the decrease in quality of DM evident in highly pressurised matches, supporting the need

451 for a dual system. In these circumstances, players often revert back to processing instant cues in

452 their environment, which is often less helpful as it is not informed by the large context (game

453 objectives) in which the decision is made. So there appears to be growing and independent

454 support for the principle that the complexity of DM requires more than one system to process

455 information.

456   Model 2 illustrates the cyclic link where knowledge is developed simultaneously in both off-

457   field and on-field environments (dual process).   The integration of the off-field environment

458   (e.g., team discussion and reflection) into the coaching process, in which performers are

459   empowered to discuss and explore aspects relating to play; combined with on-field experiences

460   results in the development of enhanced team DM. The cycle relationship between on-field and

461   off-field environments facilitates the development of a team direct stimulus system (off-field) and

462   an intuitive experienced based system (on-field) team decision making framework.   The off-field

463   environment facilitates the development of robust SMM which players personalised to their

464   playing position and in doing so construct internalised plans (understanding of their own role in

465   that specific situation, Richards et al, 2009).   The establishment of the SMM and internalised

466   plans are utilised in future playing situations, allowing deployment of enhanced rapid DM skills

467   (Richards et al., 2012).

468   Model 2 (see Figure 2) presents a three phase approach to developing team DM. The model

469   incorporates both feedback and feed-forward mechanisms, creating a cyclic link between

470   continual learning and the evolution of playing constructs. The three phases are distinctly

471   different and are responsible for developing cognitive structures (MMs/SMMs outlined in model

472   1) in relation to the specific performance contexts. The creation of these knowledge structures

473   facilitates the players (individually or collectively) attending to agreed information in the

474   performance environment. Once information is attended to, it is prioritised and ordered in

475   relation to agreed principles of play, enabling the correct action of play to be executed

476   individually or collectively as a team.

477   [INSERT FIGURE 2 HERE]

478   *Model 2: Phase 1*

479   The first phase of the model highlights the establishment and generation of playing concepts.

480   The complexity of these concepts (MMs) will very much depend on the performance level

481   parameters of the individuals and the team. Constructing a shared understanding of the team's

482 objectives allows the development of team principles. These principles also allow the

483 concepts to be recognised in play and are essential in establishing subsequent SMMs.

484 Establishing a shared player perception of playing concepts (playing philosophy) and the

485 generation of playing principles that underpin these playing concepts, results in the

486 development of a shared language that can be used to further develop teamwork (Mascarenhas

487 & Smith, 2011).

488 *Model 2: Phase 2*

489 The second phase of the model relates to the development and enrichment of knowledge

490 structures. A combination of empirical and experiential evidence suggests that, in order to

491 develop rapid DM skills in individuals and teams in competitive situations, the process of

492 slow, deliberate learning is required. Without this, developing a team's understanding of

493 concepts and transferring such knowledge to competitive situations is limited, resulting in a

494 'recipe' or 'Standard Operational Procedure' style of DM, often choreographed by the coach.

495 Most playing concepts (phase 1) are developed through team meetings of various styles,

496 where the use of video and performance analysis is increasingly common. In most situations,

497 clips are presented to the players where aspects relating to the video are reviewed. Through

498 slow deliberate and conscious team discussions, the video is explored and a group decision is

499 made with regard to the best option to take. Reflecting on these situations and identifying the

500 important aspects of each clip enables SMMs to be constructed. This employs a slow

501 deliberate approach to DM to develop a subsequent NDM application in the performance

502 setting. Engaging in such slow deliberative processes enables similar situations in future

503 games to be responded to at a quicker rate and more successfully (cf. Mascarenhas, Collins,

504 Mortimer, & Morris, 2005).

505 The creation of this slow, deliberate environment must also address the development of

506 knowledge structures that are specific to the situation. Reviewing the situation at a descriptive

507 level is not sufficient to improve DM. The development of more elaborate, often multiple

508   option SMMs for specific situations can more effectively guide the attention of the performer

509   to the relevant aspects of the display. This shared perception also facilitates a collective

510   approach to the situation where individuals have a clear understanding of their own role in the

511   situation, as well as the action required by others within the context, in addition to

512   understanding the actions being performed by the opposition. A shared perception and

513   common understanding of situations produces a higher level of connectivity between players

514   as well as an agreed team approach to addressing the situation. This also leads to the

515   development of a common language, enabling players to have an agreed understanding of a

516   situation where the execution of action by multiple players can be verbalised in just one or

517   two words (Richards et al., 2012).

518   As the playing concepts develop both in variation (specific to situations) and detail, a parallel

519   development occurs with established, team specific SMMs. Original, simple SMMs develop

520   in complexity to match the increasing complexity of multiple patterns of tactical play. This

521   deliberate knowledge environment then shapes both the development and interaction of off-

522   field and on-field practices.

523   *Model 2: Phase 3*

524   In the third phase of the model, the cognitive structures are applied to the competitive

525   situation. The application of these structures to the performance setting enables individuals to

526   execute technical and tactical skills successfully. Additionally, the team specific SMM

527   facilitates greater and more effective connective play. This is evident in multiple play patterns

528   being created by teams. The shared perception of the preferred option is recognised and

529   communicated by teammates, resulting in coordinated actions of multiple players.

530   The link between the slow deliberate environment (where constructs are created) and the

531   applied environment (where the constructs are executed) is facilitated by an interacting pair of

532   feed-forward and feedback mechanisms. These mechanisms enable the complexity of SMM to

533   be developed as the team progresses to higher playing standards. The mechanisms also

534   provide a process where the models are continually evaluated for their effectiveness, as both

535   the individual and the team reflect both on and in action.

Conclusion and moving to the next step

537   In this paper we presented an empirically tested framework for developing team decision

538   making. The model has been developed over 15 years of elite coaching practice and is

539   informed and influenced by both academic research and practical understanding. We

540   apologise if the level of referencing is a distraction to readers but, we suggest, the complexity

541   of team decision making requires the integration and understanding of several key concepts,

542   each originating from a specific and different discipline. Each of these disciplines (motor

543   control, social psychology, cognitive psychology, NDM and pedagogical preprocess) have

544   influenced our understanding of how team decision making is developed. Unfortunately,

545   however, many authors (both applied and academic) have to date explored decision making

546   through use of these various disciplines in isolation. We have focused not just on the

547   messages from several disciplines but, more particularly, on their integration; considering the

548   interactive and complimentary influences as well. We commend this approach to

549   practitioners and researchers alike.

550   In summary this paper presented a five stage framework which incorporates a holistic

551   approach to developing team decision making. The paper addresses the development of rapid

552   high speed DM processes (in competition) whilst integrating the development of SMMs and

553   cohesive structures within the team's social milieu. Reflecting this essential complementarity,

554   we suggest that the development of individual and team DM skills in sport cannot be

555   developed effectively without the use of a slow, deliberate, off field reflective environment

556   and the application of this slow deliberate thinking into the applied tactical knowledge

557   environment (performance context). The decision making process is complex and

558   multifactorial as it involves classical and naturalistic approaches; on-field and off-field

559   environments and the integration of top-down and bottom-up approaches. We would stress

560 that much of what is proposed here has been tested empirically in high level sport. This is a

561 genuinely workable solution to a real life issue. By providing coaches with the step-by-step

562 logic through which the model has been derived, we hope that the understanding of these

563 parallel processes has been developed to the degree necessary to enable them to take and

564 apply the model in their own team settings.

<div align="center">**References**</div>

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