Exploring Cue Use in Rugby League Playmakers to Inform Training Initiatives

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ABSTRACT

Within the sport of Rugby League there exists a perceived shortage of talent in playmaking positions (i.e., halfback, five-eighth and hooker) (Barton, 2013). An academy dedicated to the development of playmaking skills has recently been established (Proszenko, 2013). The precise skills targeted by the academy for development have yet to be determined. The purpose of the current research was to investigate the nature of cue use in decision making in a Rugby League context and determine whether players of differing ability could be differentiated to inform potential cue-based training initiatives. Rugby League playmakers were interviewed using a variation of the Cognitive Task Analysis, which employed a picture stimulus. The sample consisted of 10 players, six of whom played with a professional Rugby League team and four from an amateur Rugby League team. Directed content analysis was performed on the resulting transcripts, and concept maps, cognitive demands tables and a critical cue inventory was produced. Results indicated that professional players demonstrated greater cue discrimination, assigned different meaning to the cues, and processed cues in a different manner to amateur players. The results offer insights for future design of training programs in the development of playmaking skills, and raise important questions regarding the use of critical cue inventories in training.

KEYWORDS

Research/Experimentation; Cognitive Task Analysis; Decision Making; Sport

INTRODUCTION

Within the sport of Rugby League there exists a perceived shortage of skilled playmakers (i.e., halfback, five-eighth and hooker) (Barton, 2013). Consequently, an academy, dedicated to the development of playmaking skills has recently been established (Proszenko, 2013). However, the precise skills targeted by the academy for development are yet to be determined.

It could be argued that decision-making, how people select one option from a set of possible options (Tenenbaum & Bar-Eli, 1993), is a critical skill for a Rugby League playmaker. Specifically, being able to estimate or predict some aspect of the environment on the basis of available cues would seem intuitively important to such a rapidly played out sport. Cues constitute a relationship held in memory between environmental features and/or events that hold some meaning or value to the individual (Ratcliff & McKoon, 1994).

It has been hypothesised that cue selection/use results from previous environmental experience (Wiggins, 2006). The value of using appropriate cues in sports has been shown in temporal occlusion studies, which show that when particular body segments were occluded, there is a significant decrease in prediction accuracy (Shim, Carlton, Chow, & Chae, 2005). Thus, it would appear that a characteristic of superior decision-making performance may be reflected in an individual's capacity to identify prospective features, ascribe meaning to salient events and avoid being distracted by other features (Shanteau, 1992).

The importance of cues to performance has been highlighted in research demonstrating that superior performers can be differentiated by the number of cues used (Shanteau & Hall, 1992). When both relevant and irrelevant cues are given, experts are better at cue discrimination, only selecting and using the relevant cues (Shanteau & Hall, 1992). It has been suggested that too many cues may complicate an array of information, impinging upon limited information processing resources. Cue discrimination may therefore allow for superior performance. For instance, research which examined batting in cricket has revealed that highly skilled cricket players use cues from the bowler to assist in decision making (Renshaw & Fairweather, 2000). Interestingly for highly skilled batters, it is not cues in isolation which provide the most information rather the cues in association to one another which leads to more accurate predictions (Renshaw & Fairweather, 2000). This cue clustering has also been observed in expert criminal investigators (Morrison, Wiggins, Bond, & Tyler, 2013) and has been suggested as being linked to formations of highly developed domain-specific memory structures (Yarrow, Brown, & Krakauer, 2009).

There has also been differences observed in the manner that cues are processed by expert and novice decision makers. Greitzer, Podmore, Robinson, and Ey (2010) observed significant differences between novice and expert power system operators in how cues were processed. The authors observed that novices would respond to cues and patterns at a rule-based level (Greitzer et al., 2010). Novices reacted to disturbances in an effortful conscious manner consistent with applying a pre-packaged unit such as an "If X cue then Y response"(Greitzer et al., 2010). This was considerably different to the expert operators who processed information at the skill-based level, reacting to these cues at an automatic subconscious level (Greitzer et al., 2010). Cues were used preventatively rather than reactively and the behaviour was executed with little conscious thought (Greitzer et al., 2010).

Within the sporting literature, research has suggested that players control a situation by focusing on salient cues which allow them to make the most appropriate decision (Macquet & Fleurance, 2007). Within the sport of Rugby League a further study has suggested that cues may play an important role (Gabbett & Abernethy, 2013). A study compared elite and semi-elite players in their ability to react to Rugby League defensive scenarios which were projected onto a screen (Gabbett & Abernethy, 2013). Participants were compared with respect to their response times and the accuracy with which they responded to the stimulus. The study found that highly skilled players had faster response times and had greater accuracy in their responses (Gabbett & Abernethy, 2013). It was suggested that this demonstrated the ability of experts to recognise relevant game-specific cues to which the lesser-skilled players were not attuned (Gabbett & Abernethy, 2013). To date no research has examined what cues allow for this improvement in performance. Similarly, the nature of the study did not assess whether differences existed in how the cues were used as a function of skill level, nor did it explore how such rapid assessments are made possible within a decision making system.

The present study aimed to examine the extent to which cues are used within the sport of Rugby League. From the research outlined, it was anticipated that cues would be used as a means to assist in decision making. The research also aimed to determine whether cue use changed as a function of the level of players' expertise. From the research examined it was anticipated experts would practice greater cue discrimination than novices. It was also hypothesised that experts would process, assign meaning and use these cues differently to novices.

METHOD

Participants

The participants consisted of players from a semi-professional rugby league club (N=3) and players from a professional *National Rugby League* Club (N=7). The representative structure which players progress through represents a continuum with which to judge relative expertise in players. This system discriminates based on ability and only those who demonstrate consistent replicable superior performance progress to a higher grade. Although differences between grades have not been quantified explicitly, they do represent an objective measure of different competencies and were used to categorise players. Players were assigned categories based on their grade, with category 1 representing the highest level of ability and category 4, the lowest. See Table 1 for distribution of participants across gradings and their assigned player category.

Table 1. Distribution of Participants in Study

Team	Grade	Number of Participants	Player Category
Professional	First Grade	1	1
	Reserve Grade	3	2
	National Youth Competition	3	3
Semi-Professional	First Grade	1	4
	Second Grade	2	4

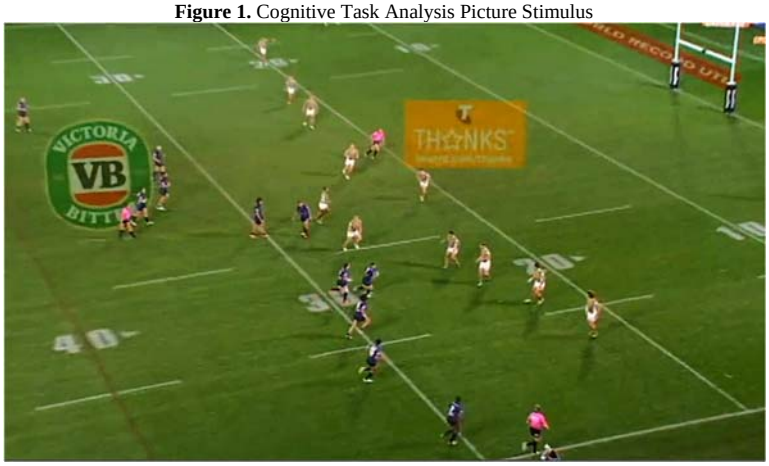
A semi-structured interview was conducted based on Cognitive Task Analysis (CTA) methodology. CTA methods were used to elicit the cues and contextual considerations influencing judgements and decisions (Militello & Hutton, 1998). The researchers used probes outlined by Militello and Hutton (1998), to help identify a range of cues and patterns. Questions were modified to align with the sport of Rugby League and the modifications were piloted on a Rugby League player. Prior to the commencement of the interviews, the modifications were verified as effective by a trained CTA expert.

Picture Stimulus

A picture stimulus was used in conjunction with the CTA as a means to stimulate further discussion and increase understanding of problem solving methods (Morrison et al., 2013). CTA methods rely on recall of an event in the player's history, which may limit the ability of researchers to compare between different participants. The stimulus created a unique opportunity to compare players of differing ability across a common scenario as well as corroborate knowledge which was elicited from the CTA interview.

The picture stimulus (Figure 1) was a scene from an actual First Grade professional rugby league match. The scene was selected due to the lack of structure in the defence which meant that there were many available options. The problem had a 'correct' answer in that the actual outcome of the scenario was a try (the optimal outcome). The scene was cropped to remove identifying information to ensure that players did not recognise the particular scene.

Figure 1. Cognitive Task Analysis Picture Stimulus



Data analysis

Data was analysed using a structured methodological approach in the form of a content analysis. Content analysis is a technique which provides knowledge and understanding of a phenomenon which ensures that all units of analysis receive equal treatment (Krippendorff, 2012). Participants were categorised and aggregated based on their level of performance and their experience. A coding framework was developed for the purpose of identifying cue use in order to guide the directed content analysis.

Text was also segmented into clusters and concepts which informed the decision maker to create concept maps. This was based on the methodology of Glaser, Lesgold, and Lajoie (1987). Concept Maps were used to represent the knowledge structures of the different categories of players as well as contextualise the cues and their constituted relationships. Concept maps have been used widely in the study of expertise (Cañas et al., 2005), often showing significant differences between experts and novices in knowledge and the structure of that knowledge (Glaser et al., 1987).

A cognitive demands table was used to decompose tasks in order to identify cue-based behaviour and allow for comparison across category groups (Militello & Hutton, 1998). The text was analysed through the identification of difficult cognitive elements and the problems and methods used by players to overcome them as outlined by Militello and Hutton (1998).

Critical cue inventories were used to organise the informational and perceptual cues that were present during a given protocol (Klein, 1996). Content analysis techniques were used to construct a critical cue inventory. This involved identification of cues based on previous operational definitions and making determinations as to whether they were present in each of the different categories of participants.

Cues were identified and tallied. If the player continued to refer to the cue that initiated his response it was only counted as one cue, consistent with Baber and Butler (2012). Parametric analysis was considered inappropriate due to the small sample size.

RESULTS

Cue Count

A cue count was conducted from both the cognitive task analysis and the picture stimulus (Table 2).

Table 2. Mean Cue Count across Category of Players

Category of Player	Mean Cue Count
4	39
3	28
2	35
1	24

Concept map

A concept map was created to analyse the relationship between cues used during decision-making and the decision response, and to compare across the different categories of players. It was observed that experts place different weighting and meaning on different cues. Concept maps allowed for this different representation of knowledge to be analysed. Cue correlations and structural differences were observed in the representation of knowledge as a function of category of player. See Figure 2 for concept map.

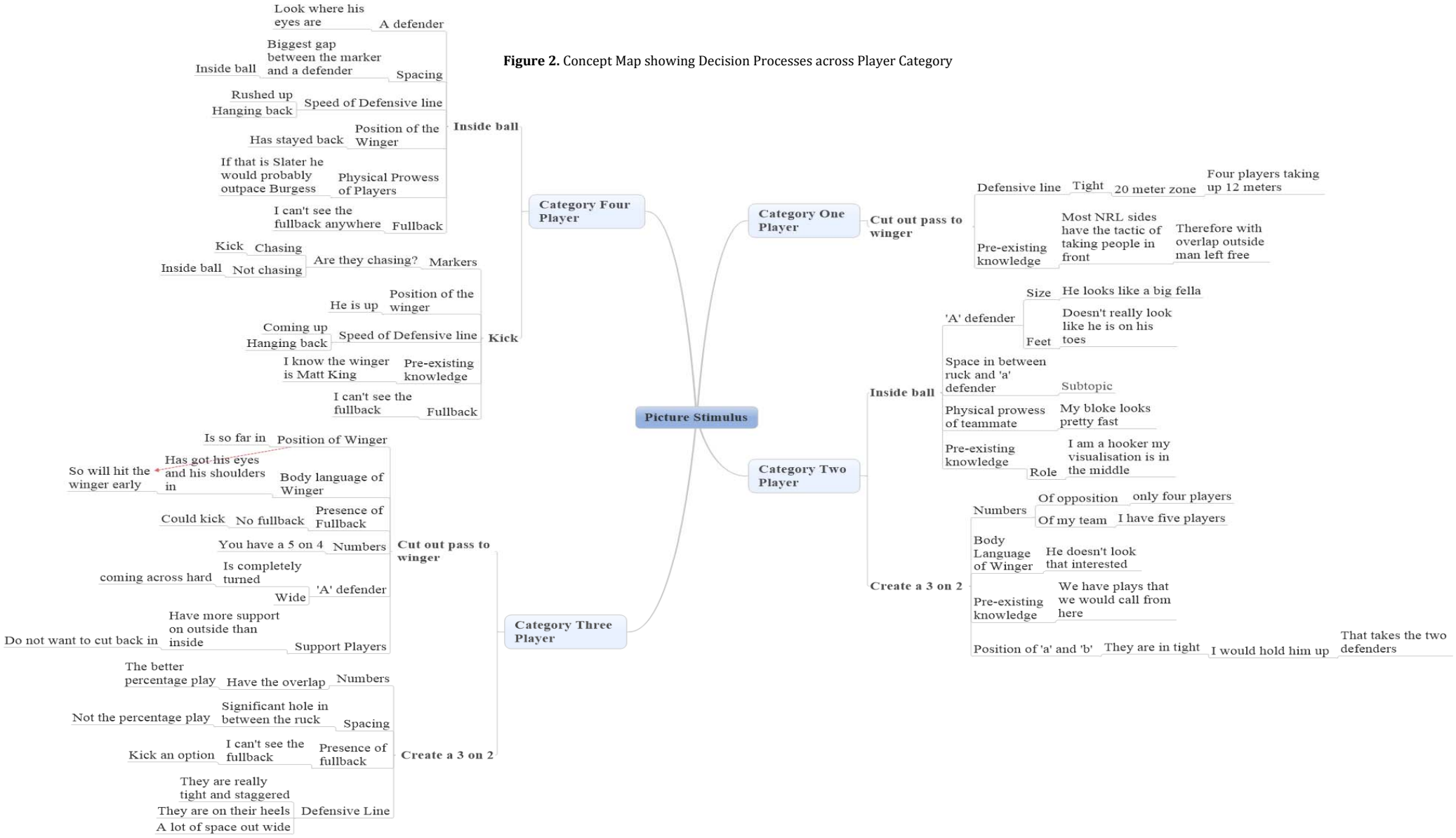


Figure 2. Concept Map showing Decision Processes across Player Category

Cognitive Demands Table

Responses to the Picture Stimulus Scenario was analysed to identify the cues and strategies used by players. The results of this are presented in Table 3.

Table 3. Cognitive Demands Table

Difficult Cognitive Element	Why Difficult?	Common Errors	Cues and Strategies Used
Picture Stimulus Scenario	There are a lot of options and a lot of unknowns	Going away from your support Not playing to your players capabilities	• Player cues: Where he is looking, size, shoulders, eyes • Numbers "When you have the numbers you let the defenders make the decisions" • How compact the defence is "Within the space of this 20 metre zone here they are taking up 12 of it" • Timing "Not showing your hand too early" • Space "Biggest gap is in between the marker and the a defender" • Ability of your players "He knows that **** is the centre and knows that if **** gets the ball he will score"

Critical Cue Inventory

A total of 10 critical cues were identified in the Picture Stimulus (Table 4). Differences in the presence of cues as a function of category of player were observed. For Category 4 players, $N = 5$, Category 3 players $N = 7$, Category 2 players $N = 7$, Category 1 players $N = 2$.

Table 4. Critical Cue Inventory

Cognitive Element	Cue	Descriptor	Category of player 1	2	3	4
Picture Stimulus Scenario						
	Space	"There is a big gap behind the ruck"	✓	✓	✓	×
	Numbers	"You obviously have the overlap, you would look at the numbering which is in our favour"	×	✓	✓	×
	Position of players	"Winger is just hanging back sort of thing and he has got his eyes and his shoulders in sort of thing so probably looking to hit the centre or the winger early" "I can't see the fullback so the kick would be an option"	✓	✓	✓	×
	Size	"That looks like a big fella so I would go to the outside of A"	✓	×	✓	×
	Eyes	"I would look where his eyes are, if he is looking at my support player"	✓	✓	✓	×
	Shoulders	"I am looking at their shoulders whether the shoulders are turned in or out"	×	✓	×	×
	Defenders	Whether they have rushed up or are hanging back"	✓	×	✓	×
	Support players	"You can't really take the line on here well you can but because you have 5 on 4 you don't really want to come back to a because that is just away from your support"	×	✓	×	×
	Defensive Line	"Within the space of this 20 metre zone here they are taking up 12" "They are really tight and you can see the staggered line"	×	✓	×	✓
	Feet	"I could see centre was either flat footed or his feet stayed planted"	× 5/10	× 7/10	✓ 7/10	✓ 2/10

DISCUSSION

As anticipated, cue use was found to be an important aspect of playing the game of Rugby League. All players recognised that cues are an effective source of information. Whilst some cues were used universally across all categories of players, there were important differences with respect to the ability for higher skilled players to discriminate amongst cues. There existed differences in the meaning attributed to the cues. There also existed differences in how cues were used. Lower skilled players were able to recognise and use cues whilst higher skilled players were able to discriminate between cues as well as having the capacity to control the opposition through deliberate moves to misdirect their cue reading (counter cues).

Cue Use and Rugby League

Consistent with previous research, cues were used as a means to inform decision making. Players used body cues such as position of the shoulders or where the player was looking as a means to predict player movement (see Table 3). This is consistent with Macquet and Fleurance (2007) and Renshaw and Fairweather (2000) who showed that players control the situation by focusing on salient cues which allow them to make more accurate predictions.

Whilst individual cues were identified, analysis revealed that the association between separate cues as components of a correlated relation was a factor. In the performance of a kick, each category of player recognised the importance that the position of the winger in conjunction with the position of the fullback held. A

Category two player identified this, "The main thing is just the position of the full back and the winger". This suggested that players do not just use cues in isolation, but rather, it is the association between each of the cues which activates the conditioned-action response. Morrison, et al. (2013) suggested that cues which are correlated together form cognitive links. These links result in a reduction in amount of cognitive resources used rather than if the individual had to consider the cues separately. Wickens and Hollands (2000) hypothesised that these individuals were able to create higher order cognitive representations of items within long term memory structures. The theoretical implication of this is that it leads to building structures upon structures, the problem of infinite regress.

Consistent with previous research, players associated with a higher degree of expertise showed greater cue discrimination (Shanteau & Hall, 1992). A comparison between a Category One and a Category Three player who gave the 'correct' answer on the picture stimulus task showed differences in the number of cues used. A cue count revealed that the Category Three player required 6 cues compared to the 2 cues required by the Category One player. This isolated effect is reflective of the pattern observed globally, which indicated that the number of cues used decreased as a function of expertise level. This is consistent with findings which have shown that highly skilled operators only engage a limited number of critical cues, as opposed to less skilled operators whom reportedly engage a number of non-relevant cues (Martell & Vickers, 2004; Raab & Johnson, 2007). It may be that experts are able to 'chunk' more information than novices with no loss in the amount of information conveyed in those 'chunks' consistent with observations made by Chase and Simon (1973). This could also be explained through pattern recognition skills, which have been shown to be more prevalent in experts (Abernethy, Baker, & Côté, 2005).

Expertise within a Rugby League context is more than just the performance of a skill, it also involves a refinement in the information processing of cues. The suggestion that the environment plays an important role in refining the cue discrimination process does not fully account for the ability of some players to be an active agent in this process. Some insight into this may be addressed through the way that players attribute meaning to the cues.

Meaning of the Cues

Previous research has shown that experts ascribe different meaning to cues which produced quantitatively different outcomes (Crandall & Getchell-Reiter, 1993). Consistent with this research, the players interviewed showed differences in the meaning that they assigned to cues. Category Four and Category One players both recognised size as an important cue. Category Four players assigned the meaning that size displayed a negative relationship with speed of the player such that a big player is thought of as slow. This is contrasted with the Category one player who assigned the additional meaning that size of the player showed a negative relationship with the speed of the play-the-ball. This discrimination within the cue creates differences in the retrieved representation and the associated response in its activation, such that for the Category One player, this meant actively avoiding big players in contrast to Category Four players who took that cue as a signal to attack. The recognition of this difference in meaning attributed by the Category Four and Category One players suggested that creating a critical cue inventory for assisting in training is not sufficient. Any training program which would be created would need to make explicit this difference in meaning.

The Category One's reporting of how he used his previous experience to inform his cue use was markedly different to how other categories assigned meaning and importance to the cues used. The Category One player used his knowledge of the game to identify the most important cue; "…most NRL sides are likely to have the tactic of taking the people in front of you and leaving the man free so to speak.." therefore "I would identify how tight they are so within the space of this twenty meter zone here". This is in constrast to a Category Three player who identified his support players as the cue which was most important; "you don't really want to come back to 'A' because that is just away from your support," therefore "I would identify options outside of me". A Category Four player assigned the gap to be the cue with the greatest meaning, "the biggest gap is in between the marker and the 'A' defender so I would probably go for the inside ball." It has been suggested that experts are able ascribe meaning and direct salience to the most effective cues (Klein, Calderwood, & Clinton-Cirocco, 1986).Whether the capacity to do this is the product or a result of expertise is yet to be determined. It was interesting that the Category One player and Category Three player both came to the same decision yet relied on a different set of cues.

How Cues Were Used

Cues used in decision making may not always trigger automatic associations but can trigger rule-based responses (Greitzer et al., 2010). A Category Four player responded to the information available within a structured rule-based way, Category Four player "I just pictured there being two defenders a lot wider than usual… and just pictured that and mentally rehearsed that so I could jump out and easily do that", this is in contrast to a Category One player who reacted to the information in an automatic, subconscious level without the need to interpret and integrate the information, "before catching the ball my mindset was a lot different to when I caught the ball… from my vision going from the defensive line to me catching the ball and then looking back and noticing that they had adjusted differently then changed my thoughts from not just running the ball but possibly getting around people." This is consistent with Greitzer et al. (2010) who observed that novices process input and

perform tasks at a rule-based level whereas experts are able to respond at a skill-based level, reacting automatically with little conscious thought. This reflected the observed progression in cue use with higher skilled players showing an ability to recognise that they were an active agent who exhibited cues and therefore would influence the cues that they would project to deceive other players; a Category One player, "I am enticing players to come out of the line. I've got the ball out in two hands and dummying, so with that being done they are obviously, they are not thinking that you are going to kick it." This was an ability not observed in lower skilled players who only identified that cues could be used as an important source of information. It is suggested that in freeing up cognitive resources more complex cue clustering may occur. This could be one explanation for the observation that experts have more complicated and detailed knowledge structures (Gourlay, 2006).

The change in cue use seems to suggest a complex process. A more in-depth exploration of the triggers, the variations, the decision thresholds, weightings and cue clusters is required. It would appear that players have developed some of these meanings and weightings based on previous experience. It could be hypothesised that the lower skilled players are continuing to reorder the cues significance whereas the higher skilled player is more confident in the reliability and validity of his cue choice to provide the outcome he wants. This is an area which requires future research.

Applications and Future Research

The methodological focus on cues meant that other aspects which may have further differentiated expert performers were not taken into account. These would include playing style or creativity, sometimes labelled instinctual playing. It would be helpful to develop questions around the players' use of cue discrimination and the reliability of cues used. This may provide greater understanding of how this cue use is developed.

An insight provided by a Category Two player suggested that the environment plays an important role in cue discrimination. Cue-based training programs work on this assumption (Perry, Wiggins, Childs, & Fogarty, 2013) and may be an effective means for novices to increase cue discrimination and learn reliable cue associations. The results of the current study suggested that all players have knowledge of the array of available cues, but differences exist in the number of cues they rely on. Zsambok (1997) developed a cue-based training program that encouraged the user to focus on and use critical cues associated with a task. This may be a more appropriate way of developing training. These training programs have currently not been applied to sporting domains. An important consideration is ensuring that the meaning of the cue and not simply the identification of critical cues is trained. Using virtual reality technology to develop cue association simulations may provide possibilities for future training in many operational domains, such as sport.

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