

Perceptual and cognitive expertise in sport

FOSTERED by visions of favourite players and teams in action, the appeal of the study of expertise in sport is fuelled by the partisan nature of spectators and armchair fans. The scientific study of expert performance provides a crucial window for understanding the acquisition of skill in sport, and in other domains. Knowing the essential attributes that distinguish experts from novices allows us to determine which types of practice are most likely to enhance the development of expertise. This allows us to test theoretical models of skill acquisition in mainstream psychology, as well as in the field of sport and exercise psychology.

It is now accepted that expert performance in sport is dependent on perceptual and cognitive skills as well as on physical and motor capabilities; consequently, the area of perceptual skill has attracted significant interest in recent years (e.g. Williams *et al.*, 1999). Studies have examined the use of optical information during interceptive tasks, such as catching and striking a ball in flight (e.g. Harris & Jenkins, 1998), as well as in more strategic situations involving 'game reading' or anticipation skill (e.g. Williams & Davids, 1998). Anticipation refers to the ability to predict what is likely to happen prior to the event itself. This ability to 'read the play' is essential in sport where the speed of the game means that decisions must typically be made in advance of an opponent's action. Key factors behind anticipation in sport include visual abilities, and perceptual and cognitive skills.

Visual abilities

Although there may be anecdotal evidence to suggest that experts possess superior visual systems than their less skilled counterparts, the empirical evidence is at best equivocal. For example, Ward *et al.* (2000) showed that elite and sub-elite football players between the ages of 8 and 18 years possess similar levels of visual function (as determined by standard measures of static and dynamic visual acuity, depth perception, and peripheral awareness). Although the visual system



Do experts have a visual and cognitive advantage?

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may set the limits to performance, these do not appear to be related to skill level (Williams *et al.*, 1999).

Perceptual and cognitive skills

From years of deliberate, purposeful practice, experts in sport (as in other domains) develop sophisticated knowledge structures that allow them to encode, retrieve and process information in an efficient and selective manner. Among other skills, experts are able to recognise and recall patterns of play effectively, use advance information cues arising from opponents'

postural orientations, and employ more appropriate visual search strategies than their novice counterparts. Also, irrespective of their ability to process contextual information from the evolving display, experts are more accurate than novices in predicting what is likely to happen. Each of these areas is briefly discussed.

Pattern recognition Following on from the classic work of de Groot (1965) and others in chess, the 'recall' and 'recognition' paradigms have been employed successfully within the sporting domain. It appears that expert sports performers display similar perceptual and memory skills as experts in chess, physics and architecture. The

seminal work by Allard *et al.* (1980) was carried out using basketball, but the findings have been extended to a variety of other sports such as volleyball, rugby, hockey and football.

In these studies experts and novices are presented with 'structured' film clips (sequences taken from regular match play) and 'unstructured' clips (e.g. teams warming up before a match, or players walking on to the field of play). Following a short viewing period, participants are required to recall players' positions at the end of each action sequence (recall paradigm) or to indicate whether they had previously viewed the action sequence (recognition paradigm). The expert's superior recall and recognition are observed on both structured and unstructured trials (Gobet & Simon, 1996), although the differences are much more pronounced on the structured sequences.

The ability to recall and recognise an evolving pattern of play is the strongest predictor of anticipatory skill in team ball sports (Williams & Davids, 1995), though there remains a vibrant theoretical debate about the mechanisms underlying such expert performance (see Gobet, 1998).

Visual search behaviours Sophisticated eye movement registration techniques have been employed in sport settings to examine differences in visual search behaviours between expert and novice performers (for a review see Williams, 2002). Initially, these studies relied on laboratory-based techniques involving static slide presentations, although recent advances in technology, such as integrated head- and eye-tracking systems, have made it possible for data to be collected *in situ* on the tennis and basketball courts (e.g. Singer *et al.*, 1998; Vickers, 1996).

The evidence indicates that expert performers show more pertinent search strategies, generally involving fewer but longer fixations, and that they fixate on more informative areas of the display than their novice counterparts. However, some conflicting findings indicate that even when the search strategies of experts and novices are indistinguishable, skill-based differences in anticipation are possible (e.g. Williams & Davids, 1998). The ability to extract better-quality information per fixation and to acquire information more effectively via peripheral vision contributes to the expert's superior anticipation in these contexts. Finally, recent data suggest that experts' search strategies are more robust than those of novices – they are less affected by changes in emotional states such as anxiety (Williams & Elliott, 1999).

Advance cue usage The more pertinent visual search behaviours employed by experts contribute to their superior ability to use early information from an opponent's postural orientation to anticipate action requirements. For example, a top-class tennis player can anticipate which side of the court they should be heading for by their opponent's body shape.

To investigate advance cue usage, participants are presented with filmed sequences that are representative of their customary view of the action. These film clips are selectively edited to provide a varying extent of advance and ball-flight information, with participants being required to predict the end result of the sequence observed.

The expert performer's superiority over the novice has been demonstrated in a range of sports, including tennis,

badminton and football, with these differences being more pronounced when the film is occluded prior to the key event such as foot-ball or racket-ball contact (see Williams *et al.*, 1999). Alternative techniques using high-speed film analysis of actual performance in squash (see Howarth *et al.*, 1984) and the use of liquid crystal occlusion glasses to replicate the film occlusion approach on the volleyball court (see Starkes *et al.*, 1995) have confirmed the robustness of this finding. A recent suggestion is that the experts' advantage on such tasks may be due to their heightened attunement to relative motion information, as opposed to the ability to fixate upon specific cue sources (Ward *et al.*, 2002).

Situational probabilities As well as their enhanced ability to process contextual information within the display, experts use knowledge stored in long-term memory to establish accurate expectations of likely events as the pattern of action unfolds. In a recent study elite and sub-elite soccer players were asked to assign probability values to the 'best passing options' available to a player in possession of the ball (Ward & Williams, in press). Various film sequences were paused immediately prior to the ball being passed and participants were required to highlight likely passing options. The elite players were better than the sub-elite group at identifying players who were in the best position to receive the ball, and were more accurate in assigning an appropriate probability to players in threatening and non-threatening positions, as determined by a panel of expert coaches. Anticipatory movements may be guided by these initial expectations and confirmed on the basis of

contextual information present within the display (e.g. effective pick-up of postural cues or recognition of an evolving pattern of play).

Implications for practice and instruction

So anticipation skill in sport appears to be due to enhanced 'computational' sophistication and improved strategic processing of sport-specific information, rather than to differences in visual abilities. To this end, cognitive interventions that develop the knowledge bases underlying skilled perception would appear to have more practical utility in facilitating the acquisition of expert performance than clinically based visual-skills training programmes. Video simulation has proved particularly effective as a method of developing perceptual skill, especially when coupled with appropriate instructional techniques (see Williams & Grant, 1999). Further research is currently being undertaken to examine how such training programmes may be designed, implemented and evaluated to facilitate effective transfer. The career practice histories of expert performers are also being examined using triangulation of data from retrospective recall, practice log books and semi-structured interviews in an attempt to identify key factors underpinning the development of perceptual and cognitive expertise in sport. Information of this nature should help practitioners develop expert performers in the future.

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