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The Relative Importance of Different Perceptual-Cognitive Skills During Anticipation

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Abstract

We examined whether anticipation is underpinned by perceiving structured patterns or postural cues and whether the relative importance of these processes varied as a function of task constraints. Skilled and less-skilled soccer players completed anticipation paradigms in video-film and point light display (PLD) format. Skilled players anticipated more accurately regardless of display condition, indicating that both perception of structured patterns between players and postural cues contribute to anticipation. However, the Skill x Display interaction showed skilled players' advantage was enhanced in the video-film condition, suggesting that they make better use of postural cues when available during anticipation. We also examined anticipation as a function of proximity to the ball. When participants were near the ball, anticipation was more accurate for video-film than PLD clips, whereas when the ball was far away there was no difference between viewing conditions. Perceiving advance postural cues appears more important than structured patterns when the ball is closer to the observer, whereas the reverse is true when the ball is far away. Various perceptual-cognitive skills contribute to anticipation with the relative importance of perceiving structured patterns and advance postural cues being determined by task constraints and the availability of perceptual information.

Keywords: Expertise; Visual Perception; Postural Cues; Task Constraints; Pattern Perception

1. Introduction

Anticipation, which is the ability to predict a future course of action or what will happen next, is critical in everyday tasks (e.g., crossing a road, performing an overtaking manoeuvre when driving), professional domains (e.g., military aviation, crowd-control, law enforcement), and sport. Regardless of the context, performers must contend with complex and dynamic environments, whereby the importance of anticipation is magnified given the strict temporal constraints involved. Those who excel at these tasks have been shown to use specific perceptual-cognitive skills that allow them to encode information and respond accordingly (Williams, Ford, Eccles, & Ward, 2011). One such process that has been proposed as critical in expert anticipation in team sports is the ability to perceive patterns within a display (Abernethy, Baker, & Cote, 2005). Another key skill is the ability of performers to pick up postural cues from an opponent's body movements. In the present study, we examine the relative importance of perceiving structured patterns and advance postural cues to anticipation.

The seminal research which highlighted the importance of perceiving structured patterns to expert performance came from the domain of chess (de Groot, 1965; Chase & Simon, 1973; Goldin, 1978, 1979) using recall and recognition paradigms. In the recall paradigm, participants recall the positions of display features after an initial exposure, while in the recognition paradigm, participants must judge whether stimuli that are presented in a 'recognition phase' have been shown in an earlier 'viewing phase'. The classical findings are that experts show an advantage in both recall and recognition for 'structured' stimuli (i.e., those sampled from in-game play), but this advantage is lost when attempting to recall or recognize 'unstructured' stimuli (i.e., those in which display features are randomly organized). The interpretation is that experts develop complex and domain specific knowledge structures that allow them to encode and store patterns from 'structured' stimuli due to their extensive exposure to such information previously. In contrast, when presented with random or 'unstructured' stimuli, their lack of exposure to such displays means experts are unable to perceive, encode, and store meaningful information and so their memory advantage is lost (Chase & Simon, 1973; Gobet & Simon, 1996).

Although these paradigms have been used extensively in the cognitive sciences, until recently there have been relatively few attempts to uncover the specific processes that underpin expert recognition and recall. Williams, Hodges, North, and Barton (2006) used the sport of soccer as a vehicle to test the hypothesis that skilled performers perceive structured patterns and relationships between features (i.e., players) to recognize stimuli, whereas less-skilled individuals rely on processing isolated and distinct surface level information. Skilled and less-skilled soccer players were presented with dynamic film displays in an initial viewing phase. In the subsequent recognition phase, participants were presented with point light display (PLD) stimuli in which background and superficial features (i.e., uniform color, environmental, and pitch conditions) were removed and individual players and the ball were replaced with colored dots that moved within an outline of the playing area. It was proposed that this procedure removed access to surface level and superficial information while retaining patterns between display features. Skilled participants demonstrated an advantage over less-skilled when recognizing PLD stimuli and were relatively unaffected in comparison to an earlier film-based recognition test. In contrast, less-skilled participants' recognition performance was negatively affected in the PLD condition compared to the film condition, implying greater reliance on superficial display features.

The findings reported by Williams et al. (2006) suggest that skilled performers perceive and encode patterns when viewing structured sequences. Such an interpretation supports Dittrich's (1999) interactive encoding theory of perception, which proposes that skilled performers in complex environments initially encode information about the temporal relationships between features within the display. This information is then matched with an internal semantic concept (template) that is formed through extensive exposure to such environments (see Dittrich & Lea, 1994; Gobet & Simon, 1996).

This ability to recognize patterns has been proposed as a central component of anticipation (Abernethy et al., 2005; Canal-Bruland & Williams, 2010; North, Williams, Hodges, Ward, & Ericsson, 2009; Williams & Davids, 1995). The argument being that when performing, experts can quickly perceive structured patterns which allows them to recognize a sequence early in its evolution, facilitating successful anticipation of the sequence of play observed. A contrasting argument is that recognition is a by-product of experience within a particular domain. Therefore, while recognition might provide an indication of the domain specific knowledge held by a performer, it does not directly contribute to, nor is it predictive of, anticipation (see Ericsson & Lehmann, 1996).

North et al. (2009) tested the latter argument by recording eye movement data while participants completed both anticipation and recognition paradigms. Performance on both tasks was moderately positively correlated ($r = .39$, $p = .06$). However, a number of differences emerged as participants made more fixations of a shorter duration to more locations when anticipating compared to attempting to recognizing clips. In a follow-up study, North, Ward, Ericsson, and Williams (2011) recorded verbal reports across anticipation and recognition tasks and reported similar findings. Anticipation and recognition performance were moderately positively correlated ($r = .42$, $p = .07$), however participants' verbal reports indicated that they were utilizing more complex memory representations when anticipating compared to making recognition decisions. The results reported by North and colleagues (2009, 2011) indicate that anticipation and recognition share a number of common processes, yet the precise mechanisms underpinning each task differ somewhat.

Anticipation is likely to be comprised of a range of perceptual-cognitive skills including, but not limited to, perceiving structured patterns in the display, and using information from advance postural cues. Perceiving patterns is considered central to contexts involving multiple individual features (e.g., chess pieces, soccer players). In situations where a performer faces one individual opponent and is required to anticipate (e.g., facing a smash in badminton or a penalty kick in soccer) the pick-up of postural cues is considered key (e.g., Franks & Hanvey, 1997; Savelsbergh, van der Kamp, Williams, & Ward, 2005). When anticipating in soccer, the performer is exposed to both the individual opponent making the pass (i.e., there is potential to use postural cues from the opponent to inform anticipation) and the positions and movements of their teammates around them (i.e., there is potential to perceive structured patterns between players to inform anticipation). In identifying the specific processes underpinning anticipation, an important issue to consider in soccer, and other such sports, is the relative contribution each of these perceptual-cognitive skills makes and how this may vary as a function of the task.

Roca, Ford, McRobert, and Williams (2013) aimed to address the above issue. Participants completed anticipation (they predicted what would happen next) and decision-making (they made a decision as to the most appropriate course of action for *them* to take on the basis of their anticipation decision) paradigms in soccer when the ball was either far away from them (far task) or close by (near task) while eye movement and verbal report data were collected. As expected, skilled participants were more accurate than less-skilled in anticipating what would happen next and deciding on an appropriate course of action, but eye movement and verbal report process measures varied as a function of how near or far away the participant was from the ball. The eye movement and verbal report data reported by Roca et al. (2013) indicated that for more distal tasks, perceiving patterns may be a more important perceptual-cognitive skill, whereas for proximal tasks the relative contribution of advance postural cues becomes more important.

In the current paper, we were only interested in examining the extent to which the perception of patterns and perception of advance postural cues contribute to anticipation. Previously, researchers (e.g., North et al., 2009, 2011) have indicated that experts recognize structured stimuli by perceiving patterns in the display. However, visual search (North et al., 2009) and verbal report (North et al., 2011) data suggest some differences in the processes underpinning anticipation and pattern recognition. We provide a more direct measure of whether skilled performers are able to accurately anticipate solely on the basis of perceiving patterns. We presented skilled and less-skilled soccer players with film and PLD stimuli and asked them to make anticipation judgments as to what would happen next. In PLD stimuli all that remained was the positions and movements of the players (and any potential patterns between them). If perception of structured patterns between players was central to anticipation, as it is to recognizing structured stimuli (c.f., Williams, North, & Hope, 2012), then we expected that skilled participants would outperform their less-skilled counterparts and that this advantage would be seen in both film and PLD conditions. If skilled participants utilize advance postural cues too then we also expected a skill x display interaction with skilled participants enhancing their anticipation accuracy and skill advantage in the film relative to the PLD condition.

A second aim was to extend the findings reported by Roca et al. (2013) by examining how the relative contribution of perceiving structured patterns and advance postural cues may vary as a function of the task constraints. The film and PLD stimuli that we presented to participants were broken down into far and near task conditions (based on whether the ball was near to, or far away from, the participant at the point an anticipation decision was required). We predicted, based on the results reported by Roca et al. (2013) and the changing task constraints, that for the far task, perceiving structured patterns would be a more important perceptual-cognitive skill and that more accurate anticipation would be observed for skilled participants compared to less-skilled in both film and PLD conditions (structured patterns between players are present in both film and PLD stimuli, and according to Roca et al. such information is of greater importance when the task constraints are such that the ball is far away from the participant). However, for the near task we expected the task constraints to promote localised information sources (such as postural cues) to be more prominent and that structured patterns would be less important. We therefore hypothesized that in the near task condition, skilled participants would outperform less-skilled for film stimuli (postural information is retained in the film display, and according to Roca et al. is of greater relative importance when the tasks constraints are such that the ball is closer to the participant) but that this advantage would be lost for PLD stimuli as postural information is removed.

2. Method

2.1 Participants

A total of 12 skilled (M age = 21.7 years, SD = 2.9) and 12 less-skilled (M age = 22.1 years, SD = 3.2) soccer players participated. Skilled participants had previously played at a professional club's Academy and/or were currently playing at a semi-professional level and all played in defensive positions. The skilled participants had been playing soccer competitively for an average of 14.0 years (SD = 2.5). In contrast, less-skilled participants only played soccer at a recreational or amateur level and had been participating for an average of 10.5 years (SD = 3.3). All participants reported normal or corrected to normal levels of visual function, provided written informed consent, and were free to withdraw from the experiment at any stage. Ethical approval was granted by Liverpool John Moores University where data collection took place.

2.2. Test Films

Participants completed two anticipation tests; one presented in normal video film format and the other in PLD format. The order in which these anticipation paradigms were completed was counterbalanced across participants. Each anticipation paradigm contained 24 dynamic action sequences, all of which were presented for 7 seconds in duration. Each individual clip showed a developing sequence of play in soccer that was occluded at the moment when the player in possession of the ball was about to make a forward attacking pass and participants were required to anticipate the pass destination of the ball. The clips were all rated as highly structured and were all filmed from an elevated position (approximate height 9 m) behind the goal (approximate distance 15 m) using a tripod mounted camera (Canon XM-2, Tokyo, Japan). The camera did not pan or zoom during recording and its position ensured the entire field of play was visible and information from wide areas was not excluded. Clips were rated for structure by three independent expert soccer coaches using a Likert-type scale from 0 to 10 (0 being very low in structure and 10 being very high in structure). Clips rated as high in structure were those judged to be most representative of typical attacking patterns and sequences in match-play. Only sequences with a mean rating of 7 or above were used in the experiment. Some examples of still frames from film clips are shown in Figure 1a and b. For the clips presented in PLD format, these were edited versions of the film clips described previously so that individual players were now represented as points of light against a black background within a series of white lines representing the outline of the playing area. The attacking team in possession of the ball were represented as green dots, the defending team as red dots, while the ball was a white dot and the playing area was represented by a series of white lines. Figures 1c and d present examples of still frames from PLD clips.

Figure 1 Near Here

In addition to the action sequences being broken down as a function of display type (i.e., film vs PLD), they were subdivided into near and far conditions based on the location on the pitch where the final pass was made from relative to the observer prior to the clip being occluded. Sequences where the attacking team made the final pass before crossing the halfway line were categorized as the far-task condition, whereas those in which the final pass was made beyond the halfway line (i.e., nearer the observer) were categorized as the near-task condition. Examples of far and near task clips in both film and PLD format can be seen in Figure 1. In each anticipation paradigm, of the 24 clips presented, half were classified as near and half as far.

2.3. Apparatus

To convert the original video film footage into PLD format, the film clips were saved into ".avi" format using video editing software (Adobe Premiere, Adobe Systems Incorporated, San Jose, CA). The clips were then exported via IrfanView (www.irfanview.com) to the software package AnalysaSoccer (Liverpool John Moores University, UK) which allowed the players' positions and movements from the original film to be digitized and reconstructed so that they were represented as points of light against a black background using real-time video playback. Once created, the PLD clips were assembled into a test film to produce the anticipation paradigm. This film was then presented using a DVD player (Panasonic, DMR-E50, Osaka, Japan) and projector (Sharp, XG-NV2E, Manchester, UK) with images being presented onto a 9' x 12' screen (Cinefold, Spiceland, IN, USA) at a rate of 25 frames per second with XGA resolution.

2.4. Procedure

Participants were provided with written information regarding experimental procedures and signed consent forms. Participants then sat in a chair 3 m from the projection screen such that the image subtended a horizontal viewing angle between the left and right sides of the screen of 62.7 degrees and a vertical viewing angle between the top and bottom of the screen of approximately 54 degrees. For the video film anticipation test, participants were presented with a series of clips showing attacking sequences of play in soccer. Participants were instructed that each individual clip would last five seconds and would finish when the player in possession of the ball was about to make an attacking pass to a teammate. The final frame was then 'frozen' for two seconds as they made their anticipation decision, making a viewing total of 7 seconds for each clip. The task for participants was to circle the player they thought would receive the ball via a pen and paper response on a print out of the final frame of the viewing sequence. At the end of the 7-second sequence, the image on the screen occluded to black, whereupon there was an inter-trial interval of five seconds before the next clip commenced. Prior to testing, participants were presented with three trials for familiarization.

After completing the first anticipation test, there was a short break (approximately 15 minutes) during which participants completed a practice history questionnaire. Participants then completed the second anticipation test. For the PLD anticipation test the procedure and task was the same as in the video film condition, however, in this condition all background and superficial information was removed and participants observed a series of colored dots representing players moving against a black background within a white outline of the pitch markings. The clip duration and inter-trial interval was the same as for the video film clips. A brief familiarization procedure was employed where the concept of point-light displays was fully explained to participants and three example clips demonstrating how normal video action sequences can be transferred to PLD format were presented prior to commencing the test.

2.5. Data Analysis

Anticipation accuracy was obtained by dividing the number of correct responses by the total number of trials and multiplying by 100 to create a percentage accuracy score. For each clip, although participants were not constrained to select their response from pre-determined alternatives, there were considered four realistic passing options as judged by an independent UEFA qualified coach. Responses were marked as correct or incorrect based upon whether participants highlighted the actual player who received the ball. Anticipation accuracy scores were analyzed using a mixed design 3-way analysis of variance (ANOVA) in which the between-participants factor was skill (skilled vs. less skilled) and the within participants factors were display (PLD vs. video) and distance (near vs far task). Prior to running the analyses, data were tested for normality using a Shapiro-Wilks test and all data satisfied the parametric assumption of normality. Partial eta squared (η_p^2) values are provided as a measure of effect size and Cohen's *d* values are reported for comparisons involving two means. The alpha level for each test was set at p <.05. Although we formed clear a-prior hypotheses for the main effect of skill, and the skill x display, and skill x display x task interactions, the other comparisons in our 2 x 2 x 2 ANOVA were somewhat exploratory in nature. To reduce the risk of making Type I errors, we employed the Bonferroni-Holm correction to control familywise error rate and adjust the alpha level (for a detailed overview see Cramer et al., 2016). All main effects and interactions are reported relative to these adjusted alpha levels.

3. Results

ANOVA revealed a significant main effect for skill, $F (1, 22) = 77.92$, $p < .0071$, $\eta_p^2 = .78$. Skilled participants ($M = 58.33\%$, $SD = 18.20$) were more accurate at anticipating final pass destination than less-skilled participants ($M = 36.11\%$, $SD = 10.36$), $d = 1.50$. There was an effect of display on anticipation accuracy, $F (1, 22) = 39.71$, $p < .0083$, $\eta_p^2 = .64$. Anticipation performance was more accurate for video film ($M = 53.82\%$, $SD = 19.37$)

compared with PLD clips (M = 40.63%, SD = 15.05), *d* = .76. There was a significant Skill x Display interaction, F (1, 22) = 15.84, $p < .0013$, $\eta_p^2 = .42$. Although anticipation accuracy for the skilled participants was significantly higher than less-skilled in both film and PLD, the advantage was substantially enhanced for film (M = 69.10 %, SD = 13.57 vs. M = 38.54 %, SD = 9.77 respectively), $t\ (22) = 8.22$, $p < .001$, *d* = 2.58, compared to PLD clips (M = 47.57 %, SD = 15.83 vs. M = 33.68 %, SD = 10.56 respectively), $t\ (22) = 5.04$, $p < .001$, *d* = 1.03. This interaction is illustrated in Figure 2.

Figure 2 Near Here

There was a significant main effect of distance on anticipation accuracy, F (1, 22) = 31.12, $p < .01$, $\eta_p^2 = .59$. Performance on the anticipation task was more accurate in the far (M = 52.95 %, SD = 18.13) than near condition (M = 41.49 %, SD = 16.97), *d* = .65. ANOVA revealed a significant Distance x Skill interaction, F (1, 22) = 8.26, $p < .025$, $\eta_p^2 = .27$. Skilled participants made significantly more accurate anticipation judgments than less-skilled participants in both far and near tasks, however their advantage was significantly greater in the far task (M = 67.01 %, SD = 13.79 vs. M = 38.89 %, SD = 9.08 respectively), $t\ (22) = 8.59$, $p < .001$, *d* = 2.41, compared to the near task (M = 49.65 %, SD = 18.14 vs. M = 33.33 %, SD = 10.99 respectively), $t\ (22) = 5.07$, $p < .001$, *d* = 1.09.

There was also a significant Distance x Display interaction, F (1, 22) = 9.66, $p < .017$, $\eta_p^2 = .31$. For video film clips, participants showed no difference in anticipation accuracy between far and near tasks (M = 56.60 %, SD = 21.28 vs. M = 51.04 %, SD = 17.26 respectively), $t\ (23) = 1.88$, $p > .05$, *d* = .29. However, for PLD clips participants were more accurate in their anticipation judgments for the far than near task (M = 49.31 %, SD = 14.31 vs. M = 31.95 %, SD = 10.03), $t\ (23) = 5.54$, $p < .001$, *d* = 1.40. This interaction is illustrated in Figure 3. The Skill x Clip Type x Distance interaction was not significant, $F(1, 22) = 1.64$, $p > .05$, $\eta_p^2 = .07$.

Figure 3 Near Here

4. Discussion

There were two main aims in this experiment. First, we investigated the extent to which anticipation was underpinned by perception of structured patterns or advance postural cues. Second, we aimed to test whether the relative importance of these two perceptual-cognitive skills was dependent on whether participants were making anticipation decisions in near or far proximity to the ball.

With regards our first aim, if skilled participants encoded structured patterns in the display to inform their anticipation decisions then we expected to see a main effect of skill regardless of the display (i.e., film vs PLD). As predicted, skilled participants were more accurate in their ability to predict event outcome, which replicates the findings from a considerable body of literature investigating anticipation (see Helsen & Starkes, 1999; Vaeyens, Lenoir, Williams, Mazyn, & Philippaerts, 2007). This advantage is believed to be a result of the extended hours of deliberate practice engaged in by highly skilled performers (Ericsson, Krampe, & Tesch-Romer, 1993) which allows them to encode and process information in an efficient manner (Abernethy & Russell, 1987). Skilled performers have also developed more complex memory representations through their extended experience within the domain, against which they can evaluate the current situation and feed-forward information to predict likely future outcomes (Ericsson & Kintsch, 1995; Ericsson, Patel, & Kintsch, 2000).

However, the precise nature of information that is processed to inform these anticipation judgments has not been clearly delineated. By testing anticipation under both film and PLD conditions and revealing a skill effect regardless, we have provided evidence to suggest that perceiving patterns between players in the display, which has been shown to underpin accurate recognition judgments (see North et al., 2009, 2011; Williams et al., 2006, 2012) is also an important source of information when anticipating. The design we employed does not allow us to definitively draw this conclusion; participants could potentially be making their anticipation decision based on the absolute motion information of one player (or point of light) rather than the relational information between players. However, considered against previously published findings (e.g., Williams et al., 2012), we believe our results suggest it is likely participants can anticipate by perceiving patterns in the display.

The Skill x Display interaction we observed shows that although skilled participants were more accurate in both film and PLD conditions, their advantage was substantially greater when anticipating film (d = 2.58) than PLD clips (d = 1.03). The large effect size for PLD clips supports the argument that skilled players can anticipate successfully by perceiving patterns in the display. However, the nature of the Skill x Display interaction suggests this is not the only source of information they use. In film displays, participants have access to the same structured patterns present in PLDs, yet this is supplemented with information from postural cues through the body positions and movements that players adopt. The increase in effect size when responding to film displays suggests that skilled participants make use of *both* structured patterns in displays *and* advanced postural cues and potentially the gaze direction of players to anticipate. Anticipation is complex and likely to be comprised of a number of perceptual-cognitive skills (see Williams & North, 2009) that interact dynamically (Roca & Williams, 2016; Williams, 2009).

The complex and multi-dimensional nature of anticipation was considered in our second aim. We examined whether the relative contribution of the different perceptual-cognitive skills varied as a function of the task constraints (i.e., whether the anticipation decision was made when the ball was far away or nearby). We hypothesized that for far task trials, skilled participants would be more accurate in anticipating event outcome regardless of display as they would primarily rely on perceiving patterns between players, information which is preserved regardless of display mode. However, for the near task trials, Roca et al's (2013) data and the changing task constraints suggest that information from postural cues would become more important. Consequently, we predicted that skilled participants would only demonstrate an advantage for film clips (where information from postural cues is maintained) and this advantage would be lost for PLD sequences as no information from postural cues or body orientation is presented.

Our results partially supported these hypotheses. A significant Distance x Display interaction was observed which showed that when anticipating in the far condition, participants were unaffected by whether the sequence was shown in film or PLD. In contrast, in the near condition participants were significantly better at anticipating film than PLD sequences. These findings are in line with our proposals that the specific perceptual-cognitive skill participants use to anticipate will be driven by the underpinning task constraints. Specifically, where the individual is far away from the action to be anticipated then perceiving patterns in the display is more important. However, as the action to be anticipated comes nearer to the individual they shift to utilizing information from postural cues. However, contrary to our hypotheses, these results were not affected by participant skill level.

One limitation in this study was the use of a third-person rather than first-person (as used by Roca et al., 2013) viewing perspective. An alternative interpretation therefore is rather than the relative contributions of pattern perception and postural cue usage to anticipation being dependent on task constraints, it is the case that in the far task, participants were unable to decipher the postural cues due to the resolution of the display and so performance suffered relative to the near task where information from postural cues was more readily available. The Skill x Distance interaction adds some support to this proposal. Findings reported by Roca et al. (2013) suggest the information used to anticipate varies as a function of the task, with perceiving patterns more important when the ball is far away and postural cues more important when it is nearby. However, the finding that skilled participants were significantly more accurate in far than near task conditions suggests skilled players were less able to utilise the information sources that are important to anticipate in the near tasks (i.e., postural cues may have been less prominent or more difficult to decipher given the screen resolution). To more stringently test the prediction that it is specifically task constraints which shape the perceptual-cognitive processes employed to anticipate (rather than issues such as screen resolution), researchers could replicate the design and task employed here using a first-person viewing perspective (as per Roca et al., 2013) or include an extra condition in which the far task is magnified to make information from postural cues more accessible. Nevertheless, our findings are in line with those reported by Roca et al. (2013) which suggest that the perceptual-cognitive skills and processes that individuals utilize depend on the task constraints or perceptual information to which they are exposed. Our data not only support the proposal that anticipation is multi-dimensional in nature (see Williams & North, 2009), but suggest that the relative importance of different perceptual-cognitive skills might interact dynamically (Williams, 2009).

In conclusion, in this paper we have presented data that suggest *both* perceiving patterns in structured displays *and* information from postural cues contribute to anticipation. Specifically, we have demonstrated that the relative contribution of these two perceptual-cognitive skills varies as a function of the task or perceptual information available to participants. When participants are near the object to be anticipated, picking up information from advance postural cues is more important. However, when far away and postural information is less readily available, perceiving patterns in the display becomes more important. Our findings highlight the dynamic interaction between different perceptual-cognitive skills during anticipation.

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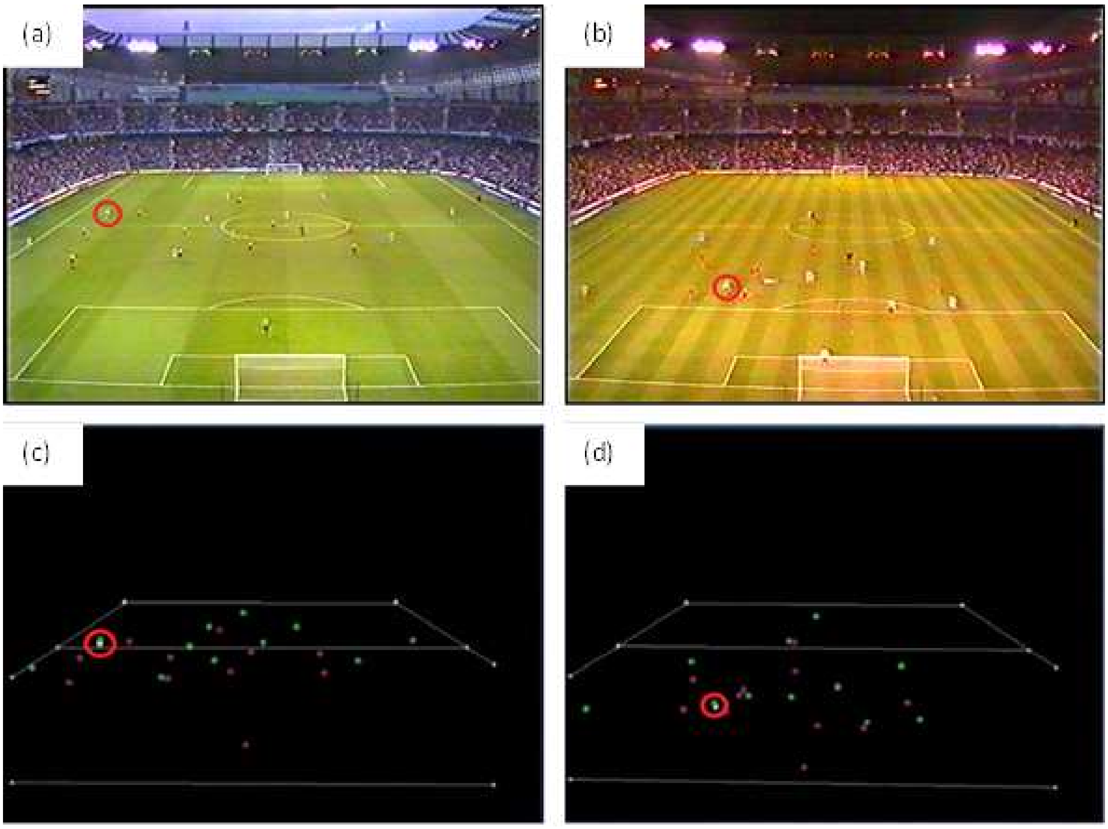
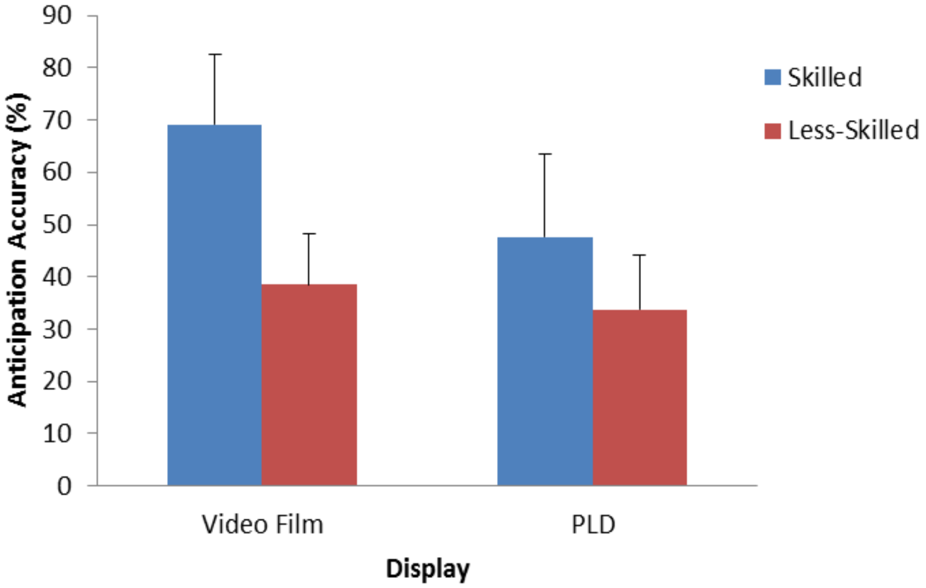
Figure Captions

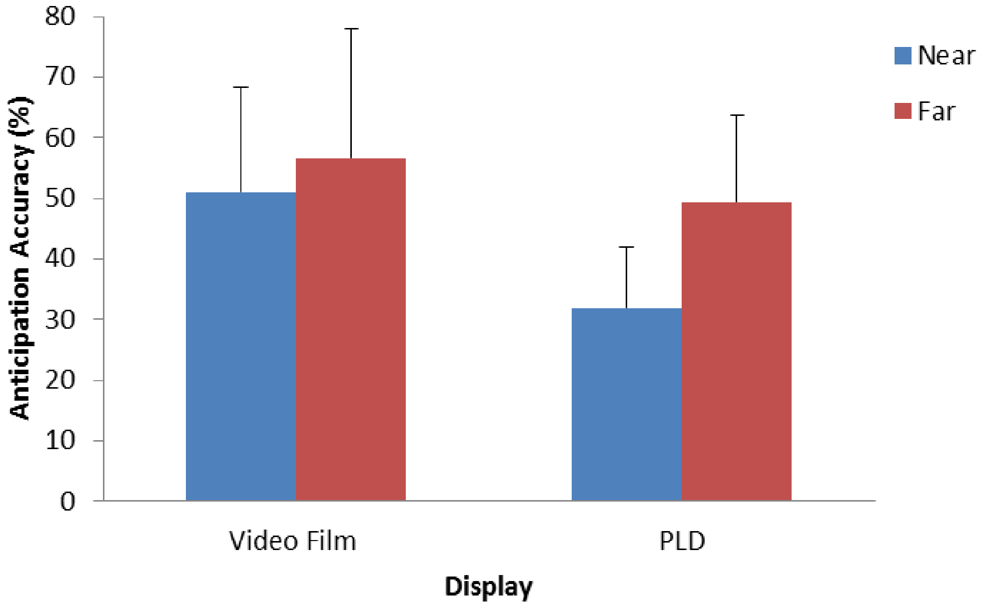
Figure 1. Examples of still frames from video film (a and b) and PLD (c and d) clips in both near (b and d) and far (a and c) task conditions.

Figure 2. The Skill x Display interaction on anticipation accuracy (+1 SD).

Figure 3. The Display x Distance interaction on anticipation accuracy (+1 SD).


(a)
(b)
(c)
(d)


90
80
70
60
50
40
30
20
10
0
Anticipation Accuracy (%)
Skilled
Less-Skilled
Video Film
PLD
Display



Anticipation Accuracy (%)
80
70
60
50
40
30
20
10
0
Near
Far
Video Film
PLD
Display

547