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**A method to identify talent:  
Visual search- and locomotion behaviour in young football players**

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## Abstract

The present study examined differences in visual search and locomotor behaviours among a group of skilled 10-12 year old football players. The participants watched video clips of a 4-to-4 position game, presented on a large screen. The participants were asked to take part in the game by choosing the best position for the reception of the ball passed by one of the players in the clip. Participants' visual search and locomotor behaviours were collected continuously throughout the presentation of the clip. A within-group comparison was made based upon the participants' interception score, i.e. more at the correct position. The findings show that the high-score group looked more to the ball area, while the players in the low-score group concentrated on the receiving player and on the hips/upper body region of the passing player. The players in the high score group covered a significant greater distance compared to the low score group. It is concluded that the within-group comparison revealed differences in visual search and locomotion behaviour that can be used as indicators for identifying talented junior football players.

PsycINFO classification:

Keywords: talent, visual search, locomotion behaviour

## 1. Introduction

Competitive sports like cricket, football, and tennis require the players to catch, intercept or return a fast moving ball. The key to such a successful action is to meet the ball precisely at the right place at the right time (Savelsbergh, Whiting & Bootsma, 1991; Caljouw, Van der Kamp & Savelsbergh, 2004, 2004a). This type of successful coordinated performance requires skill in perception as well as the efficient and accurate execution of movement patterns (Williams et al., 1999). Therefore, the contribution of visual information is equally important as the motor skill. In other words, skill in perception in conjunction with an efficient execution of movement patterns is paramount (Savelsbergh et al., 2006; Savelsbergh, Van der Kamp, Williams & Ward, 2005; Savelsbergh, Williams, Van der Kamp, & Ward, 2002; Williams & Elliot, 1999).

In the last decade, several researchers examined the skill of perception extensively. Common method in such experiments is to ask participants to predict the end result of video clips showing more or less predictive information from the opponent's body or the ball's flight path. Their findings show that experts have superior anticipatory skills compared to novices (Abernethy & Russell, 1987; Helsen & Starkes, 1999; Savelsbergh et al., 2002; Ward & Williams, 2003; Williams, Davids, Burwitz & Williams, 1994; Williams & Davids, 1998; Williams & Elliot, 1999). In fact, research shows that the fundamental difference between experts and novices appears to be the capability to pick up advance information from some visual sources (Abernethy & Russell, 1987; Helsen & Starkes, 1999; Savelsbergh et al., 2002, 2005; Williams & Elliot, 1999). For instance, with respect to football, players have developed an extensive

football-specific knowledge base that enables them to recognize meaningful associations between the positions and movements of players in game situations (Williams et al., 1994; Savelsbergh et al., 2006). In other words, not so much the visual search strategy itself, but how the expert athlete can make use of this information is essential (Abernethy & Russell, 1987; Savelsbergh et al., 2006). This perception-action perspective is based on the ideas of Gibson (1979) who suggested that movement control is based on a *continuous coupling* to available perceptual information, which is presumed to evolve over time (Savelsbergh & Van der Kamp, 2000; Savelsbergh et al., 2006).

The novice versus expert paradigm to detect differences in visual search behaviour, can be extended to talented youth players with less-talented players with a so-called within-group comparison. The importance of a within-group comparison is emphasized by the findings of Savelsbergh et al. (2005) with respect to the identification of visual information for successful performance in stopping a penalty kick. Knowledge of these determinants makes it possible to distinguish skilled from less skilled players and, therefore allows more objective identification of the players' potential ability. Additional support for this rationale was found in recent studies that used a within-group comparison and revealed differences in a football position game (Savelsbergh et al., 2006; Vaeyens, Lenoir, Williams & Philippaerts, 2007). Savelsbergh and co-workers (2006) found differences in locomotion behaviour accompanied with the same visual scanning behaviour. A high-score group continued to detect and use information while moving even after foot-to-ball contact, which implies that decisions were continuously updated. Additionally, Vaeyens et al. (2007) applied the within-group comparison method in their study. The task was to pass a ball to a player in the film clip and dealt with the decision-

making skill in youth soccer players. These researchers demonstrated that elite and sub-elite players outperformed regional players even though they were reasonably well matched in relation to age and playing experience (i.e. amount of football players years). In a second study these authors found that one of the variables for talent identification was the decision process in relation to the number of players involved in their video clips, which depicted an offensive game situation (Vaeyens, Lenoir, Williams, Mazyn, & Philippaerts, 2007). They systematically increased the number of players involved in the action (i.e. 2 vs. 1; 3 vs. 1; 3 vs. 2; 4 vs. 3 and 5 vs. 3) and found that the more complex situation discriminated between the groups (i.e. 3 vs. 2; 4 vs. 3 and 5 vs.3 in comparison to 2 vs. 1 and 3 vs. 1). This suggests that the more talented young players are able to benefit more from their exposure to the task domain, i.e., complexity of game.

In summary, the above-mentioned studies attempt to investigate the variables that are most important in distinguishing the skilled from the less-skilled football players. These variables are essential in an attempt to detect talent, and only when our understanding of them is enhanced, it is possible to develop adequate tests for talent identification. As noted by Reilly, Williams, Nevill and Franks (2000), there is no talent identification program that is based on a scientific rationale. For that purpose, the current experiment examines whether differences in visual search and locomotion behaviour can be identified in a homogeneous group of young football players who were selected as talented football players. All participants were between 10-13 years old and scouted as a talent by the Royal Dutch Football Association. To these young players video clips were shown in which children of their own age play a 4-to-4 tactical football game. The task for the participant was to 'take part' in a 4-to-4 tactical game video-projected on a large

screen by choosing a position that enabled them to receive the ball passed by one of the players in the clip. The participant's movements and visual gaze behaviour were registered continuously. Following the Vaeyens and colleagues work (2007), we also manipulate the complexity of the video scene in order to come closer to the context of the game. However, we did this not by an increase the number of players, but by making more uncertain which player will become in ball possession and as a consequence, will be the final passing player. The task for participants is to be in time at the right position in order to be able to receive that pass of the final passing player. The rationale is that when there is a dual between two players there is a longer unsure outcome with respect to the player that will become in ball possession. Thus this will put more constraints (uncertainty) on the 'receiving' participant in order to reach a decision. Following earlier reported findings, we anticipated that the participants that showed a better performance (e.g. at the correct place at the right time) will focussed more on the ball passer and ball (Williams & Davids, 1998; Savelsbergh et al., 2006).

## **2. Method**

### *2.1. Participants*

Twenty male competitive football players (mean age 11.8 years) participated in the experiment and were treated in accordance with the local institution's ethical guidelines.

Written consent was obtained from one of their parent or guardian. All participants played for the regional selection team of the Royal Dutch Football Association, or played for a professional club. On average the players had 4.8 years of football experience and in



the current season they played at different levels ranging from the 1<sup>st</sup> to the 4<sup>th</sup> Dutch youth league.

## 2.2. *Test film*

The Royal Dutch Football Association (KNVB) cooperated in producing the test films. Eight youth players (boys and girls) played a four-to-four football game on a 30 x 40 m field (Figure 1). On both ends of the field a small goal was placed. The intention of the game was to score more goals than the opposite team. Two persons, who did not take part in the game, had helmet-mounted camera's through which the play patterns were filmed. These persons were able to move around freely. Consequently the video clips that were created from these film recordings showed offensive patterns of play from the perspective of the participant in the study. Beside the cameras that were mounted on helmets, the game was also recorded with two digital video cameras placed on both long sides of the field and one high up in the stands. These recordings were used for the analysis of the ball direction and speed.

From the film material, a total of thirty video clips were edited each with a duration of 4 seconds. Every clip showed part of the position game (passing between players) and ended with a start of a pass in or not in the direction of the helmet-mounted camera. The clips stopped 80 ms after foot-to-ball contact. Ten of these test films were 'fake' clips in such a way that the ball was passed but did not approach the participant. In these clips no interception action of the participants was required. The scene in the other twenty video clips were selected and created in such a way that there were differences between these determined by in the last action that took place. The actions are either dual

between two players or solo action. The follow two categories were created: *Duel*. In the last part of the clip there was a dual and as consequence longer uncertain which player will become in ball possession and passed the ball. *Solo*. The scene involves one player in ball possession, who passed the ball. In the whole scene the number of players visible to the observer is kept constant to four players.

### 2.3. Apparatus

The video clips were presented to the participants by means of back-projection onto a large screen (2.40 x 2.40 m, Savelsbergh et al., 2006). The participant was positioned three meters in front of the screen, which gave them enough space to move around freely. The player wore a belt around their waist to which two potentiometers (ASM, WS3.1; sample rate 200Hz) were attached that served to record the participants' spatio-temporal displacements. The potentiometers output signal (V) was converted into the position of the participant in two directions (forward-backward and left-right) and was synchronised with the film clip by a 5V signal that marked the start and the end of the clip. Similar to the Savelsbergh et al. (2006) study, the floor was divided into 9 areas in order to match the 'actual' ball destination with the participants end location (Figure 2).

Visual search behaviour was recorded using an eye-head integration (EHI) system that included an Applied Science Laboratories (ASL) 5000SU eye-tracker. The EHI is a video-based monocular system that measures eye line of gaze using head-mounted optics. The system works by collecting three pieces of information: displacement between the left pupil and corneal reflex (reflection of the light source from the surface of the cornea), position of eye in head, and position and orientation of head in space. The relative

position of these features was used to compute visual point of gaze with respect to a pre-calibrated 9-point grid projected onto the scene plane. A simple eye calibration was performed to verify point of gaze before each participant. The calibration was checked following each trial. The data were superimposed onto the scene in the form of a positional cursor to highlight point of gaze. This image was then stored using a video recorder for further analysis. The data were subjected to a frame-by-frame analysis using a PAL standard video recorder (Panasonic AG7330) at 50 Hz. The accuracy of the system was  $\pm 1$  degree visual angle. System precision (i.e. amount of instrument noise in the eye position measure when the eye was perfectly stationary) was better than 1/2 degree in both the horizontal and the vertical direction.

#### *2.4. Procedure*

Prior to the experiment, participants received ten familiarization trials. These video clips were not included in the analysis.

The task required from the participants was an interception of the 'ball'. Participant stood in front of the large screen and where instructed to respond to the film clip by moving to the expected pass destination as if they would receive the ball. They were asked to stand still for a second or two before returning to the start position followed by the start of the next clip. Before each clip the participant was asked to fixate on a marker positioned in the centre of the projected film. The clip stopped at 80 ms after foot-to-ball contact by the passer of the ball. The 80 ms window was based on earlier work by Abernethy and Russell (1987; Savelsbergh et al., 2006). In the film clip the passing player was in possession of the ball for only a very short period of time,

equivalent to one or two-touch-ball contacts, which is between 1 and 5 frames (40-200 ms). The film-clips (dual, solo and fake) were projected in a random order and no feedback was given to the participants about performance.

To increase the power of our comparison, our analysis focused on clips that best discriminated the two groups (Savelsbergh et al. (2006). The discrimination analysis works as follows; firstly, we created two groups, one with a good performance and one with a poor performance on the task. Secondly, both groups are determined on which clips they perform correct and incorrect. Clips where both groups performed correct or incorrect were not used for further analysis, because it implies that these clips do not discriminate between the groups<sup>1</sup>.

### *2.5. Dependent variables and data analysis*

The following variables were obtained:

**Number of points for interception:** was defined as the amount of times the participant moved a) in the right direction, b) to the right area and/or c) at the right time. For this reason the floor was divided in nine areas (Figure 2; Savelsbergh et al., 2006). The correct area was assessed by watching the recordings of the overview camera. As the areas were behind one another it was possible for the participant to receive the ball in for instance both the areas 3 and 8. The correct time was calculated from the overview camera by dividing the distance the ball travelled by the time it took the ball to pass the end line of the field. Each correct decision (direction, area and time) was given one point, which made the maximum score of 3 points per person for each clip.

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<sup>1</sup> This is often used to analyze multiple choice exam in order to separate the questions which determine between those students who mastered the required knowledge and those who didn't.

*Amount of locomotion displacement before the ball passer makes foot-ball contact (DBefore)* was defined as the total amount of displacement in cm from the start of the clip until the ball passer touches the ball.

*Amount of displacement locomotion after the ball passer makes foot-ball contact (DAfter)* was defined as the total amount of displacement in cm after the passing player contacts the ball until the participant completed his movement.

## 2.6. Visual search data

For the visual search data of the video clips was analysed for the following visual search measures for the full 4 seconds:

*Percentage viewing time:* Percentage viewing time referred to the amount of time participants spent fixating various areas of the display when attempting to anticipate ball direction. The screen was divided into 6 fixation locations: before the ball (in direction of ball movement), on the ball, after the ball, player in ball possession; receiving player (i.e. the one that was going to receive the ball but was not yet in possession); other players in the clip.

For the last second of the clip a separate analysis was conducted. The passing player was divided into 3 fixation location areas: the head, trunk and legs.

The inter-rate was  $r = .89$  and intra-rate  $r = .91$  for scoring of the visual search data.

A 2 (Group: high vs. low) x 2 (Type of action: Duel vs. Solo) ANOVA with repeated measures on the last two factors was performed for each dependent variable separately. For the analysis of the passing player in the last second of the clip, unrelated

T-tests were used. Results with p-values  $< .05$  were considered significant and  $p < .10$  a trend. In cases where the sphericity assumption was violated, Greenhouse-Geisser adjustments were made.

### 3.0. Results

The numbers of points scored by each participant during the experiment are presented in table 1. The 'fake' clips were not included, because no interception action of the participants was required in those clips. Therefore, the maximal possible score was 60 point (20 clips x3). The mean and standard deviation for the total group was 16 and 6 respectively. The two groups were created by mean plus or minus one standard deviation. This resulted in a high-score group consisted of 7 participants (mean 23.5, standard deviation 1.5) and a low score group of 8 participants (mean 8.8, standard deviation 1.3). These two groups were used for further analysis.

#### 3.1. Locomotion behaviour

A 2 (Group: high vs. low) x 2 (Type of action: Duel vs. Solo) ANOVA with repeated measures on the last factor was performed for amount of displacement before (Dbefore) and after (Dafter) the ball passer makes foot-to-ball contact separately showed a main effect for Group ( $F(1,13) = 7.6$ ,  $p = .016$ ) for Dafter (Table 2). None of the other

analyses revealed significant main or interaction effects. The High-score group showed significantly more displacement than the Low-score group after ball contact.

### 3.2. Visual search behaviour

It was our intention to discriminate between the skilled and less skilled participants. Therefore, the clips on which everybody performed correct or incorrect were deleted from the analyses (Savelsbergh et al., 2006). This was the case for all the 'fake' clips, four of solo and 1 of dual video clips, which left 15 video clips for further analysis. In the deleted 5 films clips the predicted ball interception location was in the middle of the field and the ball came from a long distance. In these clips it was likely that the participants could easily predict here to intercept the ball. Of the fifteen remaining clips, six were 'solo' and nine 'dual' clips (for description of these video clips see appendix 1). These 15 clips were used for further analyses of visual search behaviour. In addition, for 4 participants (marked with \* in Table 1) no visual search data are obtained as a consequence that ASL didn't fit on their head (i.e. their heads were too small) or moved during data acquisition. Therefore, these visual search data are unreliable.

In Table 3 the visual search variables are reported. For every dependent variable a 2 (Group: high vs. low) x 2 (Type of action: Duel vs. Solo) ANOVA with repeated measures on the last two factors was performed.

First the three dependent 'ball' variables were considered. A significant main effect for group was found for before the ball  $F(1,9) = 20.1, p = .002$ , on the ball  $F(1,9) = 8.3, p = .019$  and after the ball  $F(1,9) = 8.9, p = .015$ . The high score group significantly looked more at the ball and the ball environment. For the type of action only a

significant effect was found for the dependent variable after the ball ( $F(1,9)= 12.9, p=.006$ ). The participants spend more time looking at the solo action in comparison to dual action. A tendency was found for the Group by Type of Action interaction with respect to the dependent variable on the ball ( $F(1,9)= 4.2, p=.071$ ; Figure 3). No other significant main or interaction effects are found.

When the three dependent 'players' variables were considered, a significant main effect for group was found for player in ball possession  $F(1,9)= 12.2, p=.007$ , receiving player  $F(1,9)= 6.6, p=.03$  and other players  $F(1,9)= 14.2, p=.004$ . The low score group significantly looked more at the players. For the type of action only a significant effect was found for the dependent variable player in ball possession ( $F(1,9)= 10.6, p=.01$ ). No other significant main or interaction effects were found.

In the last second of the clips, the visual search behaviour of the participants towards the passing player was analysed further (table 4). This additional analysis was essential to understand if the participants looked at the head, upper body or leg and ball area? These findings showed that the high score group looked more at the ball and the leg area ( $t(9)= 9, p=.029$ ) and lesser to head ( $t(4.02)= 2.9, p=.040$ ) and upper body ( $t(4.68)= 3.7, p=.016$ ) in comparison to low score group.

#### **4.0. Discussion**

The search for parameters that distinguish skilled from less skilled players is essential in talent identification. In order to do so the present study explored the visual search- and locomotion behaviour in a homogeneous group of youth football players on an



interception task. The players had to predict the final ball destination by moving towards this position in time. Based on the percentage of correctly predicted ball interceptions a high- and low-score group were created.

The results show that the high- score group was better in moving to the correct direction and to the correct area in order to receive the ball than the low- score group. However, they did not intercept the ball on time more often than the low-score group. Nevertheless, the high- and low-score group differed in the use of the nature of visual information. The low- score group looked significantly more at the other players, for instance more to the player that received the ball. The high-score group focussed constantly on the ball area. Likewise in the last second they looked more at leg area of the passing player, while the low-score group looked at the head and the upper-body region.

#### *4.1. Locomotion behaviour*

The homogeneous group of participants in this experiment showed significant different locomotion behaviour. This was also found in the experiment of Savelsbergh et al. (2006). Therefore, it can be concluded that this interception task distinguishes skilled from less skilled players that are matched for age and skill level, when locomotion behaviour is concerned.

Although the groups differed in their performance, both scored relatively low, namely 23.5 versus 8.8 point out of 60 possible points. An explanation for the 'inadequate' performance of the participants could be that children have and need a longer decision time than adults. In the experiment of Vaeyens et al. (2007) the test films had duration of three to ten seconds. The test films in the present experiment had a four

second duration. Possibly 4 seconds was too short for the participants to make a correct and quick decision. This suggestion is supported by the findings of Abernethy (1988), who reported that experts in a 12-year old group are unable to improve their performance unless a substantial amount of extra information is shown. These results and the differences found between children and adults indicate that the visual information used for decision-making was probably not the same in term of the nature of information but also in duration of the information available.

The difference between the high- and low-score groups was significant; they performed very well and very poor on the same clips. An evaluation of these clips showed that there were two test films, in which all participants moved correct and three where everybody moved incorrectly. In the two correct clips the predicted ball interception location was in the middle of the field and the ball came from a long distance. In the three 'incorrect' clips, these consisted out of a short pass where the predicted ball interception location was placed to the left front corner. As a consequence, a longer distance had to be covered to the predicted position.

The independent variable type of action did not reveal many significant findings, while we expected effects. The rationale was that in the dual situation there is a longer unsure outcome with respect to the player that will become in ball possession. Thus this will put more constraints (uncertainty) on the 'receiving' participant in order to reach a decision. And as a consequence will increase the discrimination possibilities between the two groups. However, only for dependent variables Player in ball possession and After the ball, indicated that both groups spend more time viewing the solo action in comparison to dual action. The interaction Group by Type of action for On the ball

approaches the significant level ( $p=.07$ ; Figure 3). Here a tendency can be noticed. The high-score group spend more time on duel than solo, while no such effect is apparent for low score group. However, all in all, type of action seems not to discriminate in such a way that it is useable for identifying differences between skilled and less-skilled players. The method used by Vaeyens and co-workers (2007), the manipulation of the number of players seem to be a better avenue.

#### *4.2. Visual search behaviour*

In the current study, evidence was found that the visual search behaviour of the high-score group differs significantly from the low-score group. This is in accordance with the elite versus sub-elite study of Ward and Williams (2003) in which they demonstrated that perceptual skill could reliably discriminate between these groups. The experts used the advanced information from emerging play patterns and postural cues more effectively than the sub-elites. For the particular interceptive task in the present study, the high-score group players looked more at the ball. In contrast, players in the low-score group looked significantly more at the receiver of the ball, and also more at the hips of the player with the ball during the last second of the clips. These findings are different from the adult study by Savelsbergh et al. (2006) where no clear difference was found between the visual search behaviour of the high- and low-score group. The set-up between the two studies was similar, but it seems likely that age or developmental stage induced differences in what and how to use the visual information. Since children already show differences in their search patterns and hence the source of information they use, it could be concluded that they are still developing to attune to the most informative areas in the

display. In short, children try to find out what information is important, whilst adults differ in how the information is used.

The present study provided evidence for differences in visual search and locomotion behaviour within a homogeneous group of young football players. We tentatively concluded that visual search behaviour might be a cause for a difference in anticipatory behaviour between the groups. While all participants in the study were selected because they were talented football players in a regional squad, it is remarkable that differences did occur and these should therefore be part of a talent identification program. However, it is important to bear in mind that not every football player can perform exceptionally well on this interception task. Williams and Ericsson (2005) emphasise that skills necessary to excel in a team sport such as soccer are multifaceted in nature. Thereby, positive compensation in one area may occur for a weakness in another. Nevertheless, this study could be the start of a more objective talent identification system.

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## Appendix

The description of the events in the used video clips. Ball distance is classified as Far (>7 m away), middle (5 m away) or near (within <3 m.). Ball position at the start of the clip is classified as: left, right or centre of the display. These classifications are from the view perspective of the participant.

Film clip	Distance and position of the ball at the start of the clip from the observation point of view.	Description of the clip event from observation perspective of the participant	Condition
1	Far, centre of the display	The ball is far from observation point; the player in ball possession outplays another player with an attacking movement, makes a quick action to the left, dribbles and passes from distance.	<i>Duel</i> at 3 meters from the observation point
2	Near, left side	A one-two combination between two players. After the final pass one player keeps the ball, makes a short dribble and passes from a near distance.	<i>Solo</i> at 3 meters from the observation point
3	Far, right side	Ball moves from right to left, player receives the ball, dribbles forward and passes from the right corner.	<i>Solo</i> at 7 meters from the observation point
4	Far, right side	Ball moves from right to left across the field to a player who passes.	<i>Solo</i> at 15 meters from the observation point
5	Middle, centre of the display	Ball moves through the centre to the front and is received one player in a duel. This player passes to another player on the right side, which immediate passes.	<i>Solo</i> at 6 meters from the observation point
6	Middle, centre of the display	Long horizontal pass. Is received by a player that is attacked from behind, followed by a duel and a pass.	<i>Duel</i> at 7 meters from the observation point

7	Far, left side	Duel with several players, one becomes into ball possession and crosses the others. Dribbles and passes from far.	<i>Solo</i> at 9 meters from the observation point
8	Middle, right side	Start of an attack on the right side, followed by a pass to the central player that passes the ball to a player on the left side, who is free and passes.	<i>Solo</i> at 7 meters from the observation point
9	Middle, left side	A far duel with several players, one takes possession and passes a long horizontally pass to another player that passes.	<i>Solo</i> at 6 meters from the observation point
10	Far, left side	A ball high in the airdrops in the centre, after several bumps, the ball is received by player on the left side. This player dribbles to the front and passes to the side.	<i>Solo</i> at 5 meters from the observation point
11	Far, centre of the display	Start of an attack in the centre. Ball is played to the right, player dribbles and is followed by some opposition players. Finally the player in possession of the ball passes the ball to a team member that passes.	<i>Duel</i> at 10 meters from the observation point
12	Far, centre of the display	One player dribbles and his pass rebounds/reflects from another player to the right. Continuously, the ball receives another player who makes a long solo and passes.	<i>Solo</i> at 10 meters from the observation point
13	Far, right side	Two boys in a duel on the right side. One of them wins and makes a long passes.	<i>Duel</i> at 12 meters from the observation point
14	Far, centre of the display	Ball high in the air arrives in a group of players, who all duel for the ball. One player takes possession of the ball, sprints away from the group and passes	<i>Duel</i> at 15 meters from the observation



			point
15	Far, right side	Group of players run on the right side with the ball. One player becomes in ball possession and passes from 10 meters	<i>Duel</i> at 10 meters from the observation point

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Table 1. Ranking of participants (and level of competition and position) as a function of the number of points scored.

Rank	Level	Position	Direction	Area	Time	Total score
1	2 <sup>nd</sup> league	Goalkeeper	14	8	4	26
2	4 <sup>th</sup> league*	Goalkeeper	15	8	2	25
3	4 <sup>th</sup> league	Goalkeeper	14	8	2	24
4	3 <sup>rd</sup> league	Midfielder	14	7	2	23
5	3 <sup>rd</sup> league	Midfielder	13	6	4	23
6	1 <sup>st</sup> league	Midfielder	11	6	5	22
7	2 <sup>nd</sup> league	Attacker	11	8	3	22
8	2 <sup>nd</sup> league	Defender	8	6	4	18
9	3 <sup>rd</sup> league	Attacker	9	6	3	18
10	2 <sup>nd</sup> league	Attacker	9	7	2	18
11	3 <sup>rd</sup> league	Midfielder	8	5	3	16
12	3 <sup>rd</sup> league	Attacker	8	4	3	15
13	2 <sup>nd</sup> league	Defender	6	2	2	10
14	3 <sup>rd</sup> league*	Attacker	5	3	2	10
15	3 <sup>rd</sup> league	Defender	5	4	1	10
16	2 <sup>nd</sup> league	Goalkeeper	4	3	2	9
17	3 <sup>rd</sup> league	Midfielder	6	2	1	9
18	4 <sup>th</sup> league	Defender	4	3	2	9
19	4 <sup>th</sup> league*	Attacker	4	2	2	8
20	2 <sup>nd</sup> league*	Midfielder	4	1	1	6

Table 2. The mean and standard deviation (in parenthesis) of the locomotion behaviour in distance covered (cm) as a function of the two skill level group (high versus low) and type of film clip (solo versus dual) before foot-ball contact (DBefore), after foot-ball contact (DAfter) and both together (total)

		Solo	Duel
	Group		
DBefore	High	242.8 (32.1)	243.9 (41.0)
	Low	274.2 (31.7)	270.4 (35.8)
DAfter	High	128.4 (66.7)	135.8 (59.3)
	Low	67.5 (35.2)	77.9 (26.2)
Total	High	362.1 (36.4)	370.0 (74.3)
	Low	335.9 (46.5)	334.5 (44.7)

Table 3. The mean and standard deviation (between parenthesis) of the visual search data in number of frames (A) and in mmilleseconds (B) as a function of the two skill level group (high versus low) and type of film clip (solo versus dual) for each dependent variable of the visual search behaviour.

A

		Solo	Duel
Location of view	Group		
In front of the ball	High	16.9 (2.9)	15.3 (5.3)
	Low	7.6 (1.8)	7.0 (3.7)
On the ball	High	21.5 (2.9)	30.4 (10.1)
	Low	18.9 (4.1)	17.7 (1.9)
After the ball	High	10.2 (2.7)	5.6 (2.1)
	Low	6.9 (2.2)	3.3 (2.2)
Player in ball possession	High	12.6 (3.9)	7.0 (2.9)
	Low	19.2 (5.9)	16.5 (3.2)
Receiving player	High	5.2 (2.2)	6.6 (3.6)
	Low	9.4 (3.6)	10.9 (3.7)
Other player	High	4.8 (2.3)	5.5 (2.9)
	Low	8.7 (1.1)	9.4 (2.1)

B

		Solo	Duel
Location of view	Group		
In front of the ball	High	676 (117)	612 (212)
	Low	304 (71)	280 (150)
On the ball	High	860 (116)	1216 (403)
	Low	756 (164)	708 (74)
After the ball	High	408 (109)	224 (83)
	Low	276 (88)	132 (86)
Player in ball possession	High	504 (156)	280 (115)
	Low	768 (239)	660 (127)
Receiving player	High	208 (89)	264 (145)
	Low	376 (158)	436 (148)
Other player	High	192 (93)	220 (117)
	Low	348 (43)	376 (85)

Table 4. The mean and standard deviation (between parenthesis) of the visual search with respect to the body location in milliseconds as a function of the two skill level group (high versus low) in last second of the clip

Legs	High	200 (68)	
	Low	120 (24)	
Trunk	High	56 (28)	
	Low	196 (84)	
Head	High	0 (0)	
	Low	36 (24)	

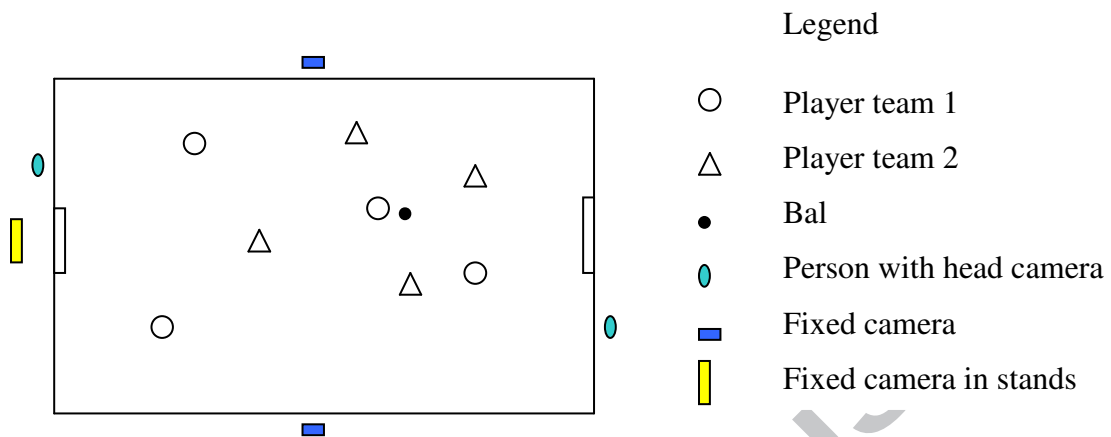
**Figure captions**

Figure 1: Bird eye view of 4-to-4 position game and fixed and ‘moving’ camera positions.

Figure 2: The division of the area’s in front of the screen. See text for further explanation.

Figure 3: The interaction group by type of action (solo versus dual). See text for further discussion.

Figure 1



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Figure 2

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.



Figure 3

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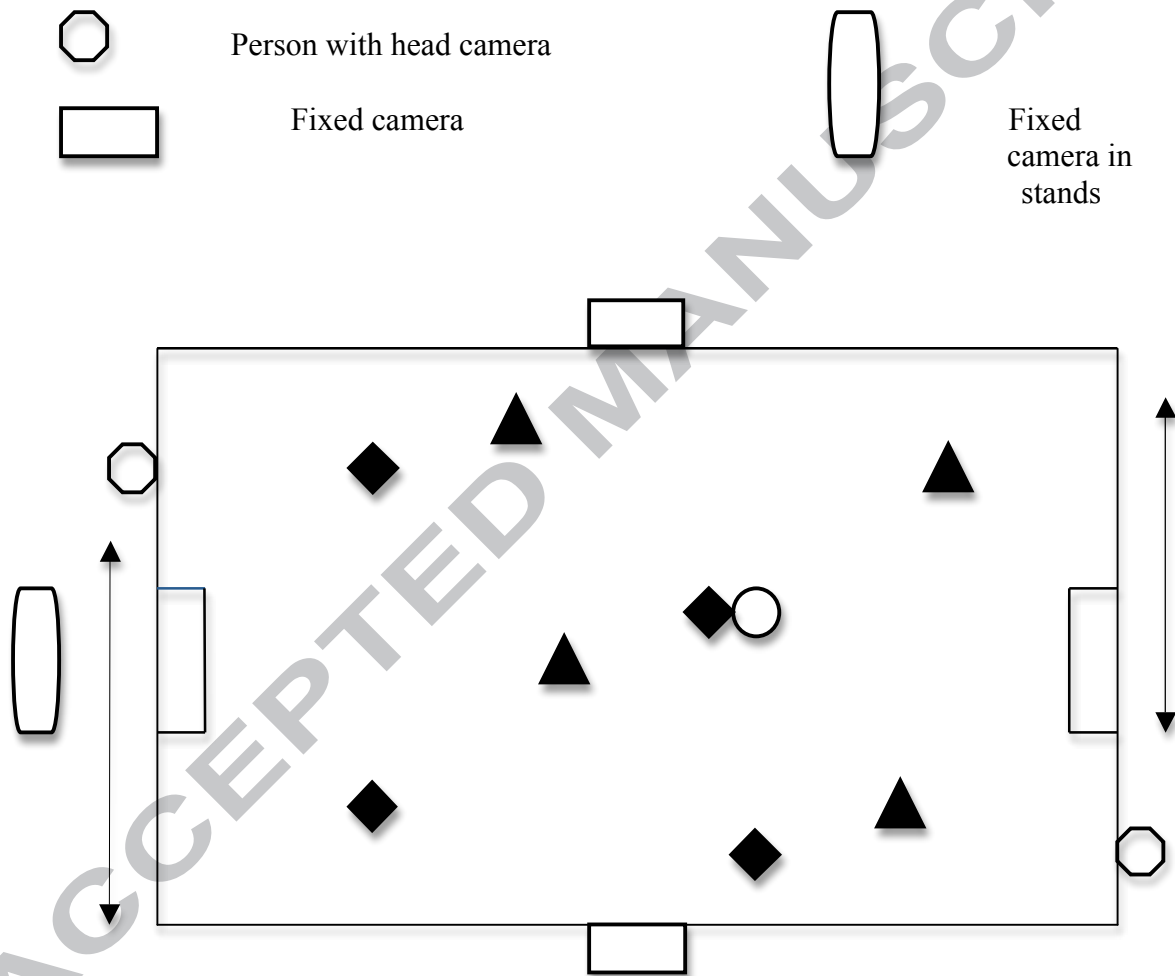


QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.



## Legend

- ◆ Player team 1
- ▲ Player team 2
- Ball
- ⬡ Person with head camera
- ▭ Fixed camera



2.5m

