The Effect of Scanning-focused Training Exercises on Scanning Activity in Elite Youth Football Players

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Abstract

Football can be seen as a complex sport, where opportunities come and go. As players scan to better act upon situations, it can be valuable to improve this scanning activity. The goal of this study was to investigate the effect of scanning-focused exercises on the scanning activity of elite youth football players. In part I of the study, 10 players from the U17 and U18 teams of an elite youth football club in the Netherlands participated in a regular passing drill. Three weeks later, these same players participated in a scanning-focused exercise. For the second part of the study, three players from the U18 (who also participated in part I), participated in two 7v7 small-sided games; once after the regular training exercise and once after the scanning-focused exercise. For part I it was hypothesised that players would show more scanning activity in the scanning-focused exercise compared to the regular exercise. Findings of this study supported this hypothesis, with higher means found in the scanning-focused exercise. For part II it was hypothesised that players would show more scanning activity in the small-sided game after the scanning-focused exercise than after the regular exercise. Although in part II all three participants had higher means of scanning activity in the scanning-focused exercise, the group size was too small to test this difference. These findings can help us understand how to improve scanning in athletes, but further research is necessary.

Keywords: visual exploratory behaviour, soccer, practice, affordances

The Effect of Scanning-focused Training Exercises on Scanning Activity in Elite Youth Football Players

Football can be seen as a complex and dynamic sport (Memmert et al., 2017), where changes in the environment occur frequently throughout a football match. Think for example about a defender stepping towards their right, resulting in different action possibilities for the player with the ball. These opportunities for action for an individual provided by the environment are called affordances (Fajen et al., 2008). Affordances are related to what information the individual sees and processes in regards to their environment. Therefore, it is important for a football player to engage in exploring their environment, so that they can adjust their choice of action, and make it as fitting as possible to the situation (Jordet, 2005). Visual exploratory behaviour can be defined as head or body movements prior to receiving the ball, to perceive information away from the ball and to act appropriately when the ball arrives (Jordet, 2005). The more someone explores their surroundings, the more task-relevant information this person can use to plan their actions. If for example a player, before receiving a pass, looks over his shoulder (head movement) and sees the position of the defender, the player can use this information to make a more successful decision.

Visual exploratory behaviour has been investigated in sports in regards to player performance. Visual exploratory behaviour has taken multiple terms through the years. The modern term, a term also more known in the sports world, is scanning (or scanning activity). The study of Jordet et al. (2013) suggested that players exhibiting more scanning activity before receiving the ball, are more successful with the ball than players who exhibit less scanning activity. The more the players scanned their environment, the better they performed. In addition, Jordet et al. (2020) showed a positive relation between scanning frequency and the amount of (forward) passes. Studies showed a positive impact of scanning activity on football players' performance, whereby a higher frequency of head movements lead to more

successful passes (Jordet et al., 2013) more attacking passes (Jordet et al., 2020; Eldridge et al., 2013; McGuckian et al., 2018), and to a reduced feeling of defensive pressure (Eldridge et al., 2013; Pedersen, 2016).

Given the relation between scanning and performance of football players, the next step is to develop training exercises that can improve a player's ability to perform more scanning activity in football games. The goal of this study therefore is to investigate the effect of a scanning-focused exercise on the scanning activity of football players. This will lead to a better understanding of how to improve scanning in athletes. To be more precise, if we know how to develop exercises that improve scanning activity, professional teams can implement these exercises into their training sessions to further improve their player's performances.

Affordances

Affordances are used to describe opportunities for action for a given individual, provided by the environment (Fajen et al., 2008). Athletes perceive how they can act under the given environmental conditions. One of the well-known theories on affordances is the ecological approach mentioned by Gibson (1979). The focus is on the functional relationship between the individual and the environment, and how skilled actions are regulated (Gibson, 1979). According to Fajen et al. (2008), affordances have multiple important features, one of them being that affordances are dynamic. This leads to affordances changing over time, and appearing or disappearing from moment to moment (Fajen et al., 2008). For example, a player might ask for a pass as he sees a passing lane to an unguarded teammate. However, when the player actually receives the pass, this passing lane might have already been cut off by the opponent. An athlete needs to be aware of their changing surroundings, to be able to adapt to new circumstances. Since football is a complex sport where the environment rapidly changes (Memmert et al., 2017), affordances change rapidly during a game as well. To be able to adapt to these changes, football players need to perceive their environment frequently.

Scanning Activity

As mentioned, it is important for a football player to be aware of his surroundings. Therefore, it is crucial that through observation skills, football players obtain knowledge of where teammates and opposition are situated within the field (Eldridge et al., 2013). This exploration of the environment is critical when it comes to adjusting one's action according to future events (Jordet, 2005). Visual exploratory behaviour, later also known as scanning activity, has been defined by Jordet (2005) as follows:

"movements of head and/or body prior to receiving the ball, engaged in to perceive information away from the ball and to act appropriately when the ball arrives" (Jordet, 2005).

As mentioned by Jordet (2005), most players make use of their peripheral vision, helping them to see what is happening in the 180 degrees visual field in front of them. However, if a player does not turn around to explore, he will not detect what is happening behind him. Head movements and body movements can help a player expand his range of vision for collecting information.

Therefore, an increase in scanning should lead to more detected relevant cues, and to an increase in performance. The relationship between scanning and a player's performance in football has been investigated by Jordet et al. (2013). The study consisted of an analysis of 27 players during 21 English Premier League (EPL) games. Results showed that the more a player scanned, the higher the probability was of the player completing a successful pass. Players who engage in extensive scanning, the period right before receiving the ball, are more successful with the ball compared to players who exhibit less of these behaviours (Jordet et al., 2013). This effect was further investigated for youth players by Eldridge et al. (2013), in a small study consisting of three youth football players. Even though there was no significant association found between scanning activity and the maintenance of possession, youth

midfielders performed more forward passes, experienced less defensive pressure and more turning opportunities when performing scanning activity (Eldridge et al., 2013). Furthermore, Pedersen (2016) investigated whether there was a relationship between eight elite football players' scanning activity and their performance. Results were in line with the results of Eldridge et al. (2013), showing a positive relationship between scanning activity before receiving the ball and the player's performance: Players performed more actions in the attacking direction, were more forward oriented when receiving the ball, and were under less defensive pressure compared to when they explored less (Pedersen, 2016). In addition, McGuckian et al. (2018) demonstrated the importance of scanning before receiving the ball. 32 semi-elite male football players (goalkeepers excluded) competed in a 11v11 match. Head turning was compared to the players' performance with the ball. The results showed that a higher exploration excursion was related to a higher likelihood of turning with the ball or playing a pass to an area opposite to which it was received. These findings suggests that, if a player gained more information about his environment by exploring, they are more likely to utilize this gained information by turning with the ball or playing a pass behind them (McGuckian et al., 2018). Jordet et al. (2020) found more evidence in favour of a positive effect of scanning on a player's performance. The main objective of their study was to examine the potential role that scanning plays for different types of performance with the ball. The results suggested that engaging in scanning lead players to more effectively detect and utilize progressive and forward-passing opportunities (Jordet et al., 2020). Altogether, higher scanning activity has been linked to better performance in football players, all suggesting the importance of using exploration techniques in football.

Improvement and Practice of Scanning Activity

The importance of scanning activity on the performance of football players has been stated by multiple studies (Jordet et al., 2013; Aldridge et al., 2013; McGuckian et al., 2018;

Jordet et al., 2020). The next step should be to investigate the possibility of improving scanning activity. According to Gibson (1979), the process of information gathering is very susceptible through learning, and the opportunities to educate attention and exploration are unlimited. Following the statement of Gibson (1979), it would be possible to improve a football player's scanning activity through practice.

Jordet (2005) investigated whether an imagery intervention combined with the observation of video footage could improve elite football players' decision-making. Although there were no improvements in decision-making, there was an increase in scanning activity found. Furthermore, the study of Pocock et al. (2017) found similar results, using an imagery intervention to train scanning activity in elite football players. The imagery intervention enhanced scanning activity, although no consistent improvement with the ball was observed. However, the decision-making of all participants improved when comparing post-intervention data to the baseline measurement (Pocock et al., 2017).

Training is important if football players want to improve their performance (Bartlett et al., 2017; Ericsson et al., 1993). The research in regards to suited training exercises that are focused on the development of scanning activity has been scarce (Pulling et al., 2018), although some studies have investigated what components challenge a player to explore more. The impact of constraints on scanning activity in football has been investigated by McGuckian et al. (2017), who observed six players participating in 3v3 small-sided games. Games were played on a normal sized pitch, a small pitch, and on a large pitch. Results showed that players scanned more frequently when playing on a pitch with less space per player. Implied was that players had less time and space when receiving the ball, and therefore had to scan more to be able to perform (McGuckian et al., 2017). This suggests that the amount of free space is important, instead of the actual size of the field.

Not to be overlooked is that we want to improve scanning activity, so that players will perform better during their football games. The scanning activity needs to be practiced, to see an improvement. Then, when the player shows more scanning activity during practice, the next step is to transfer this skill from practice situations to game situations. The greater the similarities between the practice scenario and the real game, the more likely it is that the learning will transfer from practice to game (Holt et al., 2006). Since in-game performance is what we indirectly want to improve, trainers should aim to replicate the match environment as much as possible. In a samples approach, one tries to sample behaviour that reflects the criterion behaviour as closely as possible (Wernimont & Campbell, 1968). A samples approach is closer to the actual performance in comparison to practicing a skill in isolation (e.g. practicing the skill 'dribbling' by dribbling around cones). Therefore the samples approach most likely provides a better prediction for how scanning will be used in game situations (Den Hartigh et al., 2018b). For that reason, it is advised to surround the skill of scanning with components representative of an in-game situation. Examples of in-game situation components would be the pressure of a defender, or the opportunity to decide between an attacking pass or a passive, defensive pass.

The effect of the implementation of scanning-focused training exercises in football has not been investigated enough, even though studies suggest that such exercises should be added in order to improve ones' scanning (Jordet, 2005; Pedersen, 2016; Pulling et al., 2018; McGuckian et al., 2018; Jordet et al., 2020). In addition, it has not been investigated enough whether scanning-focused training exercises are able to improve scanning activity, and if these improvements are transferable to game situations.

Current Study

The goal of this study is to investigate the effect of scanning-focused exercises on the scanning activity of elite youth football players. To answer this question, a study was

conducted at youth teams of an elite Dutch football club, where a regular training exercise was compared to a scanning-focused training exercise on scanning activity. The study is divided into two research questions.

First of all, is there a difference in the player's scanning activity between the regular training exercise and the scanning-focused exercise? Based on earlier research, that shows us that scanning activity can be learned (Gibson, 1979), it is expected that the mean scanning activity per second per player in the regular training exercise will be different from the mean scanning activity per second per player in the scanning-focused exercise. More specifically, hypothesised is that players will scan more in the scanning-focused exercise in comparison to the regular training exercise, resulting in a higher mean of scanning activity per second per player before receiving the ball in the scanning-focused exercise.

The second research question is about the effect of the scanning-focused exercise on scanning activity in small-sided games. To be more exact, is there a difference in the player's scanning activity between the small-sided game before the scanning-focused exercise compared to the small-sided game after the scanning-focused exercise? To answer this question, players will participate in a small-sided game after the regular training exercise and after the scanning-focused exercise. Expected is that the mean scanning activity per second per player during the small-sided game before the scanning-focused exercise will be different from the mean scanning activity per second per player during the small-sided game after the scanning-focused exercise. To be more specific, hypothesised is that players will scan more in the small-sided game after the scanning-focused exercise in comparison to the small-sided game after the regular training exercise, resulting in a higher mean of scanning activity per second per player before receiving the ball in the small-sided game played after the scanning-focused exercise.

Method

Participants

Elite youth football players playing at the highest level of the Dutch football competition participated in this study. Players were recruited from the men U17 and U18 teams from an elite Dutch football club. Before the training session players were asked to participate in the study, and in addition received an information letter. After agreeing to voluntarily partake in the study and before starting the experiment, participants signed a written informed consent. Participants performed the study with their own team (either U17 or U18), during the usual planned Monday practice sessions in the afternoon. The players were not compensated for their participation. The study protocol was approved by the Ethical Committee of Psychology, University of Groningen.

Part I: Scanning Activity in the Two Exercises

Regarding research question 1: "is there a difference in the players' scanning activity between the regular training exercise and the scanning-focused training exercise?", the participants belonged to the U17 and U18 teams. This group consisted of defenders, midfielders and attackers. In total, 14 players participated in this study, with seven players from the U17 and seven from the U18. Four players from the U18 were excluded from the study because of non-completion, as injuries or other personal reasons lead to four players being unable to participate in the second exercise. This means that of the 14 participants, 10 players remained for the analysis, with an average age of 16.6 years (SD = 1.02). Of these 14 participants, three players were defenders, four players were midfielders and three players were attackers.

Part II: Scanning Activity in Small-sided Games

Regarding research question 2: "is there a difference in the player's scanning activity between the small-sided game before the scanning-focused exercise compared to the small-sided game after the scanning-focused exercise?", players who participated belonged to the

U18 team. In total, seven players participated in this part (these players also participated in part I of the study). However, four participants were excluded due to non-completion (the same participants who were excluded in part I). Three participants remained for this part of the study. Two participants were 18 years old, and one participant was 17 years old. Of these three participants, one player was a defender, one player a midfielder, and one player an attacker.

Design

For both parts of the study, the independent variable was the exercise. Either the exercise was a regular passing drill, or it was a scanning-focused passing drill. The scanning-focused exercise was given once, three weeks after the first training measurement. Figure 1 shows a map of the regular training exercise. The exercise was performed by seven players, plus a keeper (who's purpose was to start the exercise by passing the ball to the first player). All players were on the same team, as no defenders from an opposite team were present in the exercise. Figure 2 shows a map of the scanning-focused exercise. This passing drill was performed by four players as attackers, and three players as defenders. An explanation of the possible routes within the scanning-focused exercise can be found in figure 3.

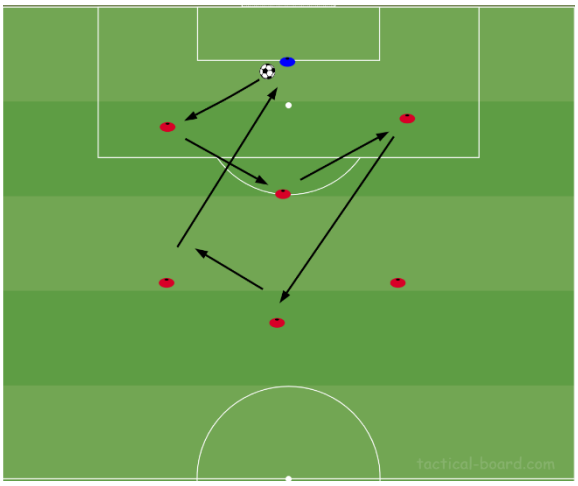
The dependent variable was the players' scanning activity, and was measured on a within-subjects level. As mentioned by Jordet (2005), this type of activity can be defined as:

"movements of head and/or body prior to receiving the ball, engaged in to perceive information away from the ball and to act appropriately when the ball arrives" (Jordet, 2005)

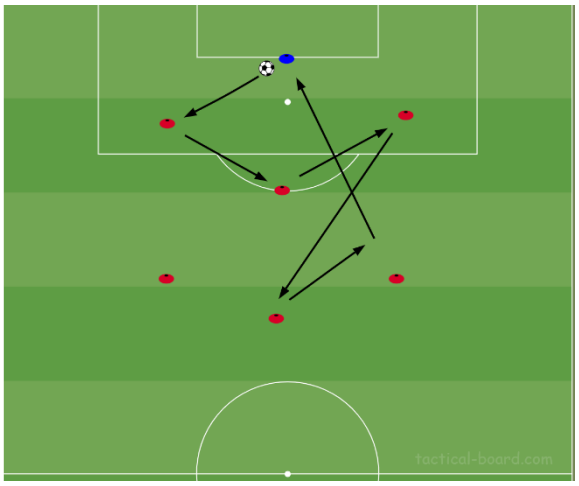
Scanning activity was assessed by dividing the total number of head movements registered in one situation with the total number of seconds in that situation (Jordet, 2005; Jordet et al., 2013). Scanning activity is therefore only measured in moments where the participant received the ball, with the amount of searches being relative to the time.

Figure 1

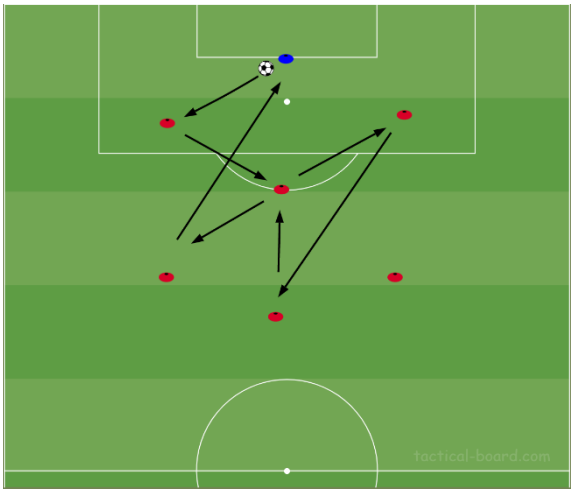
Visualisation of the Regular Training Exercises, with Explanation of the Routes



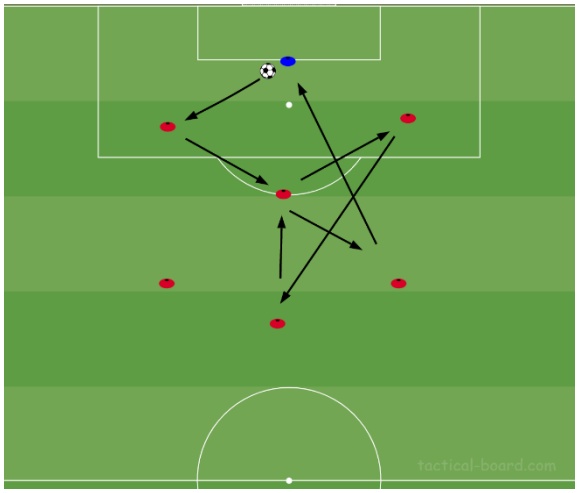
1a. First part of the first route



1b. Second part of the first route



1c. First part of the second route



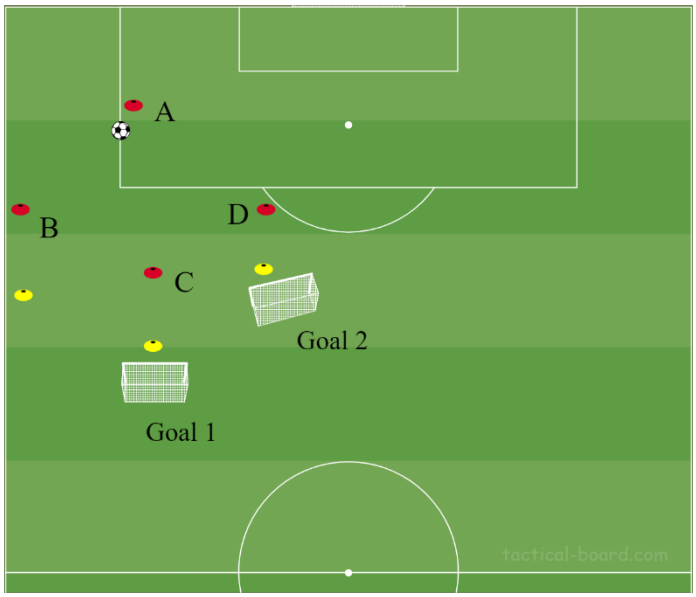
1d. Second part of the second route

Explanation first route: The route starts at the blue cone (goalkeeper). The goalkeeper's only task is to pass the ball towards the first red cone (to start the route). He does not move to another position. Player start first with the left route (a). When the left route (a) is completed, the right route (b) is performed next. When the ball is then again at the blue cone, players perform the left route (a) again, and so on. A player moves to the position to which he passes the ball to. An exception to this rule is the pass towards the blue cone, as then the player who passes the ball moves to the red cone that receives the pass from the blue cone. The first route was performed for eight minutes in the regular training exercise.

Explanation for second route: When the left route (c) is completed, the right route (d) is performed next. When the ball is then again at the blue cone, players perform the left route (c) again, and so on. A player moves to another position the same way as in the first route. The second route was performed for seven minutes in the regular training exercise.

Figure 2

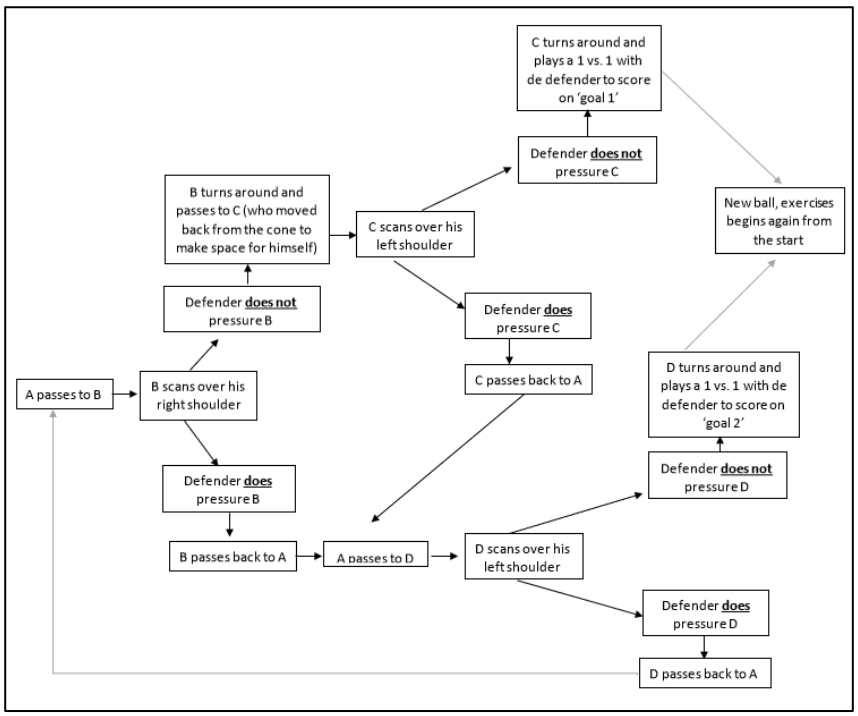
Visualisation of the Scanning-focused Exercise



Note. Red caps are the attackers, yellow caps are defenders. Only the scanning on position B, C and D was observed, since player A only performed one-two passes. Players switched to another position after every three minutes.

Figure 3

Explanation of the Different Possible Routes in the Scanning-focused Exercise



Part I: Scanning Activity in the Two Exercises

In total there were two measurements (the regular training exercise and a scanning-focused exercise) and two training sessions per team (two times for the U17, two times for the U18). All 10 players participated once in the regular training exercise and once in the scanning-focused exercise.

Regarding the time of measuring scanning activity, the maximum amount was set to three seconds in both the regular training exercise and the scanning-focused exercise. The starting point of counting was determined either when the first pass of the exercise was given, or three seconds before the player received the pass. The maximum of three seconds was set, because the exercises were rather static. Players would not receive that much more relevant information when scanning far before receiving a pass. Situations where the time between two situations was smaller than one second, were not included, as these situations were too short to show relevant scanning. Reason for this is the use of a minimum of one second in previous studies, e.g. the study of McGuckian et al. (2018). Therefore, one-two passes (a player passing the ball to a teammate and immediately receiving the ball back) were not included in the data collection, as these situations were shorter than one second.

Part II: Scanning Activity in Small-sided Games

In total, there were two measurements (small-sided game after the regular training exercise and a small-sided game after the scanning-focused exercise. Each player participated in both measurements.

Regarding the time of measuring scanning activity, the maximum amount was set to five seconds in both small-sided games. Five seconds was chosen instead of three seconds, as a small-sided game offers more scanning possibilities beforehand. Counting started either when: the player’s team gained possession, by a throw-in from a teammate, when the keeper started the play, or five seconds before the player received the ball (when the team already

had possession for longer than five seconds). Again, situations where the time between two situations was smaller than one second, were not included. For example, the one-two passes (a player passing the ball to a teammate, and immediately receiving the ball back) were not included in the data collection.

Procedure

Data was obtained by recording training sessions of the U17 and U18. It was explained to the players that the study was about the improvement of scanning behaviour in football players, and that participation is fully voluntarily. Participants received an information letter and an informed consent form before their practice session. After filling in the form and reading the information, their training session began.

Part I: Scanning Activity in the Two Exercises

First, the participants played in a regular training exercise during a regular training session (figure 1). This exercise was a 15 minute passing drill, that was not focused on scanning. The exercise was led by the researcher of this study, together with the professional trainers of the concerning teams. Three weeks later the players performed the scanning-focused exercise (figure 2). This exercise used the same size of the field as the regular training exercise. However, components representative of an in-game situation were added to the scanning-focused exercise. So were defenders positioned behind each attacker (except for attacker A, who only played one-two passes). In addition, players decided themselves what action was most suitable in each situation, and players could score on football goals. The exercise took 15 minutes, with players moving to another position every three minutes. The reason for switching positions was that players would have to make different head movements at different positions (e.g. watching over right shoulder vs. watching over left shoulder).

Part II: Scanning Activity in Small-sided Games

After the regular training exercise of part I, participants played in a 7v7 small-sided game during their regular training session. This small-sided game lasted for 12 minutes. To make the size of the field smaller, and more fitting as the amount of players in the game, each of the goals was placed on the 16-meter line. This made the pitch size smaller, which is associated with more individual ball involvements per player (Olthof, 2019). Three weeks later, after playing in the scanning-focused exercise of part I, the participants played again a 7v7 small-sided game. The measurements of the field and the duration of the game was identical to the first recorded small-sided game.

Manipulation check

After participating in the two practice sessions, players filled in an online questionnaire about the practice session and scanning in general. The players who filled in the questionnaire either participated only in part I, or both in part I and part II. The purpose of the questionnaire for the study was to see if the players deemed the exercise as distracting. Not all statements of the questionnaire were used for the manipulation check, as some of the statements were meant to let the players reflect on the training and their performance. The questionnaire was based on the questionnaire used by Jordet (2005). The statements were written in Dutch, as the participants were all Dutch youth players. The following statement was used for the manipulation check (translated from Dutch to English): ‘The training was disturbing’. Each statement was answered on a 1-7 Likert scale (1 = *not at all*, 7 = *very much*). Participants had the option within the questionnaire to add any further questions or comments about the study, practice, or questionnaire itself. None of the participants had any further questions.

Materials

Regular training equipment was used during the football practice, such as 15 balls per training exercise, caps (seven for each training exercise), cones (one on each corner for the

small-sided games), coloured vests (to differentiate between attackers and defenders), normal-sized goals (for small-sided games) and small-sized goals (for the scanning-focused exercise). Players performed the training sessions on one of the training fields of the elite football club.

The training exercises in part I of the study were recorded with a professional videorecorder from the football club. The small-sided games however, were both recorded with the professional videorecorder from the club, and with an iPhone 11 pro. The reason for this was that the iPhone could possibly be moved faster to record different parts of the field. The recorded footage was compared based on video-quality and the ability to capture the head movements of the participants. For each small-sided game one of the two recordings was chosen for data collection. The camera was placed in such a way that the players and the ball during the exercise and small-sided games was visible as much as possible. For the first small-sided game, the professional videorecorder showed to have the better recording, whereas the iPhone had the better recording of the second small-sided game.

Analysis

The moments suitable for observing a player' head movements were analysed using a software program called Mediacoder. This way the frequency of head movements could be compared to the time interval, making it possible to calculate a player's scanning activity per second. When a player was outside of the frame before receiving the ball, or when someone else was standing between the camera and player (thus blocking the player's head), this moment was deemed incomplete, and was therefore not used for calculating the frequency of head movements.

Part I: Scanning Activity in the Two Exercises

A total of 451 moments were recorded for the regular training exercise in 15 minutes of recording. A total of 80 moments were found to be incomplete. This resulted in a total of 371 moments being used from the regular exercise for the analysis, with 173 total head

movements. For the scanning-focused exercise, 258 moments were recorded in 15 minutes of recording, where 8 moments were incomplete. This resulted in 250 moments being used from the scanning-focused exercise for the analysis, with a total of 458 head movements.

Part II: Scanning Activity in Small-sided Games

A total of 25 moments were recorded in the first small-sided game in 12 minutes of recording. Three moments were found to be incomplete. Therefore a total of 22 moments were used for the analysis, with a total of 35 head movements.

A total of 26 moments were recorded in the second small-sided game in 12 minutes of recording. One moment was found to be incomplete. Therefore a total of 25 moments were used for the analysis, with a total of 55 head movements.

Results

Part I: Scanning Activity in the Two Exercises

Nine out of 10 participants reported that they were not disrupted during the practice sessions. One participant failed to fill in the questionnaire, but taken into account the small group of participants, and seeing the performance of this player during the recorded exercises, it was decided that no further participants would be excluded from the study.

In the first hypothesis it was assumed that the mean scanning activity per second per player in the regular training exercise will be different from the mean activity per second per player in the scanning-focused exercise. Expected was that players will scan more in the scanning-focused exercise in comparison to the regular training exercise, resulting in a higher mean scanning activity per second per player in the scanning-focused exercise. In order to test this, a 2x1 matched-pair design was used, in which the average of the mean scanning activity per second per player in the regular training exercise was compared to average of the mean scanning activity per second per player in the scanning-focused exercise. Both means were measured on a continuous level. The total amount of head movements per player in the

regular training exercise was 17.3 (*SD* = 10.19), whereas the total amount of head movements per player in the scanning-focused exercise was 45.8 (*SD* = 18.55).

Assumptions

Before starting the analysis of the data, the assumptions were checked. First, as assessed by the Shapiro-Wilk test, the mean scanning activity per second per player was normally distributed in the regular training exercise ($p > .05$), but was not normally distributed in the scanning-focused exercise ($p = .02$). Secondly, the skewness and kurtosis of the mean scanning activity per second per player in both exercises was calculated. The skewness of the mean scanning activity per second per player in the regular training exercise was found to be .73, indicating that the distribution was right-skewed. The kurtosis of the mean scanning activity per player in the regular training exercise was found to be -1.11, indicating that the distribution has lighter tails than the normal distribution. The skewness of the mean scanning activity per player in the scanning-focused exercise was found to be -1.88, indicating that the distribution was left-skewed. The kurtosis of the mean scanning activity per second per player in the scanning-focused exercise was found to be 4.22, indicating that the distribution was more heavy-tailed compared to the normal distribution. Thirdly, one outlier was found in the scanning-focused exercise. However, when further inspecting the data, there was no reason to exclude this participant. As the normality assumption was violated, the distributions showed skewness, and the amount of participants in our study was relatively small, the decision was made to use a non-parametric test for the analysis.

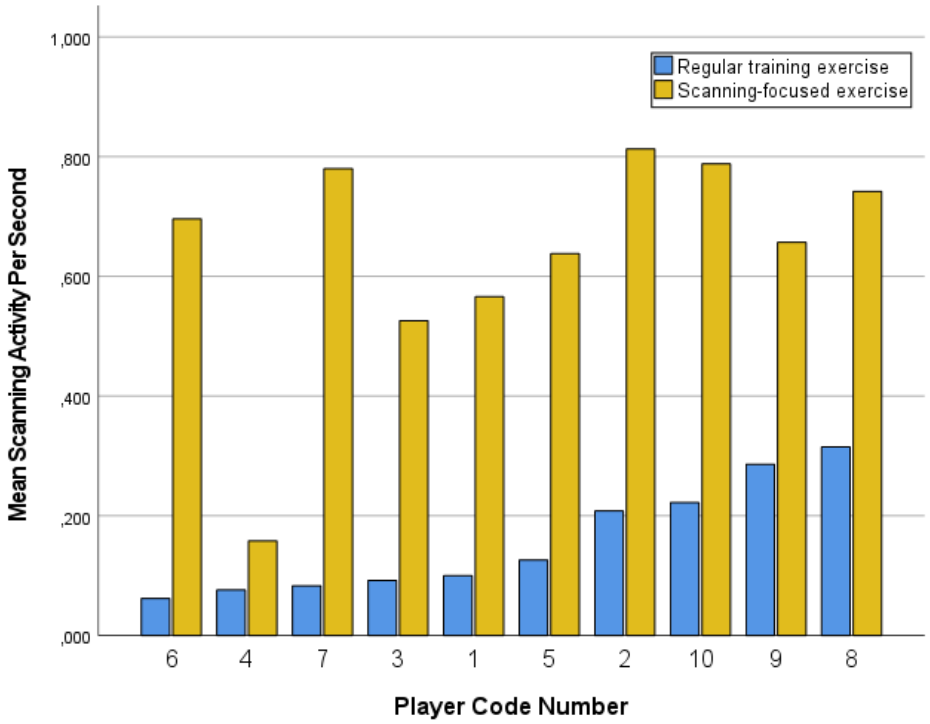
Analysis for Part I

A Wilcoxon signed-rank test was conducted. The output of the Wilcoxon signed-rank tests indicated that the scanning activity per second per player in the scanning-focused exercise (*Mdn* = 0.68) was statistically significantly higher than the scanning activity per second per player in the regular training exercise (*Mdn* = 0.11), $z = -2.80$, $p = .005$, with a

large effect size, r = .63 The scanning activity per second per player in both training exercises can be observed in figure 4.

Figure 4

Barplot comparing the Mean Scanning Activity per Second per Player in the Regular Training Exercise with the Mean Scanning Activity per Second per Player in the Scanning-focused Exercise.



Note. The 'Player code number' on the x-axis is arranged based on the level of scanning activity in the regular training exercise, ranked from lowest- to highest mean scanning activity per second.

Part II: Scanning Activity in Small-sided Games

All three participants reported that they were not disrupted during the training sessions. Therefore no further participants were excluded from the study. As the amount of

participants was deemed too small to generate useful and reliable test results, the choice was made to describe the findings in a descriptive manner.

The mean scanning activity per second per player in the first small-sided game (after the regular training exercise) was 0.37 (*SD* = 0.06). In the second small-sided game (after the scanning-focused exercise), the mean scanning activity per second per player was 0.58 (*SD* = 0.08). The mean scanning activity per second per player for both exercises is visualized in Figure 5.

Individual Performances

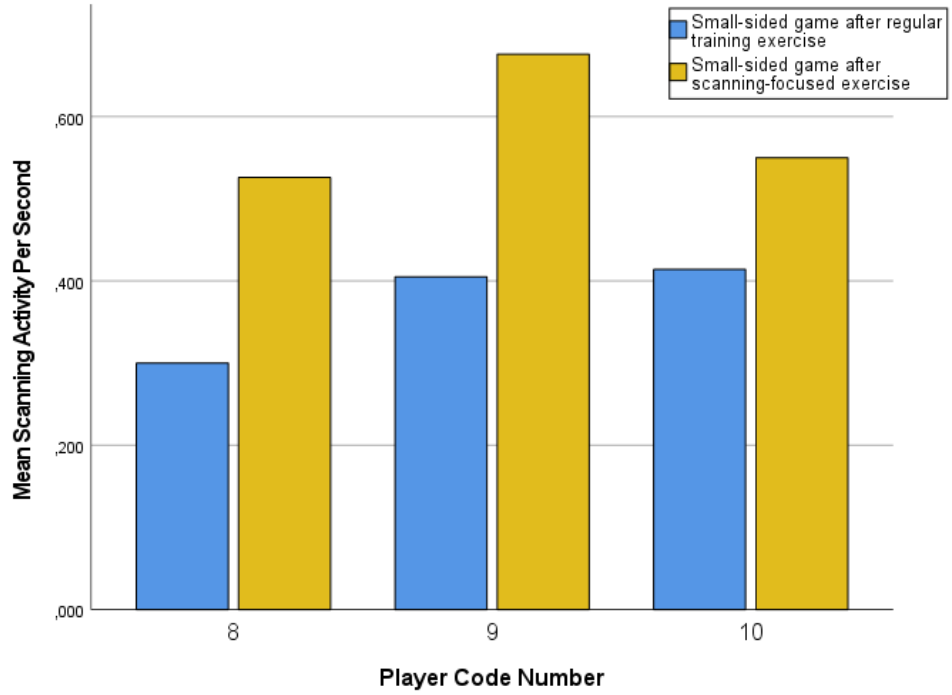
Participant I (player 8) scanned at least once in three of the four moments (75%) during the first small-sided game. In the second small-sided game, after the scanning-focused exercise, player 8 scanned at least once in five of the five moments (100%). The mean scanning activity per second of this participant went from 0.30 in the first small-sided game, to 0.53 in the second small-sided game.

Participant II (player 9) scanned at least once in nine out of 10 moments (90%) during the first small-sided game. In the second small-sided game, player 9 scanned at least once in eight out of nine moments (89%). For player 9, the mean scanning activity per second in the first small-sided game was 0.41, whereas his mean scanning activity per second in the second small-sided game was 0.68.

Participant III (player 10) scanned at least once in six out of eight moments (75%) during the first small-sided game. In the second small-sided game the participant scanned at least once in nine out of 11 moments (82%). The mean scanning activity per second for player 10 was 0.41 in the first small-sided game, whereas his mean scanning activity per second in the second small-sided game was 0.55.

Figure 5

Barplot comparing the Mean Scanning Activity per Second per Player in the First Small-sided Game with the Mean Scanning Activity per Second per Player in the Second Small-sided Game



Note. The 'Player code number' on the x-axis is arranged based on the level of scanning activity in the first small-sided game (after the regular training exercise), ranked from lowest- to highest mean scanning activity per second.

Discussion

The goal of this study was to investigate the effect of a scanning-focused exercise on the scanning activity of elite youth football players. The first hypothesis was that players would scan more in the scanning-focused exercise compared to the original training exercise. The second hypothesis was that players would scan more in the small-sided game played after the scanning-focused exercise, compared to the small-sided game after the original training exercise. To test this, for part I of the study, participants played in a regular passing drill. Three weeks later these participants played in a scanning-focused exercise. For part II of this study, participants played in a small-sided game right after the regular training exercise. Three

weeks later, the same participants played a small-sided game after the scanning-focused exercise.

Part I: Scanning Activity in the Two Training Exercises

Findings of part I showed that there was a difference between the scanning activity per second per player between the regular training exercise and the scanning-focused exercise. Players showed significantly higher levels of scanning activity per second in the scanning-focused exercise, suggesting that implementing components representative of in-game situations improves the scanning activity of football players during the given exercise. These findings are both in line with our hypothesis and with previous research. So was implied by Gibson (1979) that information gathering is susceptible to learning, with many opportunities educate exploration. Besides this, previous studies found an increase of scanning activity when participants participated in an imagery intervention (Jordet, 2005; Pocock et al., 2017). Parallel to the findings of these two studies, the results of this study show that focusing an exercise on scanning improves the scanning activity of the players in the training exercise. A player had more options in the scanning-focused exercise compared to the regular training exercise, as the defender either pressured the attacker or stayed at his spot. Because of the defender's choice the affordances of the attacker changed, as affordances are dynamic (Fajen et al., 2008). Thereupon, the players needed to scan to be able to react appropriately to the defender. This could be an explanation for the higher scanning activity found in the scanning-focused exercise, compared to the regular training exercise. Furthermore, it was suggested that the amount of free space is important when it comes to the amount of scanning activity (McGuckian et al., 2017), where less free space was associated with more scanning activity. As defenders were added to the scanning-focused exercise, less free space was available for a player to perform. In the regular exercise however, players were not defended, so players had more free space. This defensive pressure adds another element to the exercise where players

needed to react upon. This could also explain why the players scanned more in the scanning-focused exercise.

Part II: Scanning Activity in Small-sided Games

The findings of part II showed a light trend of players having higher scanning activity during the small-sided game after the scanning-focused exercise, in comparison to the scanning activity during the small-sided game after the regular training exercise. Each player showed higher scanning activity in the small-sided game after the scanning-focused exercise, compared to their scanning activity in the small-sided game after the regular exercise. This could suggest that participating in a scanning-focused training exercise leads to more scanning during small-sided games. This trend is in line with the hypothesis. However, as there was no statistical analysis conducted for this part of the study, and taken into account the small sample, the findings should be handled carefully without making any hard conclusions.

Little research is previously done on the effects of scanning-focused exercises on small-sided games (or in-game performance). However, it is known that training is important for improving performance (Bartlett et al., 2017; Ericsson et al., 1993). Accordingly, training scanning activity in a training exercise would lead to better scanning activity in small-sided games. Another possible explanation for the light trend that was found could be the use of the samples approach, as mentioned by Den Hartigh et al. (2018b) and Wernimont and Campbell (1968). For the development of the scanning-focused exercise a samples approach was used. The scanning-focused training exercise was developed in a way that the training situations mirrored the situations in a small-sided game environment. The exercise encouraged players to perform more scanning activity, as players needed to turn their heads to be able to know what action was most optimal. The similarities between the scanning-focused exercise and the small-sided game were greater than the similarities between the regular training exercise and the small-sided game. As learning is more likely to transfer from practice to game when the

similarities are greater (Holt et al., 2019), it would be expected that the player would have a higher scanning activity in the small-sided game after the scanning-focused exercise, compared to the small-sided game after the regular training exercise. this could be a possible explanation for the light positive trend of each player's scanning activity in the small-sided games.

Strengths and Limitations

A strength of this study was that the group was homogeneous. As the target population was elite youth football players, and all our participants were all football players at an Dutch elite football club, all participants were deemed to be on the same level in regards to football ability. Another strength is that the group of participants consisted of players who played different positions, as the group had defenders, midfielders, and attackers. Because of this variation, the study is not only focused on one particular position, but on multiple ones.

When interpreting the findings, the study has some general limitations that should be addressed. First of all, the sample for the first part of the study (n = 10) was relatively small. Therefore these results could be biased, and less reliable and generalisable. This could be a reason for higher variability, and have an effect the reliability. Even though the differences in scanning activity were found to be statistically significant, conclusions should be made carefully. The sample size was even smaller for the second part of the study (n = 3). Because of the mentioned bias, not conducting a statistical analysis was seen as the correct decision for the second study. Although we may have found a trend that could be interesting for further research, these findings are not suitable for concluding whether scanning-focused exercises lead to more scanning in game situations. The reason for the low sample of participants was because of non-completion. Players were injured or absent for other personal reasons, which lead to them not being able to participate in the scanning-focused exercise. Furthermore, the training sessions took place at the end of the season. This lead to some participants being

absent due to school exams, and other players not training with the team as much as during the season. For future research, it would be advised to conduct the study with a larger pool of participants. Then, even when players are excluded due to non-completion, the sample size can still be large enough to make the results less biased, and thereby more generalisable and reliable.

Another weakness of this study is that the amount of training sessions was low. Participants only played once in each training exercise, and participants of part II of the study played only two small-sided games. A player could for example perform far below his usual level on the day of recording, with this affecting the outcome of the study. Therefore, expanding the amount of practice sessions should be considered for future research. This can lead to more measurements in different time periods, resulting in a broader image of the level of scanning activity.

A different topic worth mentioning is the fact that the study compared group means. In the first part of the study, the mean scanning activity per second per player was compared between the two exercises. Even though this gave a general image of the difference of the group performance between the two exercises, it could be more useful to focus on the individual differences. Group means do not tell the whole story of individual development (Den Hartigh et al., 2018a; Kunnen, 2012), and the main focus is to help players improve their selves. Therefore, future research should focus on individual trajectories, to see if a player's scanning activity increases over time when participating in scanning-focused exercises.

Conclusion

The aim of this study was to investigate the effect of a scanning-focused exercise on the scanning activity of elite youth football players. Participants showed higher scanning activity in the scanning-focused exercise compared to the regular training exercise, suggesting that implementing components representative of an in-game situation, improves the scanning

activity of football players during the given exercise. These results can help to understand how we can improve a player's scanning activity during practice. The study did not test whether players scanned significantly more during small-sided games after playing in a scanning-focused exercise, although a trend of an increase in scanning activity was found. Further research should therefore be done to investigate the effect of scanning-focused exercises on the scanning activity during game situations. For this, small-sided games can be used, or even more directly, real football matches (such as season matches, tournament matches, or friendly games). In addition, future research should consist of more participants and more practice sessions, to see whether the same findings can be found.

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