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ORIGINAL

REFEREES´ VISUAL BEHAVIOUR DURING OFFSIDE SITUATIONS IN FOOTBALL

COMPORTAMIENTO VISUAL DE ARBITROS DE FUTBOL EN SITUACIONES DE FUERA DE JUEGO

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ABSTRACT

This study examines the 8 football referees´ visual behavior during the perception of offside actions carried out in a laboratory setting. The task consists on perceiving a rally of 24 trials onto a screen (5x3m) with reduced play situations and that could conclude with an offside action. Participants perceive the sequence with the ASL Eye Tracking SE5000 and press a laser pointer towards the screen in the trials which have an offside action. The variables to be manipulated are the distance and angle in which the offside trials are perceived. The dependent variables are the number and time (average) of visual fixations and the success rate. The results show that the distance and angle changes the referees´ visual behavior. Moreover, they have a higher success rate when they perceive trials with small angles, more specifically those with short and medium distances.

KEY WORDS: Visual behavior, referees, offside, success rate, football.

RESUMEN

El estudio analiza el comportamiento visual de 8 árbitros de fútbol durante la percepción del fuera de juego en laboratorio. La tarea consiste en percibir una secuencia de 24 ensayos en una pantalla (5x3m), donde se proyectan situaciones reducidas de juego y que concluyen con una posible acción de fuera de juego. Los participantes deben percibir la secuencia con el ASL Eye Tracking SE5000, y pulsar un puntero laser hacia la pantalla en aquellos ensayos con fuera de juego. Las variables a manipular son la distancia y el ángulo con que se perciben las acciones de fuera de juego. Las variables dependientes son el número y tiempo (media) de fijaciones visuales y el porcentaje de acierto. Los resultados muestran que la distancia y ángulo influyen en el comportamiento visual de los árbitros. Además, son más eficaces detectando el fuera de juego con ángulos pequeños y en distancias cercanas y medias.

PALABRAS CLAVE: Comportamiento visual, árbitros, fuera juego, aciertos, fútbol.

INTRODUCTION

The offside action is a common situation during a football match, and in some occasions could determinate the outcome of the play. The correct assessment of the offside in football, considering visual perception, is complex because it requires attention to a lot of stimuli during the sport situation and the selection of the most important in a short time.

Among the causes that hinder a correct assessment of offside actions in football are those psychologically related with the attention and temporal order judgments (Botella & Palacios, 2002; Gomez & Botella, 2005), optical illusions due to an incorrect position of the assistant referee (Helsen, Gilis, & Weston, 2006; Oudejans et al., 2000), or perceptual errors that are generated by the delay between the perception of dynamic stimulus visualized and its static image created on the retina (Baldo, Ranvaud, & Moyra, 2002; Catteeuw, Helsen, Gilis, Van Roie, & Wagemans, 2009; Catteeuw, Helsen, Gilis, & Wagemans, 2009b; Gilis, Helsen, Catteeuw, Van Roie, & Wagemans, 2009; Helsen et al., 2006). Also, there are physiological causes concerning the inability of the eyes to fix the vision in all stimuli at the same time (Belda, 2009; Sanabria et al., 1998).

Previous research about offside actions in football, from a cognitive perspective and using digital technology, has tried to find the possible influence of certain variables on the accuracy in detecting this not regulatory action of the game. The variables analyzed were the experience (Catteeuw, Helsen, Gilis, &

Wagemans, 2009a; Catteeuw et al., 2009b; Catteeuw et al., 2009; Gilis et al., 2009), the role on the field (Catteeuw et al., 2009a; Catteeuw et al., 2010; Catteeuw, Gilis, Wagemans, & Helsen, 2010a; Helsen et al., 2006), the place on the field where the research situation takes place (Gilis et al., 2009), distance (Button, 2006), assistant referee´s angle with perceived offside action (Catteeuw et al., 2010a), assistant referee´s position exactly when the offside action occurs (Catteeuw et al., 2010; Helsen et al., 2006; Oudejans et al., 2005), and even the temporal moment of the match in which it has appeared (Button, 2006; Helsen et al., 2006).

Previous research shows that the position, distance and viewing angle variables are not related to effective appreciations during offside actions. However, the temporal moment of the match influences the number of offside errors since during the first 15 minutes period of each play it is more difficult to predict a pattern of play and so hindering the referee´s decision making (Button, 2006; Helsen et al., 2006). Moreover, the role of the participants during the play influences the accuracy of the offside perception, and a relation between skill level and experience years, training or practice hours per week, and number of matches refereed has been established in these situations (Catteeuw et al., 2009a). The research context also affects the accuracy of the offside detection as both referees (top level: FIFA and high level: 1st division Belgium) were more likely to make mistakes in real match situations when compared to computer animations (Gilis et al., 2009).

According to the experience level (Gilis et al., 2009) it is concluded that FIFA referees have a higher success rate in the offside detection than the Belgian referees only in a laboratory setting (Catteeuw et al., 2009b), using eye-tracking technology, it is also concluded that higher-level referees are more accurate in simulated rallies, with fixations of longer duration, but they have more errors when they perceive the actions from behind the offside line (Catteeuw et al., 2009). Note that lower-level assistant referees have more flash-lag errors than the highest level referees. Therefore, the high-level assistants fix their gaze on the offside line with more time ahead, both before and after the pass, suggesting that they do not make a saccadic eye movement from the player who passes the ball to the receiver player.

Belda (2004, 2009) concludes that during the offside action the assistant referee has to perform at least three eye movements to look at the player driving the ball in order to know when he is going to make the pass (first), to search the more advanced attacking player that will receive the ball (second) and to locate the last defender, not including the goalkeeper (third). This process requires at least two saccadic eye movements that last at least 4.2 tenths of a second, and so he argues that during this short time an offside action could occur. Following the same line, Sanabria et al. (1998) concludes that at the beginning of the offside action, the last defender is perceived by peripheral vision while the player with the ball is perceived by the foveal vision. Just when the pass occurs, the assistant makes a saccadic eye movement that changes his point of gaze to the last defender while he calculates the position of the attacking player that will receive the ball.

The objectives of this research are to analyze the influence of the distance and angle of viewing variables with respect to the visual behavior and the accuracy in the decision making process during the perception of offside actions. Also, the study examines if the sample of referees develops the visual behavior described by Belda (2004) and Sanabria et al. (1998) during the offside actions in football, with technological ocular systems and video-filmed procedure.

We suggest that an effective visual behavior during the perception of the offside actions could help referees to enhance their performance on the task. A visual behavior characterized by fixing the point of gaze on the attacking player with the ball in the first place and after on the receiver player and last defender. Moreover, we suggest that the distance and angle of viewing could influence the visual behavior and accuracy of the offside actions. More specifically, the referees will have a lower performance in the detection of the offside in those trials that include the perception of the football players with far distances (large distances) and great separation between attacking player with the ball and receiver player (wide angle) because they perceive the stimuli less and the detail of the stimulus is blurred due to the restriction of the foveal visual system in the extraction of information.

METHOD

Sample

Eight intermediate football referees participated in the study. They belong to the Football Referee Committee at the region of Extremadura (Spain) and their mean age is 26.75 years (SD = 4.26). Their experience as referees is six years in competitions of football 11 organized by the Royal Spanish Football Federation (RFEF). They have refereed in the 2nd B National Division and Spanish Regional categories. Moreover, they have experience as assistant referees in the 3rd National Division category. The participants signed a consent form approved by the University Office for Research Ethics before the study.

Apparatus

The filmed sport rally was carried out with a digital camcorder Sony Handycam (DCR-SR30) on an artificial turf football (11) field. The camera was equipped with a wide angle display to record all trials and avoid the blurring of information concerning the offside actions. The rally was digitally edited by a Kinovea program (version 0.8.15) and prepared into a video projection to simulate the offside actions in the laboratory setting. This camera is located on the football field 25 m far of one football goal and 1.20 m out of the sideline, and supported by a tripod of 1.70 m. The offside trials have been recorded at three distances from the camera (near, middle and far) and so the final size of the projected players in the laboratory rally vary depending on the distance from which it has been recorded. This camera films different default offside actions, from the assistant referee´s perspective, made by federated and experienced players during reduced play situations of attack-defense. The location of the camera simulates the final position of the assistant referee should be in just at the moment of the pass to perceive the offside action, according to the 11th arbitral.

To record visual fixations the ASL Eye Tracking SE5000 system (Applied Sciences Laboratories) will be used. All participants will have the technological system coupled to their head during the rally. The system will be connected to a digital video recorder (Panasonic NV-HS1000ECP) with a detailed analysis at 50 frames/sec data frequency. This video will record, in integrated movies, the visual behavior and the offside action reflected into the scene camera. The rally will be projected in a large screen (5x3 m) using a LCD projector (Hitachi CP-S310W).

Variables

The independent variables are the recording distance from the camera (3 levels: near, medium, far) and the angle of vision in which the players are perceived (2 levels: <35° and> 35°). The distance that separates the camcorder and the attacking receiver player is considered to calculate the distance. Moreover, the distance is defined as near when the receiver player is between the sideline where the camera is placed and the projection of the line of the opponent’s penalty box. When the player is between the lines that make up the width of the penalty box, the distance is medium. Finally, when the player is further away from the line of the penalty box and near the sideline opposite to the camera, the distance will be considered as far. These distances are categorized in a similar way to those used by Catteeuw et al. (2010).

Regarding the viewing angle, it is considered small when the visual arc between the two main stimuli during the offside action (player with the ball and last defender) is between the 0°- 35°and it will be big if it exceeds of 35°. The selection of this visual angle is chosen because from 30° of visual arc, the coverage area of a saccadic eye movement ends and an exploratory behavior will require head movements. In addition, the visual acuity decreases dramatically in these visual angles until 0.1 or 0.2 (Bennet & Rabbets, 1992).

The extrinsic ocular motility will be the main dependent variable, as the visual ability to explore the space in all directions is due to the activation of the ocular external muscles (Chaveleraud, 1986). This variable is operationalized in the concept of visual fixation, defined as the minimum time of 100 ms in which the participant´s point of gaze remains fixed on the same spatial or body location (Williams, Davids, & Williams, 1999). In this study, we analyze the mean of number of fixations that the referees fix their vision on the stimuli and mean of time (in ms). Also, we analyze the accuracy of the response measured as the percentage of success rate or number of times that the referees correctly detect an offside position in relation to the total number of trials displayed. In this research, the accuracy of the response is obtained by pressing the laser pointer at the projection screen when there is an offside action and by not pressing it when there is not an offside action.

Three phases were distinguished in each trial in order to have more detail about visual behavior: phase A (time between the 4"- 2" before the attacking player passes the ball), phase B (time between the 2" prior to the moment of the pass until just on it), and phase C (time between just on the pass until 2" after it). The locations of visual fixations were: the player with the ball, attacking player that receives the ball, the ball, the last defender, the defensive line, the attacking line and the middle area (space between the attacking and the defensive lines). This structure of visual locations is partially based on the previous studies of Belda (2004, 2009), Catteeuw et al. (2009, 2009b) and Sanabria et al. (1998).

The design used (Pereda, 1987) would be intragroup, multivariate, with repeated measures on all independent variables (angle and distance of perceiving) and factorial in order to see the main effect and interaction of these variables on the visual behavior and accuracy of the response.

Procedure

Participants perceive a randomized rally of 24 trials recreating reduced play situations (4x4) that could finish with a possible offside action. A proportional number of trials to the distance (8 near, 8 medium and 8 far) and angle (12 with big angle and 12 with small angle) were showed. In the trials with offside actions the referees must press the laser pointer onto the screen in order to later know the success rate in the detection of offside actions. These actions, previously elaborated by the research team, are performed by four offensive and four defensive players who, according to the research instructions, perform requested tactical actions. The referees are placed in front of the projection screen (see Figure 1) and 4 m away from it to perceive the offside action in a similar manner to the real situation, and so avoid previous conditions in the analysis of visual search strategies (Williams, Davids, Burwitz, & Williams, 1994).

Figure 1. Participant perceiving an example of offside action in football with the ASL Eye Tracking SE5000 in a laboratory setting.

This laboratory methodology has been previously used by Armenteros (2006), Catteeuw et al. (2009b), Gilis, Helsen, Catteeuw, & Wagemans (2008) due to the control of the variables and training in the decision making process.

Data analysis

The Shapiro-Wilks and Levene tests were carried out for all dependent variables and advised for the use of parametric statistic for the data processing. First, a descriptive analysis is required to the perceptive variables and accuracy response for all trials, regardless of the viewing angle and distance. A MANOVA is made to know the main effect of viewing distance and angle variables, and its interaction in detecting offside actions. The analysis of visual locations was made according to the phase of the rally, and independently of the phases. An Alpha level <.05 is required for all analysis and the estimate of the partial effect size through statistical partial Eta squared (ηp^2). Finally, a contingency table was carried out to know the number of cases in which referees had success or mistake in the detection of offside actions according to the independent variables (angle and distance). Statistical analysis was performed with SPSS 18.0 statistical package (Statistical Package for the Social Sciences, © 2008 SPSS Inc.).

RESULTS

The descriptive statistics show the mean of number and time of fixations by phases (see Table 1) made by referees during the perception of offside actions. Results show that the locations of visual fixations with more number and time of fixations, in phase A and B, are the player with ball and defensive line. However, in phase C, the most important locations are the attacking receiver player and the last defender. Note that these locations increase the number and time of fixations along the phases. Moreover, the location player with ball decreases the number and time of fixations from phase A to phase C.

Table 1. Descriptive statistics of referees (n=8) with mean values in number of fixations (M_nfij) and time of fixations (M_tfij) in milliseconds, according to the phase of the rally and location of visual fixation.

	PHASE A		PHASE B		PHASE C	
Measure (location)	M_nfij (±SD)	M_tfij (±SD)	M_nfij (±SD)	M_tfij (±SD)	M_nfij (±SD)	M_tfij (±SD)
Player with ball	.98 (0.16)	467.18 (95.18)	.68 (0.15)	387.18 (99.00)	.07 (0.03)	15.62 (7.64)
Receiver player	.20 (0.05)	94.79 (26.61)	.46 (0.07)	218.95 (32.23)	.65 (0.07)	595.00 (71.06)
Ball	.03 (0.02)	23.75 (12.12)	.02 (0.01)	12.29 (8.82)	.03 (0.01)	16.04 (9.38)
Last defender	.39 (0.14)	228.95 (76.18)	.59 (0.17)	314.58 (92.69)	.65 (0.04)	456.45 (53.73)
Defensive line	.75 (0.09)	348.12 (74.29)	.67 (0.11)	400.10 (101.68)	.42 (0.08)	228.95 (53.07)

Attacking line	.29 (0.06)	140.83 (42.95)	.26 (0.04)	130.00 (37.16)	.32 (0.04)	148.37 (13.67)
Middle area	.33 (0.08)	160.83 (65.14)	.36 (0.09)	149.89 (50.13)	.48 (0.13)	190.02 (45.26)

From the statistics presented in Table 1, when the analysis includes the sum of the number and time of fixations for the three phases together, the referees spend 1.75 fixations and 870 ms (player with ball), 1.32 fixations and 908.75 ms (attacking receiver player), .09 fixations and 52.08 ms (ball), 1.64 fixations and 1000 ms (last defender), 1.86 fixations and 977.19 ms (defensive line), .89 fixations and 419.21 ms (attacking line) and 1.19 fixations and 500.75 ms (middle area). The two locations with the most time of fixations are the defensive locations (last defender and defensive line). Subsequently, the attacking receiver player and the player with the ball (locations related to the offensive team) obtain higher time of fixation.

The multivariate general linear model shows that the angle variable has a significant effect, in phase B, in number of fixations ($F(1,47) = 6.15$; $p < .05$; $\eta_p^2 = .12$) and time of fixation ($F(1,47) = 6.92$; $p < .05$; $\eta_p^2 = .14$) in the player with ball, with a mean of number of fixations of .94 and 564.11 ms in big viewing angles and .51 fixations and 271.83 ms with small angles. Also, the distance variable (see Table 2) has influenced in the location of middle area, in phase B, with a higher number of fixations and time in near distance than in medium and far distances ($p < .05$). In phase C, this variable has an effect on the locations of the attacking receiver player, the last defender, the attacking line and the middle area. More specifically, for the location of the attacking receiver player, near distance obtains less number of fixations than medium distance ($p < .001$) and far distance ($p < .05$); and less time of fixation than the others ($p < .001$). In the location of the last defender, the near distance has more number of fixations than the others ($p < .001$) and more time of fixation than the medium distance ($p < .01$). Regarding the location of the attacking line, the long distance obtains less number of fixations than the others ($p < .05$); and less time of fixation than the medium distance ($p < .01$). Finally, the location of the middle area has a higher number of fixations in near distance than in medium distance ($p < .05$) and far distance ($p < .01$), and more time of fixation than medium distance ($p < .05$) and far distance ($p < .01$).

Thus, the referees perform more number of fixations and time of fixation in the location of the player with the ball, in phase B, with big angles (> 35°). Moreover, they obtain more number of fixations and time of fixation time in the location of the middle area (phase B and C) and last defender (phase C), but less number of fixations and time of fixation in the location of the attacking receiver player (phase C) with near distances.

Table 2. Effects of distance variable (near, medium, far) in visual dependent variables regarding the mean values (M) and standard deviation (SD) of number and time fixation (ms) in the sample of referees (n=8).

Factor	Measure	M (±SD) Near	M (±SD) Medium	M (±SD) Far	F	sig.	η_p^2
Distance	Nfij7B	.59 (.49)	.27 (.28)	.27 (.28)	4.40	.01	.17
	Tfij7B	269.00 (321.81)	95.25 (110.58)	95.16 (102.50)	4.00	.02	.16
	Nfij2C	.46 (.40)	.82 (.31)	.74 (.31)	6.04	.00	.22
	Tfij2C	221.66 (231.35)	780.83 (353.61)	841.16 (366.45)	18.39	.00	.46
	Nfij4C	.98 (.34)	.44 (.28)	.54 (.28)	13.73	.00	.39
	Tfij4C	647.50 (423.53)	289.66 (210.83)	448.66 (252.11)	5.03	.01	.19
	Nfij6C	.36 (.40)	.38 (.22)	.13 (.18)	4.91	.01	.19
	Tfij6C	114.77 (127.14)	218.16 (172.76)	59.33 (97.88)	7.40	.00	.26
	Nfij7C	.88 (.82)	.29 (.32)	.20 (.34)	7.17	.00	.25
	Tfij7C	339.55 (304.12)	128.50 (136.78)	77.16 (113.81)	7.55	.00	.26

[Legend: Nfij: number of fixations, Tfij: time of fixation, A: phase A, B: phase B, C: phase C, 1: player with ball, 2: attacking receiver player, 3: ball, 4: last defender, 5: defensive line, 6: attacking line and 7: middle area].

The analysis of the influence of the different variables on the accuracy of the response shows that the angle variable has a significant effect ($F(1,47) = 22.28$; $p < .001$; $\eta_p^2 = .34$), obtaining a higher success rate with small angle (95%) than with big angle (80,83%). However, according to the distance variable, the referees show no significant differences in the accuracy of the response. When the analysis includes the combination of both variables, significant differences are obtained ($F(1,47) = 9.74$; $p < .001$; $\eta_p^2 = .31$) in some pairs of comparison. For example, in near distances, the success rate with small angles is 100% and with big angles it is 80% ($p < .001$). In medium distances, the success rate with small angles is 97.5% and with big angles it is 70.83% ($p < .001$).

Also, Table 3 shows the number of occasions (and percentage of success) where the referees make a mistake or have success during the perception of the offside actions. Note that when referees perceive trials with small angles they make more mistakes with far distances while with big angles they have more mistakes with near distances. However, they obtain better percentages of success rate with small angles in medium distances and with big angles in near distances.

Table 3. Contingency table with number of mistakes (accuracy=0) and successes (accuracy=1) according to the angle and distance variables during the perception of offside actions.

Angle				Distance		
				Near	Medium	Far
Small	Accuracy	0	Number	0	1	5
			% success rate	,0%	16,7%	83,3%
		1	Number	24	39	35
			% success rate	24,5%	39,8%	35,7%
Big	Accuracy	0	Number	8	7	2
			% success rate	47,1%	41,2%	11,8%
		1	Number	40	25	22
			% success rate	46,0%	28,7%	25,3%

DISCUSSION

The sample of eight intermediate referees has developed a perceptual pattern characterized by fixing their point of gaze on the player with the ball and defensive line. This visual behavior could help in obtaining information about the sequence of game regarding the attacking strategy (player with the ball) and defense strategy (defensive line). Moreover, from the moment of the pass until the end of the rally, the point of gaze moves to the attacking receiver player and last defender. This displacement of the gaze could be a visual strategy that the referee develops to achieve picking up more information about the position of the receiver player with respect to the last defender, and hence to make an accurate judgment about the position in line or not of this player with respect to the last defender.

These locations of the gaze match the visual behavior proposed by Sanabria et al. (1998). These authors suggest that for the correct detection of the offside action, at the beginning of the play sequence, an assistant referee should fix the gaze on the player with the ball and subsequently perform a displacement of the point of gaze to the receiver player and last defender. In addition, attending to the most important locations, in terms of its temporal duration, these locations are the last defender, defensive line, receiver of the ball and player with the ball. These locations are the same that Belda (2004) exposes for the correct detection of the offside action.

Therefore, our first working hypothesis is accepted because the results verify the visual strategy described by Sanabria et al. (1998) and Belda (2004) in relation to the fact that there is a saccadic eye movement which moves the point of gaze from the player with the ball to the relative position of the receiver player and last defender. Also, the most important stimuli found in this study, in terms of number and time of fixation, match those proposed by Sanabria et al. (1998) and Belda (2004). We suggest that this visual behavior is guided and influenced by the compliance of the 11th law of football regarding the offside, and that would condition the visual search strategy towards the perception of such stimuli.

We highlight the growing importance that the localization of the middle area has along the phases of analysis, both in number and time of fixation. This visual strategy reveals a progressive acquisition of information that the referees pick up through the visual pivots (Kato & Fukuda, 2003). This visual behavior would make it possible to fix the gaze on a point of the context between the attacking and defensive lines while perceiving by periphery any movement in these lines, such as the displacement or changes in the position of the players.

The variable of viewing angle has only influenced the referees´ visual behavior on the location of the player with the ball (phase B), so during the perception of trials with big angles (> 35º) there is a greater number of visual fixations and time of fixation. In these trials, the extraction of information about the position of the receiver player and last defender could correspond more to the peripheral vision. This circumstance could explain why the angle of viewing has influenced the accuracy of the response, and more specifically why, with big angles, the percentage of success rate is lower than with small angles. This result verifies the hypothesis that suggests the angle of viewing influences the visual behavior and accuracy of the response during the perception of offside actions, but does not match the results of Catteeuw et al. (2010) who argue that the angles of viewing do not have an influence on the assistant referees´ performance during the perception of the offside action.

An explanation that could justify the fact that with greater angle of visual arc the percentage of mistakes in the detection of the offside is higher, could be that with high distances between stimuli to perceive (i.e. player with the ball and last defender) the peripheral vision comes in and involves the extraction of information about the movement but not about the details of the perceived stimuli (Bennet & Rabbets, 1992). This visual system could then prevent collecting accurate and complete information about the relative position of the receiver player and last defender at the exact moment of the pass. Although the peripheral vision is characteristic in the expert sample in the sport domain (Williams & Davids, 1998) and it is an effective mechanism to pick up information in sports situations with temporal restrictions (Ávila y Moreno, 2003), the extraction of information from this visual system may not be enough to perceive correctly if the receiver player is in line, delayed or advanced with respect to the last defender on the time of the pass. This behavior is supported by the results obtained, as when the referees perceived trials with big angles, in near and medium distances, they performed with significantly lower accuracy.

The variable distance viewing has greatly influenced the referees´ visual behavior, with the exception of the location ball and defensive line, the rest of locations have shown differences in the number and time fixations. These results are in line with the contributions of Al-Abood, Bennett, Moreno, Ashford, & Davids (2002) or Reina, Luis, Moreno, & Sanz (2004) who conclude that the size of the image presented can alter the time spent to fix on certain spatial or body locations. However, although the distance influences the visual behavior, the accuracy of the response is not modified as a result of this variable because the referees show a similar percentage of success rate between distances. This behavior coincides with Button (2006) who concludes that the distance is a variable that does not affect the effectiveness of the decision making during the perception of offside actions. Therefore, our hypothesis concerning the distance is accomplished in part, since the distance perceived with the trials modifies the visual behavior but not the accuracy of the response. Further investigation should include an increase of the sample to know if larger samples could change the effectiveness on the task.

CONCLUSIONS

The research concludes that the variables angle and distance of viewing modify the eight intermediate referees´ visual search strategy, and also the angle influences their accuracy of the detection of offside actions. Moreover, when they perceived relevant stimuli with angles lower than the 35º visual arc and with near and medium distances, they obtained higher percentage of success rate.

The perceptual pattern developed by this reduced sample of football referees, during the perception of offside actions in a laboratory setting with video projection is characterized by fixing visually more often and for longer time on the locations of the player with the ball and the defensive line (before the pass), the attacking player receiver of the ball and the last defender (after the pass).

In the future, it would be interesting to increase the size of the sample of referees to verify if the variable distance of viewing would change not only the visual behavior but also the accuracy of the response. This scenario could allow us to compare their results with other groups of referees with higher level or even with regard to football players, in order to establish comparisons between groups with respect to perceptive and decision making variables. Also, filmed sequences of major perceptual difficulty could be introduced, e.g. through the increase in the speed of game actions or through the flash-lag effect induced by displacement of the defender players with respect to the line of the offside.

In later stages, a measurement of visual behavior could be tested during real game situations (i.e. football field) in order to contrast if the visual behavior and effectiveness of referees during offside actions is influenced by the dimensionality perceived.

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