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Original Article

THE ANTICIPATORY AND REACTION TIME BEHAVIORS OF THE FUTSAL GOALKEEPER

OS COMPORTAMENTOS ANTECIPATÓRIO E DE TEMPO DE REAÇÃO DO GOLEIRO DO FUTSAL

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RESUMO

Este estudo teve como objetivo investigar os comportamentos antecipatório e de tempo de reação do goleiro. Para este fim foram analisados 50 chutes executados por jogaores de futsal. O tempo de resposta do goleiro a um chute foi analisado em relação ao resultado do chute, à zona da quadra e à distância entre o goleiro e o jogador que executou o chute. Os comportamentos de antecipação e tempo de reação do goleiro foram considerados, respectivamente, como aqueles executados abaixo e acima de 200 ms considerando o início do movimento do chutador e o início do movimento do goleiro. Os resultados mostraram que o goleiro executou comportamentos antecipatórios predominantemente quando (i) ocorreram gols, (ii) os chutes foram executados das zonas central e de ataque, (iii) de distâncias entre 5,97 a 7,84 metros. Nestas condições, os comportamentos antecipatórios do goleiro implicaram em performances ineficazes.

Palavras-chave: Chute de futsal. Goleiro. Antecipação. Tempo de Reação.

ABSTRACT

This study aimed to investigate the goalkeeper's anticipatory and reaction time behaviors. For this purpose, 50 kicks performed by male futsal players were analyzed. The time of goalkeeper's response to a kick was analyzed in relation to the kick outcome, court zone and distance between the goalkeeper and player who performed the kick. The goalkeeper's anticipation and reaction time behaviors were those below and above 200 ms as the time criterion, respectively, by considering the moment the player began the preparation for kicking to the moment the goalkeeper began to respond to it. Results showed that the goalkeeper performed anticipatory behaviors predominantly when (i) goals were attained and (ii) kicks were performed in the center and attack court's zones (iii) at a distance ranging from 5.97 to 7.84 meters. In these conditions, the goalkeepers' anticipatory behaviors implied ineffective performances.

Keywords: Futsal kick. Goalkeeper. Anticipation. Reaction time.

Introduction

As a countless human motor skills, those of futsal has the time as an essential variable for attaining their goals with successful. For instance, one could say that the temporal coincidence is the main purpose of the goalkeeper's motor skills**.** This is because he/she has to intercept a moving ball by hiting or holding it in order to prevent it from entering the goal. If he/she arrives to the ball trajectory before or after it, the goal can occur and, therefore, his/her performance would be unsuccessful.

However, in order to get it a goalkeeper needs to deal with two other important temporal dimensions underlying the performance of motor skills: anticipation or reaction time[1-9]. To put it in another way, the temporal coincidence that goalkeeper seeks in relation to the moving ball in order to avoid the goal may be preceded by underlying prospective processing of information or processing of an already available target information, respectively.

Concerning to the first, one could say that anticipation involves a prediction about the event in the environment, as well as the location and time that it will occur[7,8]. In this case, perception of environmental cues (e.g. spatiotemporal tendencies of players displacement)

would allow the response selection (decision-making) and programming in advance to existence of the target stimulus itself[6,9]. For instance, the fact an attacker without the ball possession is positioned without a marking defender could lead the goalkeeper to perceive a high risk of a kick if he/she received a pass. Based on this, he/she could anticipate his/her preparation for defending the kick.

Importantly, anticipation is a hallmark of skillful behavior and as such is acquired from practice and experience[10-12]. In fact, anticipatory behavior has been related to the experienced players' perceptual ability in a way they are able to detect information for anticipation from the environment more quickly and effectively than unexperienced players[13]. For example, a study by Savelsbergh et al.[14] examined the differences in anticipation and visual search behaviors between experts and novices goalkeepers in a soccer penalty kick situation. Experts and novices goalkeepers were required to move a joystick in response to penalty kicks presented on film. The proportions of penalties saved were assessed, as well as the frequency and time of initiation of joystick corrections. Visual search behaviors were examined using an eye movement registration system. In comparing to novices, experts goalkeepers (i) were more accurate in predicting the direction of the penalty kick, (ii) waited longer before initiating a response and (iii) made fewer corrective movements with the joystick.

On the other hand, reaction time (RT) refers to the time between the beginning of the stimulus and the beginning of response. RT has been used as an approximate estimate measure which allows inferring the time required for interpreting a stimulus, selecting and programming a response[9,15-17]. Importantly to be clear that such inference is closely related to the tasks in which to respond as quickly as possible to the not foreseen stimulus is essential for successful performance.

Interestingly to note that RT manifests differently for each sensory system (e.g. tactile RT ≈ 110 ms; auditory RT ≈ 150 ms; visual RT ≈ 200 ms)[11,18-23]. Furthermore, it can differ from some other variables including age, player category (e.g. amateur or professional), field position (e.g. defense, midfield and attack) and type of physical activity/sport (e.g. soccer, basketball, surf and gym)[24-27]. It is important to highlight that most of these studies were conducted in experimental laboratory environment, which have pointed out that visual RT involves values ranging from 150 to 301 ms, whose average value still accepted is about 200 ms[11,28,29].

RT can be simple when it involves one stimulus and one response, and of choice when it involves several stimuli and responses. This latter tends to increase as the number of stimulus-response alternatives increases[9,11]. For example, the goalkeeper is confronted with the choice RT when the attacker player uses a feint composed by two simultaneous (or almost) movements to kick the ball, being one to induce the goalkeeper's error.

Similarly to the anticipation, RT is influenced by the players' experience level[5,15,26,30,31,]. For example, Ruschel[25] analyzed the visual and auditory simple RT of soccer players from differing categories (amateurs and professionals) and field positions (goalkeeper, center defender, right and left defenders, halfback, midfielder and forward). Results showed that visual RT did not differ between categories. However, professionals showed faster auditory RT than amateurs. Regarding field positions, goalkeepers showed faster visual RT than midfield players.

In sum, the fact that futsal game is a dynamic system, i.e. the interactions between players change in a non-linear way over time[10,32-34], allowed hypothesize that the anticipatory and reaction time behaviors would also function in a dynamic way. For instance, due to the game dynamic, not always the emerging patterns would imply enough cues for the anticipation of the goalkeeper. Therefore, we asked: what would influence the anticipatory and reaction time behaviors of the goalkeeper? In order to investigate this question the

goalkeeper's responses to a kick were analyzed in relation to the kick outcome, court location and distance between the goalkeeper and player who performed the kick.

Methods

Participants

Twenty-four male amateur players, men, who took part in two qualifying round games in the adult category (over 20 years old) of Futsal League of Carapicuíba in 2018 participated. This is an annual championship held in Carapicuíba, São Paulo, Brazil, which involves more than 1,000 players in various categories. All the players were experienced, since they had participated at least in two futsal official championships. The protocol of this study was approved by the Research Ethics Committee of the University of São Paulo - USP under the number CAAE: 10850513.0.0000.5391.

Procedures

Concerning the data collection, sample consisted of 50 sequences of play involving kicks performed by outfield players or goalkeeper, which were randomly selected from digital video footage of the aforementioned games. The sequences of play ranged from 16 to 494 ms of duration. They were recorded by a digital camera (GoPro HEROS3; frequency = 120 Hz) located above and behind the short axis of a futsal court, which had dimensions of 17 m x 26 m (Figure 1).

The selected sequences of kicks were digitized by KINOVEA software 0.8.15 in a slow motion video image using a computer mouse, from the moment the player began the preparation for kicking (taking the foot off the floor and flexing the knee by lifting the leg back and up), which characterized the start of the stimulus, to the moment the goalkeeper began to respond to it (start of the response). This involved any goalkeeper's movement in response to the kick. This procedure made it possible to obtain the goalkeeper's response time in milliseconds on the basis of which anticipation and reaction were defined. Specifically, the goalkeeper's anticipation and reaction behaviors were those below and above 200 ms as the time criterion, respectively[24-27.]

As previously described, the goalkeeper's behaviors were analyzed in relation to following variables:

(a) kick outcome. It was based on the kick successful by considering if a goal occurred or there was a goalkeeper's defense, kick out or an outfield player's interception.;
(b) lateral (right, center and left) and longitudinal court zones (attack, midfield and defense). For this purpose, the court was divided into six equal parts (zone);
(c) distance between the goalkeeper and player who performed the kick, which was considered in terms of quartiles[13]: 1st quartile involved distances between 2.68 and 5.92 meters; 2nd quartile were those kicks performed between 5.97 and 7.84 meters; 3rd quartile referred to the kicks performed between 7.88 and 13.79 meters; and, 4th quartile were involved kicks performed between 13.97 and 25.03 meters.

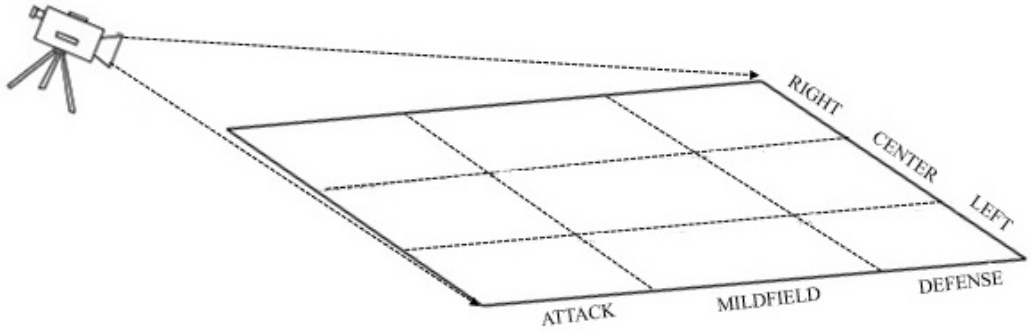

Figure 1. Illustration of the data collection experimental environment
Source: Authors

Data analysis

As the Shapiro-Wilk W test of normality and Bartlett's test of homogeneity of variance revealed that the assumptions for parametric analysis were not met, a Chi-square test of one criterion was used. This procedure allowed verifying if the observed occurrences of anticipatory and reaction behaviors differed from a balanced distribution. For this purpose, we considered as expected behaviors a balanced distribution of both behaviors. That is, from the total observed behaviors, 50% would be expected from anticipatory behaviors and 50% from reaction time behaviors. It was run by the following equation: $\chi^2 = \Sigma(of - ef)^2 / ef$, where *of* referred to observed frequency and the *ef* was the expected frequency. In order to obtain the values of the Chi-square table, the degrees of freedom was determined by $df = k - 1$, where *df* referred to the degree of freedom, *k* was the number of categories in the observed frequency distribution table. Significant difference was considered when the value of the acquired Chi-square was higher than the tabulated Chi-square value[35]. The level of significance of $p < 0.05$ was considered.

Results

Regarding the kick outcome, the Chi-square test revealed difference in the goal variable (Table 1). In this case, anticipation was more observed than reaction time in situation in which occurred goals.

Table 1. Frequencies of goalkeepers' behaviors of anticipation and reaction time and results of the Chi-square test for kick outcome variable

Kick Outcome	Anticipation	Reaction Time	Chi-square
Goal	11	1	$\chi^2 = 8.32$, df = 1, $p < 0.05$*
Goalkeeper's defense	9	5	$\chi^2 = 1.14$, df = 1, $p > 0.05$
Kick out	7	4	$\chi^2 = 0{,}80$,, df = 1, $p > 0.05$
Outfield player's interception	9	4	$\chi^2 = 1.92$, df = 1, $p > 0.05$

Source: Authors

In relation to the court zone, the Chi-square test revealed differences for center and attack zones (Table 2). In both cases, anticipation occurred more frequently than reaction time.

Table 2. Frequencies of goalkeepers' behaviors of anticipation and reaction time and results of the Chi-square test for court zones variable

Court Zone	Anticipation	Reaction Time	Chi-square
Right	6	4	$\chi^2 = 0.40$, df = 1, $p > 0.05$
Center	21	4	$\chi^2 = 11.56$, df = 1, $p < 0.05$*
Left	9	6	$\chi^2 = 0.60$, df = 1, $p > 0.05$
Attack	23	8	$\chi^2 = 7.24$, df = 1, $p < 0.05$*
Midfield	12	5	$\chi^2 = 2.88$, df = 1, $p > 0.05$
Defense	1	0	$\chi^2 = 1.00$, df = 1, $p > 0.05$

Source: Authors

Concerning the distance between the goalkeeper and player who performed the kick, the Chi-square test revealed differences for the 2nd quartile (Table 3). The observed behavior was greater than that expected in relation to the anticipation. For other distances, no significant differences were found in relation to the observed behavior of the expected.

Table 3. Frequencies of goalkeepers' behaviors of anticipation and reaction time and results of the Chi-square test for kick distance variable

Distance	Anticipation	Reaction Time	Chi-square
1st quartile	10	3	$\chi^2 = 3.76$, df = 1, $p > 0.05$
2nd quartile	10	1	$\chi^2 = 9.00$, df = 1, $p < 0.05$*
3rd quartile	8	5	$\chi^2 = 0.68$, df = 1, $p > 0.05$
4th quartile	7	6	$\chi^2 = 0.03$ df = 1, $p > 0.05$

Source: Authors

Discussion

This study aimed to investigate the anticipatory and reaction time behaviors of the goalkeeper based on the kick outcome, court zone and distance between the goalkeeper and player who performed the kick. Results showed that anticipation as the goalkeeper's predominantly behavior when (i) goals were attained and (ii) kicks were performed in the center and attack court's zones (iii) at a distance ranging from 5.97 to 7.84 meters.

Anticipation requires an understanding of the dynamics of the game. An important feature of anticipation is the impact of looking to the future about current behavior. An individual not only predicts the future, but he/she also modifies behavior according to such prediction[36,37]. Dealing with future information in the present is always accompanied by uncertainties, which implies in increasing the risk of unsuccessful performances[38].

It is possible that goalkeeper had tried to anticipate because the kicks performed at the center and attack court zones at a distance ranging from 5.97 to 7.84 meters implied a high risk of a goal occurs. In this case, anticipation would function as a kind of resource for diminishing the attacker advantage. It can be said that when an attacker is facing and close to the goal he has more options to choose how, when and where to kick the ball.

However, our results allow inferring the goalkeeper's decisions to anticipate were not successful because the kicks resulted in goals. Thus, anticipation may not have been anadequated decision, since he was unable to avoid the goal. To put it in another way, anticipation had an irreparable cost[9]. Ineffective anticipation causes the player to lose time and compromise their performance[39].

It is important to note that the futsal players who participated in this research were experienced. However, the competence in anticipatory behavior which is evident in

experienced players[8,10,11,26,30,34] was not enough for the goalkeepers to deal with the risks involved in the kicks situations.

Conclusion

The findings of this study allowed us to conclude that the goalkeeper performed anticipatory behavior predominantly when (i) goals were attained and (ii) kicks were performed in the center and attack court's zones (iii) at a distance ranging from 5.97 to 7.84 meters. In these conditions, the goalkeepers' anticipatory behaviors here considered as those responses below 200 ms implied ineffective performances. Although 200 ms be a well accept measure for inferring anticipation/reaction[24-27], most of the evidence supporting it comes from studies conducted in artificial laboratory environments. This aspect should be focused on further studies.

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