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SHAFIZADEHKENARI, Mohsen, LAGO-PENAS, Carlos, GRIDLEY, Adam and PLATT, Geoffrey K.

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Temporal Analysis of Losing Possession of the Ball Leading to Conceding a Goal: A Study of the Incidence of Perturbation in Soccer

Mohsen Shafizadeh[1], Carlos Lago-Penas[2], Adam Gridley[1] and Geoffrey K Platt[3]

[1]Academy of Sport and Physical Activity, Faculty of Health and Wellbeing, Collegiate Campus, Sheffield Hallam University, Sheffield, S10 2BP, UK
E-mail: m.shafizadeh@shu.ac.uk
[2]Faculty of Educational Sciences and Sport, Universidade de Vigo, Spain
[3]Institute for Sport, Physical Education and Health Sciences, University of Edinburgh, UK

ABSTRACT

The aim of this study was to examine the temporal occurrence of losing possession of the ball in soccer and its association with conceding a goal. Thirty two senior national teams competing in the 2010 World-Cup in South Africa and twelve youth soccer clubs were selected for match analysis. The results of time distribution analysis showed a significant positive skewness (K-S_Z =3, S=0.463, p=0.000) for losing possession of the ball, transition time in senior (K-S_Z =1.82, S=1.57, p=0.003) and youth groups (K-S_Z =2.85, S=1.29, p=0.002) and normal distribution for variability of time to losing the ball (K-S_Z =1.07, S= -0.280, p=0.19).The results of an independent t test showed that there was a significant difference (t=2.71, p=0.008) in transition time between youth and senior groups. In conclusion, this study showed that the number of times that the ball was lost increased near to a goal being conceded and the duration of the most recent loss was very close to goal-conceding. Thus effective strategies that have been employed to destabilise opponents include increasing the number of perturbations through losing possession of the ball, speeding up the transition periods and the final strike after the opponents lose the ball.

Key words: Ball Possession, Performance Analysis, Soccer, Sport Analytics

INTRODUCTION

The primary goal of performance analysis in team sports is to provide information to coaches and players about player and/or team performance, in order to face the complex and dynamic

requirements of competition. The complexity and dynamic nature of sport has been previously addressed, but there remains a very limited understanding of the ways in which applying these different paradigms contributes to improving the coaching process and sporting performance [1]. However, several valuable contributions, providing a new insight into team sports such as soccer, are already available. For example, soccer can be studied as a sport displaying emergent collective behaviours from complex, non-linear interpersonal interactions of players in space and time [2, 3].

Perturbation, self-organisation, chaos and climax in the course of the game are to be expected within the framework of these dynamic systems. In fact, most of the available research is dominated by classical and deterministic science paradigms. Although these frameworks have improved over time, they have certain limitations, especially from a tactical point of view [4]. Firstly, due to a single camera viewpoint, only on-the-ball actions are monitored systematically. Secondly, spatial and temporal information of notational systems lack sufficient accuracy to analyse in-depth tactical performance. Therefore, there seems to be a need to address a soccer team's complexity and dynamic information in order to assess game performance more adequately, particularly by using collective variables that capture the dynamics of team ball sports during real match-play or small-sided-games in training, as a representation of match sub-phases or full-sized matches [1, 4].

In soccer, the ability to retain possession of the ball enables teams to control the structure and tempo of the game. In fact, this has been suggested to be one of the key elements in achieving successful performances and winning matches [5-7]. Winning and losing possession of the ball are considered to be perturbation factors that might increase the chance of destabilising a defence and leading to shooting opportunities. According to previous studies [8, 9, 10], the overall attacking configuration with adequate space and time against an opposing defence which is out of balance had a positive effect on goal-scoring. Elsewhere, it was reported that the defensive performances, directly measured through distances and angles between attackers and defenders and the number of players, were related to delaying and diverting attacks, and covering attacking space [11-13].

Another factor that could explain the changes in stability of a team is the transitions from offence to defence and vice versa. It seems very likely that soccer teams' performances are dependent upon how players are dynamically positioned according to the teams' overall space distribution principles and the dynamic functional constraints at the scale of the environment. The time that it takes for a team to recover the defensive/offensive stability after a loss or gain of possession of the ball is considered a tactical indicator that determines the quality of the team.

According to all these considerations, the aims of this study were: 1) to examine the temporal distribution of losing the ball before a goal was conceded; 2) to evaluate the impact of the transition time from losing possession of the ball to conceding a goal; and finally 3) to analyse if there are differences between youth and senior soccer teams in these variables. We hypothesised that by increasing the occurrence of losing the ball as an indicator of perturbation, the chance of a goal being conceded is increased and the timing of losing possession of the ball could predict the probability of conceding a goal. In addition, we hypothesised that the transition ability between youth and senior teams is different.

METHODS
PARTICIPANTS
Thirty two national soccer teams participating in the 2010 World Cup in South Africa, twelve elite youth soccer club teams from the 2012-13 NexGen Cup and the English Premier League

were selected for this study. Two matches of each team in the tournament and 83 goals (56 goals for senior and 27 goals for junior groups) were recorded from live broadcasts on the BBC1, ITV1 and Eurosport TV channels.

INSTRUMENTS
The instrument developed in the present study was the Losing Possession Observational Checklist in Soccer (LPOCS) that was designed by Shafizadeh et al. [14] for observing losing possession of the ball in professional soccer matches. LPOCS has seven criteria including marked player, delay, teamwork, ball absorption, ball manipulation, clearance, and illegal movements. The reliabilities of LPOCS through Kappa coefficient for inter-rater and intra-rater were reported ($\kappa=0.75$) and ($\kappa=0.76$), respectively.

PROCEDURE
The data collection and management had two steps. The first step was the observation and analysis of the soccer matches using the Sports Performer Software (Premier Concepts Pty Ltd, Australia) that can record the frequency of movements on the basis of the defined criteria in the timeline. This software permits the collection and immediate analysis of data gathered from the observation of soccer matches either live or from a DVD recording. The computer keyboard was configured to permit the recording of multiple and overlapping frequency behaviours (how many) through pressing the appropriate keys. In the second step, all recorded matches were exported separately into Excel files so that for each instance in a row there was important information in different columns about the time of the occurrence, action name (losing criteria/ final strike), outcome (actions relevant to losing/ the quality of final strike) and area of action (different pitch zones).

In order to examine the temporal distribution of losing possession of the ball before a goal was conceded, a 15-min time scale has been chosen before each goal is scored by an opponent. All goals that were conceded due to set play were normalised so that the time interval when the ball was lost and when the play was restarted by the opponent was excluded for further analysis.

DATA ANALYSIS
Dependent variables in this study were the time of losing possession of the ball, transition time and variability of time in losing possession of the ball. Firstly, the minute of losing the ball within a 15-min time scale was assigned for each losing the ball occurrence. With this measure, it was clear in which minute the team lost possession of the ball before a goal was conceded (e.g., minute 1, 2, 3, …, 15 before a goal was conceded). Transition time was computed as a time interval (min/sec) between the last losing the ball occurrence until a goal was conceded. Variability of time in losing possession of the ball was calculated as a standard deviation of different times of losing the ball (min/sec) within 15-min time scale.

Descriptive statistics in the form of the amount of skewness and histogram bar chart were used for testing the time distribution of losing possession of the ball within a 15-min time scale. The one-way Kolmogorov-Smirnov method was used to test the normality of distribution to assess whether the amount of skewness was significant. The independent t test was used to compare the transition time between adult and youth soccer teams. The statistical significance was set at 5%.

RESULTS
Table 1 shows the frequency of losing the ball in different areas of the pitch and the reasons

for losing the ball. There was not any significant dependency between the reasons for losing and the pitch zone (X^2= 23.89, C=0.47, p=0.15) in either group.

Table 1. Percentage of Different Reasons for the Last Losing the Ball Before Goal-Conceding in Different Pitch Zones

Reasons / Zones	Defence	Mid-defence	Mid-offence	Offence
Ball manipulation	1.2	6	12	12
Delayed	1.2	1.2	6	1.2
Clearance	2.4	3.6	1.2	1.2
Teamwork	0	1.2	2.4	1.2
Marked player	0	3.6	13.2	3.6
Ball absorption	0	8.4	6	4.8
Illegal movement	1.2	1.2	1.2	1.2

The distribution of losing possession of the ball over time in senior group is presented in Figure 1. The distribution showed a significant positive skewness (K-S_Z =3, S=0.463, p=0.000) so that most incidents of losing possession of the ball occurred very close to goal-conceding. The results showed that the incidence of losing possession of the ball was increased near to a goal being conceded within a 15-min time slot that means one possible predictor for the chance of a goal being conceded is losing the ball frequently in a specific period of time. The distribution of losing possession of the ball over time in junior group is presented in Figure 2 that showed a normal distribution (K-S_Z =0.55, S=0.19, p=0.91).
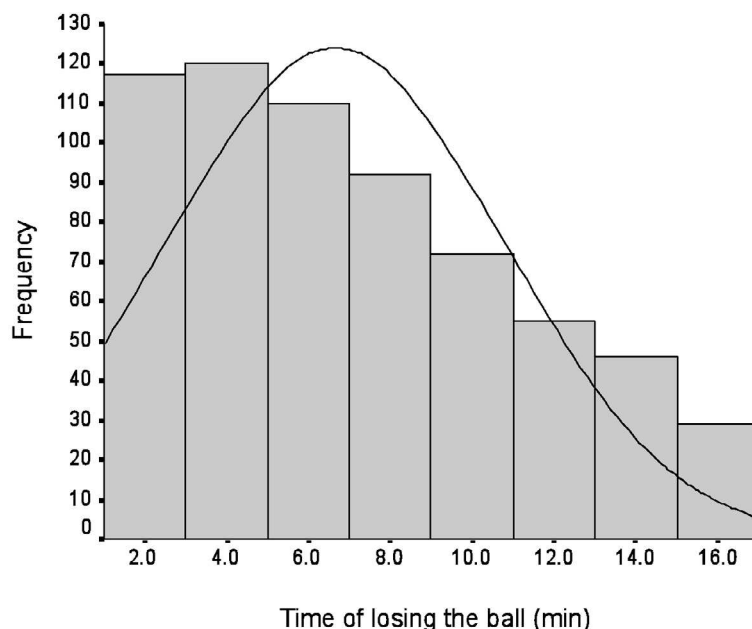

Figure 1. Frequency Distribution of Losing the Ball Possession Over Time Before a Conceded-Goal in Senior Teams
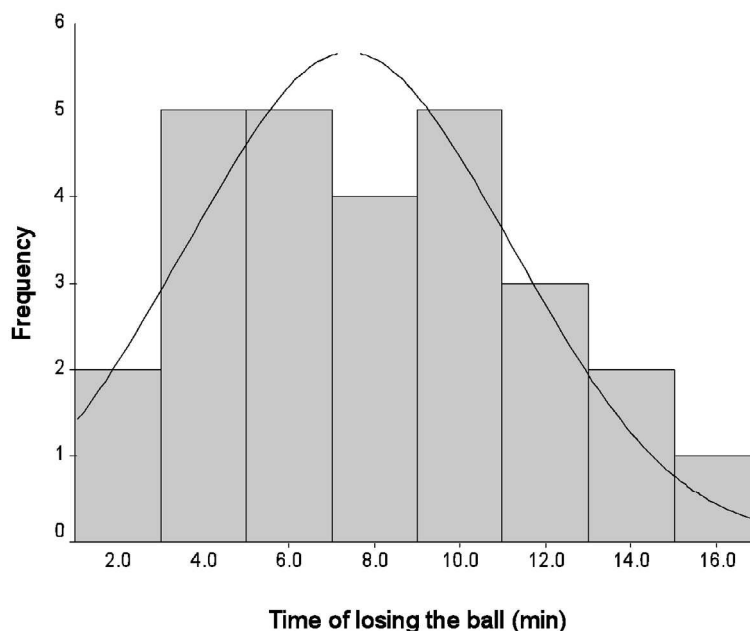
Figure 2. Frequency Distribution of Losing the Ball Possession Over Time Before a Conceded-Goal in Junior Teams

Figure 3 shows the distribution of transition time before goal-conceding in senior teams. The distribution was significantly positively skewed (K-S_Z =1.82, S=1.57, p=0.003) so that most goals were conceded less than one minute after the ball had been lost. In fact, 50% goals were conceded 37 seconds after losing the ball and 81% goals were conceded less than a minute after losing the ball. On the other hand, the speed of transition from the offence state to the defence state was a critical factor in avoiding a goal being conceded.

Figure 4 shows the distribution of transition time before goal-conceding in the junior teams. The distribution was significantly positive skewed (K-S_Z =2.85, S=1.29, p=0.002) so that most goals were conceded less than one minute after the ball was lost. In fact, 50% goals were conceded 15 seconds after losing the ball and 100 % goals were conceded less than 51 seconds after losing the ball. On the other hand, the speed of transition from the offence state to defence state was more crucial for youth soccer in order to avoid a goal being conceded.

Table 2 shows the means and standard deviations of different temporal measures in both groups. The results of an independent t test in terms of comparison of transition time between senior and junior teams showed that there was a significant difference (t=2.71, p=0.008) on

Table 2. Mean and Standard Deviation of Transition Time and Time Interval Between Different Losing Possessions in Two Groups

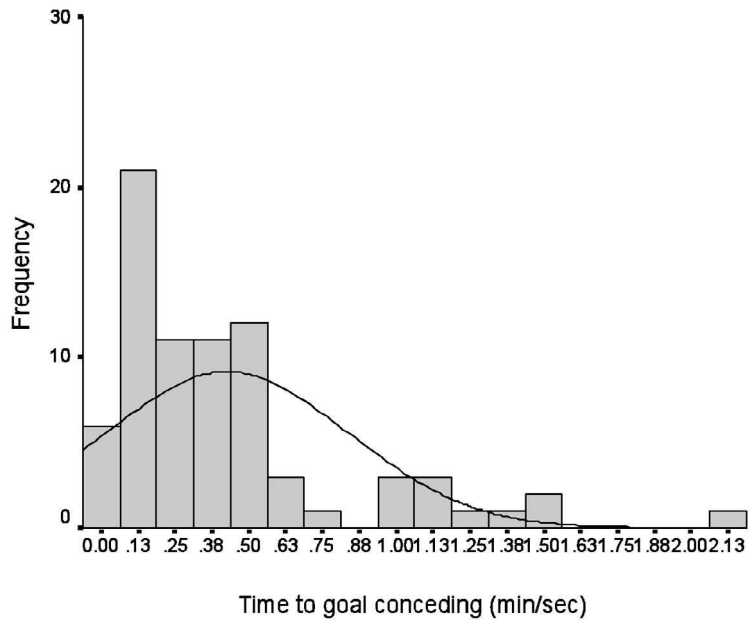| Group	Measure	Min	Max	Mean	SD
Senior	Transition time (min/sec)	0.03	5.28	0.59	0.77
	SD of Time interval (min/sec)	0.46	5.17	3.06	1.31
Junior	Transition time (min/sec)	0.05	0.50	0.18	0.12
	SD of Time interval (min/sec)	0.15	3.45	2.10	1.55

Figure 3. Frequency Distribution of Transition Time in Senior Teams

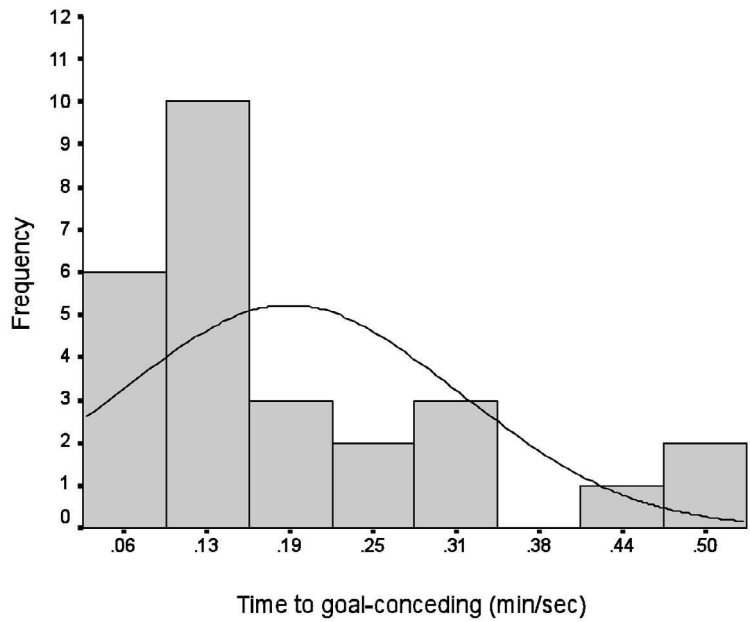Figure 4. Frequency Distribution of Transition Time in Junior Teams

transition time between the two groups so that in junior teams (M=0.18, SD=0.12) relative to senior teams (M=0.59, SD=0.48) it took a shorter time from the last loss of the ball by a team to a goal being scored by the opponent. On the other hand, senior players relative to youth players delayed the time to transit from offensive to defensive states in order to avoid a goal being conceded.

Figure 5 shows the distribution of time interval on different occurrences of losing the ball before goal-conceding in senior teams. The results represent the normal distribution of losing occurrences over time (K-S$_Z$ =1.07, S= -0.280, p=0.19) so that most losing possessions occurred between 1.5 and 4.5 minutes time interval that indicates the appropriate time difference between successive losing possessions in order to increase the chance to a goal being conceded is in this range. Figure 6 shows the distribution of time interval on different occurrences of losing the ball before goal-conceding in junior teams. The results represent the normal distribution of losing occurrences over time (K-S$_Z$ =0.78, S= 0.16, p=0.54).
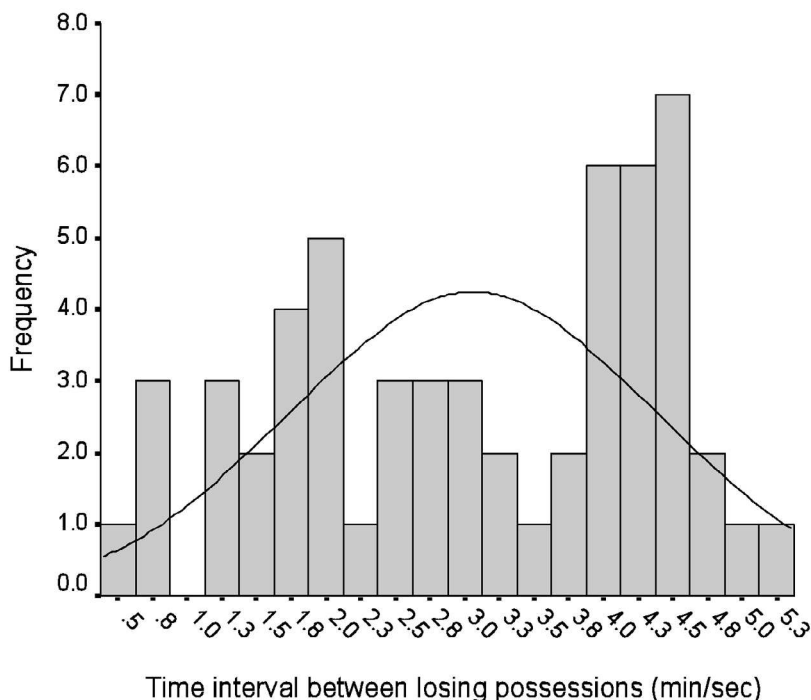

Figure 5. Frequency Distribution of Losing Time Interval (SD) in Senior Teams

DISCUSSION
The present study used the occurrence and the timing of losing ball possession to assess tactical behaviour and predict the probability of goal-conceding in soccer. Overall, the findings suggest that these elements of play could be used as performance indicators in order to analyse team performance in soccer. To our knowledge, the present study was the first to examine the impact of the time that it takes for a team to recover from the defence/offence stability after a loss or gain of possession on team performance.
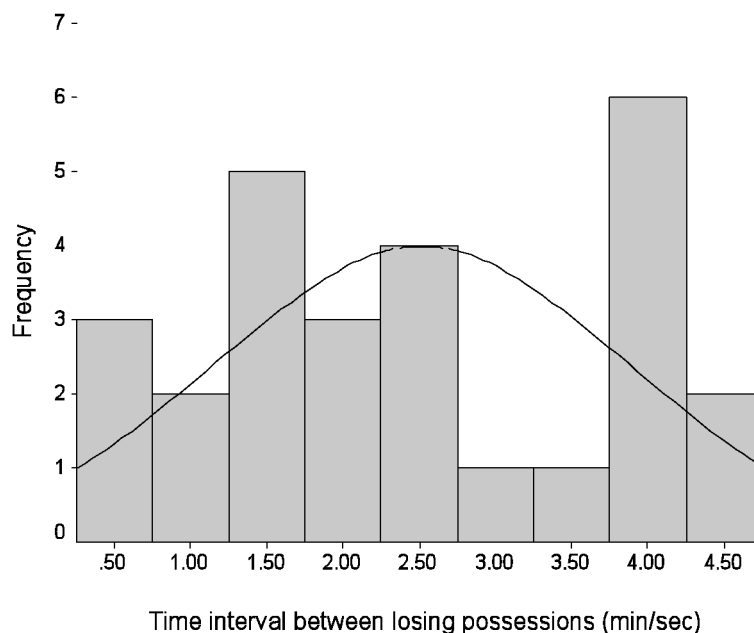
Figure 6. Frequency Distribution of Losing Time Interval (SD) in Junior Teams

The results allowed for verification that the number of times that the ball was lost increased near to a goal being conceded and the duration of the most recent loss was very close to goal-conceding in senior teams. Losing/winning the possession of the ball could be considered consequently a perturbation factor that might increase the chance of destabilising the defence and lead to shooting opportunities [8, 9]. In fact, it has been demonstrated that the decreased percentage of accurate passes in the conceding team is an important parameter of the instability of soccer teams at 5-minutes before goal-conceding [15]. In addition, the average transition time from losing the ball to a goal being conceded was 51 sec and most of the goals were conceded in less than one minute after the ball was lost. Tactically, the transition time in soccer represents the speed of the team shifting from attacking to defensive states after losing the ball [16]. This preparation state is important for counter-attack and when a team requires to change the movement patterns mostly as a form of turning, backward running, and sprinting to recover the system instability in order to prevent conceding a goal. Previous studies [8-13, 17] have reported the overall attacking and defending configurations associated with success in soccer, but none of these works have taken into account the transition time from offence to defence and vice versa.

In addition, the results of a t-test showed that younger soccer teams had a shorter transition time relative to senior soccer teams. This result indicates that the ability to shift from offence to defence when the team lost the ball is an important factor to prevent goal-conceding. The tactical understanding is an important component in movement on the pitch and probably due to low level of skill and physical and perceptual constraints in youth players [18, 19] their transition time when they lose the ball is slower.

The results suggest that the optimum range for goal-scoring through destabilising the team was around 3.06 minutes. According to dynamic systems theory, the amount of

variability in the control parameter (e.g., speed) is related to the increased chance of transit into a new state and when the system shifts into the new preferred state the amount of variability is reduced [20]. However, the results demonstrated that the frequency of losing the ball possession is an indicator of perturbation of system for goal-conceding, but we cannot confirm the second hypothesis: the shorter time interval between the occurrences of losing the ball is the optimal measure for goal-conceding. It seems that the shorter and longer time intervals could help the defensive movements system to recover better. This finding could propose an 'inverted-U' association between variability of time interval in losing possession and the chance for goal-conceding; increasing or decreasing of time interval around the optimum value could reduce the chance for goal-conceding and destabilisation of a system. There is not any empirical study to support the current findings and further studies are required in terms of temporal pattern of perturbation in invasion games generally and in soccer especially.

CONCLUSION

The findings of this study have some practical implications for coaches who try to design strategies for goal-scoring or preventing goal-conceding. It seems that constraining the opponent through marking, pressing, movement in space and defensive skills to lose the ball possession frequently could facilitate the execution of effective attack opportunities. In addition, the transition time is an important principle of perturbation in sport games. The ability to transit from defence to offence and speed up the finishing action when the opponent lost the ball could be an important indicator for successful performance.

In summary, the data demonstrate that the occurrence and the timing of losing the ball possession could be used as performance indicators in order to analyse team performances. Both variables are linked to success in soccer. In addition, the transition time from offence to defence and vice versa is a variable that discriminates between youth and senior teams. These findings provide information for coaches and sport scientists on performance requirements in soccer and this could be used to individualise training based on tactical strategy.

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