Original research

International Journal of Sports Science & Coaching

International Journal of Sports Science & Coaching
0(0) 1–15

DOI: 10.1177/1747954119827283
journals.sagepub.com/home/spo
SAGE

Design and validation of an observational instrument for defence in soccer based on the Dynamical Systems Theory

Tiago Fernandes[1], Oleguer Camerino[2,3], Júlio Garganta[1], Rogério Pereira[1] and Daniel Barreira[1]

Abstract

The research about soccer defensive phase shows many limitations regarding the procedures and operational definitions. The aims of this paper are to create an observational instrument based on Dynamic Systems concepts and evidence sufficient content validity to adequately and reliably recode defensive soccer behaviours. For these, a five-stage development process for validity was followed: (1) an initial literature review, instrument development, observation training; (2) adapting an existing systematic observational instrument; (3) pilot study with non-experts; (4) content validity with experts (coaches and researchers) and (5) inter- and intra-observer reliability. Using Aiken's *V* coefficient and its cut-off value to determine validity content, consensus was found ($V > 0.67$, $n = 32$, $p < 0.05$) for all items answered by participants in pilot study and for almost all subjects in the experts' study ($V > 0.69$, $n = 12$, $p < 0.05$). Also, Cohen's Kappa shows inter- and intra-reliability values of 0.87 and 0.90, respectively. The final model, entitled Theoretical Dynamic Model of Soccer Defence, and the observational instrument, named Soccer-Defence, with 14 criteria and category systems, and 106 categories, seems to be suitable for analysing the defensive process in soccer and could be used to find strengths or weaknesses of tactical–technical defensive patterns of play and to help coaches to better prepare their teams.

Keywords

Complex systems, content validity, defensive phase, patterns of play, performance analysis, reliability

Introduction

Soccer is characterised by two opposing teams in permanent confrontation for space and time, through antagonistic actions and cooperative relationships, due to a common purpose: to score or prevent the opponent from scoring a goal.[1] Despite the highly varied and complex environment, researchers have been using isolated variables to study soccer.[2] In fact, to model soccer processes is fundamental to consider the opposition and environment as complex system.[3] The idea is to characterise the interaction between teams, identified each one as an auto-organised open system, which continuously seek for stability in a space and time standpoint of view, this last being the via which systems function and develop. Since the proposal of Gréhaigne et al.,[3] there have been an interest from researchers to the application of dynamic systems theory to understand soccer dynamics, arguing that this perspective provides meaningful interpretation of the behaviours.[4] Also, the knowledge resulted from the application of Dynamical Systems Theory seems to be useful for coaching game processes.[5]

Systems perspective attempts to study soccer phenomenon by reducing it in interactions between main variables of the different components,[3] also known as fractal analysis. In this perspective, sub-systems behaviours reveal self-similarity of global systems behaviours.[6] Furthermore, the Dynamical Systems Theory applied to soccer present pertinent insights into tactical evolution by modelling interpersonal dynamical coordination within patterns of play, such as attack and defence.[5]

Reviewers: Maria Anguera, Julen Castellano and Iván Prieto.

[1]Centre of Research, Education, Innovation and Intervention in Sport (CIFI2D), Faculty of Sport, University of Porto, Porto, Portugal
[2]National Institute of Physical Education of Catalonia (INEFC), University of Lleida, Lleida, Spain
[3]Lleida Institute for Biomedical Research, Dr. Pifarré Foundation (IRBLLEIDA), University of Lleida, Lleida, Spain

Corresponding author:
Tiago Fernandes, Rua Dr. Plácido Costa, 91, 4200-450 Porto, Portugal.
Email: Tiagomgfernandes@outlook.com

The tactical evaluation applying notational systems and observational instruments have increased in terms of recognition and development over the past years.[7] Some researchers have documented larger and better use of those in the theoretical field,[8] but also in applied contexts providing better performances of soccer players and teams.[9] These instruments containing conceptual and operational definitions have been helping researchers to replicate methodologies and overcome studies limitations.[2,8] Moreover, recent notational systems apply more contextualised statistics[9] and produce less data size than computerised video tracking systems.[10]

Nevertheless, the majority of published works in soccer tactical contents focused on offensive phase[11] and set-pieces moments.[12] Thus, the literature concerning to defensive phase[13] seems scarce.[2,8] Notwithstanding, Brewer and Jones[14] had previously noticed that information related to validity and reliability in relation to deductive processes of systematic observation were insufficient and poorly obtained. Those concepts are important to improve accuracy in research measurement.[15] Validity is referred by the American Educational Research Association (AERA), the American Psychological Association (APA) and the National Council on Measurement in Education (NCME)[16] as an accumulation process of evidence to support test scores. On the other hand, reliability is the consistency of a measure, and is a part in the evidence of validity.[15,17] An instrument must be reliable and valid, which can be evidenced by a wide range of methods (for more details see AERA, APA and NCME[16] or Taherdoost[18] or Heale and Twycross[17]).

Specifically, it is highly recommended to establish content validity and reliability of notational systems and observational instruments in order to reduce the error caused by human subjectivity.[18,19] Previous research has used a five-stage development process to evidence content validity, first implemented by Brewer and Jones[14] in Rugby and then applied by Prudente et al.[20] in Handball, Cushion et al.[21] in coaching behaviours, Barreira et al.[22] and Cobb et al.[19] in Soccer. This process includes more or less the following stages: (1) literature review; (2) instrument development; (3) observation training; (4) amendment of an existing observation instrument; (5) pilot study; (6) establishment of content validity with experts; (7) inter-observer reliability and (8) intra-observer reliability assessment.

Therefore, the aims of this paper are to create an observational instrument and theoretical model regarding the coordination and perturbation of soccer game system, and to follow a systematic process according to the procedures mentioned to accumulate evidence of content validity and reliability to adequately categorise and record behaviours concerning to soccer defensive phase.

Methods

Participants

In the preliminary study, 32 graduate students (mean $\pm$ SD $= 20.56 \pm 0.84$ years) were selected from soccer subject classes. Then, 12 experts (mean $\pm$ SD $= 42.58 \pm$ 8.02 years) with the minimum requirements had voluntarily agreed to participate in the study. Selection of experts was based on the minimum requirements from one of the following aspects[20,22]: (i) UEFA PRO coach qualification or (ii) minimum First Division Coach Experience. Accordingly, six and three experts had coach certificate UEFA PRO and UEFA A, respectively. Five experts had a PhD academic qualification. Six experts had the highest-level experience as coach in U17 National First Division ($n = 3$), National First Division ($n = 1$), Europe League ($n = 1$) and National Team ($n = 2$). At last, one of the experts played in National First Division. More detailed characteristics of the subjects are shown in the supplementary material (Tables S1 and S2).

Instruments

In this study, we used a survey with two different versions developed in Google Forms to assess face and content validity. In the first version, we use 252 close items to assess agreement, univocity and adequacy for the 21 criteria and category systems, and 279 categories of the observational instrument, and for the 4 criteria and category systems, and 14 categories of the theoretical model, the redundant questions of which were aggregated as one (e.g. Field zones). According to APA, AERA, NCME[16] and Fitzpatrick[23] guidelines, we defined the dimensions as: "Agreement" – the degree of general acceptance of criteria and category systems relevance; "Univocity" – clarity domain of a definition; "Adequacy" – level of pertinence and importance of criteria and category systems specific purpose. To facilitate the answers, matrix-type question was used. For agreement, a five-point Likert scale (Strongly disagree, Disagree, Neither disagree nor agree, Agree, Strongly agree) was utilised; for univocity, we used a binary scale (Yes or No) and for adequacy, a different five-point Likert scale (Very low, Low, Medium, High, Very high) was applied. Then, a reduced version to 215 close items (concerning the 21 criteria and category systems, and 192 categories from both theoretical model and observational instrument) was applied to the panel experts. Additionally, in both surveys we incorporated demographic (e.g. nationality) and sports history questions (e.g. coach qualification), and open items to have the expert generally judgement about each criterion. For reliability, we used the final version of Soccer-Defense Observational System

(SOC-DEF) implemented in Lince 1.4 software.[24] The SOC-DEF final version is displayed in Table 1.

Procedures

The process to perform content validity for SOC-DEF is illustrated in Figure 1.

Stage 1: Initial literature review, instrument development and observer training. The selection of categories to build up the observational instrument started with a search for collective and individual defensive variables in literature. Then, television soccer matches were analysed to evaluate the viability of the selected criteria. According to Brewer and Jones,[14] a researcher must follow a systematic observation programme with a suitable existing instrument before constructing a new one. SoccerEye instrument[22] was selected for this purpose, with researchers who had used the instrument performing a previous lecture. Then, a half session of a Spanish first division soccer match was recorded, and the data reviewed.

Stage 2: Adapting an existing systematic observational instrument. Theoretical framework of the observational instrument: For an observation to constitute scientific knowledge requires constant attention and maximum objectivity, which must be supported by a conceptual system, whose structure is imposed on the observer as a presupposition prior to observation.[37] The conceptual framework was named Theoretical Dynamic Model of Soccer Defence because it was built according to the concept of *rapport de forces* (i.e. defenders' tactical–technical behaviours are constrained by the opponent actions), functional characteristic (i.e. regulations and reorganisation over time) and fractal analysis (i.e. reduction of the phenomenon without losing their fundamental characteristics) of Dynamical Systems Theory applied in soccer.[3,5,6] Regarding the first two, we adapted the Soccer Model Organization of Barreira et al.,[22] and for the last the Suzuki and Nishijima[34] model of the defensive process on a subsystem level (Figure 2) was adopted.

In the model created, we integrate the phases described by Suzuki and Nishijima[34] as subphase in the Soccer Model Organization proposed by Barreira et al.[22] The following three subphases were implemented in both ''attack/defence state-transition'' and ''development of non-possession of the ball'' phases: (1) ''delay attack'', (2) ''force the opponent direction'' or ''reducing space'', and (3) ''controlling space''. If these behaviours succeed, the phase ends. However, if the defence is unsuccessful, the process starts again with the delayed phase of attack. The modelling was based on interaction of time (i.e. phases and subphases as a dynamic cycle), space (i.e. distance between attacker and defenders), task (i.e. defenders' tactical–technical behaviours), and organisation (i.e. synergies between defenders) dimensions, which all are constrained by the opponent actions.

The subphases respect a specific moment and object, which refers to the time of action and the author(s) of action(s) whom analysts must direct their look to observe study behaviours, respectively. To determine the moments, we examined the action itself, instead of exclusively considering the tactical–technical pass of the opposing player. We therefore considered other types of tactical–technical actions rather than the pass (e.g. reception, feint, dribble). We decided it would be more pertinent to consider a concept that encompassed the various possibilities of the player. Castelo's description of defensive behaviour[28] outlines the process split into times related with opponent: defence firstly starts before the opponent has the ball under control; secondly, the defender adopts a position that encourages the attacker with the ball to move to a specific own zone and thirdly, the defender tries to reduce space to increase the possibilities of ball recovery. From this perspective, researchers should focus on the following moments: (1) first touch; (2) moment during the action or actions that allows the attacking player to continue with ball control (three touches minimum) (3) action upon release/loss of the ball (or last touch).

Then, the objects defined by Suzuki and Nishijima[34] were: (1) direct defender of the ball carrier, (2) defender against the attacker without the ball and (3) defender against the attacker in space. The number of objects converges with the orientations of the conceptual framework of Costa et al.,[38] who noted that numerical configuration of three players guarantees the occurrence of all tactical principles and consequently respecting the self-similarity principle of the Dynamical Systems Theory. Moreover, it is also important to consider, as objects, the sectoral lines.[39] According to Clemente et al.[39] the defensive, midfield and forward lines are performance indicators and facilitate the understanding of the relationship and synchronisation between spaces and players.

In our model, are considered the following objects in terms of their interpersonal coordination: (1) ''first defender'' (the player closest to the ball); (2) ''second defender'' (the player closest to the ball and first defender); (3) ''third defender'' (the player closest to the ball and the second defender) and (4) the group of players – back unity (consisting of the others players responsible for the space and team organisation).

Design of the observational instrument: The initial design was composed of 21 criteria and category systems ($n = 279$ categories), which were selected from both literature and observer training, namely match

Table 1. Final criteria, category systems and categories of Soccer-Defence Observational System (SOC-DEF).

Criteria, category systems and categories	Code	Definition
Criterion 1: Match status		This criterion is related to the number of goals scored by teams and is categorised by the following categories, adapted from Ruiz-Ruiz et al.:[25]
Winning > one goal difference	Rwm1	Defending team is ahead in scoreline by more than 1 goal
Winning by one goal difference	Rw1	Defending team is ahead in scoreline by 1 goal
Draw	Re	Defending team has the same scoreline than the opponent team
Losing by one goal difference	Rl1	Defending team is behind the scoreline by 1 goal
Losing < one goal difference	Rlm1	Defending team is behind the scoreline by more than 1 goal
Criterion 2: Match location		Related to the stadium where defending team is playing, adapted from Sarmento et al.[26]
Home	Lh	Defending team is playing in their own stadium
Away	La	Defending team is playing at opponent's stadium
Neutral	Ln	Defending team is not playing in opponent's or own stadium
Criterion 3: Opponent quality		Quality of opponent according to their final ranking and type of competition, adapted from Bradley et al.[27]
Tier 1	To	1st to 4th ranked teams in league or teams who reach the semi-final in tournament
Tier 2	Tt	5th to 12th ranked teams in league classification or teams who lost in eighth or quarterfinals
Tier 3	Tth	Below 12th rank in league classification or teams who lost in 16th finals or did not pass the group stage
Tier 4	Tf	All teams that do not satisfy requirements of other three categories.
Criterion 4: Type and stage of competition		Criterion that identifies the format of games in a competition
League first round	CLf	First game between two teams in a domestic competition
League second round	CLs	Second game between two teams in a domestic competition
Group stage	Cgs	Stage which teams are separated by groups and only top-ranked teams (usually top two) pass to the knockout stage
Single knockout stage	Csk	One-match-knockout stage between teams that passed group stage or other knockout stages (excluding final)
Double knockout stage	Cdk	Two-match-knockout stage between teams that passed group stage or other knockout stages (excluding final)
Final	Cf	Last game of knockout stage where team with final advantage is considered winner
Criterion 5: Start of defensive phase		Beginning of non-possession of the ball (for more details, see Theoretical Dynamic Model of Soccer Defence)
Sub-criterion: Direct		No interruption in the behavioural flow of game (i.e. tackle). There are seven different variables:
Goalkeeper save	IDdg	Non-possession starting after hands intervention by the goal-keeper in a goal situation
Shot blocked	IDrb	Non-possession starting by an interruption of the ball trajectory after defensive team shot towards to opponent goal
Goalkeeper technique	IDtg	Non-possession starting by goalkeeper tactical–technical actions of catching or deflecting the ball in non-goal situation[28]
Tackle	IDds	Non-possession starting by opposing team tactical–technical action made who wins possession in direct contest with defender[28]
Interception	IDi	Non-possession starting by opponent's tactical–technical gesture of taking ball after pass, excluding interception using the head[28]

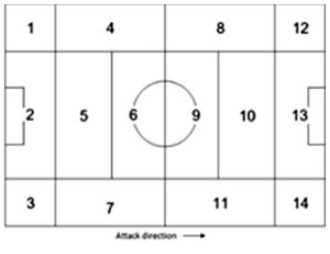
(continued)

Table 1. Continued

Criteria, category systems and categories	Code	Definition
Heading/aerial duel	IDda	Non-possession starting after tactical–technical action through aerial direct ball fight and/or interception by opponent's header[28]
Ball carrier error/mistake	IDep	Non-possession starting through loss of possession by defensive player error, except for goalkeeper[29]
Sub-criterion: Indirect		Interruption in the behavioural flow of game (i.e. foul). There is only one variable:
Interruptions and laws infractions	Ilil	Starting through fouls, free kicks, goal kicks, throw-ins and corner kicks according to game laws[30]
Criterion 6: Type of development		Development of defensive phase (for more details, see Theoretical Dynamic Model of Soccer Defence).
Transition-state attack/defence	DTSd	Development of defensive phase after losing directly the ball possession until constant numerical superiority relation
Non-possession of ball after transition-state attack/defence	DNpt	Development of defending phase after constant numerical superiority relation or set pieces in DTad
Non-possession of the ball	DNpb	Development of defending phase after losing indirectly the ball possession
Criterion 7: Restart play		Various types of set pieces that occur in team non-possession of ball
Development by throw-in	Dll	Defending team conceded a throw-in[30]
Development by goal kick	Dpb	Defending team conceded a goal kick[30]
Development by corner kick	Dpc	Defending team conceded a corner kick[30]
Development by free kick	Dpl	Defending team conceded a free kick[30]
Development by start/restart of game	Dcrj	Non-ball possession initiates by starting each half of game or goal scored by observed team
Development by goalkeeper action	Dgr	Non-ball possession starts by specific technique of ball capturing with hands by goalkeeper
Criterion 8: Type of subphase		Subphase of cyclic system of defensive phase model (for more details, see Theoretical Dynamic Model of Soccer Defence)
Delay	TSaa	Moment of first touch by opposing player
Forcing the opponent direction/reducing space	TSfd	Moment after three touches by opposing player, or defending player attempts to win ball
Controlling space	TSce	Moment of last touch by opposing player
Criterion 9/10/11: First/second/third defender tactical–technical actions[a]	DD/DS/DT	Possible defensive behaviours of defenders critically selected (for more details, see Theoretical Dynamic Model of Soccer Defence)
Player marking	mh	Tactical–technical action of positioning oneself with opponent (still without ball), in order to win or prevent opponent from controlling ball. Marking by itself is considered tight or active surveillance,[31] in which we define distance between them as 1.5 m[32]
Aerial duel	da	Action in which defending player contests or heads ball in uncontrolled air path
Pressure	cp	Pressure implies "oppressive" movement toward ball for reducing space and time of action[31]
Temporisation	ct	Action to delay or be placed between opponent and goal[28]
Unsuccessful tackle	tr	Tactical–technical action made by defender who tries to intercede on ball, in direct fight with opponent[28]
Intervention without success	is	Temporarily intervention on ball by defending player (excluding goalkeeper) without recovering the ball possession[29]

(continued)

Table 1. Continued

Criteria, category systems and categories	Code	Definition
Goalkeeper tactical–technical action	ag	All direct tactical–technical intervention on ball by goalkeeper
Close longitudinal spaces	el	Close spaces by positioning in width of field to prevent ball going to front/back[33]
Close transversal spaces	et	Close spaces by positioning in length of field to prevent ball going side to side[34]
Zonal cover with player marking	cz	Defender takes position in specific space of pitch and moves linked to closest opponent[35]
Control or balance positioning	pe	Occupation of spaces to maintain proper organisation or arrangement of defenders in relation to ball[35]
Displacements of recovering	dr	Type of defensive movement either to pursue defender or to recover balance of defence[28]
Goalkeeper positioning	gp	Rational occupation of tactical–technical spaces of defending goalkeeper
Contention	c	Technical action of delaying opponent through pressure or temporisation
Cover	cb	Positioning immediately behind direct or indirect defender to constitute another obstacle to ball carrier[28]
Criterion 12: Centre of the game[22,29]		The difference number of players in conditions to play in a specific moment between defending and attacking team[22,29] And the following criteria were adapted to:
Numerical equality without pressure	SPi	Defending team has same number of players as the opponent in Centre of the Game and ball carrier is oriented back to own goal
Numerical equality pressure	Pi	Defending team has same number of players as the opponent in Centre of the Game and ball carrier is oriented to own goal
Relative numerical superiority	Pr	Defending team has one or two players more than opposing team in Centre of the Game
Absolute numerical superiority	Pa	Defending team has more than three players than opposing team in Centre of the Game
Relative numerical inferiority	SPr	Defending team has one or two players less than opposing team in Centre of the Game
Absolute numerical inferiority	SPa	Defending team has less than three players than opposing team in Centre of the Game.
Criterion 13: Field zones, adapted from Fidelis et al.[36] and Barreira et al.[11]	1	Left strip and ultra-defensive sector
	2	Central strip and ultra-defensive sector
Field zones of ball = B[b]	3	Right strip and ultra-defensive sector
Field zones of first defender = D[b]	4	Left strip, defensive sector and defensive midfield
Field zones of second defender = S[b]	5	Central strip and defensive sector
Field zones of third defender = T[b]	6	Central strip and defensive midfield
	7	Right strip, defensive sector and defensive midfield
	8	Left strip, offensive midfield and sector offensive sector
	9	Central strip and offensive midfield sector
	10	Central strip and offensive sector
	11	Right strip, offensive midfield and sector offensive sector
	12	Left strip and ultra-offensive sector
	13	Central strip and ultra-offensive sector
	14	Right strip and ultra-offensive sector
Criterion 14: End of defensive phase		Ball recovery and end of non-possession (for more details, see Theoretical Dynamic Model of Soccer Defence)

(continued)

Table 1. Continued

Criteria, category systems and categories	Code	Definition
Sub-criterion: Effective		Defined as successful recovery of the ball
Tackle	FEds	Ball recovery through action made by the opponent who interceded on ball and won possession, in direct fight with defender[28]
Interception	FEi	Ball recovery by taking ball after an opponent pass, which interception using the head is excluded[28]
Ball carrier error	FEep	Ball recovery by defensive team after opponent mistake with ball (e.g. bad ball reception)
Heading	FEda	Ball recovery after tactical–technical action through aerial direct duel and/or a head interception by the defender
Interruptions and laws infractions	FEil	Ball recovery after favourable regulatory breakdown of game such as fouls (excluding offside)
Offside	FEfj	Ball recovery after interruption caused by opposing team through offside[30]
Goalkeeper technique	FEtg	Ball recovery by goalkeeper tactical–technical actions of catching or deflecting ball in a non-goal situation[28]
Shot blocked	FErb	Ball recovery by defensive team after an interruption of the ball trajectory of opponent shot towards to goal of defensive team
Sub-criterion: Ineffective		Defined as finishing opportunities created by opponent
Shot on goal	FIrb	Ball recovery through save by goalkeeper or goalposts after shot conceded to own goal
Shot off goal	FIrf	Ball recovery after shot conceded out of own goal line
Goal conceded	FIg	Shot conceded that passes the own goal line

[a]The code of each defender is concatenated to each of the codes of the categories in the category systems (i.e. DDmh), except for the first defender in the following behaviours: contention and covering; and for second and third defenders for the following: pressure, temporisation and interception without success.
[b]The code of each defender is concatenated to each of the codes of the categories in the category systems (i.e. D9).

status ($n = 5$), time intervals ($n = 8$), match location ($n = 3$), type and stage of competition ($n = 8$), opponent quality ($n = 6$), defensive team formation ($n = 6$), opponent team formation ($n = 6$), start of defensive phase ($n = 12$), development transition-state attack/defense by delay ($n = 16$), development transition-state attack/defense by forcing the opponent direction ($n = 14$), development transition-state attack/defense by reducing space ($n = 15$), development of non-possession of the ball by delay ($n = 16$), development of non-possession of the ball by forcing opponent direction ($n = 19$), development of non-possession of the ball by reducing space ($n = 15$), interaction direct and indirect defender ($n = 20$), interaction direct–indirect and third defender ($n = 20$), players position ($n = 18$), centre of the game ($n = 6$), player identification ($n = 6$), field zones ($n = 48$), end of defensive phase ($n = 12$ categories).

Stage 3: Pilot study – Survey to non-experts. In this stage, the first survey ($n = 252$ close items to assess the 25 criteria and category systems, and 293 categories of both theoretical model and observational instrument) was applied to 32 graduate students. This empirical study aimed to assess the face validity, find inaccuracies, estimate time of survey completion and reduce or modify the survey questions using respondents' answers and suggestions. The survey was applied in a classroom environment, where all students had their own device. Laptops, tablets or smartphones were all permitted. No explanations were given to simulate real application through a web survey. However, students were told to report any technical problems or possible errors in the survey. Two problems arose, which resulted in the exclusion of one question and one participant, whose answers were not saved because of technical problems with wireless connectivity.

Stage 4: Validity – Survey to experts. The survey was conducted in the same web format as the pilot study. However, each survey was divided into seven parts because of size and no option to save answering progress. Completion face-to-face ($n = 5$) and online ($n = 7$) were permitted because of coaches' schedule issues. After the pilot study, the survey was reduced to 215 items about the 21 criteria and category systems, and

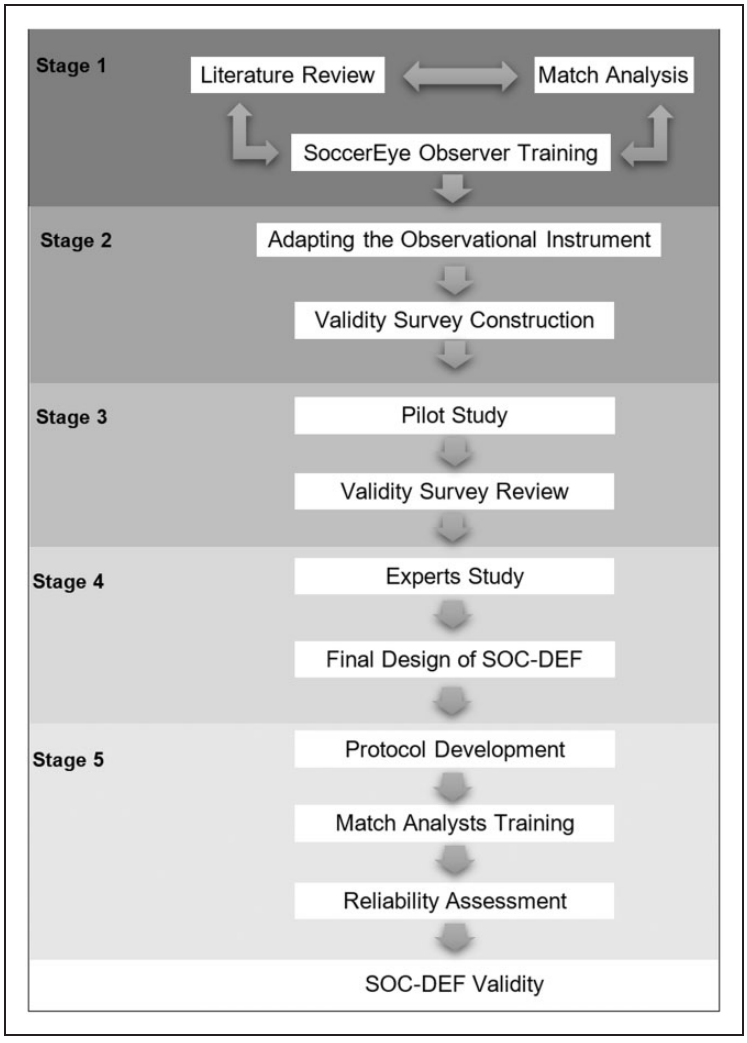


Figure 1. Five-stage SOC-DEF validity evidence process.

192 categories from both the theoretical model and observational instrument. The entire process is shown in Figure 3.

Stage 5: Inter- and intra-reliability. To measure reliability, we followed the procedures developed by Brewer and Jones[14] and Barreira et al.[22] Firstly, conceptual and procedure protocol was developed. Secondly, two coders with nine years aggregated with soccer match analysis/coach/player experience and with the highest level of Third National and Second Local Division were trained following the protocol. Thirdly, unmatched behaviours between coders were discussed and reanalysed. Inter-operator and intra-operator were then calculated by analysing the first half of one World Cup 2014 group stage match. Sample selection size was based on the previous work by Barreira et al.[22] Finally, the same halves were analysed over six weeks and compared with one coder sample to calculate intra-operator reliability.

Statistics analysis

For descriptive analysis, mean and standard deviation were used. For content validity, Aiken's V[40] was calculated as a summarised value of the ratings obtained because it enables specific hypothesis testing through the right tail probability normal distribution and determines confidence intervals.[41] The p level considered was .05 with a 95% confidence interval. Score confidence interval proposed by Penfield and Giacobbi[42] was used providing expected accuracy of Aiken's V value.

We adapted García-Santos and Ibáñez[43] criteria to change and eliminate items. For instance, we only accepted items with Aiken's V values higher than .80. Conversely, we eliminated adequacy and agreement lower than the cut-off and univocity between .69 and .80.

For intra- and inter-reliability, the coefficient Kappa[44] was used and the interpretation or strength of agreement as follows:[45] poor, <.40; intermediate to good, .40 to .75; excellent, >.75.

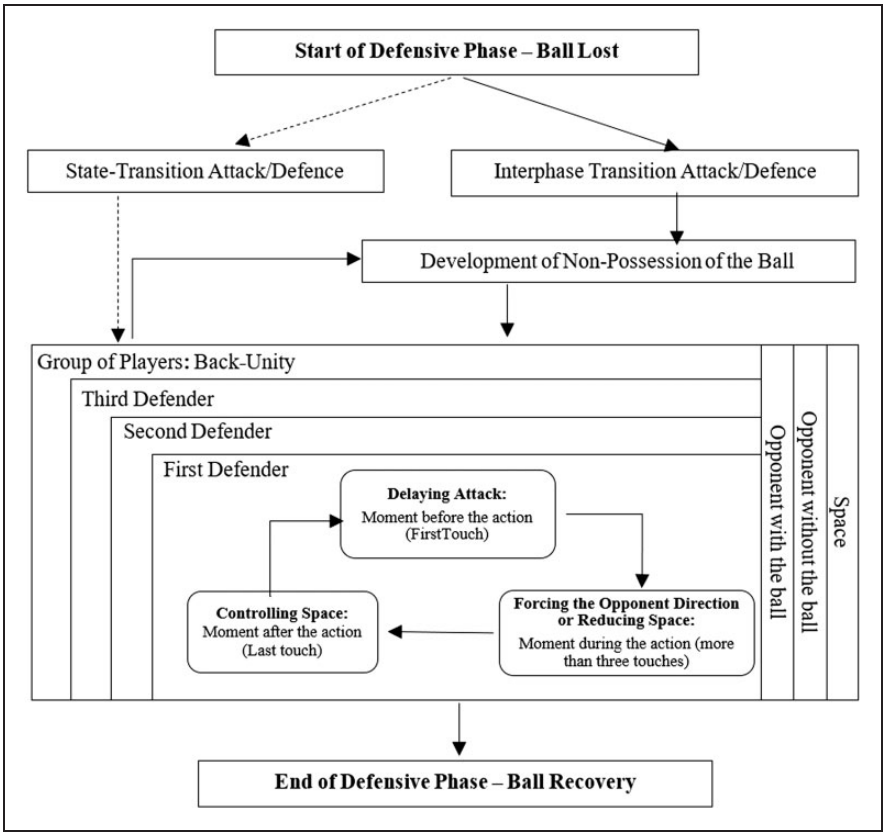


Figure 2. Final Theoretical Dynamic Model of Soccer Defence.

Finally, we used Microsoft Excel 2016 to compute the values of Aiken's V; Lince 1.4 software[24] to record the behaviours and GSEQ 5.1. software[46] to calculate Cohen's Kappa.

Results

Means and standard deviations of experts' answers were calculated for instrument criteria. Due to great amount of data, only the values of the theoretical model are shown in Table 2, thus the rest of the results are available in the supplementary material (Tables S3 to S9).

Face and content validity

More than half of the students responded, ''very unsatisfied'' or ''unsatisfied'' by the extent of the survey. Subsequently, the instrument in the experts' first application was reduced. Taking into consideration the number of experts answering the items, in general the proportions were considerably high, but lower than in the study pilot group.

Face and content validity were measured by Aiken's V coefficient.[40] Some values are presented here and the remaining as supplementary materials (Tables S3 to S9). Nevertheless, an illustration of those results is available in Figure 4.

Generally, Aiken's V results show that in the pilot study, all the items (except ''tier 6'' of the ''opponent quality'') were above the cut-off value of $V > 0.67$ ($n = 32$; $p < 0.01$) for the five scale (adequacy and agreement) and for the binary scale ($V > 0.68$; $n = 32$; $p < 0.05$) inherent to the univocity dimension. Moreover, in the expert values, evident results fall below the calculated cut-off. The first great decrease (ranging from 40 to 60) corresponds to the formation ($n = 10$), in which all categories were eliminated. Finally, the lower values correspond to the ''spatial patterns of teams' interaction'' ($n = 12$), ''field zones'' ($n = 25$) and ''player position'' ($n = 21$).

Inter- and intra-reliability

Generally, the values of Kappa for intra- and inter-reliability ranged from .77 to 1.00, and .72 to 1.00, which is interpreted as excellent and good to excellent, for the strength of agreement. Specifically, good intra- and inter-reliability strength of agreement were found in the following criterion, respectively: first defender

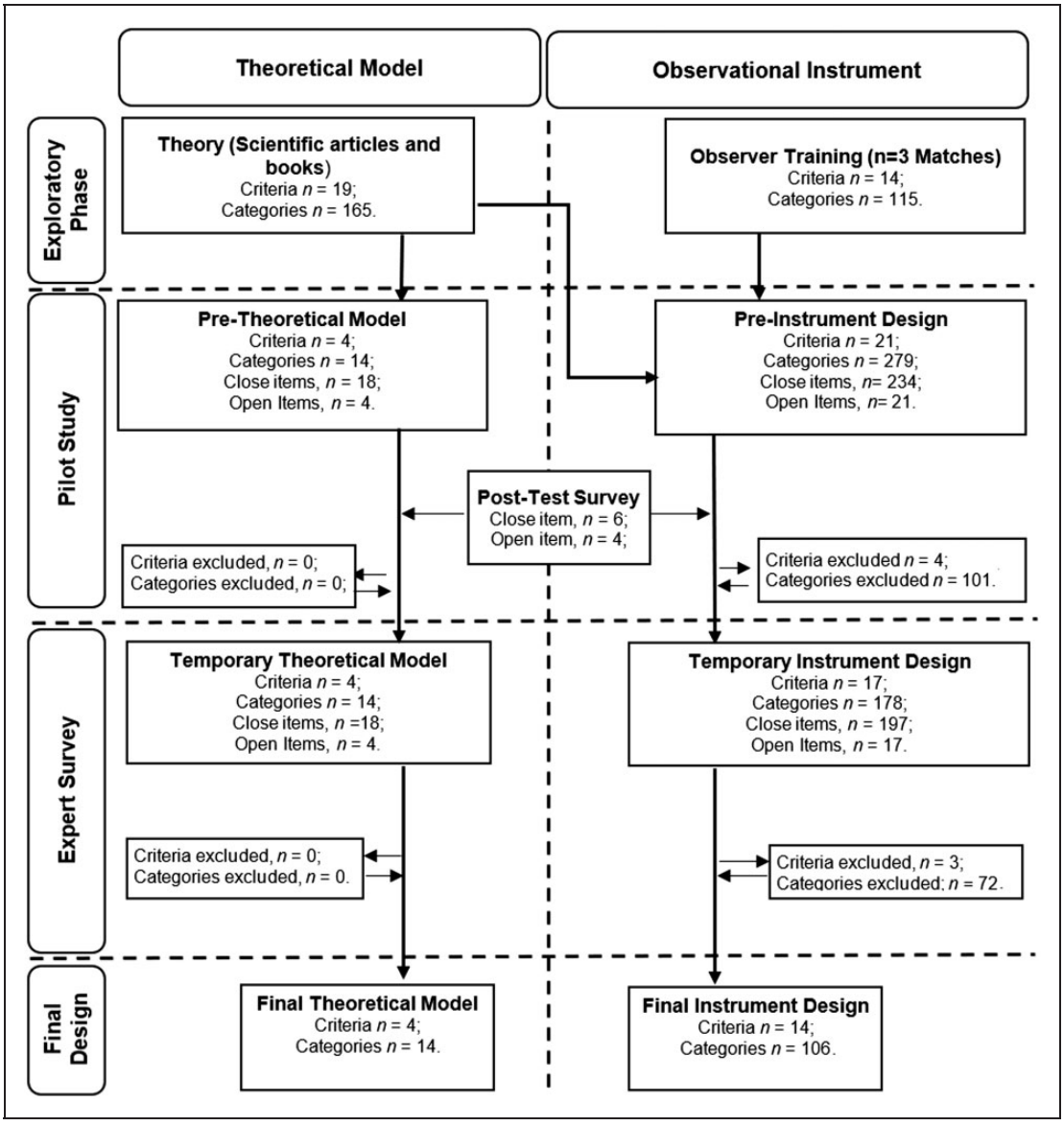


Figure 3. Flow chart of SOC-DEF validation evidence process.
Criteria: concepts that allows to build systems of categories, which implies exhaustivity and exclusivity requirements between these categories; Criteria excluded: criteria that were deleted from the current design either by review choice or by the *V* Aiken's for agreement/adequacy and univocity below cut-off; Category: observation behaviour to analyse; Close items: question type Likert measuring agreement, adequacy and univocity in the survey; Open items: opinion/suggestion question type in the survey.

tactical–technical actions ($k = .80$ and .76), second defender tactical–technical actions ($k = .77$ and .76), third defender tactical–technical actions ($k = .76$ and .72). Correspondingly, excellent strength of agreement were achieved in opponent quality ($k = 1.00$ and 1.00), type and stage of competition ($k = 1.00$ and 1.00), match status ($k = .99$ and 1.00), start of defensive phase ($k = .98$ and .96), type of development ($k = .98$ and .90), restart plays ($k = .96$ and .93), type of sub-phase ($k = .86$ and .83), centre of the game ($k = .81$ and .78), field zones of first defender ($k = .88$ and .86), field zones of second defender ($k = .86$ and .82), field zones of third defender ($k = .84$ and .79), field zones of ball ($k = .90$ and .88), end of defensive phase ($k = .97$ and .94).

Discussion

The general aims of this study were to create an observational system integrating the concepts of Dynamical Systems Theory for defence in soccer and follow a systematic validity evidence process adapted from

Table 2. Aiken's *V* values of criteria, category systems and categories of the Theoretical Dynamic Model of Soccer Defence.

		Adequacy (5-scale)					Agreement (5-scale)					Univocity (2-scale)				
					95%					95%					95%	
	n	M	SD	*V*	L	U	M	SD	*V*	L	U	M	SD	*V*	L	U
Criterion 1: Theoretical Dynamic Model of Soccer Defence	12	3.9	0.7	0.73*	0.59	0.83	4.1	0.8	0.77*	0.63	0.87	1.8	0.4	**0.83****	0.55	0.95
Delay	12	3.9	0.7	0.73*	0.59	0.83	4.2	0.6	0.79*	0.66	0.88	1.9	0.3	**0.92****	0.65	0.99
Forcing the opponent direction	12	3.9	0.5	0.73*	0.59	0.83	4.1	0.5	0.77*	0.63	0.87	1.9	0.3	**0.92****	0.65	0.99
Reducing space	12	3.8	0.7	0.71*	0.57	0.82	4.1	0.5	0.77*	0.63	0.87	1.8	0.4	**0.83****	0.55	0.95
Criterion 2: Analysis object	12	3.7	1.0	0.67	0.53	0.78	4.2	0.8	0.79*	0.66	0.88	1.8	0.5	0.75	0.47	0.91
First defender	12	4.3	0.8	**0.81***	0.68	0.90	4.4	0.7	**0.85***	0.73	0.93	1.9	0.3	**0.92****	0.65	0.99
Second defender	12	4.0	1.0	0.75*	0.61	0.85	4.3	0.7	**0.83***	0.70	0.91	1.8	0.5	0.75	0.47	0.91
Third defender	12	3.9	1.0	0.73*	0.59	0.83	4.3	0.6	**0.81***	0.68	0.90	1.8	0.4	**0.83****	0.55	0.95
Group of players – back unity	12	4.0	1.0	0.75*	0.61	0.85	4.1	0.7	0.77*	0.63	0.87	2.0	0.0	**1.00****	0.76	1.00
Definition criteria	12	3.7	1.1	0.67	0.53	0.78	4.2	0.8	0.79*	0.66	0.88	1.7	0.5	0.67	0.39	0.86
Criterion 3: Object references	12	4.0	0.7	0.75*	0.61	0.85	4.3	0.8	**0.81***	0.68	0.90	1.9	0.3	**0.92****	0.65	0.99
Ball carrier	12	4.3	0.9	**0.81***	0.68	0.90	4.5	0.5	**0.88***	0.75	0.94	1.9	0.3	**0.92****	0.65	0.99
Opponent without the ball	12	4.1	0.7	0.77*	0.63	0.87	4.4	0.5	**0.85***	0.73	0.93	1.9	0.3	**0.92****	0.65	0.99
Space	12	3.9	0.9	0.73*	0.59	0.83	4.4	0.5	**0.85***	0.73	0.93	1.8	0.4	**0.83****	0.55	0.95
Criterion 4: Observation moments	12	3.9	1.0	0.73*	0.59	0.83	4.1	1.0	0.77*	0.63	0.87	1.8	0.5	0.75	0.47	0.91
First action moment	12	3.9	1.0	0.73*	0.59	0.83	4.1	1.0	0.77*	0.63	0.87	1.8	0.4	**0.83****	0.55	0.95
During action moment	12	3.9	1.0	0.73*	0.59	0.83	4.1	1.0	0.77*	0.63	0.87	1.8	0.5	0.75	0.47	0.91
Last action moment	12	3.8	1.0	0.71*	0.57	0.82	4.1	0.8	0.77*	0.63	0.87	1.8	0.5	0.75	0.47	0.91

Note: For 5-scale: *$p < 0.05$ and $V > 0.69$ ($n = 12$); for 2-scale: **$p < 0.05$ and $V > 0.83$ ($n = 12$); bold represents the values $V > 0.80$ that require no review. Agreement: degree of general acceptance of criteria, category systems and categories relevance; Univocity: clarity domain of a definition; Adequacy: level of pertinence and importance for criteria, category systems and categories specific purpose. L: lower 95% confidence interval limit; U: upper 95% confidence interval limit.

previous ones.[14,20,22] Moreover, content validity and reliability were demonstrated, and the objectives of the study accomplished.

The validation process of this study revealed some evident differences compared to the studies outlined above. For instance, Barreira et al.[22] and Prudente et al.[20] conducted studies exclusively face-to-face. Our method facilitated the recruitment of experts and the criteria for selecting them are more flexible than Barreira et al.[22] but more restricted than Almeida et al.[47]

Our results showed that experience had a higher critical opinion when compared with less experience, which is proven by the fact that all categories evaluated in the pilot study group were all above the cut-off value Aiken's *V* coefficient. Experts' answers assessment using Aiken's *V* showed considerable evidence of validity content for most criteria: High, Medium and Low coefficient items were accepted, reviewed and excluded, respectively.[43]

As the Theoretical Dynamic Model of Soccer Defence, it showed consensus among experts by means of no elimination of items. For subphase criteria, all categories were above the Aiken's *V* cut-off for all three dimensions. We believed that the use of the concepts of *rapport* of forces (i.e. tactical–technical behaviours constrained by opponent actions), functional characteristics (i.e. sequential codification of behaviours by type of development and subphase) and the fractal analysis (i.e. analysis of the closest three defenders to the ball carrier) have contributed for these results. Still, the object of analysis and definition criteria were below .80. The focus on only three defenders appears to contribute with useful information about defence, yet according to these experts, the adequacy of the defence analysis is less than ideal. This opinion concurs with Costa et al.,[38] who propose that, though not perfect, three players are sufficient for the observance of tactical principles.

We defined the distance of the ball carrier as the main criteria for determining the three defenders (e.g. the second defender would be closest to the ball and the first defender, and so on and so forth). To dispel any uncertainty, we selected two more criteria to hierarchically check if the first criterion is not found: orientation and subsequent action participation of each

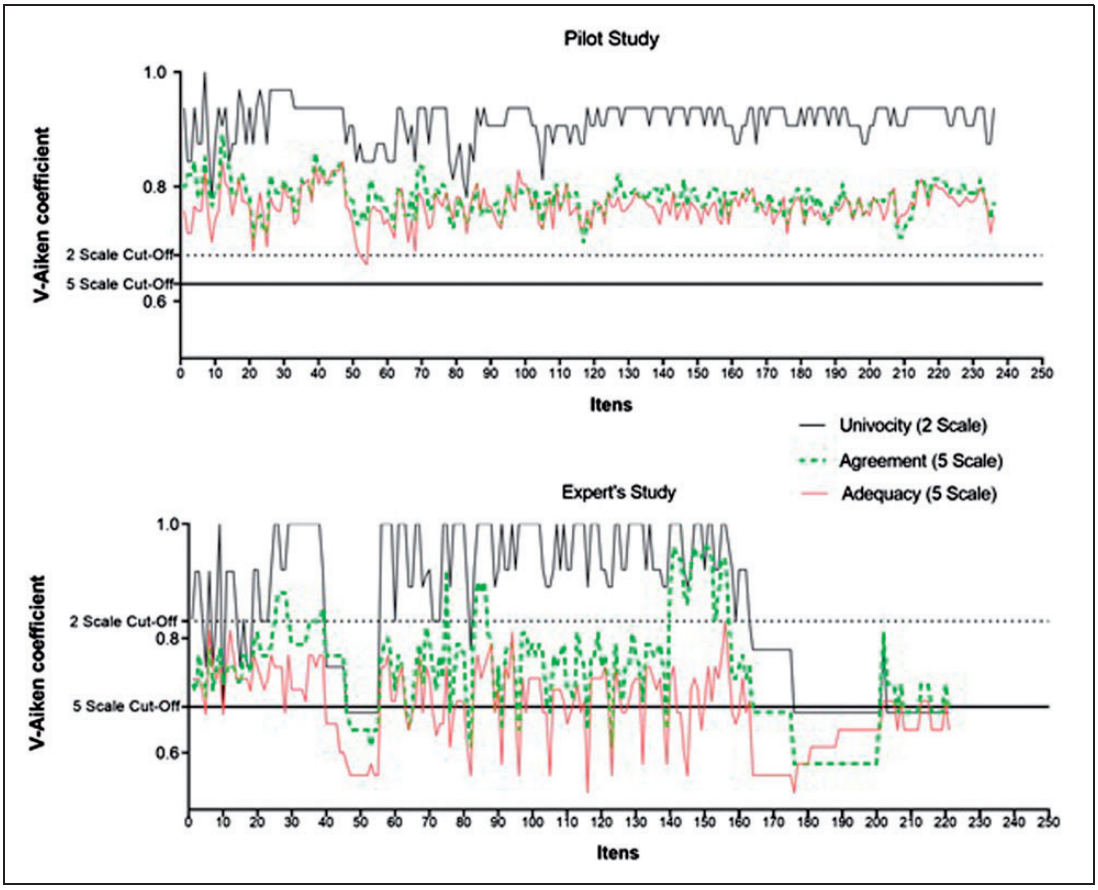


Figure 4. Comparison of Aiken's *V* values between pilot and expert studies.

defender. Here, we privilege the constraints that the opponent with the ball is most probably aware of.

However, due to soccer game complexity, it would be unviable and unfeasible for an analyst using a notational recording system to analyse the tactical–technical behaviours of all players. That is why the attempt of Dynamical Systems Theory in reducing the phenomenon of game play to the mains variables interactions are important either to viably enable the analysis of soccer game either to provide better understanding.[3,5] Also, our focus was on using an integrated method of task, time and space variables to infer organisation indicators, similar to the works of Garganta[31] and Fernandez-Navarro et al.[48] who made inferences using the zones of ball recovery to describe teams' defence style. Here, we add the possibility to understand how the behaviour of the closest defenders defines team configurations of plays.

The disadvantages of data analysis for large amounts of data and the need to prioritise information are well known.[10] However, the positional data of multiple camera tracking systems would provide meaningful information for our observational instrument and others through a mixed methods approach.[49]

Furthermore, observation moments for first, third and last ball touch were clarified (e.g. the first touch pass is only considered in the first moment). These moments are associated with frequency of analysis. For example, it is possible in multiple camera tracking systems to use 25 Hz – each position of the player is recorded 25 times per second, but only one part of the data is usually considered for data analysis; using these moments, only the data of interest is recorded, which is the three subphases of the defensive phase.

For situational variables, the different team formations were not pertinent or consensual between experts and were excluded from the instrument. All remaining situational variables (''match status'', ''match location'', ''opponent quality'', ''type and stage of competition'') were accepted and reviewed. Specifically, ''opponent quality'' and ''type and stage of competition'' categories presented low values for adequacy. The experts' comments suggested a reduction and we grouped the possible categories (see Table 1): In the quality of opponent, we used a more global definition as different operations for variable changes between studies, according to a specific ranking competition[47] or clustering.[50]

After scrutinising the criteria of the starting and ending of defensive phase, we eliminated three categories: lateral, slide and behind tackle. The experts did not consider tackle discrimination as either pertinent or important for the beginning of the defensive phase. ''frontal tackle'' was then defined as the general concept of ''tackle'' enclosing all types of tackle.

Experts judged adequacy more positively, in terms of discriminating the type of tackle, at the end rather than at the ''start of the defensive phase'', Even with answers of this last suggested to exclusion we decided to use only ''tackle'' in both criteria.

Contrary to SoccerEye observational system, which have already the tactical–technical behaviours associated to each ''development of ball possession'' and ''transition-state defence/attack'', we create two criteria, ''type of development'' and ''defender tactical–technical actions''. No category was eliminated in the ''type of development'' criteria, but all were reviewed:

In ''restart plays'', the ''ball out of play'' was eliminated and the goalkeeper hands and feet techniques were grouped and named ''goalkeeper action''. All remaining categories were flagged for review, but because they are related to game structure (and the definitions were clear), nothing was done.

Concerning to tactical–technical behaviour for each defender, ''opponent without the ball marking'' was eliminated from the criteria of the first, but not from the second or third defender, since agreement was above the Aiken's V cut-off value. ''heading without intervention'' was also eliminated from the criteria of the first, but not from the second or third defender, although a review was requested for the latter two. This concept of heading with or without intervention was modified for ''aerial duel'', irrespective of whether or not the player touches the ball. In contrast, ''temporisation'' passed the Aiken's V cut-off value for the first, but not for the second or third defender, perhaps because ''temporisation'' in the second and third defender is associated with ''covering'', which was accepted with no need for review. Conversely, the experts assessed ''ball protection'' and ''non-defensive tactical–technical action'' as unimportant or not pertinent for analysis for each of the three defenders, according to the Aiken's V calculated.

Moreover, the high values for Aiken's V of the ''centre of the game'' criterion itself did not suggest review, which is not surprising as works using this terminology are often used by researchers.[22,29,51]

''Spatial patterns of teams' interaction'' between teams was surprisingly eliminated in full, contrary to existing studies on this type of criteria.[22] An explanation might be that those studies focused on the offensive process.

For the ''field zones'', experts' responses were also more negative than positive. Some reported comments led us to believe that numerous zone divisions were the main problem. We therefore reduced them according to the 12 zones of Barreira et al.[11] and the pressing zones of Fidelis et al.,[36] resulting in a 14-zone field.

Generally, the instrument has shown objectivity in measures. For instance, inter- and intra-reliability had good to excellent scores for the coefficient values of Kappa. However, defenders' behaviours had the lowest values compared to the others, those could be explained by the variability and quantity of categories of each. We would recommend exercising caution when interpreting the results of those criteria. Although, researcher could logically aggregate categories (e.g. contention with temporisation and contention with pressure to contention).

Method application was a limitation of this study and, to eliminate bias, we believe it is preferable to opt for only one. Further limitations of the study were the extent and division of the survey due to loss of follow-up participants and unfinished answers, respectively.

Conclusion

SOC-DEF observational instrument integrating a Theoretical Dynamic System Model for Defence in Soccer evidenced content validity, inter- and intra-reliability for analysing the defensive phase in soccer.

The present study concludes that the final framework and instrument are adequate and consistent for analysing successful and non-successful tactical–technical defensive patterns of play. Also, the variables and operational definitions from this instrument could be helpful to academics replicate and create studies, and meaning of data useful for coaches to set the strategies of their teams.

Acknowledgements

The authors are grateful to the students and coaches who voluntarily participated in the study and to the FIFA Films database archive who provided the public footages of matches.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The authors gratefully acknowledge the support of INEFC (National Institute of Physical Education of

Catalonia) and the support of two Spanish government projects (Ministerio de Economía y Competitividad): (1) La actividad física y el deporte como potenciadores del estilo de vida saludable: Evaluación del comportamiento deportivo desde metodologías no intrusivas (Grant number DEP2015-66069-P); (2) Avances metodológicos y tecnológicos en el estudio observacional del comportamiento deportivo (PSI2015-71947-REDP); and the support of the Generalitat de Catalunya Research Group, Research group and innovation in designs (GRID). Technology, multimedia and digital applications to observational designs (Grant number 2017 SGR 1405).

Supplemental Material

Supplemental material is available for this article online.

ORCID iD

Tiago Fernandes http://orcid.org/0000-0001-5714-410X

References

1. Garganta J. Dos constrangimentos da acção à liberdade de (inter)acção, para um Futebol com pés... e cabeça. In: Araújo D (ed.) O contexto da decisão A acção táctica no desporto. Lisboa: Visão e Contextos; 2005, pp.179–190.
2. Mackenzie R and Cushion C. Performance analysis in football: a critical review and implications for future research. *J Sports Sci* 2013; 31: 639–676.
3. Gréhaigne JF, Bouthier D and David B. Dynamic-system analysis of opponent relationships in collective actions in soccer. *J Sports Sci* 1997; 15: 1371–49.
4. Vilar L, Torrents C, Araújo D, et al. Ecological dynamics as an alternative framework to notational performance analysis in Complex Systems in Sport. In: Davids K, Hristovski R, Araújo D (eds) *Complex systems in sport*. New York: Routledge, 2014, pp.229–240.
5. Gréhaigne JF and Godbout P. Dynamic systems theory and team sport coaching. *Quest* 2014; 66: 96–116.
6. Davids K, Araújo D and Shuttleworth R. Applications of dynamical systems theory to football. In: Reilly T, Cabri J, Araújo D (eds) *Science and football V*. Oxon: Routledge, Taylor & Francis, 2005, pp.537–550.
7. Nevill A, Atkinson G and Hughes M. Twenty-five years of sport performance research in the Journal of Sports Sciences. *J Sports Sci* 2008; 26: 413–426.
8. Sarmento H, Marcelino R, Anguera MT, et al. Match analysis in football: a systematic review. *J Sports Sci* 2014; 32: 1831–1843.
9. James N. Notational analysis in soccer: past, present and future. *Int J Perform Anal Sport* 2006; 6: 67–81.
10. Rein R and Memmert D. Big data and tactical analysis in elite soccer: future challenges and opportunities for sports science. *Springerplus* 2016; 5: 1410.
11. Barreira D, Garganta J, Castellano J, et al. How elite-level soccer dynamics has evolved over the last three decades? Input from generalizability theory. *Cuadernos de Psicología del Deporte* 2015; 15: 51–62.
12. Fernández-Hermógenes D, Camerino O and García AdA. Acciones ofensivas a balón parado en el fútbol. *Apunts Educación Física y Deportes* 2017; 129: 78–94.
13. Casal C, Andujar M, Losada J, et al. Identification of defensive performance factors in the 2010 FIFA World Cup South Africa. *Sports* 2016; 4: 54.
14. Brewer C and Jones L. A five-stage process for establishing contextually valid systematic observation instruments: the case of Rugby Union. *Sports Psychol* 2002; 16: 138–159.
15. Sullivan GM. A primer on the validity of assessment instruments. *J Grad Med Educ* 2011; 3: 119–120.
16. American Educational Research Association APA, National Council on Measurement in Education and Joint Committee on Standards for Educational and Psychological Testing. *Standards for educational and psychological testing*. Washington, DC: AERA, 2014.
17. Heale R and Twycross A. Validity and reliability in quantitative studies. *Evid Based Nurs* 2015; 18: 66–67.
18. Taherdoost H. Validity and reliability of the research instrument: how to test the validation of a questionnaire/survey in a research. *Int J Acad Res Manage* 2016; 5: 28–36.
19. Cobb NM, Unnithan V and McRobert AP. The validity, objectivity, and reliability of a soccer-specific behaviour measurement tool. *Sci Med Football* 2018; 2: 196–202.
20. Prudente J, Garganta J and Anguera M. Desenho e validação de um sistema de observação no andebol. *Rev Port Cien Des* 2004; 4: 49–65.
21. Cushion C, Harvey S, Muir B, et al. Developing the coach analysis and intervention system (CAIS): establishing validity and reliability of a computerised systematic observation instrument. *J Sports Sci* 2012; 30: 201–216.
22. Barreira D, Garganta J, Prudente J, et al. Desenvolvimento e validação de um sistema de observação aplicado à fase ofensiva em Futebol: SoccerEye. *Rev Port Cien Desp* 2012; 12: 32–57.
23. Fitzpatrick AR. The meaning of content validity. *Appl Psychol Meas* 1983; 7: 3–13.
24. Gabin B, Camerino O, Anguera M, et al. Lince: multiplatform sport analysis software. *Procedia Soc Behav Sci* 2012; 46: 4692–4694.
25. Ruiz-Ruiz C, Fradua L, Fernandez-Garcia A, et al. Analysis of entries into the penalty area as a performance indicator in soccer. *Eur J Sport Sci* 2013; 13: 241–248.
26. Sarmento H, Leitão J, Anguera MT, et al. Observational methodology in football: development of an instrument to study the offensive game in football. *Motricidade* 2009; 5: 19–24.
27. Bradley PS, Archer DT, Hogg B, et al. Tier-specific evolution of match performance characteristics in the English Premier League: it's getting tougher at the top. *J Sports Sci* 2016; 34: 980–987.
28. Castelo J. *Futebol a organização do jogo como entender a organização dinâmica de uma equipa de futebol e a partir desta compreensão como melhorar o rendimento e a direcção dos jogadores e da equipa*. Lisbon: Jorge Castelo, 1996.

29. Barreira D. *Tendências evolutivas da dinâmica tática em Futebol de alto rendimento. Estudo da fase ofensiva nos Campeonatos da Europa e do Mundo, entre 1982 e 2010*. PhD Thesis, University of Porto, Porto, 2013.
30. The International Football Association Board. Laws of the game 2017–2018, www.fifa.com/mm/Document/FootballDevelopment/Refereeing/02/90/11/67/Lawsofthegame2017-2018-EN_Neutral.pdf. (2017, 10 January 2018).
31. Garganta J. Modelação táctica do jogo de Futebol: Estudo da organização da fase ofensiva em equipas de alto rendimento. PhD Thesis, University of Porto, Porto, 1997.
32. Tenga A, Kanstad D, Ronglan LT, et al. Developing a new method for team match performance analysis in professional soccer and testing its reliability. *Int J Perform Anal Sport* 2009; 9: 8–25.
33. Hughes M, Caudrelier T, James N, et al. Moneyball and soccer – an analysis of the key performance indicators of elite male soccer players by position. *J Hum Sport Exerc* 2012; 7: 402–412.
34. Suzuki K and Nishijima T. Validity of a soccer defending skill scale (SDSS) using game performances. *Int J Sport Health Sci* 2004; 2: 34–49.
35. Bangsbo J and Peitersen B. *Defensive soccer tactics*. Champaign: Human Kinetics, 2002.
36. Fidelis AJM, García-Tormo JV and Morante-Rábago JC. Análisis de la eficacia de las acciones de pressing en partidos de fútbol en función de los sectores del campo. Lecturas Educación Física y Deportes, Revista Digital, www.efdeportes.com (2012, 14 September 2017).
37. Anguera M. *Metodología de la observación en las Ciencias Humanas Madrid*. Madrid: Ediciones Cátedra, 1978.
38. Costa IT, Garganta J, Greco PJ, et al. Análise e avaliação do comportamento tático no futebol. *Revista da Educação Física/UEM* 2010; 21: 443–455.
39. Clemente FM, Martins FML, Couceiro MS, et al. Developing a football tactical metric to estimate the sectorial lines: a case study. In: Murgante B, Misra S, Rocha A, et al. (eds) *Computational science and its applications – ICCSA 2014, Pt 1. Lecture notes in computer science*, Guimarães, Portugal, 30 June–3 July, pp.743–753. Cham: Springer International Publishing.
40. Aiken LR. Content validity and reliability of single items or questionnaires. *Educ Psychol Meas* 1980; 40: 955–959.
41. Dunn J, Bouffard M and Rogers W. Assessing content-relevance in sport psychology scale-construction research: issues and recommendations. *Meas Phys Educ Exerc Sci* 1999; 3: 15–36.
42. Penfield RD and Giacobbi JPR. Applying a score confidence interval to Aiken's item content-relevance index. *Meas Phys Educ Exerc Sci* 2004; 8: 213–225.
43. García-Santos D and Ibáñez SJ. Design and validation of an observational instrument to basketball referee evaluation (IOVAB). *Revista Euroamericana de Ciencias del Deporte* 2016; 5: 15–26.
44. Cohen J. A coefficient of agreement for nominal scales. *Educ Psychol Meas* 1960; 20: 37–46.
45. Fleiss J. *Statistical methods for rates and proportions*, 2nd ed. New York: John Wiley & Sons, 1981.
46. Bakeman R and Quera V. *Análisis de la interacción: Análisis secuencial con SDIS y GSEQ*. Madrid: Ra-Ma, 1996.
47. Almeida CH, Ferreira AP and Volossovitch A. Effects of match location, match status and quality of opposition on regaining possession in UEFA champions league. *J Hum Kinet* 2014; 41: 203–214.
48. Fernandez-Navarro J, Ford PR, McRobert AP, et al. Attacking and defensive styles of play in soccer: analysis of Spanish and English elite teams. *J Sports Sci* 2016; 34: 2195–2204.
49. Camerino O, Castañer M and Anguera M. *Mixed methods research in the movement sciences: case studies in sport, physical education and dance*. New York: Routledge, 2012.
50. Liu HY, Hopkins WG and Gomez MA. Modelling relationships between match events and match outcome in elite football. *Eur J Sport Sci* 2015; 16: 516–525.
51. Castaner M, Barreira D, Camerino O, et al. Mastery in goal scoring, T-pattern detection, and polar coordinate analysis of motor skills used by Lionel Messi and Cristiano Ronaldo. *Front Psychol* 2017; 8: 741.