Description of collective behaviour in football according to the level of competence in representative tasks from positional data: systematic review

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Abstract

The aim of this systematic review is to provide a base of knowledge from studies that have dealt with the description of collective behaviour in young footballers according to the level of competence associated to that age group, taking representative tasks from positional data as our starting point. Following the PRISMA statement a systematic revision was carried out on three meta-search engines (PubMed, Web of Science and SportDiscus). The following key words were used in the search: football, tactical behaviour, positional data and age-group, together with their equivalents. Of the 423 articles identified, 11 fulfilled the inclusion requirements. The main results suggest that: the variables made up of the joining of two points with a line (Width, Length and distance between dyads) and the collective area covered increase with age; however, the individual area tends to reduce. The increase in level of competence appears to require a greater functional variability in order to generate uncertainty and to counteract that of the opposing team. These results could allow trainers to identify on which tactical behaviour to focus intervention with the aim of fostering optimal development according the age.

Keywords: team sport, tactical behaviour, tracking system.

1. Introduction

Analysing tactical variables – keys in a collective duel like football (Duarte, Araújo, Correia, & Davids, 2012; Clemente, Couceiro, Martins, & Mendes, 2013) – can be useful for attempting to understand the game dynamic from the very complexity that characterises it (Balagué, Torrents, Hristovski, Davids, & Araújo, 2013). To know just how the players adapt their behaviour (Goncalves, Figueira, Macas, & Sampaio, 2014) within the co-adaptive macrosystem formed by both teams (Duarte et al., 2012) according to their level of competence, the opponent and/or contextual variables (e.g., current score, where the match takes place, weather, etc.), may help to better interpret the collective synergy of the teams in competition (López-Felipe, Davis, Frank, & Dixon, 2018).

The growing interest in studying collective behaviour (Low, Coutinho, Gonçalves, Rein, Memmert, & Sampaio, 2019; Coito, Davids, Folgado, & Travassos, 2020; Lord, Pyne, Welvaert, & Mara., 2020; Rico-González, Pino-Ortega, Castellano, Oliva-Lozano, & Los Arcos, 2021a), while not recent (Castellano & Hernández-Mendo, 2000), has benefited from the development of tracking device technology such as a global or local positioning system or semi-automated video-tracking system (Memmert, Lemmink, & Sampaio, 2017; Rico, Pino-Ortega, Nakamura, Moura, Rojas-Valverde, & Los Arcos, 2020b). This technology enables us to locate the player and the ball in the playing area using X and Y co-ordinates, thus allowing us to calculate different collective variables (Yue, Broich, Seifriz, & Meister, 2008) that can be grouped into three major categories (Rico, Pino-Ortega, Clemente & Los Arcos, 2020a), such as: the point (e.g., team centroid), line or distance separating two points (e.g., width or depth of the team) and the area of three or more points (e.g., effective play space).

It is not only in the professional field (Lord et al., 2020; Rico et al.,2021a), that expanding tactical knowledge in formative football (Folgado, Lemmink, Frencken, & Sampaio, 2012) is greatly relevant for the detection, selection and development of sporting talent (Pastor et al., 2020). One possible use in this formative field is that it would make it possible to identify the type of collective organisation to be adopted by the players in relation to their stage of development (Brito, Roriz, & Garganta, 2020; Lapresa, Arana, Garzón, Egüén, & Amatria, 2010; Serra-Olivares, García-López, & Gonçalves, 2019), when it comes to dealing with the issue of social motricity when playing football. A detailed description of the collective performance could help to keep pace with its biological and football maturing processes (Lapresa et al., 2006, 2009, 2010 y 2013), enabling a task design and adaptation of competition formats in line with its problem-

solving capabilities. In this sense, formats played with representative characteristics that involve contextualised behavioural stimuli capable of being assimilated in the short/medium term by the player (Borges, Guilherme, Rechenchosky, Arantes da Costa, & Rinadi, 2017), may be an appropriate teaching tool through which to develop the necessary adaptability in a context of social uncertainty implicit in football.

The representative design (Brunswik, 1956) implies emphasising the specific nature of relationships between individuals and environment, respecting the meta-stability inherent to the game (Hristovski, Davids, & Araujo, 2009; Davids, Araujo, Hristovski, Passos, & Chow, 2012). Thus, tasks that are not very representative could make the system – and therefore the collective variables that encompass them – express themselves in a different way to how they would in a competition (Olthof, Frencken & Lemmink, 2019). It seems appropriate, if we are aspiring to investigate the system's potential, to do so starting from representative contexts (Pinder, Davids, Renshaw, & Araujo, 2011), i.e., contexts that maintain the structural features that determine competitive activity (e.g., regulation matches). In formative football, the degree of representation will depend on the type of format of the competition (U5, U7-U8 or U11) appropriate to each age group or category. On the basis of the aforementioned, it would be relevant to consider the constrictions of the task that the studied players will undertake (Serra-Olivares, Clemente, & González-Víllora, 2016), associated to the degree of representation of the same: total, partial or absent (according to the number of players on each team, relative dimensions, and other kinds of rules similar to those of competition).

Despite various authors in the formative field having analysed behaviour, taking into consideration collective variables, the idea of representation in the task was not considered in the same way. Folgado et al. (2012), starting from positional data, were the first to compare collective task responses with different numbers of players according to age. They concluded that the players showed a greater intra and inter team distance as they got older (U13>U11>U9) in 3vs3 situations (three players per team), although the differences were not so clear when the number of players in the task rose to four per team. Olthof, Frencken, & Lemmink (2015), this time via GPS, also compared the collective behaviour of young players (U17 and U19) according to age. They observed that older players, in 5vs5 duels, positioned themselves wider, reporting significantly higher Stretch Index lateral values and lower LxW ratio values. Both the absolute and relative dimensions chosen in the task also appeared to influence collective performance (Olthof, Frencken, & Lemmink, 2017), showing that using game dimensions that are close to

regulation ones favours the increase of intra-team distances. Later, Olthof et al. (2019) went on to report significant differences in the *surface area* between U-13 and U-19 players in eleven-a-side competition format. Subsequent studies (Clemente, Castillo, & Los Arcos, 2020) produced similar results in terms of the increase in the surface area covered by the team as the players got older.

Given all the above, the aim of this study is to carry out a systematic review of research work that has described the collective behaviour of young football players, from positional data in representative tasks. The results will allow information to be revealed about the 'route' of the collective behaviour dynamic from a longitudinal perspective throughout the players' formative journey.

2. Method

2.1. Representativeness of competition formats

The representativeness of competition formats or tasks used in the studies was assessed, taking as reference the appropriate regulation for each formative stage (Table 1). Representative is understood as all played tasks that, in a collective duel, sets two teams against each other in stable numerical equality, sharing a rectangular playing space, with their own goal to defend and an opposing goal to attack, situated facing each other at opposite ends of the pitch, and without establishing any additional rules except those included in each regulation.

Table 1. Structural characteristics that determine representative features in accordance with the regulations.

Format	Age group	Relative space per player in m^2	N of players per team	Offside	Targets in m (WxH)	Min and max dimensions (LxW) in m
F5	<U9	>47 <131	5vs5	No	3x2 or 3x1.6	Mín=25x15 Máx =42x25
F7-F8	U10 toU14	>125 <244	7vs7 8vs8	Large area	6x2	Mín = 50x30 Máx = 65x45
F11	U15 to U19	>202 <540	11vs11	Midfield	7.32x2.44	Mín = 90x45 Máx =120x90

Note: Dimensions extracted in accordance with regulations: F11 (Rules, 2021); F7 and F5 (Rules, 2021a and b). The values correspond to those homologised for national competitions. WxH= Width per Height, LxW= Length per Width. RS= Relative Space (taking as reference field players without goalkeepers).

To assess the level of representativeness of the analysed game formats, the age of the participants was taken as a reference, along with the competition format in which they usually participate. Three types of representativeness were identified, one total and two partials. Thus, the studies that were considered totally representative were those whose

analysed game formats fulfilled the regulation requirements of space and number of players per team, whilst partial representativeness was attributed to the research that studied formats in which only space or number of players corresponded to the competition format (Table 2).

2.2. Collective variables

Following a proposal similar to that of Rico et al. (2020a), the collective variables were placed into two big groups, 1) line variables and 2) area variables (individual or collective).

The first, the line representative variables (Figure 1a), integrate all the variables made up from the joining of two points via a line, whether to trace the distance between two players (distance between dyads, length, width and opponent proximity index), the distance between two calculated middle points (distance between centroids) or the distance from one calculated middle point in relation to a physical point (centroid-own goal distances, centroid-centre or the field distance) or to a set of players (Stretch Index). Meanwhile, the variables relative to area (Figure 1b) are shaped by the polygon formed by the external players in a team (intra-team surface area) or both (inter-team surface area), and variables that indicate the surface or mean area covered by each player (Spatial Exploration Index).

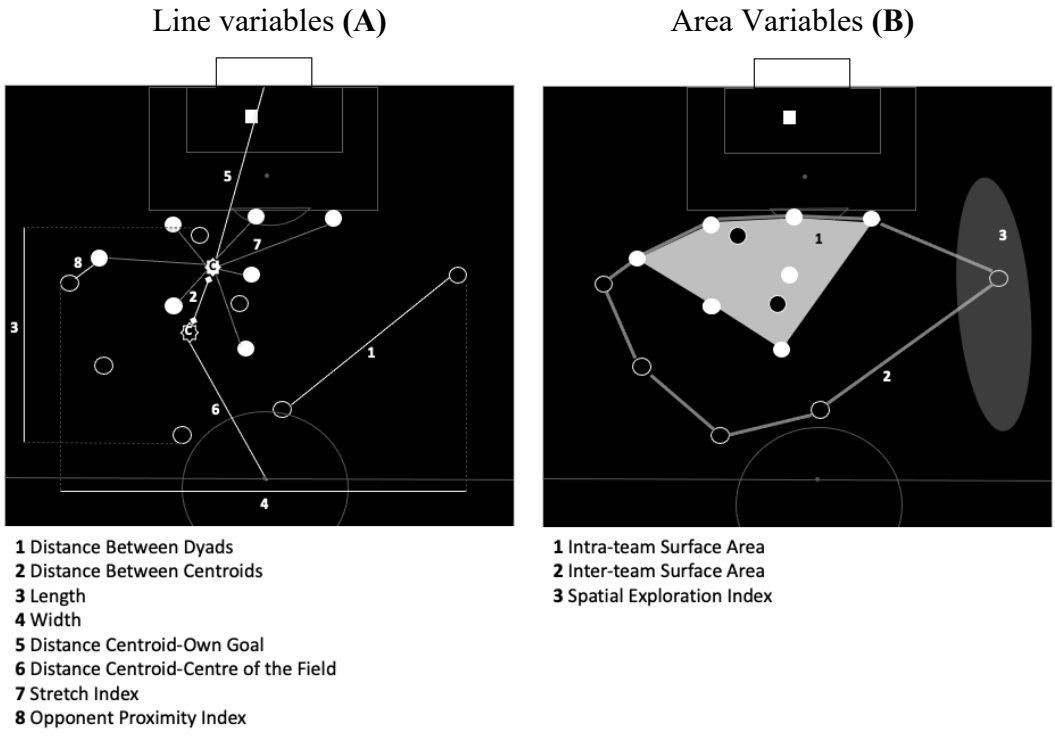

Figure 1. Graphic representation of line (a) and area (b) variables.

As a complementary measure, in order to understand the dynamics used by players to deploy these collective variables, represented in lines or areas, or the degree of disorder generated in the representative task, also included in the review were: the entropies, synchrony and coefficients of variation obtained in the studies.

2.3. Search, inclusion and exclusion criteria for the articles

The following systematic review process was subjected to the criteria set out in the adaptation of the PRISMA statement for sports science (Rico, Pino-Ortega, Clemente & Los Arcos, 2021b). The process of study identification was carried out in three meta-search engines: Pubmed, Web of Science and Sport Discus. The search was done using Boolean operators (AND, OR and NOT, accordingly) and the following key words which make up the four pillars of the review: (1) *sport*: soccer OR football NOT (futsal, rugby); AND (2) *collective behaviour*: tactical analysis OR tactical behaviour OR tactical variables OR collective behaviours OR collective variables OR collective synchrony OR team dynamics OR team behaviour OR dynamical systems OR interpersonal coordination OR spatiotemporal OR voronoi OR synchronization OR movement variability OR positional variables OR exploratory behaviour; AND (3) positional data: positional data OR computational tracking OR global positioning system OR GPS OR local positioning system OR LPS OR video tracking NOT observational; AND (4) *age-group*: youth OR young OR age-related OR adolescence NOT (professional).

The established inclusion criteria were: 1) experimental or intervention articles, in Spanish or English, 2) indexed in the *Journal Citation Report* (JCR), 3) in the publication period 2012-2021 (latest review dated 27/9/2021), 4) articles that compare different age groups, and 5) that include total or partial representative proposals. Furthermore, inclusive bias characteristics were established: male and female gender.

The exclusion criteria were: 1) review or opinion articles, 2) articles that use only observational methodology, 3) articles that use a pre-post study design, 4) players above the under-20 age group, 5) articles that didn't use different ages or levels of competence as an independent variable, distinguishing the results according to the gender of the participants, and 6) articles that, despite comparing collective behaviour in formative age groups did not fulfil the requirements of total or partial representativeness. This process is shown in the flow chart (Figure 2).

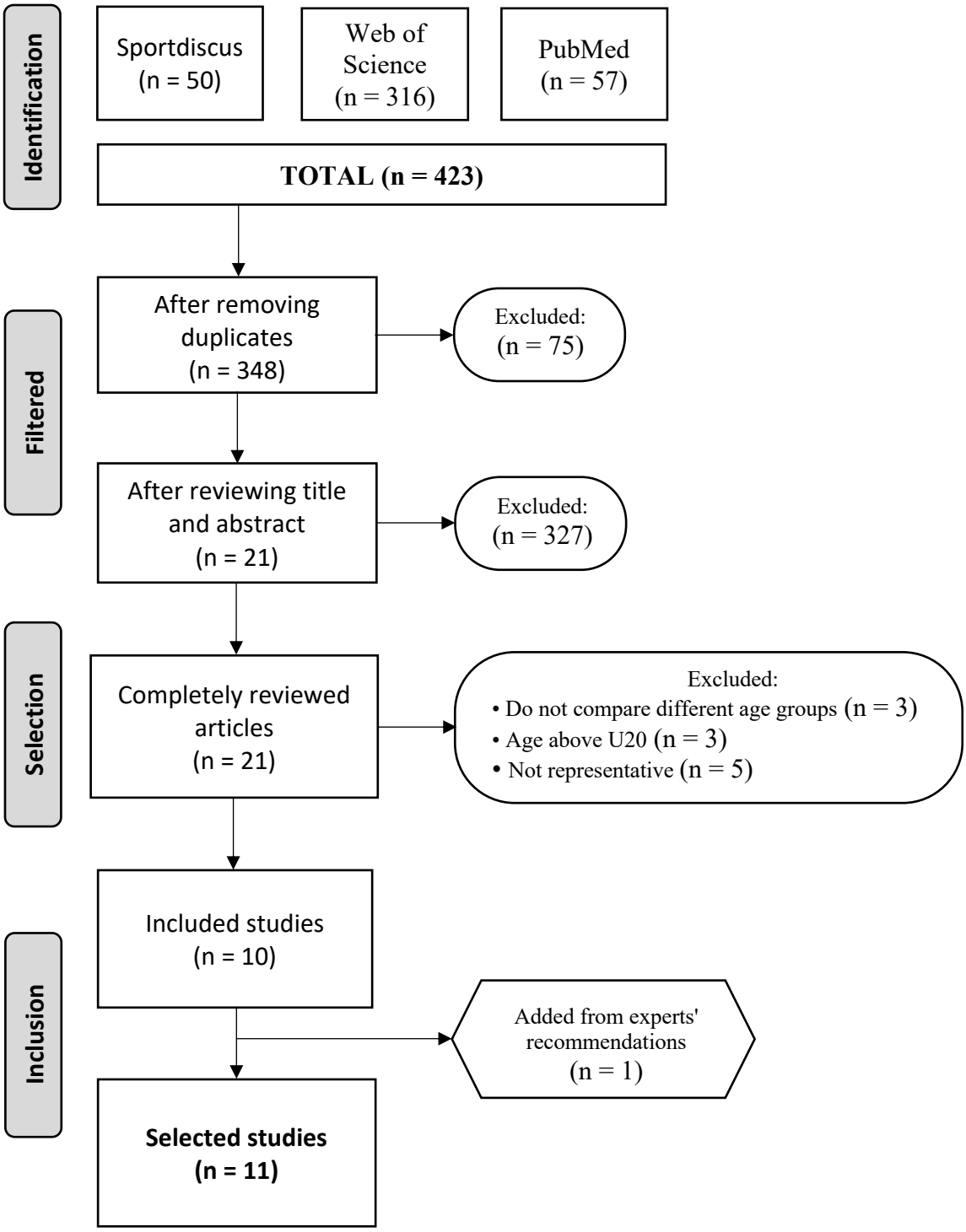

Figure 2. Flow chart of the identification process, filtered, selection and inclusion of studies.

2.4. Article selection

The extraction of information from the different articles for their selection was carried out by the two authors, S.N. and J.C., obtaining a Cohen's Kappa coefficient of 0.98. When in doubt, the two observers reached a consensus on its inclusion and, when

there was disagreement, a third author (I.E.) took part in the decision. The description of the studies was done following ten items (see annex): 1) author/s and year, 2) age group, 3) the game format in which they compete, 4) duel and system used, 5) format (task or match) and absolute and relative game dimensions, 6) prescription, 7) constraints, 8) tracking systems,9) collective variables analysed, and 10) quality score.

2.5. Quality of the studies

As with previous studies (Sarmento, Clemente, Araújo, Davids, McRobert, & Figueiredo, 2018; Low et al., 2019), the quality of the included studies was assessed, following the 16 items as previously proposed. All the items had an exclusive binary response (1=yes, 0=no) except items 6 and 13, in which the option "not applicable" was also admitted. The items were as follows: (1) clarity of the proposal, (2) quality bibliographical support, (3) an appropriate study design, (4) study sample, (5) justification of the sample size, (6) informed consent, (7) measurement reliability, (8) measurement validity, (9) detailed description of the method used, (10) results report, (11) analysis methods, (12) practical importance described, (13) makes reference to retirements (if there were any), (14) well drawn up conclusions, (15) practical applications, and (16) study limitations recognised. The sum total of the 16 items produces a result (Q-score) that allows us to assess the methodological quality of the studies using the following scale: (1) low methodological quality = result <50%; (2) good methodological quality = result >50% and <75%; and (3) excellent methodological quality = result >75%.

3. Results

Eleven studies were selected for inclusion in the review, the methodological characteristics of which are shown in Table 2 (see annex), where screenings are presented according to the degree of representativeness (total or partial). Table 3 (see annex), compiles the main results of those studies with totally representative characteristics. The results cover the period between 2012 (first study that deals with the proposed subject matter, as far as records exist) and the present (27/9/2021). Within this range, there is an incremental tendency in the number of publications, there being a higher number of the most recent, which indicates a growing interest in the study of the proposed subject matter. It has been over the last few years particularly (from 2017 onwards) that representative proposals have been most dealt with. No results were obtained from the proposed criteria for the female gender. The behavioural 'route' obtained from these

results was expressed graphically in Figure 3 (collective variables) and Figure 4 (entropies, coefficients of variation and synchronicity relative to the collective variables).

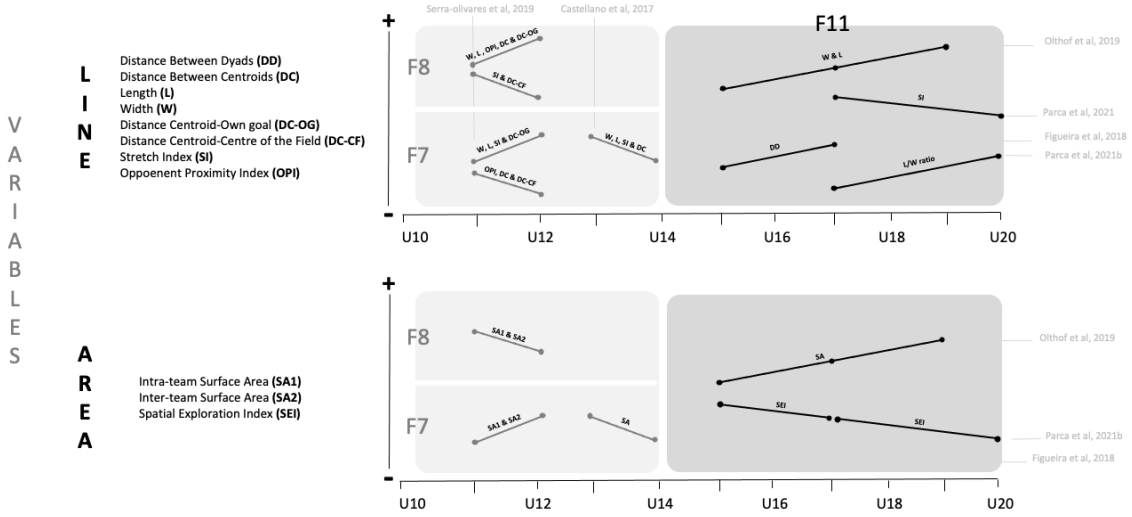

Figure 3. Graphical representation of the tendencies obtained by the different authors in collective variables and representative tasks.

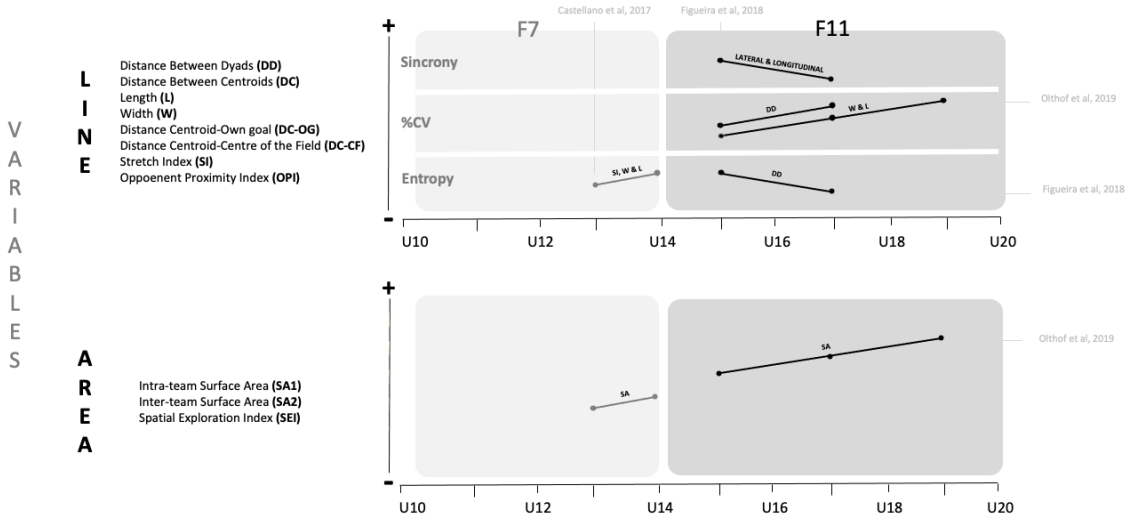

Figure 4. Graphical representation of the tendencies obtained by the different authors in synchrony, variability and (in)stability of collective variables and representative tasks.

4. Discussion

The purpose of this systematic review was to describe, from positional data, the collective behaviour of young football players confined exclusively to competition formats or representative tasks. Only six of the eleven studies selected used representative tasks in dimensions, number of players per team and regulations used, in which age categories from U11 to U20 were analysed, underlining that all the studies covered only two or three levels of age or competence. Despite this limitation, the main conclusion of the study is that an evolution in collective behaviour could be established with a non-

lineal tendency among age groups. These results highlight the need to continue investigating, attempting to cover longitudinal research with the aim of discovering the collective behaviour 'route' that a novice player travels before becoming an expert.

Regarding collective line variables (e.g., width, length, distance between dyads, distance between centroids, distance centroid-own goal, distance centroid-centre of the field, stretch index & opponent proximity index), it is worth mentioning that there are differences depending on age. In a-7 football, Serra-Olivares et al. (2019) studied exclusively the moment of ball possession and observed that higher level players (e.g., U12>U11) tended to place themselves more widely, longer, further away from their own goal and centre of mass, and, on average put more distance between themselves and their nearest opponent. By contrast, in the higher age group they reduced the values of distance between centroids, and distance from the centroid to the centre of the field, i.e., the teams were mutually closer, with more play in midfield, represented by a placement nearer to the centre zone of the field of play. However, Castellano et al. (2017), also in a-7 football, in a higher age group (U13>U14) described a decrease in the values of the variables length, width and distance between centroids. Serra-Olivares et al. (2019), a-8 football, with an equal absolute space but a reduced relative space, observed the same tendency as when they studied a-7 football, except for the variable distance between centroids, stretch index and opponent proximity index, describing an opposite tendency (U11>U12). In a-11 football, Olthof et al. (2019) described that the teams with older players positioned themselves wider (width) and deeper (length), U19>U17>U15. This same tendency was seen in the distance between teammates (U17>U15), studied by Figueira, Gonçalves, Masiulis, & Sampaio (2018). Just like Serra-Olivares in a-8 football, Parca, Rochael, Francklin, Rodrigues da Silva, & Pereira de Andrade (2021b) observed in a-11 football that older players positioned themselves closer to their own centroid, thus forming a more compact block which is also more stable, represented in the lower variability (%CV) of the mean distance of the players in relation to their centroid (U15>U17).

The variability associated with line variables provided an increase in tandem with age. In a-7 football, greater competence implied a more variable team width and length (e.g., entropy U14>U13) (Castellano et al., 2017). Olthof et al. (2019) described the same results, this time through the coefficient of variation (%CV) (U19>U17>U15). Only Figueria et al. (2018) found an inverse tendency in the entropy of the distance between teammates variable (U15>U17) which, at the same time, didn't coincide with the value of %CV (U17>U15).

In relation to the area variables (Inter and Intra-team Surface Area and Spatial Exploration Index), Serra-Olivares et al. (2019) observed in a-7 football that older and more competent players covered a greater surface area, both intra and inter-team. This tendency showed up as inverse when the eight-a-side format was studied (a-7 football) and coincided with that reported by Castellano et al. (2017) in a-7 football. However, in a-11 football, Olthof et al. (2019) described a tendency in which teams with more competent players tended to cover a large surface area (U19>U17>U15). In terms of the variable Spatial Exploration Index, both Figueira et al. (2018) and Parca et al. (2021b), coincided in highlighting a decreasing tendency in its values as age increased (U15>U17>U20). These results may indicate that a higher degree of competence facilitated the players performance in a smaller sphere of action.

As regards the diachronic analysis of the variables that represent an area, it is worth pointing out that variability tends to be higher as the age of the players increases (Castellano et al., 2019), both in entropy (U14>U13) and in %CV (U19>U17>U15) (Olthof et al., 2019). This appears to suggest that more experienced players have a greater capacity for team contraction and expansion, trying to self-organise and co-adapt in relation to the opposing team, in an attempt to complete the motor task efficiently.

This study is not without limitations, among which it is worth mentioning, above all, the reach of the described results. As we have attempted to express throughout this paper, we accept that the evolution in the collective behaviour that a player goes through during the formative period does not conform to a lineal pattern; however, we believe it is interesting to address a possible initial picture of this progression. We are aware that the incorporated studies describe the behaviour of different clubs and/or countries (e.g., with particular experience in the activity), and so the levels of competence may be unequal, despite belonging to the same chronological age range. Furthermore, none of the studies deals longitudinally with the description of the evolution of collective behaviour as the same players progress through the different categories. Among the studies that fulfilled the inclusion criteria, three age groups at best are analysed. The incorporation of eleven studies in itself supposes a limitation. Therefore, this suggests the need to undertake more studies, capable of longitudinally analysing the progress of football competence among different age groups. This fact would reveal the 'route' of the progress in the completion of representative tasks, within similar competence contexts (e.g., teams within the same club). Finally, it would be interesting in future studies to contextualise positional data, integrating other dimensions (e.g., tactical behaviour, conditional or

emotional aspects…), which would enable a refining of the knowledge concerning the collective dynamic that young, inexperienced players display throughout the formative stages until they reach the highest level of football competence.

5. Conclusions

The main conclusion of the study is that collective behaviour varied according to age (and therefore the players' level of competence). The playing style of players with a higher level of competence whose performance is more efficient, tends to be typically wider, which involves placing themselves closer to their opponents and doing so with a higher functional variability. However, more studies are needed that compare the collective behaviour of various age groups higher up on the formative ladder, with analysis in representative game proposals in order to give consistency to these currently scarce results.

6. Practical applications

The applications that can be drawn from this study can be summarised in the following points:

- The collective behaviour that emerges in the motor completion of a task does not only depend on the player's age or level of competence, but also on the kind of task where it takes place, so any interpretation of the evolution of collective behaviour should assess the degree of representativeness of these.
- To have information that connects the characteristics of collective behaviour with a specific level of competence would allow us to make a more reliable diagnosis from which to propose a progression of training content.
- To increase knowledge of the collective behaviour route in formative football would enable a refining in the design of tasks that provoke or favour an optimisation in players' football competence.

Acknowledgments

The authors gratefully acknowledge the support of a Spanish government subproject *Mixed method approach on performance analysis (in training and competition) in elite and academy sport* [PGC2018-098742-B-C33] (Ministerio de Ciencia, Innovación y Universidades, Programa Estatal de Generación de Conocimiento y Fortalecimiento Científico y Tecnológico del Sistema I+D+i), that is part of the coordinated project *New approach of research in physical activity and sport from mixed methods perspective* (NARPAS_MM) [SPGC201800X098742CV0].

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Table 2. Studies with total (dark grey) or partial (light grey) representative features listed in chronological order with the characteristics analysed.

Authors	Age-group	Format	Duel & system	LxW & RS	Task	Prescription	Constraints	Collective behaviours [statistic]	Q-score (%)
Folgado et al. (2012)	U9 U11 U13	F5 F7	4 vs 4 U9 U10 U11 5 vs 5 **U9** U10 U11	30x20 100m² **U9** U10 U11 30x20 75m² **U9** U10 U11	Task	2 matches of 6' each age group in each format	Number of players and Level of competence associated with age	• Length x Width ratio • Centroid distance	87
Castellano et al. (2017)	U13 U14	F7	7 vs 7 gk-3-2-1 **U13 U14**	60x40m 200m² **U13 U14** 50x40m 167m² **U13 U14** 40x40m 133m² **U13 U14** 30x40m 100m² U13 U14	Task	4x7´(4´rec)	Level of competence associated with age and field length variation	• Inter/intra team Width (W) • Inter/intra team Length (L) • Inter/intra team Stretch Index (SI) • Inter/intra team Surface Area (SA) • Distance between centroids • W, L, SI & CH inter team [ApEn]	93
Gonçalves et al. (2017)	U15 U17	F11	11 vs 11 gk-4-3-3 **U15 U17**	106x65m 344m² **U15 U17**	Task	2x25´ (10´rec)	Level of competence associated with age and performance (high and low)	Correlates Networks (Closeness & betweenness centrality) with collective variables: • Distance between all dyads • Distance between dyads [ApEn] • Voronoi • Average area covered by each player [CV]	80

Table 2. (continued 2/4)

Authors	Age-group	Format	Duel & system	LxW & RS	Task	Prescription	Constraints	Collective behaviours [statistic]	Q-score (%)
Olthof et al. (2017)	U13 U15 U17 U19	F7 F11 F11 F11	5 vs 5 gk-1-2-1 U13 U15 U17 U19	68x47m 400m² U13 **U15** **U17** **U19** 40x30m 150m² **U13** U15 U17 U19	Task	5x4´(4´rec)	Level of competence associated with age and Individual Space for Interaction	• Inter-team distances & variability [%CV] • Length per Width (LxW) ratio & variability [%CV] • Surface Area (SA) & variability [%CV] • Longitudinal/lateral Stretch Index (SI) & variability [%CV] • Goalkeeper-defender distance (Gk-D) & variability [%CV]	93
Figueira et al. (2018)	U15 U17	F11 F11	11 vs 11 gk-4-3-3 **U15** **U17**	105x70 367m² **U15** **U17**	Match	2x25´(10´rec)	Mixed vs. homogeneous levels of competence and period of play (1st vs. 2nd part)	• Distance between players, variability [CV] & regularity [ApEn] • Near-in-phase synchronization longitudinal and lateral [% of time] • Spatial exploration Index	80
Serra-Olivares et al. (2019)	U11 U12	F7-8 F7-8	7 vs 7 gk-2-3-1 **U11** **U12** 8 vs 8 Gk-3-3-1 **U11** **U12**	64x44m 235m² **U11** **U12** 64x44m 201m² **U11** **U12**	Match	11 matches of 30´	Game format´s (F7/F8) player´s level (local vs regional) & Age group (U11/U12)	<u>Variables for team with ball possession:</u> • Surface Area inter/intra team • Movement freedom • Distance between centroids • Distance between centroid of a team (in ball possession) and the centre of the field • Own goal distance (From centre of team) • Opposing goal distance (from team's centroid) • Stretch Index • Opponent proximity Index • Width • Length • Team expansion (team area evolution during offensive situations)	81

Table 2. (continued 3/4)

Authors	Age-group	Format	Duel & system	LxW & RS	Task	Prescription	Constraints	Collective behaviours [statistic]	Q-score (%)
Olthof et al. (2019)	U13 U15 U17 U19	F7-8 F11 F11 F11	5 vs 5 gk-2-1-1 U13 U15 U17 U19 7 vs 7 gk-2-3-1 **U13** U15 U17 U19 9 vs 9 gk-3-3-2 **U13** U15 U17 U19 11 vs 11 U13 **U15** **U17** **U19**	68x47 400m^2 U13 **U15** **U17** **U19** 80x56 373m^2 U13 **U15** **U17** **U19** 91x63 358m^2 U13 **U15** **U17** **U19** 105x68 357m^2 U13 **U15** **U17** **U19**	F5, F7 & F9 = Tasks F11 = Match	F5=4x5´(4´rec) F7=5x5´(4´) F9=3x10´(4´)	Level of competence associated with age and number of players per team.	• Interpersonal distance [%CV] • Surface area (m) [%CV] • Length [%CV] • Width [%CV]	87
Brito et al. (2020)	U8 U10 U12 U14	F5 F7-8 F7-8 F7-8	5 vs 5 gk-1-2-1 **U8** U10 U12 U14 7 vs 7 gk-2-3-1 U8 **U10** **U12** **U14** 9 vs 9 gk-3-4-1 U8 **U10** **U12** **U14** 11 vs 11 gk-4-3-3 U8 U10 U12 U14	68x47 m 400 m^2 U8 U10 U12 U14 80x56 m 373 m^2 U8 U10 U12 U14 91x63 m 358 m^2 U8 U10 U12 U14 100x64 m 320 m^2 U8 U10 U12 U14	Task-Match	48 matches 30´no recovery	Level of competence associated with age and game format.	• Spatial distribution [Shannon Entropy] • Relative positioning [Ellipse] • Covered areas	75

Table 2. (continued 4/4)

Authors	Age-group	Format	players per team & system of play	LxW & RS	Task	Prescription	Constraints	Collective behaviours [statistic]	Q-score (%)
Coutinho et al. (2021)	U9 U11 U13 U15 U17 U19	F5 F7-8 F7-8 F11 F11 F11	5 vs 5 gk-1-2-1 **U9** U11 U13 U15 U17 U19	40x30m 150 m^2 U9 **U11** **U13** U15 U17 U19	Task	3x4´ (2´ rec)	Number of touches allowed: 1) Free 2) 2 touches 3) 1 touch	• Distance to the team centroid (m) • Distance to opposing team centroid (m) • Distance to nearest teammate (m) • Distance to the nearest opponent (m) • Length/Width ratio (m) • Spatial Exploration Index (m) • Longitudinal synchronization (%) • Lateral synchronization (%)	87
Parca et al. (2021)	U13 U14	F7-8 F7-8	3 vs 3 U13 U14 3 vs 3 +1 U13 U14 3 +1 vs 3 +1 U13 U14	36x27 m 162 m^2 **U13** **U14** 36x27 m 139 m^2 **U13** **U14** 36x27 m 121 m^2 U13 U14	Task	4x4´ (4´ rec)	Floaters and rol: 1) Floater played for both teams, supporting team in attack 2) Each team have one floater (who have to leave the field when his team lose the ball) 3) No floaters	• Length • Width • Length/Width ratio • Stretching Index • SEI	87
Parca et al. (2021b)	U17 U20	F11	11 vs 11 **U17** **U20**	105x68 m 357 m^2 **U17** **U20**	Match	2x45´(15´rec)	Match period: 1st vs 2nd half	• Width • Length • Length/Width ratio • Stretch Index • Spatial Exploration Index	87

Note: Light grey shading in the age group indicates no representativeness in either players per team or Relative Space (RS). Dark grey shading indicates representativeness for that age group. In the Authors section, studies shaded in dark grey indicate full representativeness: all age groups studied played in EII and number of players per team according to their regulations. Those shaded in light grey indicate partial representativeness: at least one age group did not meet the criteria of representativeness in IBD and/or number of players per team.

Table 3. Studies with fully representative features and main results obtained in each of them for collective variables.

Author	Age	-a side			Dimensions (RS)	Collective variables										
		7	8	11		L/W ratio	Width	Length	Centroid distances	Distance Centroid-centre of the field	Distance Centroid-own goal	Stretch Index	Surface Area	Dyads distance	Opponent proximity index	SEI
Serra Olivares et al. (2019)	U11 U12				64x44 (234m2) (201m2)		U12>U11 U12>U11	U12>U11 U12>U11	U11>U12 U12>U11	U11>U12 U11>U12	U12>U11 U12>U11	U12>U11 U11>U12	• Intra U12>U11 • Inter U12>U11 • Inter U11>U12 • Intra U11>U12		U12>U11 U12<U11	
Castellano et al. (2017)	U13 U14				40x40 (133m2)		Intra-team U14>U13 (Es=Trivial) Inter-team U14>U13 (Es=Trivial)	• Intra-team U13U14 (Es=Moderate) • Inter-team U13>U14 (Es=Moderate)	U13>U14 (Es=Trivial)			• Intra-team U13U14 (Es=) • Inter-team U13>U14 (Es=Moderate)	• Intra-team U13>U14 (Es=Moderate) • Inter-team U13>U14 (Es=Moderate)			
					50x40 (167m2)		• Intra-team U13>U14 (Es=Trivial) • Inter-team U13>U14 (Es=Trivial)	• Intra-team U13>U14 (Es=Moderate) • Inter-team U13>U14 (Es=Moderate)	U13>U14 (Es=Trivial)			• Intra-team U13U14 (Es=) • Inter-team U13>U14 (Es=Moderate)	• Intra-team U13>U14 (Es=Moderate) • Inter-team U13>U14 (Es=Moderate)			
					60x40 (200m2)		• Intra-team U13>U14 (Es=Trivial) • Inter-team U13>U14 (Es=Trivial)	• Intra-team U13U14 (Es=) • Inter-team U13>U14* (Es=**Large**)	U13>U14 (Es=Trivial)			• Intra-team U13U14 (Es=) • Inter-team U13>U14 (Es=Moderate)	• Intra-team U13>U14 (Es=Moderate) • Inter-team U13>U14 (Es=Moderate)			
Goncalves et al. (2017)	U15 U17				106x65 (345m2)											
Figueira et al. (2018)	U15 U17				105x70 (367m2)									• 1st half U17>U15 • 2nd half U17>U15		• 1st half U15>U17 • 2nd half U17>U15
Olthof et al. (2019)	U15 U17 U19				105x68 (357m2)		U15<U17<U19	U15>U17>U19					U15<U17<U19	U15<U17<U19		
Parca et al. (2021b)	U17 U20				105x68 (357m2)	• 1st half U20>U17* ES=**Medium-large** • 2nd half U20>U17* ES=**Medium-large**	• 1st half U17>U20 ES=Medium • 2nd half U17>U20 ES=Medium	• 1st half U20>U17 ES=Medium • 2nd half U20>U17 ES=Medium				• 1st half U17>U20 S=Small-medium • 2nd half U17>U20 ES=Small-medium				• 1st half U17>U20* ES=**Medium-large** • 2nd half U17>U20 ES=Small-medium

*Significant differences between age groups

Table 4. Studies with fully representative features and the main results obtained in each of them for regularity, variability and synchrony variables.

Author	Age	-a side			Dimensions (RS)	Regularity (Entropies)					Variability (CV)					Synchronies (% time)	
		7	8	11		Surface Area	Width	Length	Stretch Index	Successful passes with intra-team dyads regularity	Distance between dyads	Distance between dyads	Length	Width	Surface Area	In phase longitudinal	In phase lateral
Serra Olivares et al. (2019)	U11 U12				64x44 (234m2) (201m2)												
Castellano et al. (2017)	U13 U14				40x40 (133m2)	Inter-team ApEn U14>U13	Inter-team ApEn U14>U13	Inter-team ApEn U14>U13	Inter-team ApEn U14>U13								
					50x40 (167m2)	Inter-team ApEn U13>U14	Inter-team ApEn U14>U13	Inter-team ApEn U14>U13	Inter-team ApEn U13>U14								
					60x40 (200m2)	Inter-team ApEn U14>U13	Inter-team ApEn U14>U13	Inter-team ApEn U14>U13	Inter-team ApEn U14>U13								
Goncalves et al. (2017)	U15 U17				106x65 (345m2)					U17 =Trivial Negative correlation U15=Moderate Negative correlation							
Figueira et al. (2018)	U15 U17				105x70 (367m2)						ApEn • 1st half U15>U17 • 2nd half U15>U17	• 1st half U17>U15 • 2nd half U17>U15				• 1st half U15>U17 • 2nd half U15>U17	• 1st half U15>U17 • 2nd half U15>U17
Olthof et al. (2019)	U15 U17 U19				105x68 (357m2)								U19>U17>U15	U15>U17>U19	U19>U17>U15		
Parca et al. (2021b)	U17 U20				105x68 (357m2)												