Full Length Article

# Age-related effects of practice experience on collective behaviours of football players in small-sided games

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## ABSTRACT

The purpose of this study was to examine whether offensive and defensive collective behaviours emerging in six-a-side football games (GK+5 vs. 5+GK) varied according to age-related practice experience of young, male players (U16, U17 and U19 yrs). Players' were not instructed to implement specific tactical plans and their movement trajectories (2D analyses) were recorded using 10 GPS units. Four common measures of team dispersion investigated in previous research (*surface area*, *stretch index*, *length* and *width* of a team) were used to analyse team performance behaviours. After recording these collective variables, we used sample entropy (SampEn) and cross-sample entropy (Cross-SampEn) measures to assess the regularity and synchronization of participant actions in teams. Results demonstrated clear age-related variations in effects on the collective performance measures analysed. In attacking phases, older and more experienced players occupied a greater *surface area* and displayed higher values of *team width and stretch index*. In defensive phases, significant differences were observed in *team length* and *stretch index*. Cross-SampEn analysis demonstrated a greater synchronization between offensive and defensive *surface areas and team width* in older age groups (U17 and U19 yrs). Data suggest how coaches can manipulate practice task constraints to enhance development of team tactical performance behaviours in developing footballers between 16 and 19 yrs of age.

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## 1. Introduction

Use of small-sided games and conditioned (SSGs) is a common approach in training players of different ages and skill levels in team sports such as association football (see Duarte et al., 2010; Hill-Haas, Coutts, Rowsell, & Dawson, 2008; Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011). These popular training practice tasks offer many advantages in acquiring relevant skills and can provide physiological and tactical adaptations in team games players leading to performance development (Frencken, Lemmink, Delleman, & Visscher, 2011; Hill-Haas et al., 2011; Sampaio, Lago, Gonçalves, Maçãs, & Leite, 2013). The majority of studies on this research topic have tended to focus on analysing physiological outcomes of SSG performance (e.g., Owen, Twist, & Ford, 2004; Rampinini et al., 2007), especially physical and motor responses (e.g., Casamichana & Castellano, 2010; Hill-Haas, Dawson, Coutts, & Rowsell, 2009). Although fewer studies have examined technical and tactical performance of players (e.g., Hill-Haas et al., 2009; Dellal, Hill-Haas, Lago-Penas, & Chamari, 2011), in

recent years, the study of team tactical behaviours in SSGs has focused on the theoretically-framed dynamical information related to player interactions and on-field emergent coordination tendencies (Folgado, Lemmink, Frencken, & Sampaio, 2014; Frencken et al., 2011; Olthof, Frencken, & Lemmink, 2015; Sampaio & Maçãs, 2012; Sampaio et al., 2013). Player behaviours in attack and defence can be highly variable and dependent on continuous, emergent interactions between team-mates and opponents. Indicators widely used in notational-based performance analysis have some limitations in adequately capturing on-field team coordination tendencies, because they are dominated by *descriptions* of team performance, typically founded on frequency analyses of individual performance measures (Davids, Araújo, & Shuttleworth, 2005; Folgado et al., 2014; Travassos, Davids, Araújo, & Esteves, 2013; Vilar, Araújo, Davids, & Button, 2012).

Driven by a strong theoretical rationale to analyse interactive behaviours of athletes during competitive performance, some studies have investigated various team dispersion variables, such as: *surface area* (Duarte, Araújo, Freire, et al., 2012; Frencken et al., 2011), *stretch index* (Bourbousson, Sève, & McGarry, 2010; Duarte, Araújo, Folgado, et al., 2012; Duarte, Araújo, Freire, et al., 2012; Olthof et al., 2015), *team width and length* (Duarte, Araújo, Folgado, et al., 2012; Duarte, Araújo, Freire, et al., 2012; Fradua et al., 2013; Sampaio & Maçãs, 2012), *length per width ratio (lpwratio)* (Folgado et al., 2014; Olthof et al., 2015) and distances between *each team's centroids* (Duarte, Araújo, Folgado, et al., 2012; Duarte, Araújo, Freire, et al., 2012; Folgado et al., 2014; Sampaio & Maçãs, 2012; Sampaio et al., 2013). These interactive performance variables have been used to capture and synthesize, at a team level, the diversity of player movement trajectories in relation to each other on field during competitive performance. In one exploratory study, Frencken and Lemmink (2008) analysed the collective behaviours of two competing football teams during five-a-side games (GK+4 vs. 4+GK), using *centroid* and *surface area* measures. They confirmed the usefulness of both variables for describing the ebb and flow of competitive games, players' interpersonal coordination tendencies, and the emergence of goal-scoring opportunities. Later, Frencken et al. (2011) identified a crossing of centroid positions in attacking teams, compared to those of defending teams in a forward-backward direction in 53% of the goals scored during SSGs. In similar vein, Duarte, Araújo, Folgado, et al. (2012) and Duarte, Araújo, Freire, et al. (2012) examined the emergent patterns of coordination in four-a-side games (GK+3 vs. 3+GK) near the scoring zone. Also, using *centroid* and *surface area* measures, they reported how both teams moved forward and backward in a highly synchronized spatiotemporal manner. This observation reflected the coordinated activity of attackers and defenders near the goal area. Findings also emphasized that major transitions in collective behaviours of each team emerged just before an assisted pass leading to a goal-scoring attempt was made (i.e., leading to a loss of stability in the state of a four-a-side game).

Previous research has confirmed that, from a constraints-led perspective, SSG formatting (pitch size, number of players and rule modifications) has implications for the emergence of individual and collective actions performed by players (Almeida, Ferreira, & Volossovitch, 2013; Duarte et al., 2010; Ford & Williams, 2012). Nevertheless, it remains to be clarified how players of different ages, differing in physical and psychological capacities, as well as levels of playing experience, perform under different practice task constraints. Are their performances similar, or does maturation and development, as well as greater learning and playing experience, shape the way that older and younger developing footballers coordinate their interpersonal interactions with other players over space and time? If not, how can observed differences be explained in terms of the adaptive behaviours of players? Which collective variables might be expected to change between the key ages of 16–19 yrs in the so-called 'investment' period of performance development (Coté, Baker, & Abernethy, 2007), and which might not? This information is needed so that performance development programmes can be designed on the basis of empirical understanding of emergence of team tactical behaviours in different age groups.

To the best of our knowledge, only two studies have analysed possible age-related differences in team dispersion behaviours in young footballers (Folgado et al., 2014; Olthof et al., 2015). Folgado et al. (2014) compared the performance of three different age groups (under-9, under-11 and under-13 yrs) in two SSG formats (GK+3 vs. 3+GK and GK+4 vs. 4+GK), studying the collective variables of *lpwratio* and *team centroid distance*. Data revealed that the distribution of younger players on field was characterized by a higher ratio of length by width, as well as by a reduced distance between the geometric centers of the teams. It is also worth noting that players of different ages responded in different ways to the changes in SSG format. Tactical behaviours of older football players (U17 and U19) were analysed in five-a-side games (GK+4 vs. 4+GK) by Olthof et al. (2015). The U19 players showed wider field occupation reflected by a larger lateral stretch index and smaller length by width ratio than the U17 age group.

The existence of only one study that has analysed team tactical behaviours of footballers over 16 yrs of age reveals a scarcity of empirical evidence about these collective performance aspects in players approaching the final stage of development, during the investment years (Coté et al., 2007). Since this phase of performance development is critical for a successful transition to a professional career in a team sport like football, a detailed understanding of team behaviours evolving at these age levels could be fundamental to implement an evidence-based practice approach to the formatting of SSGs. For example, the data could provide some evidence on how the age-based maturation of players might shape their propensity to display team tactical behaviours in different SSG formats. This information would inform interpretation of performance evaluations in athlete development programmes in team sports.

The aim of the present study was to examine how team dispersion behaviours evolved across three different age groups (U16, U17 and U19 yrs) in the investment years, during attacking and defending phases of game play. More specifically, our approach sought to analyse potential age-related effects on the regularity and synchronization of team's behaviours (predicated on differences in maturation and development), as well as learning and competitive experience during six-a-side games.