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Full Length Article

A social network analysis of the goal scoring passing networks of the 2016 European Football Championships

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ABSTRACT

In the current study, social network analysis (SNA) and notational analysis (NA) methods were applied to examine the goal scoring passing networks (GSPN) for all goals scored at the 2016 European Football Championships. The aim of the study was to determine the GSPN characteristics for the overall tournament, between the group and knock out stages, and for the successful and unsuccessful teams. The study also used degree centrality (DC) metrics as a novel method to determine the relative contributions of the pitch locations involved in the GSPN. To determine changes in GSPN characteristics as a function of changing score line, the analysis considered the match status of the game when goals were scored. There were significant differences for SNA metrics as a function of match status, and for the DC metrics in the comparison of the different pitch locations. There were no differences in the SNA metrics for the GSPN between teams in the group and knock out stages, or between the successful and unsuccessful teams. The results indicate that the GSPN had low values for network density, cohesion, connections, and duration. The networks were direct in terms of pitch zones utilised, where 85% of the GSPN included passes that were played within zones or progressed through the zones towards the goal. SNA and NA metrics were significantly different as a function of changing match status. The current study adds to the previous research on goal scoring in football, and demonstrates a novel method to determine the prominent pitch zones involved in the GSPN. These results have implications for match analysis and the coaching process.

1. Background

Within the past decade, Social Network Analysis (SNA) has emerged as a method for analysing the intra-team passing networks in relevant sports (Clemente, Martins, Kalamaras, Wong, & Mendes, 2015; Clemente, Martins, Wong, Kalamaras, & Mendes, 2015; McLean, Salmon, Gorman, Naughton, & Solomon, 2017; Passos et al., 2011). SNA is used to investigate intra and inter-group relationships, in terms of how the entities within groups interact with each other (Lusher, Robins, & Kremer, 2010). When using SNA for football passing networks, the players in the network represent the entities in the group, and the passes are the connections linking the entities (Clemente, Martins, Kalamaras, et al., 2015; Clemente, Martins, Wong, et al., 2015; Passos et al., 2011; Ribeiro, Silva, Duarte, Davids, & Garganta, 2017). Using SNA for analysing passing networks has advantages over previously used methods such as passing frequencies and percentages (Ribeiro et al., 2017). SNA describes a team's interactive behaviour, rather than using

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reductionist analyses of individuals within a team (Clemente, Martins, Kalamaras, et al., 2015; Clemente, Martins, Wong, et al., 2015), thereby, providing a more comprehensive and detailed analysis. Whole of network, and nodal metrics are used to describe the team's interactive behaviours via connectivity (how connected the team is by passes) and cohesive metrics (reciprocal passes within the team), as well as the influential entities (players) within the team (relative to the entire team) (Clemente, Martins, Wong, et al., 2015; Lusher et al., 2010; McLean, Salmon, Gorman, Naughton, et al., 2017). Numerous SNA metrics exist, and different SNA metrics can be used to investigate different variables of interest (Lusher et al., 2010). Relevant to passing networks in football, the SNA metric of density is commonly used to analyse a team's connectivity, and degree centrality (DC) and sociometric status (SMS) metrics have been used to determine the most influential entities (players) within a team (Clemente, Martins, Wong, et al., 2015; McLean, Salmon, Gorman, Naughton, et al., 2017).

SNA of team passing has been used in a wide range of different contexts in football. These include, a large sample of English Premier League (EPL) matches (Grund, 2012), single match case studies (Trequattrini, Lombardi, & Battista, 2015; Yamamoto & Yokoyama, 2011), entire tournaments (Clemente, Martins, Kalamaras, et al., 2015; Clemente, Martins, Wong, et al., 2015), youth football teams (Ribeiro et al., 2017), individual teams within a tournament (Cotta, Mora, Merelo, & Merelo-Molina, 2013), determining the influential playing positions within a team (Clemente, Martins, Wong, et al., 2015), and team passing networks leading to goals scored during continental tournaments (McLean, Salmon, Gorman, Naughton, et al., 2017). For overall match passing networks, these studies have shown that successful compared to unsuccessful teams have greater connectivity, suggesting that cooperative and coordinated playing styles are related to better performance (Clemente, Martins, Kalamaras, et al., 2015; Clemente, Martins, Wong, et al., 2015; Grund, 2012).

Whilst the application of SNA to passing networks has provided information regarding the connectivity of overall team passing networks, there are other potential applications. The use of SNA as a method to analyse specifically how goals are scored in terms of the passing networks that create the goal, provides additional information that will aid coaches, match analysts, and researchers. Two areas of potential use include examining the goals scoring passing networks (GSPN) in conjunction with contextual variables such as match status (winning, drawing, losing) and the pitch locations. For example, an important line of inquiry is the extent to which passing network structure changes when losing compared to winning (i.e. do teams change their approach to scoring when losing compared to when winning?). It has previously been shown that match status influences team strategy and behaviour (Taylor, Mellalieu, James, & Shearer, 2008). Research has indicated that losing teams, compared to wining and drawing teams, have greater ball possession (Lago, 2009; Lago & Martín, 2007; Lago-Peñas & Dellal, 2010), and make more penalty area entries (Ruiz-Ruiz, Fradua, Fernández-GarcÍa, & Zubillaga, 2013). As such, it is likely that this increased attacking emphasis would result in differences in network characteristics across different score lines. SNA is an appropriate method to detect such differences, and would inform coaches of whether winning, losing or drawing influences the characteristics of teams passing networks related to goals.

A further criticism of PA in football is the lack of match context regarding the pitch locations where important actions occur (Mackenzie & Cushion, 2013; McLean, Salmon, Gorman, Read, & Solomon, 2017). Despite the importance of pitch location to coaches (Mackenzie & Cushion, 2013; McLean, Salmon, Gorman, Read, et al., 2017), the current methods used in PA only allow simple descriptions, such as the location of shots, crosses, and tackles (Gómez, Gómez-Lopez, Lago, & Sampaio, 2012), or the percentage of time in possession in specific pitch locations (Lago, 2009; Ridgewell, 2011). An important and often missing component of existing analysis methods is the capacity to track possession through different pitch locations, and to determine the most prominent pitch locations involved within the GSPN. SNA can be used to determine the prominent pitch locations involved in passing networks. The pitch can be divided into zones to represent the nodes, and the passes in, out, and within the zones can be analysed using SNA metrics to determine the most prominent zones. Degree centrality (DC) metrics are used to quantify nodal importance, such as passes into, and out of nodes and have previously been used to analyse prominent players in teams (Clemente, Martins, Wong, et al., 2015). As such DC metrics provides the potential to analyse how passing networks progresses through specific pitch zones by providing quantifiable metrics to determine the most prominent zones involved in GSPN.

The aims of the current study were to use SNA and notational analysis (NA) to analyse the GSPN at the 2016 European Football Championships (EUROs) to determine the overall characteristics of the GSPN. In addition, this study will include analysis of the GSPN as a function of match status, and to compare the GSPN during the group stages and knock out stages, and the successful and unsuccessful teams. The study also explored DC metrics as a method to determine the pitch zones involved in the GSPN. Given that the process of scoring goals is an important indicator of performance (Winter, Rasche, & Pfeiffer, 2017), the current analysis of the GSPN was anticipated to provide information on team passing interactions, and pitch areas involved in the GSPN at the world's second largest football tournament.

2. Methods

2.1. Study design

The current study analysed all 108 goals scored at the 2016 European Football Championships played across France, to determine specific characteristics of the GSPN. All goals were analysed from recorded television footage. Own goals ($n = 8$) were omitted from the analysis, and one other GSPN that could not be determined from the television coverage was also omitted, providing a total of 99 goals for analysis. A combination of SNA and NA were used to determine the characteristics of the GSPN. Comparative analysis was