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Original Article

Technical accuracy it is associated with prominence levels in basketball?

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Abstract:
The aim of this study it was verify the association level between technical accuracy and tactical prominence variables of basketball players from different competitive levels. For such analysis, technical accuracy it was analysed using Team Sports Assessment Procedure and tactical prominence using social network analysis metrics. Forty-two basketball players from four different competitive levels (U14, U16, U18 and amateurs with more than 20 years old) it were observed during three official matches. Correlation tests revealed that %inDegree showed a large positive correlation with efficiency index ($r = 0.665$; $p = 0.001$) and very large positive correlation with volume of play ($r = 0.844$; $p = 0.001$) and performance score ($r = 0.843$; $p = 0.001$). The %outDegree showed very large positive correlation with volume of play ($r = 0.743$; $p = 0.001$), efficiency index ($r = 0.710$; $p = 0.001$) and performance score ($r = 0.776$; $p = 0.001$). This study allowed to identify that technical accuracy has great levels of correlation with tactical prominence, mainly in the case of inDegree centrality.
Key words: graph theory; adjacency matrix; match analysis; basketball; attack; network; metrics.

Introduction

The study of team sports players has mainly focused in the physiological and physical aspects (Filipe M Clemente, Couceiro, Fernando, Mendes, & Figueiredo, 2013). For that reason, the analysis of technical performance and mainly tactical performance lacks for a greater investment in order to bring new advances for the understanding how players behave and if is possible to optimize the collective performance (Vilar, Araújo, Davids, & Bar-Yam, 2013).

In the specific case of basketball, the tactical analysis based on computational methods it is very small (Bourbousson, Sève, & McGarry, 2010; F. M. Clemente, Martins, Kalamaras, & Mendes, 2015). In the case of collective organization it was found that the team tend to spread their field occupation during attacking moments and to contract the inter-teammates distances in defensive moments (Bourbousson et al., 2010). In the case of network analysis it was found that point guard position it was the most prominent player in to receive and in to pass the ball for teammates (F. M. Clemente et al., 2015). In fact, the social network analysis (SNA) applied to this last study allowed to identify that the interaction level in the team it is not homogenous, thus existing some players with greater prominence than others during attacking moments.

In the case of technical analysis based on notational process a relevant study that compared different competitive levels and sex found that men's teams it is discriminated from women's teams by the percentages of blocks, steals and unsuccessful 2-point field goals (Sampaio, Godoy, & Feu, 2004). In the same study, it was found that younger teams were discriminated from senior teams by the percentages of assists and turnovers (Sampaio et al., 2004). In other interesting study conducted in U16 basketball players, it was found that more competitive matches (final score differences below to 9 points) the discriminant variables are the turnovers and the assists (Lorenzo, Gómez, Ortega, Ibáñez, & Sampaio, 2010). In other hand, in balanced matches (final score differences between 10 and 29 points) the discriminate variables are the successful 2-point field goals and defensive rebounds. Finally, in unbalanced matches (final score differences above 30 points) the discriminant variables are the successful 2-point field goals (Lorenzo et al., 2010).

Despite the volume of studies that analysed the technical performance in association with team's performance, no studies have been made based on the interaction between technical performance and tactical prominence in the match. Moreover, few studies have been comparing different competitive levels mainly using technical and tactical analysis. For these reasons, the aim of this study was to analyse the association levels between technical performance and tactical prominence in basketball players from different competitive levels.

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Method

Participants

Forty-two male basketball players (U14 – 13.56 ± 0.4 years old and 3.61 ± 0.9 years of practice; U16 – 15.31 ± 0.8 years old and 4.76 ± 1.1 years of practice; U18 – 17.59 ± 0.7 years old and 6.15 ± 0.6 years of practice; Amateurs with more than 20 years old – 26.67 ± 5.8 years old and 15.94 ± 3.9 years of practice) were observed during three official matches. All participants signed the Free and Clarified Consent Form according to the Declaration of Helsinki for the study in humans.

Sample

Three official matches per competitive level were analysed and codified in this study. For network analysis a volume of 3.120 passes between teammates were recorded and processed. In other hand, 7.965 individual actions were recoded during technical analysis.

Data Collecting

The players were codified based on their tactical positions: Player 1 - Shooting Guard; Player 2 - Point Guard; Player 3 - Small Forward; Player 4 - Power Forward; and Player 5 - Post.

In the case of social network analysis, it was used the pass as linkage indicator between nodes (teammates). It was developed an adjacency matrix per each unit of attack (passing sequence without lose the ball). This study followed similar protocols for social network analysis in football (Filipe Manuel Clemente, Martins, Kalamaras, Wong, & Mendes, 2015). For the case of technical analysis, it was developed a observational system based on the Team Sport Assessment Procedure (TSAP) (Gréhaigne, Godbout, & Bouthier, 1997). The offensive and defensive categories of analysis were recorded based on video-camera observation after match.

Both analyses and observations it were made by the same researcher. The reliability of the data acquisition were tested using a test-retest protocol with 20-day interval for 10% of the full data. The statistical test of Cohen's Kappa revealed a value of 0.91 that it is considered an appropriate margin for these observational procedures (Robinson & O'Donoghue, 2007).

Technical Analysis

Following the procedures of TSAP (Gréhaigne, Richard, & Griffin, 2005), five main indicators per players it were collected: i) conquered balls (CB) – balls recovered from the opponent; ii) received balls (RB) – passes received from teammates; iii) neutral balls (NB) – routine pass without progress in the field; iv) pass (P) – pass to a teammate that contributes to moving forward in the field; and v) shots on goal (SS) – shot to the opponent's goal.

Using these five technical indicators, three levels it were computed:

i) volume of play ($Volume\ of\ Play\ (VP) = CB + RB$);

ii) efficiency index ($Efficiency\ Index\ (EI) = \frac{P + SS}{10 + LB}$); and

iii) performance score ($Performance\ Score\ (PS) = \left(\frac{VP}{2}\right) + (EI \times 10)$).

Network Analysis

Two centrality metrics were used in this study to analyse the prominent levels of players. Both metrics were computed in the software SocNetV (version 1.8.). The SocNetV it is a specific software that it is used to process the network data based on Social Network Analysis (Kalamaras, 2014). The both metrics will be following introduced.

Out-degree Centrality

The centrality level that determines how a player it is important to the passing sequence it is the OutDegree. The algorithm used to measure the %OdC it is (Opsahl, Agneessens, & Skvoretz, 2010):

$$C'^{w}_{(D-out)}(n_i) = \frac{k_i^{w^{out}}}{\sum_{i=1}^{n}\sum_{\substack{j=1 \\ j \neq i}}^{n} a_{ij}}, \quad (1)$$

that is the proportion of weights of nodes that are adjacent to n_i.

In-degree Centrality

The in-degree centrality (IDC) measure the in-degree of each node, which can be denoted by k_i^{in} or $k_i^{w^{in}}$ (Wasserman & Faust, 1994). For the case of standardize the group size n, the %IdC may be computed as follows (Opsahl et al., 2010):

$$P'^{w}{}_{D}(n_i) = \frac{k_i^{w^{in}}}{\sum_{i=1}^{n}\sum_{\substack{j=1 \\ j\neq i}}^{n} a_{ij}} \quad (2)$$

that is the proportion of weights of nodes that are adjacent to n_i.

Statistical Procedures

The relationship between network metrics (%InDegree and %OutDegree) and technical variables (volume of play, efficiency index and performance score) was investigated using Pearson product moment correlation coefficient. Preliminary analysis was performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity (Pallant, 2011). The following scales were used to classify the correlation strength (Hopkins et al., 1996): very small, 0–0.1; small, 0.1–0.3; moderate, 0.3–0.5; large, 0.5–0.7; very large, 0.7–0.9; 0.9–1, nearly perfect; 1, perfect. All statistical analyses were performed using IBM SPSS Statistics (version 22) at a significance level of $p < .05$.

Results

This study analyzed the network centralities and the technical efficacy of U14, U16, U18 and amateurs (more than 20 years old) in three official basketball matches. The descriptive statistics can be verified in the following Table 1.

Table 1. Descriptive statistics (mean and standard deviation) of network performance and technical efficacy per tactical position and competitive level.

	%InDegree		**%OuDegree**		**Volume of Play**		**Efficiency Index**		**Performance Score**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
					U14					
SG	14.93	2.80	22.03	5.42	32.67	15.63	1.37	0.97	30.20	16.37
PG	33.90	3.70	26.47	5.56	65.33	20.55	1.70	0.62	49.47	15.38
SF	18.47	0.65	18.63	0.86	37.00	12.17	1.17	0.67	30.20	12.44
PF	11.80	4.68	11.27	2.07	29.33	16.26	0.97	0.49	24.03	12.71
P	20.90	2.95	21.63	1.96	50.00	17.78	1.33	0.38	38.50	12.38
					U16					
SG	18.97	0.40	23.20	2.60	63.00	7.81	1.53	1.15	46.70	3.28
PG	36.00	3.72	33.33	5.41	112.33	29.26	2.10	0.20	77.13	16.27
SF	13.73	1.88	16.10	2.98	44.00	1.73	1.17	0.12	33.60	2.00
PF	14.67	2.64	14.57	1.86	51.00	16.52	1.07	0.23	35.97	9.77
P	16.67	4.35	12.80	2.84	56.67	8.96	1.10	1.17	39.37	5.94
					U18					
SG	15.37	1.40	18.87	0.29	50.00	10.15	1.30	0.36	37.87	7.21
PG	37.53	3.00	32.60	2.01	110.67	2.08	1.87	0.21	74.07	1.70
SF	17.23	1.85	16.67	2.56	49.33	4.73	1.37	0.25	38.53	2.15
PF	16.83	1.85	17.93	1.64	53.33	8.74	1.23	0.31	38.87	6.31
P	13.00	2.62	13.97	0.83	45.33	11.24	1.03	0.15	32.70	7.04
					Amateurs (more than 20 years old)					
SG	23.23	1.42	22.33	2.45	71.67	9.71	1.37	0.15	49.43	4.00
PG	32.07	1.55	28.70	1.82	97.67	10.12	2.03	0.15	69.17	5.62
SF	14.37	1.21	15.87	1.68	46.67	2.08	1.07	0.06	33.73	0.71
PF	14.30	1.60	19.53	1.34	48.33	4.16	1.27	0.06	36.60	2.55
P	16.03	2.11	13.57	1.44	50.33	3.21	1.00	0.10	35.50	2.55

The relationship between network centralities (%InDegree and %OutDegree) and the characteristics of the technical efficacy (volume of play, technical efficiency and performance score) was investigated using Pearson product-moment correlation coefficient. The values of the coefficients are shown in Table 2.

Table 2. Correlation values between the network centralities and the technical efficacy – overall.

	%IdC	%OdC	VP	EI	PS
Network Centralities					
(1) %IdC: InDegree	1	0.866**	0.844**	0.665**	0.843**
(2) %OdC: OutDegree		1	0.743**	0.710**	0.776**
Network Performance					
(3) VP: Volume of Play			1	0.741**	0.983**
(4) EI: Efficiency Index				1	0.852**
(5) PS: Performance Score					1

* Correlation is significant at $p \leq 0.050$. ** Correlation is significant at $p = 0.001$.

The %IdC showed a large positive correlation with EI ($r = 0.665$; $p = 0.001$) and very large positive correlation with VP ($r = 0.844$; $p = 0.001$) and PS ($r = 0.843$; $p = 0.001$). The %OdC showed very large positive correlation with VP ($r = 0.743$; $p = 0.001$), EI ($r = 0.710$; $p = 0.001$) and PS ($r = 0.776$; $p = 0.001$).

Based on the analysis per tactical position, it was carried out r-Pearson test organized per position. The results can be found in table 3.

Table 3. Correlation values between the network centralities and the technical efficacy – tactical position.

		%IdC	%OdC	VP	EI	PS
	Network Centralities					
	(1) % IdC: InDegree	1	0.356	0.844**	0.039	0.690*
	(2) % OdC: OutDegree		1	0.371	0.678*	0.570
Shooting Guard	**Network Performance**					
	(3) VP: Volume of Play			1	0.308	0.922**
	(4) EI: Efficiency Index				1	0.652
	(5) PS: Performance Score					1
	Network Centralities					
	(1) % IdC: InDegree	1	0.618*	0.443	-0.293	0.307
	(2) % OdC: OutDegree		1	0.469	-0.077	0.382
Pointing Guard	**Network Performance**					
	(3) VP: Volume of Play			1	0.598*	0.984**
	(4) EI: Efficiency Index				1	0.731**
	(5) PS: Performance Score					1
	Network Centralities					
	(1) % IdC: InDegree	1	0.687*	-0.181	0.353	0.093
	(2) % OdC: OutDegree		1	-0.374	0.188	-0.114
Small Forward	**Network Performance**					
	(3) VP: Volume of Play			1	0.629*	0.916**
	(4) EI: Efficiency Index				1	0.886**
	(5) PS: Performance Score					1
	Network Centralities					
	(1) % IdC: InDegree	1	0.553	0.915**	0.609*	0.896**
	(2) % OdC: OutDegree		1	0.667*	0.641*	0.709**
Power Forward	**Network Performance**					
	(3) VP: Volume of Play			1	0.649*	0.971**
	(4) EI: Efficiency Index				1	0.812**
	(5) PS: Performance Score					1

	Network Centralities					
	(1) % IdC: InDegree	1	0.709**	0.343	0.589*	0.470
	(2) % OdC: OutDegree		1	-0.088	0.438	0.097
Forward	**Network Performance**					
	(3) VP: Volume of Play			1	0.699*	0.970**
	(4) EI: Efficiency Index				1	0.847**
	(5) PS: Performance Score					1

* Correlation is significant at $p \leq 0.050$. ** Correlation is significant at $p = 0.001$.

In the correlation of %IdC of shooting guard it was found statistical very large positive correlation with VP ($r = 0.844$; $p = 0.001$) and large correlation with PS ($r = 0.690$; $p = 0.013$). The %IdC of power forward revealed large positive correlation with EI ($r = 0.609$; $p = 0.035$), very large correlation with PS ($r = 0.896$; $p = 0.001$) and nearly perfect correlation with VP ($r = 0.915$; $p = 0.001$). The %IdC of post position revealed large positive correlation with EI ($r = 0.589$; $p = 0.044$).

In the correlation of %OdC of shooting guard it was found statistical large positive correlation with EI ($r = 0.678$; $p = 0.015$). The %OdC of power forward revealed large positive correlation with VP ($r = 0.667$; $p = 0.018$), EI ($r = 0.641$; $p = 0.025$) and very large correlation with PS ($r = 0.709$; $p = 0.010$).

Table 4. Correlation values between the network centralities and the technical efficacy – competitive level.

		%OdC	%IdC	VP	EI	PS
	Network Centralities					
	(1) % IdC: InDegree	1	0.729**	0.696**	0.330	0.592*
	(2) % OdC: OutDegree		1	0.424	0.416	0.458
U14	**Network Performance**					
	(3) VP: Volume of Play			1	0.756**	0.964**
	(4) EI: Efficiency Index				1	0.903**
	(5) PS: Performance Score					1
	Network Centralities					
	(1) % IdC: InDegree	1	0.906**	0.943**	0.931*	0.964**
	(2) % OdC: OutDegree		1	0.850**	0.938**	0.889**
U16	**Network Performance**					
	(3) VP: Volume of Play			1	0.864**	0.993**
	(4) EI: Efficiency Index				1	0.918**
	(5) PS: Performance Score					1

		%OdC	%IdC	VP	EI	PS
	Network Centralities					
	(1) % IdC: InDegree	1	0.939**	0.976**	0.777**	0.974**
	(2) % OdC: OutDegree		1	0.919**	0.783**	0.929**
U18	**Network Performance**					
	(3) VP: Volume of Play			1	0.761**	0.989**
	(4) EI: Efficiency Index				1	0.849**
	(5) PS: Performance Score					1
	Network Centralities					
	(1) % IdC: InDegree	1	0.877**	0.978**	0.885**	0.979**
	(2) % OdC: OutDegree		1	0.883**	0.917**	0.909**
Amateurs (> 20 years old)	**Network Performance**					
	(3) VP: Volume of Play			1	0.882**	0.992**
	(4) EI: Efficiency Index				1	0.933**
	(5) PS: Performance Score					1

Significantly nearly perfect correlations were found in %IdC of U16 with VP ($r = 0.943$; $p = 0.001$), EI ($r = 0.931$; $p = 0.001$) and PS ($r = 0.964$; $p = 0.001$). In U18 competitive level, significantly nearly perfect correlations were found in %IdC with VP ($r = 0.976$; $p = 0.001$) and PS ($r = 0.974$; $p = 0.001$). Significantly

nearly perfect correlations were found in %IdC of Amateurs with more than 20 years old with VP ($r = 0.978$; $p = 0.001$) and PS ($r = 0.979$; $p = 0.001$).

Significantly nearly perfect correlations were found in %OdC of U16 with EI ($r = 0.938$; $p = 0.001$). In U18 competitive level, significantly nearly perfect correlations were found in %OdC with VP ($r = 0.919$; $p = 0.001$) and PS ($r = 0.929$; $p = 0.001$). Significantly nearly perfect correlations were found in %OdC of Amateurs with more than 20 years old with EI ($r = 0.917$; $p = 0.001$) and PS ($r = 0.909$; $p = 0.001$).

Discussion

The tactical prominence of basketball during attacking moments were analysed in this study in association with the technical performance. The overall idea is that the level of recruitment from teammates may be constrained by the accuracy of player to ensure the best possible result in each attacking play.

The overall results from different competitive levels and tactical positions showed large correlations between indegree centrality (level of passes received) and outdegree centrality (level of passes performed) with volume of play (passes received more balls conquered), efficiency index (volume of offensive actions less the inaccurate actions) and performance score (overall result crossing volume of play and efficiency index). In the specific case of overall results, it was possible to observe bigger correlations of indegree with volume of play and performance score and, in other hand bigger correlation of outdegree with efficiency index. This result may be explained by the fact that indegree depends from the passes received and that in the specific case of performance score there was a greater tendency to receive the ball than to be efficient. In other hand, the greater level of correlation of outdegree centrality with efficiency index may be explained by the fact that outdegree centrality depends from the passes made successfully, thus the most accurate players are who have greater prominence in to be the playmaker during attacking moments.

In the case of analysis made by the tactical position it was found that shooting guard and power forward were the players with greater correlation values of indegree centrality with volume of play and performance score. By other hand, power forward and forward were the positions with bigger correlations of indegree centrality with efficiency index. The results may suggest that in the case of forward and power forward the tactical prominence in to receive the ball may be justified by their capacity to be accurate in the moment to process and finalize the attack. Thus, teammates may recruit with more frequency these players by the fact of their greater accurate levels, helping to improve the results of the team. In other hand, the great level of indegree centrality in shooting guard may be ensure by their volume of play and to be recruited in the initial stages of attacking building.

Also in the case of analysis by tactical position it was verified that shooting guard, pointing guard and power forward have the greater correlations of outdegree with volume of play and performance score. It was also observed that shooting guard and power forward were the players with bigger correlations of outdegree centrality with efficiency index. As suggest before, the power forward may represent the player with greater tendency to be accurate and for that reason is the player that achieve greater prominence levels in to receive the ball and also in to pass for teammates. For that reason, this specific position seems to be the most representative of the association between technical performance and tactical prominence in match.

Another sub analysis it was made by the competitive level. In this case it was found that U16 level of competitive have greater values of correlation of indegree centrality with volume of play, efficiency index and performance. In other hand, amateurs with more than 20 years old had greater values of correlation of indegree centrality with efficiency index. These results, may suggest that in high competitive levels the recruitment of player may be more constrained by their capacity to be efficient and accurate, thus increasing the possibilities of the team to be successful. In younger stages, the volume of play maybe be the most predictive variable to ensure the indegree centrality, thus depending more from the personal activity in to recover balls and in to receive passes. By other hand, in the case of correlation of outdegree centrality with efficiency index it was found the greater values in U16 and Amateurs with more than 20 years old. These results suggest that the prominence in to be the playmaker may depend from the capacity to be accurate in to pass the ball.

This study had some limitations associated with the small sample per each competitive level and for the small number of variables collected. In the future, will be necessary to increase the volume of matches observed and to increase the technical and tactical variables in order to improve the possibility to understand how technical performance may influence the tactical prominence in a network point-a-view. Moreover, will be also interesting to add some collective analysis based on the proximity between teammates and the dynamics of decision-making during attacking moments.

Conclusion

In this study it was analysed the association level between technical performance and tactical prominence in basketball players from different competitive levels. The study showed that in general there are large correlation values between technical performance and tactical prominence. Particularly, the indegree centrality has the greater correlation values with volume of play, efficiency index and performance score, thus suggesting that the players with greater recruitment level from teammates have the most accurate performance

during the match. These results may suggest that teammates opt to pass with greater frequency to the players with better efficacy in order to ensure the best possible result in attacking moments.

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