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Abstract

Objectives: This study aimed to identify styles of play in the National Rugby League (NRL) relative to season and end of season rank (position on the NRL ladder) across the 2015-2019 seasons. **Design:** Retrospective, longitudinal analysis of performance indicators. **Methods:** Forty-eight performance indicators (e.g. runs, tackles) from all NRL teams and matches during the 2015-2019 seasons (n=2,010) were quantified. Principal component analysis (PCA) was then used to identify styles of play based on dimensions (Factors) of performance indicators. Multivariate analysis of covariance (MANCOVA) was then used to explain these emergent styles of play relative to 'season' and 'end of season rank'. **Results:** The PCA revealed nine Factors (six attacking, two defensive and one contested style) accounting for ~51% of seasonal team performance variance. These nine Factors differed across 'seasons', with four showing an effect against 'end of season rank'. From these four, two Factors (ball possession and player efforts) impacted upon the combined effects of 'season' and 'end of season rank'. **Conclusions:** The PCA identified nine Factors reflecting a spread of attacking, defensive and contested styles of play within the NRL. These styles differed relative to season and a team's end of season ranking. These results may assist practitioners with the recognition of more contemporary styles of play in the NRL, enabling the development of strategies to exploit competition trends.

Keywords: Team sports; sport analytics; performance analysis; playing style

Practical implications

- Current playing styles in the National Rugby League exhibit a largely attacking focus (eg more 'runs' and 'scoring actions') with defensive and contested playing styles appearing less influential.
- Using the contemporary styles of play identified in this study, coaching and performance staff could develop various training and match-principles around exploiting the observed (predominately attacking) styles of play to improve the likelihood of team success .
- The analytical approaches used in this study could be applied to other team sports, providing insight into current playing styles representative of their competition.

Introduction

Sports performance analysis has become an important practice within high performance environments, as it affords practitioners insight into critical elements of match play, training design, opposition analysis and player selection and recruitment.[1] With the rapid improvement of technologies in sport, the capture and analysis of performance indicators, through the use of notational or automated analyses, has become more accessible for sporting organisations at all developmental levels.[1] Through such analyses, sporting practitioners have been afforded increased clarity surrounding the resolution of key performance indicators capable of explaining match events at both team and individual levels.[2-4]

Within Rugby League (RL), performance analysis research has focused on aspects of match play inclusive of time and location of ball (re)possession, playing position differences, comparisons of higher and lower ranked teams, and comparisons between elite and sub-elite competition levels.[5-7] For example, Parmar et al.[8] highlighted the utility of cluster analysis for identifying performance indicators capable of explaining match outcome in the European Super League. Notably, using principal component analysis (PCA), three principal components that best explained match outcome were identified, 'making quick ground', 'quick play' and 'amount of possession'.[8] Undoubtedly, such research has led to greater clarity with regards to training and match strategies intended to improve on-field performance. Interestingly, though, an examination of playing style, like done by Parmar et al.[8], is yet to be performed within the National Rugby League (NRL).

Style of play in sport has been examined from a competitive and commercial (e.g. commentary, supporters, and the media) perspective.[9-11] However, it is only recently that the application of analytical approaches intended to better understand the indicators that contribute

to teams' style of play has been investigated.[2,11] For example, Fernandez-Navarro et al. [12] used cluster analysis to identify important groups of technical performance variables that explained the different attacking and defensive styles of play of soccer teams from the Spanish La Liga and the English Premier League. The authors identified six factors which were able to explain 12 different playing styles, whereby 'direct' and 'possession' styles were the most apparent. Further, Lago-Peñas et al.[13] and Gómez et al.[2] explored the application of various modelling techniques to identify different playing styles of soccer teams in the Chinese and Greek soccer leagues, respectively. These studies utilised PCA to identify related, high-order performance variables.[14] This information was subsequently used to define team playing style (e.g. attacking or defensively focused), and its relationship with factors such as end of season rank, and seasonal evolution.[2]

To date, work is yet to investigate the effect of factors, such as end of season rank and season, has on the emergence of playing styles within the NRL. This is important, as greater clarity with regards to styles of play that differentiate end of season ranking, as well as evolution over time, could enable RL practitioners to better understand and exploit current trends in performance. The aim of this study was to identify styles of play within the NRL relative to season and end of season rank across the 2015-2019 seasons.

Methods

Following a retrospective, longitudinal research design, 48 technical performance indicators from all 16 teams and matches (n = 1,005 matches) within the NRL during the 2015-2019 seasons were extracted from a licensed central database (Analyzer; The League Analyst, Version V4.14.318). The technical performance indicators from full matches and both competing teams were chosen in accordance with previous work,[15] being shown in full in Supplementary Table 1. Further, while the array of performance indicators used in this study

may not be accessible for readers given licensing restrictions, a reduced selection of the indicators can be found on the following commercial website (www.nrl.com/stats/). As an important footnote to this commercial data, the match data provider for Analyzer (Stats Perform) code performance indicators during a match in accordance with a listed set of definitions, which are then checked for inaccuracies. The proprietor self-reported reliability of these coded events is >99% (the coefficient of variation being <1%). All procedures were in accordance with ethical approval gained from the local institutional Human Research Ethics Committee (H7968).

Firstly, to identify definable styles of play across the observational period, a PCA was used. Based on previous research,[15,16] PCA was deemed to be an appropriate technique for reducing the 48 technical performance indicators into '*n*' number of Factors based on their seasonal variance. This is achieved by resolving the eigenvalue, a scaling factor which determines the number (and magnitude) of the principal components used, dropping "less informative" components where necessary. As such, the number of Factors (principal components) retained in the PCA was determined using eigenvalues > 1.2, best resolving the number of Factors and model accuracy. Specifically, by extracting the rotated component matrix (i.e. correlation coefficients between technical performance indicators and the identified Factors) for values greater than |0.60|, this analysis identified the 'Factors' (combined performance indicators) that best explained seasonal performance variance across the NRL. Prior to this, a Kaiser-Meyer-Olkin test and Bartlett's test of sphericity confirmed the suitability of the data for factor analysis.

Secondly, multivariate analysis of covariance (MANCOVA) was used to check factorial differences identified by the PCA across 'season' and 'end of season ranking'. Post-hoc testing involving pairwise comparisons with Bonferroni correction was conducted with

significance level set to $p<0.05$. Magnitude of differences across seasons was calculated as effect size (ES) using partial eta square from the MANCOVA with the following effect thresholds: 0.01 = small; 0.06 = medium; and 0.14 = large.[2,17,18] Finally, all descriptive statistics for Factors were represented as mean and standard deviation (mean ± SD). All statistical analyses were carried out using the statistical software IBM SPSS for Windows version 25 (Armonk, NY, USA, IBM Corp.).

Results

Firstly, the PCA revealed nine Factors (eigenvalues >1.2) that accounted for ~51% of the seasonal variance in team performance (sum of observed technical performance variables) between 2015 and 2019 (see Supplementary Table 2). The values presented in the rotated component matrix (see Supplementary Table 3) indicated the strength of the relationship between the various technical performance variables and the nine associated factors. The nine Factors are shown in Table 1 with an associated style of play (based on subjective interpretations and inspection of the performance indicators grouped into the Factor). Descriptive statistics for these Factors are presented in Table 2.

[Insert Tables 1 and 2 approximately here]

Secondly, the results of the MANCOVA revealed differences for each Factor when compared across 'seasons' (Table 3). The results of the pairwise comparisons, however, indicated only four Factors were different (small effects) when compared with end of season rank (Table 3): Factor 3 ('Try Causes'; conceded line break, try cause), Factor 4 ('Last Play Kicking'; handling errors, kick total), Factor 8 ('play the ball won and lost'; play the ball won and lost in possession) and Factor 9 ('Effort plays'; kick pressure, supports). Further, when examining the between factor interaction effects (season x end of season ranking), only Factor

8 (medium effect) and Factor 9 (medium effect) were different across season and end of season ranking.

[Insert Table 3 approximately here]

The descriptive statistics for end of season ranking and each of the nine Factors identified are shown in Supplementary Table 4. There were no observed differences in Factor 1 ('Runs'; runs, run metres, passes, hit ups, metres after contact, kick total), Factor 4 ('Last play kicking'; handling errors, kick total;), Factor 5 ('Tackling'; tackles made) and Factor 9 for end of season rank. Upon closer review of the MANCOVA results, the top half of the competition (end of season rankings of 1-8) exhibited a greater average number of 'Scoring actions' (Factor 2) compared to the bottom half (end of season rankings of 9-16) of the competition. Further, the top four teams exhibited a negative average for 'Try causes' (Factor 3) while teams ranked ninth through twelfth showed the greatest number of penalties (won and conceded) (Factor 8) compared with the rest of the competition.

Discussion

The aim of this study was to identify styles of play in the NRL relative to season and end of season ranking across the 2015-2019 seasons. Overall, results indicated that: (i) team styles of play changed across the observational period; and (ii) different styles of play were evident when a team's end of season ranking was considered. These findings were similar to that observed in soccer[2,12,13] highlighting the importance of identifying specific styles of play and their impact on end of season ranking. Specifically, three attacking ('last play kicking', 'play the ball won and lost' and 'effort plays') and one defensive ('try causes') styles of play were observed to have changed relative to end of season ranking. The current study has extended

158 prior work through the identification of seasonal evolution with regards to emergence of a
159 predominant attacking style of play in the NRL.

160 Collectively, nine Factors explained ~51% of total performance variance within the
161 NRL across the observational period. It was previously reported that teams capable of attaining
162 more meterage with ball in hand were more likely to be successful.[4] The results of the current
163 study support these findings, having identified that attacking styles of play leading to more
164 'runs' (Factor 1: runs, run metres, passes, hit-ups, metres after contact and total kicking
165 distance) and 'scoring actions' (Factor 2: line breaks, line break assists, tries, try assists and
166 conversions made) were the most important factors for differentiating team styles of play,
167 accounting for ~15% and 9% of total variance of NRL teams, respectively. In fact, of the nine
168 Factors identified, six (Factors 1, 2, 4, 7-9) were attacking focused with two being defensive
169 (Factors 3 and 5) and one considered as contested (Factor 6; penalties). Further, 'try causing
170 actions' (Factor 3), 'last play kicking actions' (Factor 4), 'play the ball won and lost in attack'
171 (Factor 8) and 'effort plays' (Factor 9) influenced a team's end of season ranking. Based upon
172 these Factors, coaching and performance staff could develop match-principles around
173 exploiting the strengths and weaknesses of these identified (predominately attacking) styles of
174 play. This could elicit a positive response (i.e., winning) and thus improve teams' chances of
175 obtaining a favourable end of season ranking.

176 It has been suggested that elite sporting teams employ a 'follow the leader' type
177 response during competitive seasons, whereby teams constantly adjust their styles of play to
178 reflect that of the competition leaders.[7] It would be expected that team's performance
179 characteristics would be in a constant state of flux season-to-season, as teams attempt to
180 replicate or anticipate a dominant 'style of play'. Our results support this proposition,
181 identifying a small effect of season on Factors 1-7, and a large effect for Factor 8 (play the ball

182 won and lost) and Factor 9 (Effort Plays). Across seasons, the total number of play the balls
183 (won and lost) progressively increased, reflecting a greater number of play the balls won
184 compared to play the ball losses (due to the inverse relationship between play the ball won and
185 lost, Supplementary Table 3). Contextually, this emerging 'style of play' may indicate more
186 attacking players landing forward in a tackle, resulting in a faster play of the ball for the
187 attacking team that restricts the opposing team's time to set their defensive line.[8] Conversely,
188 there was a gradual decline of Effort Plays, whereby players reduced their supporting runs
189 and/or application of kick pressure. Potentially, the reduction in Effort Plays resulted from
190 competition rulings imposed (e.g. the obstruction ruling), leading to fewer supporting runs for
191 fear of incurring an infringement. Whilst this reduction may not be a deliberate tactical shift in
192 team play and more so dependent on external factors, the increase in the number of play the
193 balls across the seasons suggested teams were placing a greater emphasis on speeding up the
194 match in an attempt to manufacture more scoring opportunities. Exemplifying this, top ranked
195 teams had a greater occurrence of play the ball won and lost, and concomitant greatest number
196 of 'scoring actions' (Factor 2) when compared to the rest of the competition. Further supporting
197 the notion that teams regularly adjust their styles of play to reflect that of the competition
198 leaders, and that these leaders are often more successful at doing so.[7]

199 Whilst both Factors 8 and 9 changed across the observational period, it is important to
200 highlight those factors which did not (Factors 1-7). Recognising Factors that did not change
201 may be an important starting place for teams to build a foundation for team success, before
202 attempting to manipulate the changes (or trends) in team styles of play. As shown previously,[7,8]
203 teams that controlled possession and exhibited greater attacking play (Factors 1, 2, 4, 7-9) and
204 reduced defensive mistakes (Factors 3 and 5), had a greater chance of achieving a winning team
205 performance. Using the current and prior information, practitioners could develop training and

match-play strategies suited to elicit similar team performance, subsequently affording the greatest chance of winning matches in this competition.

Data reduction techniques, such as PCA, have distinguished physical and technical performance demands in a range of sporting competitions such as soccer,[2,13,19] basketball[20,21] and European Super Rugby.[8] The use of this analysis for the NRL presently further demonstrates the suitability of analogous analytical techniques for match style resolution. For example, sports practitioners could resolve playing styles of their opposition, enabling greater support around decisions relating to preparation and subsequent team selection. Further research exploring the utility of these analytical approaches for match style resolution will offer greater clarity around current individual and team performance characteristics, and subsequent scope for manipulating league-wide trends to maximise a team's likelihood of success in the NRL.

Despite the novelty of this study and its findings, it is not without limitations that require discussion. Specifically, our analysis did not consider contextual variables, such as score differential or match location. The effects of such contextual factors have been documented across various sports and is worthy of future consideration in RL.[22-25] Further, it is important to note the large amount of team performance variance (~49%) that was unaccounted, which is in direct contrast with similar work in RL.[8] It is possible that other contextual information such as team form, match location and comparative ladder positioning[8] may be critical for greater predictive accuracy in these analyses. Additionally, the data utilised in this study was extracted over a relatively short timeframe and may not be reflective of long-term evolutionary changes.[7] Thus, further exploration of team playing styles in RL should consider the impact of contextual factors (e.g. match location or score differential) and extend

229 the observational period beyond five seasons to provide greater clarity about factors important
230 for current and future success.

231 **Conclusion**

232 The findings of this study identified different styles of play across the 2015-2019 seasons in
233 the NRL. Generally, successful team styles of play were more reflective of an attacking focus,
234 with specific styles of play being evident when considering teams' end of season ranking. For
235 example, teams' showed an increased emphasis on play the ball wins, in an attempt to create
236 more scoring opportunities and less focus on Effort Plays. The use of data reduction techniques,
237 such as PCA, could assist practitioners of various team sports to identify, and then develop
238 playing styles representative of their competition.

239

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Figures and Table Captions

Table 1. Principal components identified with their associated technical performance characteristics and subsequent styles of play.

Table 2. Descriptive statistics for all Factors identified via principal component analysis (PCA) relative to match time for each season.

Table 3. MANCOVA results for all Factors identified from the principal component analysis (PCA) in terms of season, end of season rank and their combined effects.

Supplementary Table Captions

Supplementary Table 1. Description of assessed technical skill performance metrics.[15]

Supplementary Table 2. Eigenvalues for principal components identified and total variance explained.

Supplementary Table 3. Rotated component matrix for all technical performance indicators examined; values representing the correlation between each variable and the nine principal components.

Supplementary Table 4. Descriptive statistics for each Factor identified by principal component analysis (PCA) by individual and group End of Season ranking.

Table 1. Principal components identified with their associated technical performance characteristics and subsequent styles of play.

Factor	Technical Performance Indicators	Style of Play
Factor 1 (Runs)	Runs, run metres, passes, hit ups, metres after contact, kick total;	Attacking Play
Factor 2 (Scoring Actions)	Line breaks, line break assists, tries, try assists, conversions made;	Attacking Play
Factor 3 (Try Causes)	Conceded line break, try cause;	Defensive Play
Factor 4 (Last Play Kicking)	Handling errors, kick total;	Attacking Play
Factor 5 (Tackling)	Tackles Made	Defensive Play
Factor 6 (Penalties)	Penalty conceded (attack), penalty won (attack);	Contested Play
Factor 7 (Kick Try Assist)	Kick breaks, failed kick defusal, kick try assist;	Attacking Play
Factor 8 (PTB Won and Lost)	PTB win (attack), PTB loss (attack);	Attacking Play
Factor 9 (Effort Plays)	Kick Pressure, Supports	Attacking Play

PTB = Play The Ball; Descriptors of technical performance characteristics (see Supplementary Table 1).

Table 2. Descriptive statistics for all Factors identified via principal component analysis (PCA) relative to match time for each season.

	2015		2016		2017		2018		2019	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Factor 1 (Runs)	0.05	0.99	0.03	1.00	-0.03	1.00	-0.25	0.98	0.21	0.97
Factor 2 (Scoring)	0.09	0.99	0.11	1.08	0.01	0.99	-0.08	0.98	-0.13	0.93
Factor 3 (Try Causes)	0.06	0.98	-0.22	1.08	0.03	0.94	0.13	0.96	0.00	1.00
Factor 4 (Last Play Kicking)	0.34	1.02	0.00	0.90	-0.20	0.96	-0.11	1.04	-0.03	0.98
Factor 5 (Tackling)	0.05	0.95	0.06	0.98	-0.16	0.96	-0.27	1.04	0.33	0.97
Factor 6 (Penalties)	-0.08	0.92	0.06	1.04	-0.06	0.93	0.09	1.13	-0.01	0.95
Factor 7 (Kick Try Assist)	-0.24	0.92	0.12	1.12	0.23	1.12	-0.15	0.83	0.05	0.90
Factor 8 (PTB Won and Loss)	-0.33	0.68	-0.47	0.99	-0.40	0.92	0.68	0.80	0.55	0.92
Factor 9 (Effort Plays)	0.57	0.78	0.60	0.96	-0.44	0.90	-0.53	0.82	-0.20	0.88

Negative values indicate a reduced occurrence of the combined variables for that factor in that year (relative to time played) compared to the prior year.

Table 3. MANCOVA results for all Factors identified from the principal component analysis (PCA) in terms of season, end of season rank and their combined effects.

	SS	df	MS	F	Sig.	η_P^2	ES interpretation
Season							
Factor 1 (Runs)	43.57	4	10.89	11.15	<0.01	0.02	Small
Factor 2 (Scoring Actions)	18.24	4	4.56	4.64	<0.01	0.01	Small
Factor 3 (Try Causes)	29.10	4	7.28	7.85	<0.01	0.02	Small
Factor 4 (Last Play Kicking)	68.86	4	17.22	18.09	<0.01	0.04	Small
Factor 5 (Tackling)	84.55	4	21.14	22.41	<0.01	0.05	Small
Factor 7 (Kick Try Assist)	60.69	4	15.17	15.64	<0.01	0.03	Small
Factor 8 (PTB Won and Lost)	477.89	4	119.47	178.44	<0.01	0.27	Large
Factor 9 (Effort Plays)	487.01	4	121.75	168.14	<0.01	0.26	Large
End of Season Rank							
Factor 3 (Try Causes)	23.452	15	1.563	1.688	0.047	.013	Small
Factor 4 (Last Play Kicking)	31.182	15	2.079	2.184	<0.01	.017	Small
Factor 8 (PTB Won and Lost)	33.68	15	2.25	3.35	<0.01	0.03	Small
Factor 9 (Effort Plays)	39.76	15	2.65	3.66	<0.01	0.03	Small
Season x End of Season Rank							
Factor 8 (PTB Won and Lost)	180.04	59	3.05	4.56	<0.01	0.12	Medium
Factor 9 (Effort Plays)	82.88	59	1.41	1.94	<0.01	0.06	Medium

Column Descriptors (SS – sum of squares; df – degrees of freedom; MS – mean square; F – F statistic; Sig. - significance; η_P^2 – partial eta squared; ES – effect size). Factor descriptors (see Supplementary Tables 1 and 2).

401 **Supplementary Table 1.** Description of assessed technical skill performance metrics.[15]

Technical Performance Metrics	Description
Runs	Attacking player carries the ball into the defensive line
Run Metres	Total distance covered in possession of the ball
Line Breaks	Ball carrier breaks the defensive line during open play OR crosses the try line and scores
Line Break Assists	An action by an attacking player that occurs immediately before a line break from their team mate
Hit ups	Ball carrier runs directly into the tackler, without making an attempt to evade the tackler
Kick Break	An attacking kick that results in the attacking team breaking the defensive line and recovering it further up the field
Tries	Major point score, involves a team placing the ball in a controlled fashion on the ground on between the try-line and the dead ball line of the opposition team (worth 4 points)
Try Assists	The final pass made to a team mate in the lead up to a try being scored
Offloads	Pass attempted whilst being tackled by opposing players
Tackle Breaks	The ball carrier manages to elude the tackler and keeps the ball in play without conceding a tackle
Passes	Ball is thrown by an attacking player to a team-mate
Play the Ball Wins	Attacking player lands on their front, often resulting in a quick play the ball for the offensive team
Play the Ball Losses	Tacklers manage to get the attacking player on their back in the tackle, often resulting in a slow play the ball.
Tackled Forced Turnover	Loss of possession as a result of a tackle resulting in the opposing team gaining possession of the ball
Pass Turnover	A pass that results in the opposition team gaining possession of the ball
Botched Try	Try scoring opportunity missed, e.g. knock the ball on over the try line
Handling Error	Loss of possession by an attacking player, example: dropped catch, throwing an intercept, losing the ball out, etc.
Decoy	Attacking player near the football that acts as if they may receive the football but don't
Support	Attacking player pushes up with the ball carrier as an attacking option to assist on the play as the ball carrier takes the ball into the line
Meters After Contact	Run meters accrued by the ball carrier after the initial moment of contact from a defender.
Tackles Made	A defensive action that involves physically holding or wresting a player to the ground
Tackles Missed	Unsuccessful tackle attempt made by defensive player
Tackle Forced Turnover	Successful tackle attempt that results in the defending team regaining possession of the ball
Scraps	Player recovers a loose ball
Rambo	Defensive player charges at the opposing kicker in general play in an attempt to impede the kick attempt
Intercepts	Defensive player takes possession of the ball off a pass from the opposing team
Try Saves	Defensive action, such as a tackle, that stops an opposing player from scoring a try
Penalty Conceded	Infraction of the rules by a player, resulting in a penalty being awarded to the opposition
Conceded Line break	Defensive action that results in the ball carrier breaking the defensive line during open play OR crosses the try line and scores
Try Cause	Defensive action that results in the opposition team scoring
Kick Defused	Successful recovery of an opposition kick; can be caught on the full or cleaned up from the ground
Failed Kick Defusal	Unsuccessful in the recovery of an opposition kick; may result in a turnover
Kick (total)	An offensive action that involves a player striking the ball with their foot
Kick meters	The distance that a ball covers once kicked by an offensive player

Field Goal Made	Attacking team successfully attempts to drop kick the ball over the crossbar (worth 1 point)
Field Goal Miss	Attacking team unsuccessfully attempts to drop kick the ball over the crossbar
Penalty Made	Successful attempt at goal following a penalty (worth 2 points)
Penalty Miss	Unsuccessful attempt at goal following a penalty
Conversion Made	Successful attempt at goal following a try (worth 2 points)
Conversion Miss	Unsuccessful attempt at goal following a try
Kick Try Assist	An offensive kick that results in a teammate scoring a try
Kick Error	Kick that results in a negative play for the attacking team e.g. Kicked dead, out on the full, etc.
Kick Forced Dropout	Ball is kicked into the defensive teams in-goal area, and forces the defensive side to drop kick the ball back to the opposition from the goal line
Kick Dead	The ball is kicked and leaves the field of play from the in-goal area. The ball is then restarted from the 20m line by the defensive team
Kick Caught in Goal	Defensive player successfully catches the opposing teams kick on the full inside their own in-goal. This results in a 7-tackle set and a 20m restart for the defensive team
Kick 40/20	Ball is kicked from behind the attacking teams own 40m line and goes out between the try line and 20m of the opposing team. The ball must bounce before going out. The ball is then awarded back to the attacking team in the form of a scrum

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Supplementary Table 2. Eigenvalues for principal components identified and total variance explained.

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	6.988	14.559	14.559	6.988	14.559	14.559	5.129	10.685	10.685
2	4.355	9.073	23.632	4.355	9.073	23.632	4.913	10.236	20.921
3	2.491	5.189	28.822	2.491	5.189	28.822	2.316	4.825	25.746
4	2.075	4.323	33.145	2.075	4.323	33.145	2.282	4.754	30.500
5	1.955	4.072	37.217	1.955	4.072	37.217	2.144	4.467	34.968
6	1.878	3.913	41.130	1.878	3.913	41.130	2.050	4.271	39.238
7	1.808	3.767	44.897	1.808	3.767	44.897	2.032	4.234	43.472
8	1.688	3.517	48.413	1.688	3.517	48.413	1.832	3.817	47.289
9	1.381	2.878	51.291	1.381	2.878	51.291	1.656	3.450	50.739
10	1.276	2.657	53.948						
11	1.171	2.439	56.388						
12	1.117	2.328	58.715						
13	1.086	2.263	60.979						
14	1.059	2.206	63.184						
15	1.055	2.198	65.382						
16	1.039	2.165	67.547						
17	.997	2.077	69.624						
18	.984	2.049	71.673						
19	.939	1.956	73.630						
20	.929	1.934	75.564						
21	.897	1.869	77.433						
22	.896	1.867	79.299						
23	.823	1.715	81.014						
24	.795	1.657	82.671						
25	.779	1.623	84.295						
26	.748	1.559	85.854						
27	.669	1.394	87.248						
28	.648	1.350	88.598						
29	.609	1.269	89.867						
30	.594	1.237	91.104						
31	.519	1.082	92.186						
32	.507	1.056	93.242						
33	.465	.970	94.212						
34	.435	.906	95.117						
35	.391	.816	95.933						
36	.349	.726	96.659						
37	.304	.632	97.291						
38	.259	.539	97.830						
39	.214	.446	98.276						
40	.183	.381	98.657						
41	.177	.369	99.027						
42	.175	.364	99.391						
43	.119	.249	99.640						
44	.088	.184	99.824						
45	.064	.133	99.957						
46	.020	.041	99.998						
47	.001	.002	100.000						
48	0.000	0.000	100.000						

Supplementary Table 3. Rotated component matrix for all technical performance indicators examined; values representing the correlation between each variable and the nine principal components.

	Components								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Runs	.904	.165	.175	.019	.010	-.026	.001	.059	-.040
Run (m)	.750	.371	.163	.027	.061	-.044	.021	.087	-.026
Line Break	.133	.882	.027	-.062	-.044	-.030	-.137	.017	-.064
Line Break Assist	.126	.855	.032	-.014	-.016	-.007	-.140	-.042	-.010
Hit Ups	.728	.099	.130	.123	-.189	-.034	.042	-.098	.184
Kick breaks	-.019	.120	.005	.003	.017	-.009	.777	-.116	.102
Tries	.043	.909	.082	.096	-.108	-.026	.228	.004	.040
Try Assist	.039	.871	.090	.093	-.068	-.004	.239	-.019	.040
Offloads	.429	.110	-.249	-.374	-.116	.027	-.035	-.027	.055
Tackle Break	.305	.384	.026	-.265	-.038	-.023	.012	.193	-.199
Passes	.840	.019	.127	.064	-.154	-.010	.021	.040	-.085
PTB Win (Attack)	.377	-.002	.065	.108	.078	.001	.014	.866	-.034
PTB Loss (Attack)	.325	.002	.141	.150	.036	-.048	.039	-.872	.049
Tackled FTO	-.143	-.185	.248	-.535	.219	-.004	.005	.040	.150
Pass TO	.102	-.031	-.110	-.350	.025	-.034	-.063	-.029	.046
Botch Try	.024	-.015	.080	.026	-.033	-.017	-.031	.084	-.050
Handling Errors	-.069	-.237	.134	-.777	.049	-.029	.040	.068	.030
Pen Conceded (Attack)	-.035	-.026	.004	.005	-.002	.992	-.005	.008	-.024
Pen Won (Attack)	-.035	-.026	.004	.005	-.002	.992	-.005	.008	-.024
Decoy	.356	-.079	.144	-.067	-.326	.035	-.031	.181	-.450
Support	.252	.022	.225	-.026	-.225	.012	.047	.145	.602
Metres After Contact	.879	.018	.158	.086	.068	-.029	.058	.010	.010
Tackle Made	-.071	-.474	-.072	-.028	.658	-.018	-.124	.082	.061
Tackle Miss	-.126	-.246	-.531	-.124	.005	-.024	-.023	.132	-.074
Tackle Forced Turnover	.132	-.106	.284	.034	-.337	-.025	.048	.185	.438
Scraps	.127	.042	.143	-.082	-.062	.000	.018	-.018	.400
Kick Pressure	.103	-.195	.112	-.069	.429	.038	.023	.118	.600
Intercepts	-.143	.001	-.060	-.214	-.101	-.027	.070	-.030	.025
Try Saves	.006	-.029	-.033	-.068	.087	.001	.017	.032	.429
Pen Conceded (Defence)	-.399	-.063	.130	-.069	-.243	-.071	-.101	.099	.027
Conceded Linebreak	-.211	-.169	-.808	.030	-.074	-.032	-.003	.004	.037
Try Cause	-.301	-.161	-.739	.001	-.083	.020	-.064	-.043	.023
Kick Defused	-.055	-.109	.110	.040	.719	-.001	-.042	-.020	.045
Failed Kick Defusal	.186	-.025	-.038	.025	-.093	.011	.611	.007	-.093
Kick Total	.527	-.158	.145	.607	.239	-.121	.277	.062	.040
Kick (m)	.268	-.099	.148	.574	.445	-.127	.124	.148	-.003
FG Made	.118	-.028	.078	.062	.000	-.006	-.135	.011	.089
FG Miss	.173	-.060	-.075	-.057	.145	.092	-.004	-.014	.120
Pen Made	-.082	-.063	.358	.206	-.250	-.036	-.115	.089	-.061
Pen Miss	.005	-.071	.032	-.031	-.075	-.042	.098	-.010	-.082
Conversion Made	.024	.753	.009	.101	-.138	-.076	.247	.038	-.008
Conversion Miss	.039	.507	.147	.017	.018	.076	.027	-.053	.086
Kick Try Assist	-.029	.243	.072	.084	.001	-.011	.799	.062	.037
Kick Errors	.066	.024	.071	.222	-.011	-.014	-.105	-.128	.219
Kick Forced Dropout	.322	-.101	.253	.176	-.325	-.032	.040	.138	.103
Kick Dead	.074	-.062	-.007	.154	-.046	-.019	.023	-.063	.125
Kick Caught in Goal	.125	-.104	-.111	.092	-.035	.003	-.008	-.088	-.004
Kick 40/20	-.013	.066	.030	.066	.073	.041	.037	-.036	.025

Supplementary Table 4. Descriptive statistics for each Factor identified by principal component analysis (PCA) by individual and group End of Season ranking.

	Factor 1 (Runs)		Factor 2 (Scoring)		Factor 3 (Try Causes)		Factor 4 (Last Play Kicking)		Factor 5 (Tackling)		Factor 6 (Penalties)		(
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	M
Rank 1	0.04	1.08	0.17	1.19	0.03	1.07	0.17	0.90	-0.04	0.99	-0.06	0.95	-0
Rank 2	-0.14	0.99	0.08	1.04	0.12	0.94	-0.12	0.89	-0.12	1.06	0.13	1.08	0
Rank 3	-0.03	1.02	0.11	0.93	-0.05	0.86	0.06	0.96	-0.16	1.05	-0.06	0.93	0
Rank 4	-0.09	1.00	0.02	0.91	-0.01	0.96	0.04	0.91	-0.02	0.98	-0.02	0.92	0
Rank 5	0.06	0.97	-0.06	0.97	0.10	1.02	-0.08	1.03	0.00	0.94	-0.09	0.95	0
Rank 6	0.12	1.08	-0.01	0.95	0.15	0.90	-0.18	1.10	0.02	1.05	0.04	1.01	-0
Rank 7	0.02	0.97	0.03	0.90	-0.03	0.96	-0.22	0.95	-0.06	0.83	-0.08	0.89	-0
Rank 8	0.02	0.93	0.04	1.04	0.01	1.00	-0.02	0.90	0.12	1.01	-0.08	0.89	-0
Rank 9	-0.02	1.02	0.11	1.08	0.04	1.09	0.15	0.99	0.12	1.00	-0.03	0.93	-0
Rank 10	0.03	0.94	-0.09	1.11	0.04	1.04	-0.02	0.97	-0.23	0.99	0.18	1.10	-0
Rank 11	-0.14	1.02	-0.05	1.04	0.08	1.11	-0.03	1.13	0.01	1.01	-0.05	0.98	0
Rank 12	-0.04	0.99	-0.15	1.00	-0.03	1.18	0.07	0.92	0.06	1.03	0.11	1.01	-0
Rank 13	-0.04	1.08	0.00	0.95	-0.12	1.04	-0.05	1.09	0.14	1.08	-0.01	0.97	-0
Rank 14	0.00	0.95	-0.08	0.82	-0.02	0.88	0.28	1.09	0.04	0.98	0.16	1.43	0
Rank 15	-0.07	0.97	-0.05	0.93	-0.04	0.83	0.06	1.05	0.08	1.01	-0.16	0.86	0
Rank 16	0.24	0.96	-0.06	1.05	-0.35	1.03	-0.06	1.01	0.02	0.94	0.00	0.96	-0
Top 8	0.00	1.01	0.05	0.99	0.04	0.96	-0.04	0.96	-0.03	0.99	-0.03	0.95	-0
Bottom 8	-0.01	0.99	-0.05	1.00	-0.05	1.03	0.05	1.03	0.03	1.01	0.03	1.03	0