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ORIGINAL PAPERS

Feedback of GPS training data within professional English soccer: a comparison of decision making and perceptions between coaches, players and performance staff

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ABSTRACT

Purpose: The aim of the study was to examine the perceptions of training data feedback from key stakeholders within the coaching process of professional soccer clubs. A survey assessed the importance of training data towards reflection and decision-making, potential barriers and player preferences.
Methods: A total of 176 participants comprising coaches, players and performance staff completed the survey.
Results: The training data coaches most commonly identified as wanting to see to support reflection was 'high-intensity' actions and variables recognised by the coach as 'work rate/intensity'. All stake- holders reported training data as at least somewhat important in guiding their coaches' practices, with lack of a common goal and high volumes of information being the main barriers to effective feedback of training data. Players deemed feedback as positive to change their behaviour, with total distance, high-speed running and sprint distances as the information they would most like to see. It would be likely to be looked at via message or pinned up in the changing room.
Conclusion: Training data are seen as an impactful and effective tool for use by all key stakeholders. Despite this, its use can be optimised by increasing opportunities for informal reflection, using less information, and improving communication of data.

ARTICLE HISTORY
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KEYWORDS
Decision-making; reflection; evaluation; coaches; performance staff; players

Introduction

In professional soccer, the role of the coach is to improve their team's performance by planning and delivering training sessions that allow the players to acquire the necessary qualities to triumph in competition (Williams and Reilly 2000). In order to improve performance, the coach must provide their players with feedback (Williams and Hodges 2005; Ford et al. 2010) as well as making many complex decisions, such as session content and team selection for an upcoming game. Consequently, decision-making is considered a very important aspect of the successful coaching process (Cushion et al. 2010; Mata and da Silva Gomes 2013).

To improve players physical performance, many professional soccer clubs employ performance staff (e.g. sport scientists) to collect, analyse and feedback training data (e.g. total distance, sprint distance, high-speed running, etc.) from players (Akenhead and Nassis 2015) via methodologies such as global positioning systems (GPS). This information can be subsequently used to evaluate and improve current practices and decision-making (Buchheit 2017; Robertson et al. 2017; Ward et al. 2019). For example, training data collected by performance staff through GPS have previously been illustrated to help form a range of measures that may identify injury risks (Rossi et al. 2017) and changes in physical qualities (Clemente et al. 2019). Though the potential impact of collecting training data is becoming clearer, further research is required to understand specifically whether this feedback is utilised to support coach decision-making.

Integral to the decision-making process is the ability of the coach to reflect on past and current experiences to generate new knowledge and improve coaching quality (Cooper and Allen 2018; Stodter and Cushion 2019). The reflective process can evaluate whether a desired change has occurred alongside performance outcomes and coaching technique (Cooper and Allen 2018). Furthermore, it has been shown that feedback to coaches via video-stimulated recall enhanced the use of reflection and coaching behaviour change, perhaps due to the provision of a structure for reflective practice and increased self-awareness (Partington et al. 2015; Stodter and Cushion 2019). Though the use of reflection in the coaching process is well understood, the use of feedback of GPS training data to facilitate this reflection is not.

In order to better understand the impact of feedback of GPS training data on the coaches decision-making process, those involved in this process should be considered (Greenwood et al. 2012; Cooper and Allen 2018). Previous work examining coaches and performance staff perceptions of training data, such as that collected via GPS has shown that though coaches have an awareness of sport science, they perceive this data as only fourth in their interests behind mental and physical skills in addition to group dynamics (Brink et al. 2018). Moreover, despite a level of agreement between coaches and performance staff in terms of the usefulness of load monitoring, coaches only reported that training is sometimes altered based upon training load data. Practitioners reported GPS as the most utilised method

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(22%) for training monitoring and data collected was perceived as positive. A large proportion of practitioners (84%) perceived it as beneficial to their club (Weston 2018). Clear gaps exist with reference to how coaches use GPS training data to reflect and evaluate their sessions and make decisions to influence the coaching process.

Though the above research show that both coaches and practitioners find training data feedback valuable (Buchheit 2017; Weston 2018), it is important to understand the perceptions of players in the use of GPS training data. Players play a fundamental role in the decision-making process as lack of feedback to them has been shown to be attributed towards a disengagement with the practices of training data feedback (Neupert et al. 2019). For example, rugby union players valued video feedback to identify areas of weakness to improve on (Francis and Jones 2014). To date, perceptions towards feedback of GPS training data have not been examined.

To that end, the aim of the present study was to examine the perceptions of GPS training data feedback from key stakeholders included in the coaching process (i.e. coaches, performance staff and players) of professional soccer clubs. Moreover, a second aim was to understand how feedback of GPS training data influences decision-making processes and reflections of the coach. Findings from this study may inform future practice of sports science provision within professional soccer.

Methods

Participants

A total of 176 participants comprising coaches, performance staff and players currently working in professional soccer voluntarily completed an online survey. Participants were recruited using a poster advertised on social media platforms Twitter and LinkedIn and directly through the research team's network of contacts. In order to increase visibility and utilise 'snowball sampling' (Morgan 2008), participants were encouraged to circulate the poster to their personal networks and peers. The survey was first made available on the 23 November 2018 and was open for approximately 20 weeks, with social media promotion every 4 weeks. Inclusion criteria defined that participants were working in professional soccer at the time of data collection and were utilising GPS systems in their practice. In the present study, the survey was not limited to one response per team for each of the cohorts given the large number of squads within each professional club (e.g. from youth team to senior/first team). Players were required to be 18 years old or above. All participants were able to view and download the participant information sheet on the first page of the survey and were advised that by taking part their informed consent was given. To ensure that responses were collected from targeted populations, exclusion criteria were provided on the first page of the survey and no information regarding participant age, gender or club was requested thus they remained confidential. The procedure was ethically approved by the local ethics committee of the host university.

Survey design and distribution

Three separate surveys were created, with one for each group of participants. Surveys took an average of 3–5 min to complete and responses were anonymous with no identifiable information requested. Surveys began with a glossary of terms which classified GPS as '*the unit typically worn by soccer players in a vest during training and matches that captures information regarding a players movements*' and training data as '*the information collected by the GPS units during training and match play, such as distances in different speed zones*'. This was followed by a number of closed-ended questions examining participant demographics and a number of key topics relating to the use of training data in the coaching process including: (1) Training session reflection and evaluation examined the logistics of how training sessions are evaluated and how training data are utilised in this process while questions regarding the importance of training data examined the perceived influence of collected data on coaches and performance staff practice; (2) Sources of information used to design practice to see how training data compare to other sources while barriers to training data use aimed to gain a deeper understanding of possible causes of a translational issue between training data and the coaching process; (3) Impact on players examined the potential behaviour change of players following feedback of their data. Some questions were specific to each group of participants while some questions were the same to allow comparison across the groups. Questions included multiple-choice and Likert scale responses on a 5-point scale with all points labelled with anchors (Wade 2006). A free-text response option was added to questions where required, allowing for respondents to provide context around additional information. Despite this option, no participants needed to add such extra detail meaning that no analysis of free-text data was required. Questions were developed by the lead researcher and were based on experience and relevant literature (Wright et al. 2012; Akenhead and Nassis 2015; Stoszkowski and Collins 2016). The survey was reviewed for content validity (Stoszkowski and Collins 2016) via three rounds of group discussions with the research team. Two rounds of pilot testing were performed through discussion with two coaches (one coach and one assistant manager), three players (all playing for a U-23 development squad) and three performance staff (one physiotherapist and two sport scientists) working in an English Premier League club. This resulted in the modification of the wording of several questions to enhance readability/understating (coach = 3; performance staff = 2; player = 2) which were readdressed and approved by the same stakeholders. The surveys were uploaded to the online survey platform Survey Monkey (Survey-Monkey, California, USA). The final surveys consisted of 14 items for coaches, 14 items for performance staff, and 8 items for players.

Data reduction and analysis

Responses from Survey Monkey were exported into Microsoft Excel and subsequently SPSS (version 25, IBM, New York, USA) for further analysis. For categorical and multiple-choice questions, frequency analysis was conducted with the percentage of respondents reported for each response. To assess for between-group differences in these responses, a proportion ratio was used (Hopkins 2010) as per Weston (2018). Qualitative inferences trivial, small, moderate, large, very large and extremely large were represented by the ratios 1.00, 1.11, 1.43, 2.0, 3.3 and 10, respectively, with their inverses represented by ratios of 0.9, 0.7, 0.5, 0.3 and 0.1 (Hopkins 2010).

Likert scale responses were converted to integers and represented by the qualitative anchor associated with the mean response (Hopkins 2010). Between-group differences were reported as differences in the mean response with 95% confidence intervals. An independent t-test was used to assess for statistical significance in these differences. This information, in addition to a smallest worthwhile change of 1-point in the Likert scale, was input into a custom-made spreadsheet (Hopkins 2007) to allow for a yes/no interpretation of a clear between-group difference.

Results

Participant demographics

Of the 176 participants who took part in the study, 35 were coaches, 79 were performance staff and 62 were players, this distribution was similar to that previously seen in the literature (Weston 2018). The coaching staff group consisted of coaches (6%), assistant coaches (17%), managers (11%) and assistant managers (11%). Performance staff were predominantly sport scientists (54%), strength and conditioning coaches (17%), and medical staff (17%) such as physios and doctors. Performance analysts (5%) and other roles (7%) such as sport science analysts made up the rest of the group. Demographics of participants can be seen in Table 1. The majority of coach staff worked with English Premier League clubs (35%), whereas performance staff worked with English Championship clubs (38%), players were more evenly distributed across leagues. Furthermore, the majority of participants were responsible or played for first team or professional development phase groups (87%).

Importance of training data

Coaches and performance staff reported that sport science training data were 'somewhat important' and 'very important' in guiding their own practice, respectively (Table 2). In terms of guiding the coach's practice, players rated it 'very important' while performance staff suggested it was 'somewhat important'. All groups of respondents selected 'player fitness', 'injury prevention' and 'assessment of effort' as 'very important' with which sport science data contribute greatest to. Players and performance staff also reported 'planning training' as 'very important'.

Reflection and evaluation

The majority of coaches reported reflecting with other coaches either 4 to 5 times (38%) or >5 times (44%) per week whereas performance staff response were distributed between once per week through to >5 times per week (Table 3). When detailing when this typically takes place, coaches selected 'in the morning before training' (82%), 'no specific timing structure' (74%), 'immediately following training' (50%) and 'after concerning events' (47%) most frequently while performance staff selected 'in the morning before training' (59%), 'no specific timing

Table 1. Proportion of league clubs worked with, player age categories and years' experience by the participants. Also included are the ratio of proportion (C:PS; C:P; PS:P) and qualitative inference for the ratio.

	Coaches % (No.)	Performance % (No.)	Players % (No.)	Proportion Ratio	Qualitative Inference
During the 2018/19 season, what league does your current senior/first team compete in?					
Premier League	18 (6)	35 (28)	25 (15)	0.5; 0.7; 1.4	Large; Large; Small
Championship	38 (13)	18 (14)	16 (10)	2.1; 2.4; 1.1	Large; Large; Trivial
League 1	15 (5)	11 (9)	27 (17)	1.4; 0.6; 0.4	Small; Moderate; Large
League 2	9 (3)	11 (9)	24 (15)	0.8; 0.4; 0.5	Small; Large; Large
Other (e.g. National League)	21 (8)	24 (19)	8 (5)	0.9; 2.6; 3.0	Small; Large; Large
Which age group are you primarily responsible for?					
First Team	53 (18)	53 (41)	47 (29)	1.0; 1.1; 1.1	Trivial; Trivial; Trivial
Professional Development Phase	26 (9)	28 (22)	53 (33)	0.9; 0.5; 0.5	Small; Large; Large
Youth Development Phase	18 (6)	9 (7)		2.0	Large
Foundation Phase	0 (0)	0 (0)		0.0	Trivial
More than 1 age group	3 (1)	9 (7)		0.3	Very Large
Other	0 (0)	0 (0)		0.0	Trivial
How many years' experience do you have in your current/similar role in professional soccer?					
0–3 years	3 (1)	44 (34)		0.1	Extremely Large
4–6 years	0 (0)	21 (16)		0.0	Extremely Large
7–9 years	26 (9)	22 (17)		1.2	Small
10–12 years	26 (9)	9 (7)		1.2	Small
13–15 years	18 (6)	1 (1)		18	Extremely Large
More than 15 years	26 (9)	4 (3)		6.5	Large

Table 2. Mean (± SD) coach, performance staff and players responses to the Likert scale importance of sport science training data to influence practice questions, along with the mean difference, *p* values and 95% confidence intervals.

	Coaches (Mean ± SD)	Performance (Mean ± SD)	Player (Mean ± SD)	Clear 1-Point Diff on Likert Scale (Mean Diff; *p* Value; 95% CI)
How important do you feel sport science information, such as that collected from GPS tracking devices, is in guiding:				
Your own practice?	Somewhat important (3.3 ± 0.8)	Very important (4.0 ± 0.8)		No (−0.67; $p = 0.00$; −1.0 to −0.34)
Your coach's practice?		Somewhat important (3.4 ± 0.9)	Very important (3.6 ± 0.8)	No (0.22; $p = 0.14$; −0.07 to 0.53)
How important is the sport science data in contributing to the following:				
Planning training	Somewhat important (3.5 ± 0.8)	Very important (3.7 ± 0.9)	Very important (3.6 ± 0.9)	No (−0.21; $p = 0.53$; 0.66 to 0.24); No (−0.11; $p = 0.83$; −0.58 to 0.35); No (0.09; $p = 0.84$; −0.24 to 0.66)
Coach team selection	Not important (2.1 ± 1.0)	Not important (2.4 ± 1.0)	Somewhat important (2.7 ± 1.0)	No (−0.3; $p = 0.34$; −0.79 to 0.2); No (−0.58; $p = 0.22$; −1.09 to −0.07); No (−0.29; $p = 0.25$; −0.71 to 0.14)
Winning matches	Not important (1.8 ± 0.9)	Somewhat important (2.6 ± 1.0)	Somewhat important (3.0 ± 1.0)	No (−0.88; $p < 0.01$; −1.38 to −0.39); Yes (−1.29; $p < 0.00$; −1.8 to −0.78); No (−0.41; $p = 0.07$; −0.83 to 0.02)
Player retention	Not important (1.9 ± 1.0)	Somewhat important (2.6 ± 1.2)	Not important (2.4 ± 1.0)	Yes (−0.71; $p < 0.01$; −1.24 to −0.17); No (−0.43; P = 0.15; −0.99 to 0.12); No (0.27; P = 0.34; 0.17 to 1.24)
Player fitness	Very important (4.0 ± 0.8)	Very important (4.0 ± 0.9)	Very important (3.9 ± 0.9)	No (0.06; $p = 0.94$; −0.37 to 0.49); No (0.08; $p = 0.90$; −0.36 to 0.52); No (0.02; $p = 0.99$; −0.34 to 0.39)
Injury prevention	Very important (3.9 ± 0.7)	Very important (3.8 ± 0.7)	Very important (4.0 ± 1.0)	No (0.74; $p = 0.93$; −0.4 to 0.55); No (−0.05; $p = 0.97$; −0,54 to 0.44); No (−0.13; $p = 0.74$; −0.53 to 0.28)
Assessment of effort	Very important (3.7 ± 0.8)	Very important (3.6 ± 0.9)	Very important (3.7 ± 1.0)	No (0.15; $p = 0.73$; −0.31 to 0.61); No (−0.01; $p = 0.99$; −0.48 to 0.47); No (−0.16; $p = 0.62$; −0.55 to 0.24)

structure' (55%) and 'after concerning events' (49%) most frequently. Coaches found that the use of sport science training data in this reflective process was 'somewhat important' while performance staff viewed it as 'very important'. The most selected information coaches wanted to see to support reflection was 'high-intensity actions' (82%), 'work rate/intensity' (74%) and 'comparing physical outputs to what players do in a match' (59%). Similar responses were recorded for performance staff who also selected 'individual player workload' (77%) frequently.

Barriers to use

Coaches 'agreed' that 'too much information', 'poor communication from sport science department' and 'lack of a common goal' were barriers to using sport science data to inform their practice (Table 4). Performance staff, however, only 'agreed' that 'lack of a common goal' was a barrier for their coach.

Players perspectives of feedback

Most coaches (59%) and performance staff (63%) indicated that players could be affected in a positive manner following seeing their training and match data while approximately a third of both groups (coach = 35%, performance staff = 36%) suggested that players could be affected in both a positive and negative manner (Figure 1(a)). In response to whether players would alter their future behaviour as a result of seeing their data, the majority of coaches (94%) thought they would while most performance staff (75%) also thought they would (Figure 1(b)). Players most frequently selected 'total distance' (89%), 'high-speed running and sprint distances' (87%) and 'maximum speed reached' (73%) as the information they would like to see following a training session (Table 5). Players selected 'against players in your position' and 'against a typical 90-minute match' most frequently in terms of how they wanted to see training data compared following training. This information was most likely to be looked at if it was either 'pinned up in the changing room' or 'sent to your phone'. Players reported they were 'likely' to change their effort levels in response to both seeing their data after a session and seeing their data live during the session.

Discussion

Findings from the present study develop our knowledge of the use of training data within professional soccer. Stakeholders deemed training data as somewhat important to guiding their coach's practice, with 'high-intensity actions' and variables recognised by the coach as 'work rate/intensity' as most important. Furthermore, for the first-time, players perceptions of this practice were explored. To increase the prospect of behaviour change, players desired to see total distance, high-speed running and sprint distances. Finally, several barriers potentially exist such as communication and lack of a common goal result in limiting translational effects between data collection and training modifications.

Importance of training data

All stakeholders reported training data as at least somewhat important in guiding their coach's practices (Table 2). As

Table 3. Proportion of performance staff and coach's response to use of training data to evaluation and reflection, along with ratio of proportion (PS: C) and qualitative inference for the ratio. Also included mean (± SD) performance staff and coach responses to the Likert scale value of training data to evaluation and reflection, along with the mean difference, *p* value and 95% confidence interval (CI) for the difference.

	Performance %	Coaches %	Proportion Ratio	Qualitative Inference
How many times per week will you typically reflect and evaluate on your training sessions:				
With your coaching staff?				
None	11	0	0.0	Extremely Large
1	24	0	0.0	Extremely Large
2 to 3	31	18	0.6	Large
4 to 5	16	38	2.4	Large
More than 5	19	44	2.3	Large
With your sport science department?				
None	4	9	2.3	Large
1	9	38	4.2	Very Large
2 to 3	30	47	1.6	Moderate
4 to 5	20	6	0.3	Very Large
More than 5	36	0	0.0	Extremely Large
When does this typically take place?				
No specific timing structure (i.e. informal conversations)	55	74	1.4	Small
Immediately following training	20	50	2.5	Large
Later in the day	28	18	0.6	Moderate
In the morning before training	59	82	1.4	Small
Before a match	4	12	3.0	Large
After a match	35	15	0.4	Large
After concerning events (e.g. injury/poor performance)	49	47	1.0	Trivial
Other	7	9	1.3	Small

	Performance (Mean ± SD)	Coaches (Mean ± SD)	Clear 1-Point Diff on Likert Scale (Mean Diff; *p* Value; 95% CI)
How do you value sports science data in this process? For example, do you require to see the information prior to these discussions and use it as a focal point for which you can evaluate and make decisions on going forward?	Somewhat valuable (3.4 ± 0.8)	Very valuable (3.9 ± 0.8)	No (−0.5; P = 0.002; −0.8 to −0.2)

	Performance %	Coaches %	Proportion Ratio	Qualitative Inference
Work rate/intensity	79	74	0.9	Trivial
High-intensity actions (i.e. high-speed running)	94	82	0.9	Trivial
Analysis of individual drills	51	29	0.6	Moderate
Comparing physical outputs to what players do in a match	64	59	0.9	Trivial
Individual player workload	77	47	0.6	Moderate
Average workload by whole squad or playing position	54	21	0.4	Large
Fatigue response, such as how tired a player is due to a session	29	18	0.6	Moderate
Other	6	6	1.0	Trivial

expected and consistent with the literature (Weston 2018), given their responsibility of the physical attributes of players, performance staff reported training data of higher importance. All stakeholders reported that training data are deemed most important for player fitness and injury prevention (Table 2). This understanding suggests coaches likely consider the dose–response relationship when programming training loads to account for player fitness and injury risk (Manzi et al. 2013). This is as the 'dose' of training has potential to yield positive (i.e. fitness) and negative (i.e. fatigue) responses, which may be valuable for training design. This suggestion is further supported by all stakeholders deeming training data important to the planning process (Table 2). While research exists showing a dose–response relationship between training load and injury risk (Rossi et al. 2017), research examining training load and fitness measures reports little usefulness. For instance, unclear associations between high-intensity running distances and changes in intermittent running capacity were reported by professional soccer players across pre-season (Taylor et al. 2018; Rabbani et al. 2019). In contrast, several studies have reported associations between internal load measures provided by heart rate-based indices and changes in fitness (Akubat et al. 2012; Manzi et al. 2013; Taylor et al. 2018). Given the above, it could be suggested the effectiveness of training data feedback provided to coaches using measures of load solely from GPS on player fitness requires further research.

Reflection and evaluation

Reflection and evaluation of training sessions represent an ideal opportunity to feedback training data, and both coaches and performance staff reported that the data is valuable in

Table 4. Mean (± SD) performance staff and coach responses to the Likert scale barriers to feedback questions along with the mean difference, *p* value and 95% confidence interval (CI) for the difference.

	Performance (Mean ± SD)	Coach (Mean ± SD)	Clear 1-Point Diff on Likert Scale (Mean Diff; *p* Value; 95% CI)
What are the barriers in reducing your coach's use of training data to inform their practice?			
Lack of understanding	Neither agree nor disagree (3.4 ± 1.0)	Neither agree nor disagree (3.0 ± 1.2)	No (−0.6; $p = 0.01$; −1.1 to −0.2)
Information delivered in unsuitable format	Neither agree nor disagree (2.9 ± 1.2)	Neither agree nor disagree (3.0 ± 1.1)	No (−0.2; $p = 0.39$; −0.7 to 0.3)
Too much information	Neither agree nor disagree (3.1 ± 1.1)	Agree (4.1 ± 1.0)	No (0.8; $p = 0.01$; 0.3 to 1.3)
Poor communication	Neither agree nor disagree (3.1 ± 1.2)	Agree (3.7 ± 0.9)	No (0.6; $p = 0.01$; 0.1 to 1)
Lack of a common goal	Agree (3.6 ± 1.0)	Agree (3.6 ± 0.9)	No (0.1; $p = 0.82$; −0.4 to 0.5)
Takes too long	Disagree (2.5 ± 1.0)	Disagree (1.9 ± 0.9)	No (−0.6; $p = 0.01$; −1 to −0.2)
Impact on players	Neither agree nor disagree (2.6 ± 1.1)	Disagree (2.3 ± 1.0)	No (−0.4; $p = 0.12$; −0.8 to 0.1)
Not seeing benefits or seeing it 'work'	Neither agree nor disagree 2.8 ± 1.1)	Neither agree nor disagree (3.3 ± 0.9)	No (0.5; $p = 0.03$; 0 to 0.9)

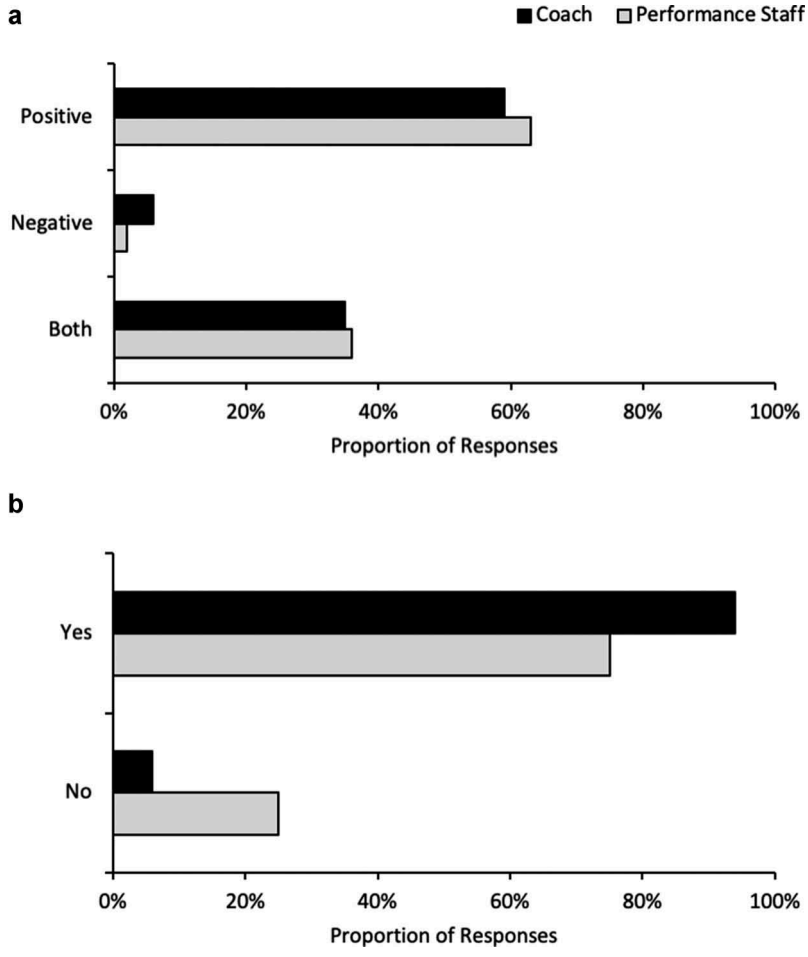

Figure 1. (a) Do you believe that players are mostly affected in a positive or negative manner by seeing their training and match data? (b) Do you think that players may alter their behaviour in training due to this? Coaches answers are presented in the black columns and performance staff answers in the light-grey columns.

reflection (Table 3). There was also agreement on what data coaches preferred and what performance staff were likely to report. Measures relating to high-intensity actions (Coaches; 82%, Performance; 94%) and work rate/intensity (Coaches; 74%, Performance; 79%) were most frequently selected (Table 3). This may be due to the observed increases in the physical demands of soccer. For example, from 2006 to 2013, soccer players from the English Premier League increased high-intensity sprint distances and actions by 30–80% (Barnes et al. 2014). These parameters may have been chosen as they allow

Table 5. Mean player response to the multiple-choice information feedback, along with mean (± SD) player response to the Likert scale on data on presentation of data.

	Player %
After training, what information would you like to see?	
Total distance	89
High-speed running and sprint distances	87
Heart rate information (i.e. time spent in 'red zone')	40
Accelerations and decelerations	31
Maximum speed reached	73
Other	4
How likely are you to look at your training data if it was presented to you by:	
Pinned up in the changing room	Likely (3.8 ± 0.5)
Pinned up in the gym	Neutral (3.2 ± 1.2)
Sent to your phone	Likely (4.3 ± 0.8)
Delivered in meetings	Neutral (3.4 ± 0.9)
Having seen your data after a training session, how likely is it that you will change your effort levels in the next day's training?	Likely (3.7 ± 1.0)
If you are able to see your data live in a training session, how likely is it that you will change your effort levels during the session?	Likely (3.9 ± 1.0)

coaches and performance staff to compare training and match loads (Kelly et al. 2020) which helps contextualise the data fed back to coaches.

Though coaches and performance staff deemed training data valuable, within-department reflection and evaluation occurred more frequently than inter-departmentally. This within-departmental reflection mostly occurred via morning meetings and informal conversation (Table 3). This finding is consistent with the literature (Stoszkowski and Collins 2016), which suggested that coaches prefer peer discussion as a method of learning. Typically, most departments do not share office space consequently, therefore limiting the opportunity for between-department discussion. This reduction in between-department discussion may reduce impact feedback of training data has in supporting coach learning, therefore, limiting impact on the coaching process.

Barriers to use

Though feedback of training data has shown to be effective, barriers exist that can reduce its efficiency. As can be seen in Table 4, coaches and performance staff were in agreement that a lack of a common goal was the main barrier to effective training data feedback. Research has consistently shown a relationship between injury and fatigue (e.g. Rossi et al., Thorpe et al. 2017) as well as fitness (e.g. Manzi et al. 2013; Taylor et al. 2018). Consequently, it could be suggested that both coaches and performance staff work together to reduce training load rather than increasing players physical output. If such actions conflict with the coach's philosophy (Stodter & Cushion 2017), this may present a barrier towards impact on the coaching process and thus it may be the responsibility of sport scientists to educate coaches to aid this adoption and use. A further barrier to feedback of training data from coaches is high volumes of information coupled with poor communication from performance staff which highlights the transitional gap between information and impact (Eisenmann 2017). Recently, a number of interventions have been shown to have a positive effect on quantity and quality of training data feedback (Thornton et al. 2019). For example, a colour coding system has been previously employed to reduce the volume of information to indicate an athlete's performance and availability (Robertson et al. 2017). Such delivery of feedback is crucial to the coaching processes and further research is needed to reduce these barriers.

Players perspectives of feedback

Crucial to the coaching process are the players themselves, as such, training data feedback provided to players should also be considered. This feedback can be promotion (positive) or change oriented (negative), and the effects of which depend on delivery method (Deci et al. 1999). Results showed the majority of coaches and performance staff thought players could be affected in a positive manner by seeing training data (Figure 1) whilst also suggesting players may change future behaviour following both concurrent and post-session feedback (Table 5), which has previously been observed in rowing (Lintmeijer et al. 2019) and weightlifting (Weakley et al. 2019). Furthermore, the data in Table 5 and Figure 1 support previous research from performance analysis where youth soccer players and rugby players reported video analysis as a useful reflection and learning tool to identify and improve on weaknesses (Francis and Jones 2014). This is the first study to explore how professional soccer players might respond to feedback of training data. Research exploring their attitudes and whether behavioural changes occur as a result of receiving feedback of training data would further develop this understanding.

A potential barrier to the use may be their understanding of training data relates to their performance. As can be seen in Table 5, total distance, total distance, sprint distance and high-speed running were considered most important to players. Despite acceleration variables being one of the most reported by performance staff (Akenhead and Nassis 2015), it was considered least important to players. In terms of how to feedback the training data, players preferred their data to be in comparison with players in a similar position, thus promoting competition and possibly motivation. The data is also most likely to be understood if it was sent to their mobile phone or pinned in the changing room, suggesting ease of access to players plays

a crucial role in the feedback process. These findings offer initial insights into players perspectives of feedback of training data and in doing so, may reduce barriers previously shown to result in poor engagement with the training monitoring process (Neupert et al. 2019).

Limitations

The present study had responses from 176 participants. Though higher responses tend towards findings with greater external validity (Baruch and Holtom 2008). This sample is low compared to the hundreds of coaches and performance staff together with the thousands of players within professional soccer and therefore must be acknowledged when generalising these results. To provide context for the surveys response rate, this number is similar to (Weston 2018; *n* =, p. 182) though more than (Akenhead & Nassis 2015; *n* = 41) in other studies that utilised surveys to examine stakeholder's perceptions of training monitoring. Furthermore, in this study, we used a convenience sample (i.e. personal networks) and did not approach all key stakeholders within English professional soccer. Though limiting a survey to one response per team ensures that the findings are not influenced by multiple responses from the same team (Harper et al. 2016). In the current study, more than one response was allowed given the large number of squads within each team in professional football. Consequently, the possibility for clustering of responses has been acknowledged though accepted so as to gain a greater environmental understanding. Finally, the focus of the present study was key stakeholder perceptions on feedback of training data collected via GPS. Professional soccer clubs use other methods to collect training data such as heart rate or rating of perceived exertion. Therefore, the data on the present study should not be generalised to all training data collected in professional football. Future studies should seek to understand perceptions and decision-making of key stakeholders (coaches, performance staff, players) on other methods of collecting training data.

Conclusion

The present study examined how the feedback of GPS training data is utilised to support decision-making in the coaching processes, as well as understanding players perceptions towards this training data. Training data are seen as an impactful and effective tool for use by all key stakeholders. Despite this, its use can be optimised by increasing opportunities for informal reflection, using less information, and improving communication of data. Further research is needed to examine feedback mechanisms of training data to coaches is needed.

Practical applications

All key stakeholders generally support the notion that feedback of training data plays a role in supporting the coaching process. Findings from the current study indicate that players would modify their behaviours based on the data fed back to them, therefore it is important for practitioners/coaches to understand their feedback preferences to increase the engagement. Further study is required on the translation between data collection, self-autonomous behaviour, and future physical performance in training. To improve the effectiveness of feedback of training data and its use to inform practice it is important to address the potential barriers that exist. It could be recommended that performance staff reduce the amount of information provided to coaches yet ensuring that the correct data to inform effective decision is included. One way to achieve this may be by adopting data reduction tools such as principal component analysis (PCA), a technique that reduces the dimensionality of data set (i.e. GPS data) that consists of a number of highly correlated variables. This technique has proved highly effective in reducing the complexity of training data in team sports such as rugby league (Weaving et al. 2019), yet data in professional soccer are currently missing.

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Data Availability

The data that support the findings of this study are available on request from the corresponding author (MA). The data are not publicly available due to restrictions (e.g. their containing information that could compromise the privacy of research participants).

Disclosure statement

The authors report no conflict of interest.

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Appendix

Table 6. Survey questions and possible responses for Coaches.

Question	Type of question	Possible responses
What is your current primary role?	Multiple Choice	• Manager • Assistant Manager • Coach • Assistant Coach • Other
Which league does your current senior/first team compete in?	Multiple Choice	• Premier League • Championship • League 1 • League 2 • Other (e.g. national league)
Which age group are you primarily responsible for?	Multiple Choice	• First Team • PDP • YDP • FP • More than 1 age group • Other
How many years coaching experience do you have in professional football?	Multiple Choice	• 0–3 years • 4–6 years • 7–9 years • 10–12 years • 13–15 years • More than 15 years
How important do you feel sport science training information, such as that collected from GPS tracking devices, is in guiding your coaching practice? For example, do you use this information to make decisions on the contents of your training sessions or to make decisions on the work required for certain players, etc.	Likert Scale	(1) Not important at all (2) Somewhat important (3) Important (4) Very important (5) Extremely important
How many times per week will you typically reflect and evaluate on your training sessions: (a) On your own or with coaching staff? (b) With the sport science department?	Multiple Choice	• None • 1 • 2–3 • 3-4 • More than 5
When does this typically take place?	Multiple Choice	• No specific timing structure – informal conversations with staff • Immediately following training • Later in the day • In the morning before training • Before a match • After a match • After concerning events such as player injury or poor performance • Other
How do you value sports science data in this process? For example, do you require to see the information prior to these discussions and use it as a focal point for which you can evaluate and make decisions on going forward?	Likert Scale	(1) Not valuable at all (2) Somewhat valuable (3) Valuable (4) Very valuable (5) Extremely valuable
From a physical perspective, which aspects of training information would you use to reflect/evaluate on your sessions?	Multiple Choice	• Work rate/intensity • High-intensity actions (i.e. high-speed running distance) • Analysis of individual drills • Comparing physical outputs to what players do in a match • Individual player workload • Average workload either by the whole squad or by playing position • Fatigue response such as how tired a player is due to a session • Other
How important are the following in contributing to designing your training sessions? (a) Previous experience as a player (b) Own coaching experience and intuition (c) Coaching courses and clinics (d) Watching other coaches (e) Advice from science and medical department (f) Sport science training data (g) Online, such as videos and blogs	Likert Scale	(1) Not important at all (2) Somewhat important (3) Important (4) Very important (5) Extremely important

(*Continued*)

Table 6. (Continued).

Question	Type of question	Possible responses
How important is the sport science data in contributing to the following? (a) Planning training (b) Team selection (c) Winning matches (d) Player retention (e) Player fitness (f) Injury Prevention (g) Assessment of effort	Likert Scale	(1) Not important at all (2) Somewhat important (3) Important (4) Very important (5) Extremely important
How strongly do you consider each of the following issues are in reducing your use of sport science data to inform your coaching practice? (a) Lack of understanding (b) Information delivered in an unsuitable format (c) Too much information (d) Poor communication from sport science team (e) Lack of a common goal in the use of the training data (f) Takes too long (g) Impact on players (h) Not being able to see its benefits or seeing it 'work'	Likert Scale	(1) Not strong at all (2) Somewhat strongly (3) Strongly (4) Very strongly (5) Extremely strongly
Do you believe that players are mostly affected in a positive or negative manner by seeing their training and match data?	Multiple Choice	• Positive • Negative • Both
Do you think that players may alter their behaviour in training due to this? For example, if a player is shown to have covered much less distance than players in a similar position, will they increase their output in the next training session.	Multiple Choice	• Yes • No

Table 7. Survey questions and possible responses for performance staff.

Question	Type of question	Possible responses
What is your current primary role?	Multiple Choice	• Sport scientist • Strength and conditioning coach • Medical staff (Physio, Doctor) • Performance analyst • Other
Which league does your current senior/first team compete in?	Multiple Choice	• Premier League • Championship • League 1 • League 2 • Other (e.g. national league)
Which age group are you primarily responsible for?	Multiple Choice	• First Team • PDP • YDP • FP • More than 1 age group • Other
How many years experience do you have in professional football?	Multiple Choice	• 0–3 years • 4–6 years • 7–9 years • 10–12 years • 13–15 years • More than 15 years
How important do you feel sport science information, such as that collected from GPS tracking devices, is in guiding: (a) Your practice? (b) Your coaches practice?	Likert Scale	(1) Not important at all (2) Somewhat important (3) Important (4) Very important (5) Extremely important
How many times per week will you typically reflect and evaluate the coach's training sessions: (a) With the coaching staff? (b) With the sport science/medical department?	Multiple Choice	• None • 1 • 2–3 • 3-4 • More than 5
When does this typically take place?	Multiple Choice	• No specific timing structure – informal conversations with staff • Immediately following training • Later in the day • In the morning before training • Before a match • After a match • After concerning events such as player injury or poor performance • Other
How do you value sports science data in this process? For example, do you require to see the information prior to these discussions and use it as a focal point for which you can evaluate and make decisions on going forward?	Likert Scale	(1) Not valuable at all (2) Somewhat valuable (3) Valuable (4) Very valuable (5) Extremely valuable
From a physical perspective, which aspects of training information would you typically report back to coaches to support their evaluation of their sessions?	Multiple Choices	• Work rate/intensity • High-intensity actions (i.e. high-speed running distance) • Analysis of individual drills • Comparing physical outputs to what players do in a match • Individual player workload • Average workload either by the whole squad or by playing position • Fatigue response such as how tired a player is due to a session • Other
How important do you believe your coach values the following as sources of information for designing training practices? (a) Previous experience as a player (b) Own coaching experience and intuition (c) Coaching courses and clinics (d) Watching other coaches (e) Advice from science and medical department (f) Sport science training data (g) Online, such as videos and blogs	Likert Scale	(1) Not important at all (2) Somewhat important (3) Important (4) Very important (5) Extremely important
How important is the sport science information in contributing to the following? (a) Planning training (b) Team selection (c) Winning matches (d) Player retention (e) Player fitness (f) Injury Prevention (g) Assessment of effort	Likert Scale	(1) Not important at all (2) Somewhat important (3) Important (4) Very important (5) Extremely important

(*Continued*)

Table 7. (Continued).

Question	Type of question	Possible responses
How strongly do you consider each of the following issues are in reducing your coach's use of sport science data to inform their coaching practice? (a) Lack of understanding (b) Information delivered in an unsuitable format (c) Too much information (d) Poor communication from sport science team (e) Lack of a common goal in the use of the training data (f) Takes too long (g) Impact on players (h) Not being able to see its benefits or seeing it 'work'	Likert Scale	(1) Not strong at all (2) Somewhat strongly (3) Strongly (4) Very strongly (5) Extremely strongly
Do you believe that players are mostly affected in a positive or negative manner by seeing their training and match data?	Multiple Choice	• Positive • Negative • Both
Do you think that players may alter their behaviour in training due to this? For example, if a player is shown to have covered much less distance than players in a similar position, will they increase their output in the next training session.	Multiple Choice	• Yes • No

Table 8. Survey questions and possible responses for Players.

Question	Type of question	Possible responses
Which league does your current senior/first team compete in?	Multiple Choice	• Premier League • Championship • League 1 • League 2 • Other (e.g. national league)
Which age group do you primarily play for?	Multiple Choice	• First Team • Under 23 • Under 18 • Other
How many years have you been playing professional football?	Multiple Choice	• Less than 5 years • 6–10 years • More than 10 years
How important do you feel sport science information, such as that collected from GPS tracking devices, is in guiding your coaches' practice?	Likert Scale	(1) Not important at all (2) Somewhat important (3) Important (4) Very important (5) Extremely important
Typically, data such as distances in different speed zones is collected from yourself during training using GPS units. How important do you think this data is to each of the following? (a) Planning training (b) Team selection (c) Winning matches (d) Player retention (e) Player fitness (f) Injury Prevention (g) Assessment of effort	Likert Scale	(1) Not important at all (2) Somewhat important (3) Important (4) Very important (5) Extremely important
After training, what GPS information would you like to see?	Multiple Choice	• Total distance • High-speed running and sprint distances • Heart rate information • Accelerations and decelerations • Your maximum speed reached
How likely are you to look at your training data if it was delivered to you in each of the following ways? (a) A comparison of what you achieved on the day against your average for that day previously, i.e. your output on the day before a match against your average for that day previously (b) A comparison against players in your playing position (c) A comparison against all players in your squad (d) Your output in individual drills (e) Your output compared to a typical 90 minute match	Likert Scale	(1) Not likely at all (2) Somewhat likely (3) Likely (4) Very likely (5) Extremely likely
Having seen your data after a training session, how likely is it that you will change your effort levels in the next days training? For example, if you are shown to have covered much less distance than players in a similar position, will this motivate you in future training sessions? (a) Pinned up in the changing room (b) Pinned up in the gym (c) Sent to your phone (d) Delivered in meetings (e) Other	Likert Scale	(1) Not likely at all (2) Somewhat likely (3) Likely (4) Very likely (5) Extremely likely