Player Perceptions of Sports Science Monitoring Practices in Elite Academy Football

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Abstract

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Introduction: Professional football players are subject to several different sports science and performance monitoring practices in an attempt to give applied practitioners a sound understanding of what training load coaches are prescribing to their players, but also to receive feedback on how players are reacting to the given training stimulus. To the writer's knowledge however, little to no information exists in the current literature base that discusses what perceptions players themselves have of these monitoring practices. **Study Purpose**: The objectives of this study were to 1) Give athletes the opportunity to share experiences and feedback their own thoughts on monitoring methods, 2) Give applied practitioners feedback on how to successfully implement sports science monitoring practices from the opinion of the players themselves, 3) Provide evidence in an ongoing discussion surrounding the use of data in professional sport and inspire further study in the domain. **Methods:** 4 football players (age 17-21) from the development squad of a category 1 professional football academy took part in a 30-minute, semi-structured, focus group interview led by the head researcher to share their experiences of monitoring practices within their football academy. Thematic Analysis was then used to identify topics for wider discussion, and feed on recommendations to applied practitioners in the field and for further study. **Results:** Players appear to show a greater understanding and adherence to methods that are collected from them daily as opposed to practices that are more sporadic in nature. Player responses also highlighted the importance of player education regarding monitoring uses and the theory behind them in order to maximise adherence and limit negative perceptions of the practice or the practitioner. **Conclusion:** It is recommended that in order to help improve player perceptions of sports science monitoring practice that: 1) The monitoring methods are used as an educational tool for players. 2) This information is readily available to players should they wish to view it. 3) The information collected is used to inform practice or cause tangible change where possible. Indeed, these results reflect the reality of monitoring practices within one football academy and more research should be conducted with larger and more varied data sets to further investigate the perceptions of players more broadly in professional football.

Key Words: Monitoring, Football, Soccer, Subjective, Player Feedback

Introduction

Association football, or soccer, is a multi-billion-pound industry. Influential and global media company Forbes reported this year (2023) that two of the world's most successful clubs had reached over $6 billion dollars in total value and rank the average value of the world top 30 clubs at $2.17 billion. The astronomical value of these football clubs is of course largely as a result of off the pitch techniques and plans that generate club income (Horky. T. 2021), but innately, the popularity of these football clubs and ability to generate such money is heavily reliant upon on-pitch performance (Weimar, D. 2019).

As result, clubs pump increasingly large sums on money into player wages and player operations to help increase the chances of team success (Gerhardts et al. 2017). Consequently, players themselves become an expensive commodity, and clubs pour increasing time, money and research into keeping players fit enough to play multiple matches per week, and minimise the probability of players picking up significant time-loss injuries. A key method to do this in particular is through the extensive monitoring of player training load that is prescribed by the coaching staff and subsequently the player response to the prescribed stimulus. Then using this information to alter the training dose throughout the training week to ultimately prepare the players effectively to peak during match play. Some writers have theorised that the creation of the sports science discipline and the use of technology to maintain peak physical state as one that is more for the financial wellbeing of a football club as opposed to for the sake of benefitting on field performance (Kennedy et al. 2016).

Over recent years applied researchers in the sports science and performance space have put extensive amounts of time and energy into improving the player performance technology (Beiderbeck et al. 2023), monitoring processes and investigate reputable insights that can be drawn from these methods. More recently, a trend is also beginning to identify the soft skills that are required to not only monitor information correctly, but also to feed forward the relative information accurately and help key decision makers in the sport (Brink et al. 2018), i.e., the coaching staff, to make sense of the plethora of information that is provided.

Interestingly however it would appear that far less attention has been afforded to the athletes and players that are subject to this explosion of testing measures and procedures. The curiosity that has fuelled this project is the result of observation within the applied environment. As an applied practitioner working within a professional football club, I can count a minimum of four separate incidences daily in which separate tests, questionnaires or tracking information is collected on an athlete by applied sports science staff alone. Within those separate entities, each medium of feedback can give hundreds of data points, all stored, explored and analysed by the performance department to help make sense of how the body is reacting to the prescribed training stimulus. Upon scouring the literature, I have found it difficult to find supporting evidence that suggests that players or athletes themselves respond well to this burden of testing. Or less still, whether athletes had even been consulted on the matter. It seems paradoxical to me that methods of monitoring that are in place solely for the benefit of the athlete are used so freely before the community has even

discussed how players themselves may perceive these practices. Or what sort of psychological toll a round-the-clock monitoring system could have on professional athletes.

Ultimately, this research project has not been fuelled with a hypothesis in mind and it is exploratory by nature. Observations of the applied environment have given me the impression that player's experiences of sports science monitoring practices would be largely negative. Or believe that the practices are a necessary evil. A practice that has become so institutionalised within professional sport that it is accepted as a prerequisite of the training regime. But the reality remains that in a formal, scientific setting, to my knowledge athletes have not yet been given the platform or opportunity to share their own experiences of monitoring practices, share how they think it may or may not have benefitted their own preparation. The lessons that could be learnt from listening to our athletes could provide information on how to improve more relationship-dependant variables such as player buy-in or improve adherence to tests, which consequently can improve the validity of some of the meaures that practitioners choose to monitor. But more than that, morally I feel practitioners should take upon the moral obligation to investigate the more personable effects that objective monitoring is having on players. And ultimately spark conversation and debate that considers psychological player welfare alongside physical status when providing best practice performance support in an applied football setting.

Review of the Literature

Chapter 1: Playing Demands

Football is an invasion-based game requiring repeated bouts of high intensity physical activity intertwined with tactical, technical, and other physical factors (Bangsbo, J, 2014). Due to the nature of invasion based tactical games, the demands placed upon players become entirely dependent on a number of tactical factors such as playing formation, playing style and playing position (Abbott et al. 2018, Ariol-Serrano et al. 2021).

It remains the world's most popular sport, played at differing levels of ability both professionally and at amateur levels. Whilst the rules and regulations of the game remain the same throughout these different playing levels, the physical demands of elite football in comparison to it's sub-elite, junior and amateur level differ greatly Bradley et al. 2010, Reynolds et al. 2021, Trecorci et al. 2018).

Not only in football, but in other team-based invasion sports it has been found that one of the key differentiators between elite and sub-elite performance is the volume of high intensity activity completed by players during games (Young et al. 2018, Kelly et al. 2019). Citing that the higher the level of competition, the greater the volume of these intensity metrics. Moreover, studies have also suggested the same differences also occur in women's variations of the sports (Clarke et al. 2019).

Where it is found that these high intensity bouts only make up less than 15% of the total distance travelled during match play (Bradley et al. 2009), similar to that of other invasion games such as basketball which also requires high intensity activity for around 15% of the game (Koyama et al. 2022), some observational studies have even suggested trends between the volume of these actions and performance outcomes during games. Namely that the distances covered at high intensities were often higher when teams won matches (Andrzejewski et al. 2016). Whilst it should be noted that the volume of these metrics is often affected by the tactical style dictated by a team's coaching staff or management team and not necessarily a bi product of players being capable of performing to these physical levels.

To further support this claim, the demands of football at an elite level continue to develop with time. Contemporary research (Tuo et al. 2019) tells us that on average the professional player completes almost 350m (2810m vs 2492m) more of High-Speed Running (HSR) per match compared to 10 years prior (Bradley et al. 2009) but retain similar total distance (TD) requirements. Therefore, cementing the idea that the physical demands of the game have developed to create a reliance on more intensive actions during match play.

Perhaps more importantly however than the ability to complete these high intensity actions, is the ability to allow the body to recover and repeat the high intensity bout multiple times during a game (Gabbett & Mulvey. 2008). The repeated nature of high intensity, football specific actions require a high rate of anaerobic energy turnover during match play (Bangsbo, J. 2014). As an unwanted product of this demand, the body increases its lactate accumulation and therefore can have implications on the

body's recovery time – previously suggested to require around 48-72 hours for the body's fatigue markers to return to normal (Nédélec et al. 2014, Djaoui et al. 2016).

In addition to more physically demanding match play, an increase in the financial sector of the sport has led to a more congested match schedule. The increased marketisation of the sport has led to the increases in match incidence across multiple competitions as well as a less uniform playing schedule, often leaving less time for recovery and more controlled training between games. These games can also demand the added complication of domestic and international travel which further decreases the opportunity to manipulate training schedules. Whilst competing across these different competitions can be more lucrative financially, it is suggested that the increase in match play does put players at a greater risk of developing both contact and non-contact injuries (Ekstrand et al. 2011).

The European football governing body, UEFA, run a continent-wide injury surveillance study, to identify trends and changes in the demands the the game is having on its players. A 2023 (Ekstrand et al.) study examining solely injuries to the lower extremities found that in comparison to the previous hamstring related UEFA club study (2013) the incidence and burden of hamstring injuries over the past 8 seasons had increased significantly. With the proportion of all injury absence days caused by hamstring injuries having increased from 10% to 20%. Confirming previous theories suggesting that key risk factors for hamstring injury include extensive running at high speeds and also suggested that 50% of all hamstring injuries in football occurred during match play. Most likely due to the chaotic and extremely taxing nature of the games themselves compared to the more controlled nature of training. This study, in combination with a previous UEFA study conducted two years previous (Ekstrand et al. 2021), which suggested that as a whole that injury incidence decreased in training and matches over an 18 year surveillance period, suits the narrative that whilst clubs and practitioners are now better understanding and controlling the demands placed on players during training to reduce the risk of injury, the increases in high intensity match demands are still causing significant time-loss.

Some observational studies have suggested that players that partake in two or more games per week as opposed to those that only play in one are over six times as likely to develop an injury (Dupont et al. 2010). Furthermore, the act of performing multiple games every week for extended periods of the season is thought to lead to symptoms of chronic fatigue, an issue known to influence both athletic performance and an increase in injury risk (Nédélec et al. 2012). As a result, clubs have become more invested into recovery strategies and monitoring methods to help prevent these injuries from occurring. Some of the theories surrounding the dosage of training and how they are monitored will now be discusses in the subsequent chapters of this thesis.

Chapter 2: The Need for Systematic Training in Football

Traditionally in football, teams perform in competition at least once a week at the weekend over the course of a 40+ week season. Naturally, this then provides practitioners with 6 other days of the week that they are free to manipulate and change to ensure that players are ready to reach peak performance in time for the following competition match.

As discussed in chapter one, an ever-growing competition schedule has inevitably created weeks of the season with multiple matches, and increased the overall demand of competition play for teams and their players. As such, it is as important as ever that applied practitioners are able to monitor and manipulate training and balance the target of promoting physiological adaptation during the season with ensuring players are fresh enough to perform maximally multiple times every week.

Periodisation

The manipulation of training is quantified through a number of different monitoring methods, that will be discussed later in the following chapter. But essentially, this occurs through the cyclical planning and manipulation of training load. Training load is defined as “the cumulative amount of stress placed on an individual from multiple sessions and games over a period of time” (Gabbett et al. 2014).

In Olympic sports, and those that require a short competition phase, practitioners are afforded lots of time and space to plan the training process to ensure that the athlete is able to perform at the highest level at predetermined points in time. The process of structuring training practices with this greater goal in mind is known as periodization. Defined as an ongoing, evidence-based reflection process that is used to evaluate the current training status of an athlete and inform future program development (Haff, G .2021). Essentially, it is the breaking up of a larger training calendar into defined training periods or units (Issurin, v. 2008).

The cyclical nature of this manipulation occurs weekly (microcycle), monthly (mesocycle) and yearly (macrocycle) (Matvyev, L. 1977) which allows practitioners and coaches to appropriately train disciplines at certain times of year and allow for peak performance outcomes during competition time. Block periodisation for example, a method that has been successfully employed throughout the individual sporting landscape (Rønnestad et al. 2014, Marques et al. 2017), is the method viewing a year’s training plan with a long-sighted goal in mind.

Bompa (2015) categorises the yearly training plan into the Preparatory, Competitive and Transition phases. The work of Bompa is more closely aligned with purely strength training principles, but over time, sport specific and different energy system specific derivatives of this work have been tried and tested to help push the boundaries of sports performance.

Contrary to Olympic sports, football maintains a longer competition phase (in Europe lasting between August and May), and therefore provides slightly different challenges to those discussed in early periodisation theories.

Football Specific Planning

In elite football, with competition occurring ever week, it becomes imperative that the microcycle training structure is altered effectively in order to train a number of motor abilities that are all dependent upon particular energy systems and all have different rates of recovery, whilst also ensuring that athletes peak at the right time for competition each week (Bompa, 2015). According to Bompa (2015) it is important that during any given microcycle, the amount of training load placed upon players is altered to help create four distinct phases within the training week:

The Start-Up

The Strength/Conditioning Phase

The Taper

Competition

Figure 1 from Los Arcos et al. (2017) shows the periodization structure of the starting players in an elite football team playing in the Spanish first division, La Liga, faced with one game in seven days. In line with the work of Bompa, the sRPE-TL (an internal monitoring method multiplying a subjective feedback score related to the difficulty of training with the total time of training) suggests the overall training load will increase from the beginning to the middle of the week, before completing a taper for the last two training days prior to match play. While there is no consensus of what systematic training structure is the most effective, many methods opt to use a similar model of tapering the overall stress on the body towards the end of the week.

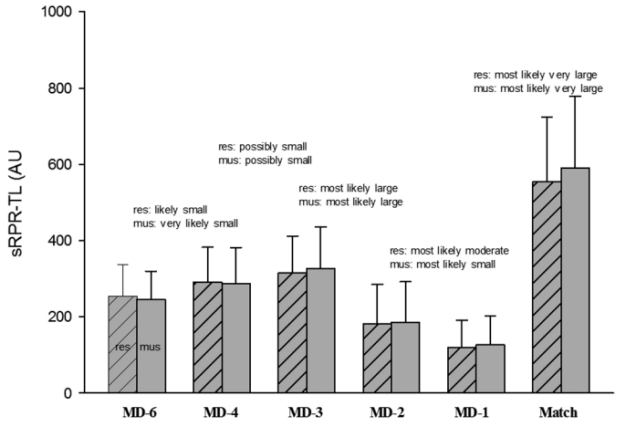

Figure 1 - Los Arcos et al. 2017

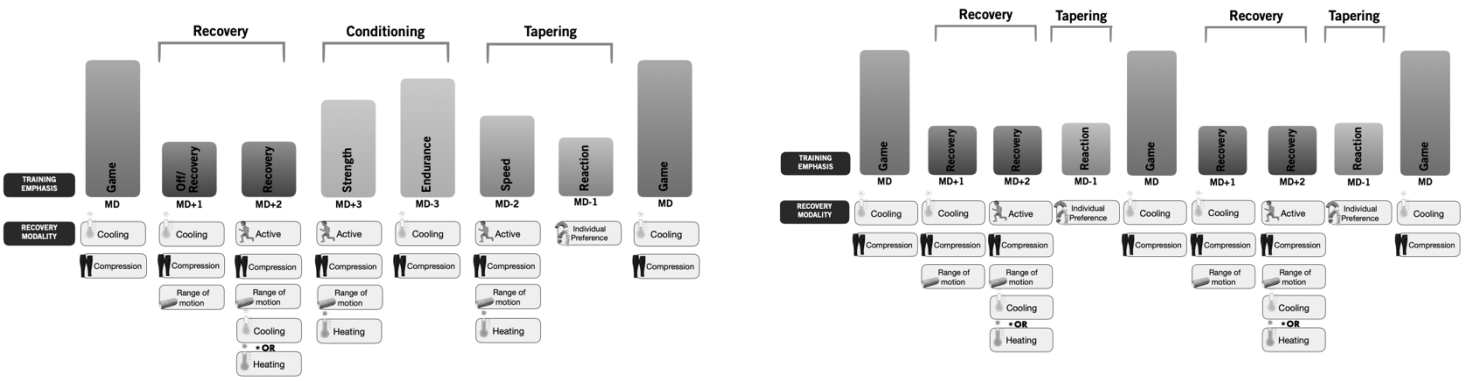

Figure 2 – Gregson et al. 2022

Not only for performance benefits during competition, but it has also become equally important that periodization models are planned meticulously to help mitigate the risk of non-contact injury. For example, in an attempt to further quantify the planning of weekly training load in team sports, Tim Gabbett created the Acute:Chronic work ratio. Whilst it's validity is contested fiercely throughout the literature, Gabbett argues that if the acute load (last 7 days) of an athlete exceeds that of their chronic load (last 4 weeks) at a rate of 1.4-1.9, it puts the athlete at significant risk of injury. A 2020 systematic review on the topic found the ratio to be a valuable tool for monitoring overall workload and its relationship with injury risk but concluded that "does not translate into the ability to predict the occurrence of an injury." (Griffin et al. 2020). Therefore, highlighting the importance of training monitoring and planning taking a multi-factorial approach of many different measures to ensure the best-practice decision making can be followed.

Further complicating matters in the modern game, is the need to now compete across a number of different competitions and at varying time of day and at varying frequencies due to broadcasting requirements. As a result, more often than not, professional clubs will compete in multiple games each week. Providing less time to manipulate training to promote physiological adaptation and increased exposure to high demands at pre-determined times.

The tables below (Figure 3) show the planning of training principles for each day for an elite football team, and the differences between a one and two game week (Strudwick, T. 2016). The introduction of a second game in the week places further impetus on recovery during the training cycle, as it is now imperative that practitioners do not only periodise training stimulus, but also recovery strategies during each weekly microcycle, as seen in Figure 2 (Gregson et al. 2022).

Table 12.4 Planning: One Game Per Week

	Playing squad	**Nonplaying squad**
Sunday	Rest or recovery	High-intensity aerobic, speed endurance
Monday	Moderate- to high-intensity aerobic	Moderate- to high-intensity aerobic
Tuesday	High-intensity aerobic	High-intensity aerobic
Wednesday	Speed endurance	Speed endurance
Thursday	Technical, tactical, individual	Technical, tactical
Friday	Reactive speed, tactical	Reactive speed, tactical
Saturday	Game	Rest

Table 12.5 Planning: Two Games Per Week

	Playing squad	Nonplaying squad
Sunday	Recovery	High-intensity aerobic, speed endurance
Monday	Moderate-intensity aerobic, tactical	Moderate-intensity aerobic, tactical
Tuesday	Game	Rest
Wednesday	Recovery	High-intensity aerobic, repeated sprint
Thursday	Moderate-intensity aerobic, individual	Moderate-intensity aerobic
Friday	Reactive speed, tactical	Reactive speed, tactical
Saturday	Game	Rest

Figure 3 - Training principles by training day in professional soccer (Strudwick, T. 2016)

Anderson et al. (2016), compared the change in training dosage for a premier league team when faced with one, two and three game weeks respectively. Supporting the theory of the end of week taper leading into competition play. For example, in a one game week, Anderson found clear evidence of progressive de-loading on days 5 and 6, when matchday is day seven. And observed the hardest training day to take place during the middle of the training week, on day 4. This further supports similar loading methods discussed in this chapter and suggests many clubs choose to include a tapering phase into their weekly microcycles in order to appropriately prepare for match play.

Conversely, when faced with the prospect of two or even three matches in one week, naturally, practitioners lose the ability to be more proactive with their training stimulus and are forced to become more reactive to the physiological response of these games. Figure 3 shows the removal of the previously discussed “conditioning” phase from the training schedule, with increased focus on recovery after games. Similarly, this is consistent with the findings of Anderson et al. (2016) when faced with two or three game weeks, with on pitch training load significantly reduced from the one game week model, but weekly total volume increasing as a result of the increased game time.

Dosing High Speed Actions

As discussed in the previous chapter, the majority of non-contact injuries in football occur while running or sprinting (Ekstrand et al. 2023). Hamstring injuries in particular, are often attributed to acute spikes in high muscle recruitment activity, such as high-speed running or sprinting (Malone et al. 2017), and therefore the chronic management of this dosage, provides a protective effect against muscular injury (Duhig et al. 2016).

When it comes to in-season programming, the ability to anticipate weekly high-speed dosages is very important. This is because all programming must consider the time between sessions and previous/prospective match play, in order to minimise the fatiguing aspect of highly taxing neuromuscular actions (Buchheit, M. 2019). Furthermore, the importance of accurately monitoring this information is vital for an applied sports scientist or applied practitioner, given the relation between minimising injury incidence and overall team performance (Hägglund et al. 2013).

To help visualise the extent to which high speed and sprinting actions are discussed and controlled in professional soccer a 2023 systematic review (Gualtieri et al. 2023) found that on average for high-speed running distance per week, players are usually exposed to between 0.2-2.3 times the match load during any given training week, with 0.03-1.3 for sprint distance. Conversely, for metrics not associated with high-speed actions such as total distance, acceleration and deceleration actions, it is suggested that players face up to four times their match load for these metrics in any given week. This gives a clear indication that high speed actions continue to be closely monitored or dosed in a professional training week.

Where it is vital that these dosages are applied through previously tested, evidence-based models. More recent literature has tried to dose high speed and high intensity actions into training relating to the most intense periods from match play and using these periods to inform training drill design. The individualised nature of this method to almost replicate match actions and their physical outputs has provided the opportunity to prepare the musculature quite literally for the exact demand that could be demanded during match play.

Indeed, it is also important to note that where ultimately the goal of the training process is to prepare players for the demands of match day, over the course of the full season, match play becomes a very important part of the overall training process (Morgans et al. 2018) and should also be considered an opportunity to provided appropriate stimulus to gain training adaptation. Though, the match-to-match variability can be great in relation to physical demand, particularly in regards to intensity metrics (Gregson et al. 2010), meaning a reliance on match play to always provide the appropriate stimulus can be risky.

It becomes completely imperative, then, that the training load placed onto players is accurately monitored and quantified through a multitude of monitoring methods. In the following chapter, I will discuss some of the most common methods employed in professional soccer and discuss their usefulness in the current applied climate.

Chapter 3: Monitoring Practices in Sport

Monitoring Training Load

As discussed in the previous chapter, appropriately delivering systematic training induces a functional adaptive response from the body (Impellizzeri et al. 2019). And as such, in order to ensure that training itself is systematic, planned and delivered appropriately, it is well within the interests of practitioner to objectively monitor or control the training dosage to ensure that beneficial adaptations can take place. Or as suggested by Carling et al. (2008), “a thorough understanding of the physical demands of soccer via information on player work rates is required so that optimal training and preparation strategies can be constructed”.

The method of monitoring training or playing stimulus through load monitoring is then generally categorised into two subsections: internal and external load. External load is defined as the physical work that has been prescribed in the training plan (Impellizzeri et al. 2005) and naturally is dependent upon the exercise taken place. An external loading stimulus can be categorised as the total tonnage of weight lifted in a gym-based program or in team-based field sports can also be a multitude of metrics that tell the story of how far and how fast the body has travelled during a training session or match play. Versus internal load, a measure that is relative to the athlete, and relates to the biological stressors placed on the body during exercise (Bourdon et al. 2017).

In this chapter I will discuss some of the most common monitoring practices that players are subjected to in professional soccer, both for internal and external load monitoring.

External Load Monitoring –

GPS Data:

Typically, in elite football, the most commonly used external load monitoring device used are GPS systems (Weston, M. 2018). As previously mentioned, GPS systems are used to tell the story of physical movement during exercise. The devices are typically worn on the upper back and transmit radio signals to satellites that are a part of the Global Navigation Satellite System (GNSS). These signals then transmit the physical position of the unit (global latitude and longitude) at a high frequency to give information surrounding the speed and distance of travel. Though other external monitoring tools are used, such as optical tracking systems, a method that makes use of a number of cameras based around a playing environment that record the movement of athletes (Clubb and Murray, 2022). GPS data remains a popular method due to being easy to travel with and requiring no set up at different locations besides taking a GPS unit itself.

It's use in sports performance is highlighted in its exponential increase of GPS related sports research since the first recorded paper on the matter in 2001 (Larsson et al.). Particularly over the past 10 years (Malone et al. 2018). Malone et al. found from an online database search that studies focused on the use of GPS monitoring in an

applied sports setting had risen from a rate of less than 10 per year to 75 studies per year over a 10 year period between 2005 and 2015. Its importance therefore cannot be understated.

In team sports, the most common metrics collected have been acceleration and deceleration at different velocities, total distance, high-speed distance, sprint distance and metabolic power. Buchheit and Simpson (2017) have discussed the different levels of metric collection from all external monitoring practices relating to athlete movement and how they inform practice. In summary, it was discussed that at the base level all metrics from tracking systems are able to track distances covered at specific velocity zones. As a result this helps inform practitioners to create an activity profile which will change from session to session over the course of a season. More complex technologies are then used to assess changes in velocity in acceleration and deceleration phases, as well as monitor changes of direction, which helps to further inform game demands and drill design. With technology that is more complex still collecting information from events deriving from inertial sensors or accelerometers that can help to identify fatigue within individuals.

A key benefit of GPS tracking is that it's use is allowed during competition, and therefore allows practitioners to accurately quantify the external demands of match play, and the reverse engineer its demands to manipulate training sessions train to a certain percentage of match play.

Optical Tracking:

One of the first objective motion analyses of soccer was completed by Professor Tom Reilly in 1976. The study included a manual coded notation system of a single players movements during a match (Reilly, T. 1976). With significant advances in technology over recent years the accuracy and validity of monitoring playing demands in elite football has naturally improved. Methods such as optical tracking – the method of using camera systems around a playing environment to record the positions of objects and their movements over a given time span – have been implemented within elite football since the mid 1990's (Clubb and Murray, 2022).

Benefits of the method have included that of having no direct contact with the athlete themselves, and will have little to no physical impact on the exercise itself. Though the nature of tracking via an optical system during match play but a separate method during training can cause practitioners issues regarding accurately combining external loading metrics from two different sources. For example, if collecting via optical tracking sources for match play and GPS data during all training sessions, it can become difficult to accurately compare training with match outputs due to the different methods of collection. Generally, in professional soccer, optical tracking would only be used during match play due to logistical issues around installation at training centres, and so practitioners must weigh up the value of zero player interference on match day with the validity of the data collection when choosing external load methods to use in their sports science and performance provision.

Internal Load Monitoring –

Where the previously mentioned monitoring methods have been used to try and quantify the playing demands of the sport, it is also important that practitioners are able to accurately monitor the athlete's response to these playing demands. Generally, this comes in the form of internal training load monitoring. One of the key differences of course between internal and external load, is that internal load is influenced by several individual factors such as individual characteristic, psychological status, health, nutrition, genetics and the playing environment (Impellizzeri et al. 2019).

Session RPE

According to Borg (1998), perceived exertion is essentially how hard or easy it feels to breathe or contract the working limbs during exercise. This can be quantified using the Rate of Perceived Exertion (RPE). A number attributed to the magnitude of effort an individual has perceived to exert at any given time during physical activity.

Borg (1985) suggested that a scale for perceived exertion should be based on a scale of 6-20, and one that increased linearly with stimulus intensity. Though over time different iterations have been suggested often practitioners operate with customised scales of varying degrees, it is suggested that these modified scales should be avoided in athlete monitoring (McLaren et al. 2022) to maximise the reliability of the measure. Simply then, to gain a value for session RPE, the athlete is asked to give a value to the desired scale during that session. As a result, session RPE is collected retrospectively, and it is important that the value is collected as close to the end of the training session as possible to negate effects of perceiving the session differently once given the opportunity to recover. The measure can be further developed by multiplying the feedback given by the duration of the training session in minutes to gain sRPE Training Load (sRPE-TL).

Globally, sRPE or sRPE-TL is a useful tool for understanding how an athlete may have tolerated the total load of a session, but doesn't accurately reflect the specific demands of certain exercises (McLaren et al. 2022), for example the more specific demands of isolated musculature. Once again, the subjectivity of the method also relies on the athlete themselves to give a truthful and accurate account of training for the result to be effective. Ultimately, particularly in the case of subjective feedback, psychological factors are a key influence in the feedback process (Marcora and Staiano, 2010). For example, the perceived effort of exercise could be affected by energy or tiredness, mood and emotions (Ekekakis, P. 2012). Or more personal traits that an athlete may portray, such as extraversion or a psychological resistance to pressure, criticism or stress. Suggesting that individuals with more positive affect phenomena is associated with lower perceived exertion (Hall et al. 2005., Coquart et al. 2012.).

Though generally, due to its low cost and more individualised feedback form, sRPE has been collected widely throughout the sports performance landscape at a variety of competition levels for more than 20 years.

HR Monitoring

Heart Rate Monitoring (HRM) and heart rate variability (HRV), the measure of the variation of beat-to-beat intervals over a specific period of time, have become metrics that are often a staple of internal load monitoring in the field of human performance (Buchheit, M. 2014).

Given the growing inclusion of heart rate monitoring software into modern technological products, HR and HRV monitoring has never been more accessible. Generally speaking, the methods used to detect HR fall into one of two categories electrical (ECG) or optical (photoplethysmography) (Jamieson, J. 2022).

More useful to sports scientist and fitness coaches, however, is the way in which heart rate is analysed during training. Most commonly, the heart rate value (given in beats per minute (BPM)), will be categorised into one of three to five zones derived from a percentage of an individual's absolute maximum heart rate. Coaches can then plan training around completing a specific amount of time within each specific work zone to promote physiological adaptations.

With the overall objective of a physical training program being to promote positive change in physiological capacity, the monitoring of the hearts rhythm during exercise remains a crucial tool for identifying whether the body has improved at becoming a more efficient in regard to meeting the physiological demands of the chosen exercise.

Response Feedback

Further still, where practitioners can quantify the demands placed on the body through the previously mentioned monitoring methods, the same arbitrary TL will naturally evoke a different response from each athlete due to interpersonal differences in physiological makeup or musculature. As a result, it also remains vital that practitioners are able to monitor the individual responses that athletes have to a given training stimulus.

Wellness/readiness questionnaires

Another commonly collected data collection technique is that of the subjective readiness or questionnaire. A 2020 systematic review (McGuigan et al. 2020) on monitoring methods in professional sports suggested that between up between 53-80% of practitioners working in the applied setting use some form of this monitoring method. Largely, these self-reporting questionnaires will differ and generally created for use on an individual basis.

These self-reporting questionnaires aim to give a practitioner the opportunity to assess internal response to training through subjective means, in a similar vein to that of session RPE. The main difference is these questionnaires are for the most part collected at the start of a day, at around the same time, to assess athlete readiness for a training session or match play. Topics of the questions typically include fatigue,

muscle soreness, sleep and mood (Taylor et al. 2012), but will ultimately differ on a case-by-case basis.

Despite its popular usage, its efficacy has been discussed extensively throughout the literature.

Efforts to further quantify the use of readiness questionnaires some practitioners have sought to produce quantifiable readiness to train (RTT) metrics through an aggregated percentage based off of readiness questionnaires. However, studies investigating its validity have suggested that assessing an athlete's readiness to train is far too complex to make a decision through a singular value, and therefore the analysis of a multitude of subjective feedback methods is more effective (Cullen et al. 2021).

Ultimately, the use of subjective readiness questionnaires is used for two reasons; to assess the physical state of an athlete prior to a session and therefore use this to make alterations to session design, and to assess the training response following a previous session. For the latter in particular it has been found to be an effective tool for assessing training load. A study on Division 1 College Soccer Players identified the Fatigue, Soreness and Stress ratings given by players to increase significantly with an increase in the ACWR (Sekiguchi et al. 2021). Highlighting the readiness questionnaire to be a cost effective and accurate tool for managing training load for practitioners with limited resources. Though collection of the feedback is of course post training activity, and therefore means there is a lack of opportunity to modify training during the session.

This method also retains a reliance on truthful feedback. Given the nature of subjective feedback, the validity of the data is entirely reliant upon the athlete and can be affected by a number of contextual factors. Such as when the data is collected, if any actions are taken as a result of the data being collected, who goes into view the responses amongst others As a result, it lacks reliability (Fitzpatrick et al. 2019) and should be used as a supporting measure to some of the other methods previously discussed.

Performance Testing

A method that has seen an exponential increase over the last decade due to an increase in new technology in the space is the analysis of performance diagnostic testing. Most popularly, jumping (Bishop et al. 2021) and isometric or dynamic strength tests are used post training stimulus and results are compared to baseline to gain information on TL response.

In the professional sports setting, the primary uses of these performance testing methods are for: Profiling and Benchmarking, Load Response Monitoring, and rehabilitation and return to play (Cohen & Kennedy, 2022).

More soccer specific testing procedures have also been used to help identify athlete fatigue levels. 20m Sprint testing for example, has been suggested as a test that is sensitive to neuromuscular fatigue symptoms, with athletes showing an overall increase in 20m sprint time 24 hours post soccer match play, but returning to baseline at 48 hours (Djaoui 2016). Concerns however over the potential risks of maximal testing under fatigue though mean that tests requiring less effort should be considered.

Indeed, research comparing jump testing to sprint testing suggests that CMJ metrics are negatively affected for up to 72 hours post-match play (Silva et al. 2018). Coupled with the overall ease of testing with new technologies, many practitioners opt to use derivatives of jump testing as a marker of neuromuscular fatigue in professional sport.

The improvement in technology in this space has improved both the validity and interest in this form of monitoring. Particularly through the use of force plates or platforms. Previously, practitioners would have made use of jump mats that track time-based measures for example flight time and jump height. New technology in this space has allowed practitioners to not have to solely explore outcome-based metrics but also analyse strategy and impulse metrics that help create a more extensive neuromuscular analysis. Where force platforms had also previously been large and difficult to move around or travel with, lighter and more mobile versions of this equipment have now been created and validated as best practice. Feedback is now even available via applications on the mobile phone with the same level of accuracy (Balsalobre-Fernández et al. 2015). And highlights the technological advancements in this field.

Jump test in particular are seen to be an effective method for both sport specific physical performance metrics (Rodríguez-Rosell et al. 2017) and identifying fatigue between from 0-72 hours post exercise. These fatigue markers can then be used to inform or modify training practices in the days post heavy exercise, so that athletes are not at risk of injury and recover appropriately for the following bout of competition.

Evidently then, whilst only choosing to discuss a small number of methods that may be instilled in a professional sports team in the review section of this paper, athletes are indeed subject to a sizeable number of technologies or methods to capture individual data points. In the following chapter of this paper, I will go on to discuss some of the effects that this amount of monitoring could be having on athletes. And whether similar environments exist outside of the sporting landscape.

Chapter 4 – The Pervasiveness of Monitoring

A key theme running through this project and one of the key inspirations for choosing to follow this research idea, is one of an ethical sort. In an age of big data and omnipresent monitoring, and a world in which such observations are discussed at lengths by sociological intellects into their pervasiveness and perceived status as 'surveillance' or a form of social control (Lyon, 2001), is it fair that as sports science and medical practitioners, that our pursuit of providing first rate performance enhancement services often misses any potential psychological or ethical issues that could be associated with a round-the-clock athlete monitoring system?

There is no denying, as discussed extensively in the previous chapter, that advances in monitoring methods over recent years has never put practitioners into a better place in regards to profiling, monitoring and ultimately controlling the physical state of professional athletes. But at what cost? Studies outside of sport, most notably in office environments have been trialling and discussing the effectiveness of performance monitoring in the office setting since the turn of the millennium. Indeed, whilst the purpose of this monitoring in the office setting does not correspond directly with that of performance sports, I would draw you to assured parallels. Mainly, objectively measuring some sort of human performance (whether physical, mental, workload/task specific), and the use of this overtly. One study investigating electronical monitoring in an office environment, with particular emphasis on tracking workload (by all means similar to external load monitoring) cited that "close performance monitoring had significant negative effects on job attitudes such as job satisfaction and affective commitment" (Jesca & Santuzzi. 2015). Whilst another study which included a group of workers observed using a similar form of electronical performance monitoring, and a control group that was unobserved, suggested that the unobserved group displayed significantly lower stress levels whilst working (Aiello & Kofb. 1995). Should the findings of this study correlate with the performance sport environment, it would surely display great irony in performance practitioners increasing the levels of an unwanted psychological phenomenon, simply by trying to quantify it?

Now, again, whilst the context is not sport specific, it has ultimately led the curiosity of delving into the prominence of similar findings in a sports specific context. Though interestingly, little research in the sports science monitoring landscape of this nature exists. In the nutritional space, some research has been conducted aiming to identify the psychological effects of weight monitoring in-season, and the findings should create cause for concern. In female sport in particular, Papthomas (2018) cites 'surveillance' in elite performance sport as a leading cause of eating disorders, subsequently argued to 'slide into mental illness'. In the paper it is argued that, particularly in the discipline of food and nutrition, that approaches to the subject in sport should take become more 'culturally informed', or in other words act in ways that would be otherwise supported outside the bubble of professional sport.

Similarly, the Australian Institute of sport released a review (2020) on the issue of eating disorders in sport, and included suggestions on how to avoid such issues. The institute also alluded to the theory that amongst other factors, an environment heavily reliant on the monitoring and surveillance of their athletes, particularly with body composition was an increased risk factor in relation to the mental wellbeing of athletes.

Though it is of course acknowledged that this factor is indeed interwoven with more nuanced sociocultural risk factors that performance sport may amplify. As discussed in previous research, the institute also cite a healthy cultivated team environment is an important factor in preventing such issues. They also cite “Education regarding body composition and testing including procedure, rationale, consent and use of information must be conducted for all athletes prior to commencing any testing.”, which supports other findings in relation to developing buy-in and successful sports science provision within an applied environment.

With this information, then, it become apparent that there *can be* unwanted or unplanned effects that could negatively impact both athlete mental state and then subsequently team performance or negatively impact the team culture. Whilst the majority of current research discussing the topic is mostly within the sports nutrition space, I would argue that both the applied nutrition research and wider studies on the more general population provides an adequate food to fuel the curiosity to discuss what effect our monitoring practices could be having in the applied sports world.

The misuse of athlete data is also a topic that is gaining traction in the current sporting environment. In 2021, a group of football players under the project name ‘project red card’ threatened legal action against sports data companies over the unlawful use of player performance data, which in the light of new data protection laws under the new EU general data protection regulation (GDPR) laws has given athletes the licence to take more ownership over their own data that is collected by football clubs and third party organisations. And whilst the legal action in question is towards third party companies choosing to profit from performance data, it should not be outside the realms of possibility that attention could turn to data collectors and analysts that work within the same organisations of the players themselves.

It is with this in mind then that it becomes increasingly important that those with a vested interest in player performance data or sports science monitoring practices begin to question their own data frameworks, and discuss the effects that these practices could be having on their own athletes. How is the data collected? How and when is the information shared? With whom? And in what context? But most importantly putting the welfare of the athlete first. To help avoid some of the inadvertent side effects that have previously been discussed in this chapter.

Study Purpose

Ultimately, the journey to developing a healthier data culture begins with a single step. As discussed previously, little research exists on simply identifying the possible effects our monitoring practices could be having on athletes, let alone what the most effective methods are to fix them. From the review of the literature that I have carried out, it would appear that the effects that performance monitoring can have on athletes psychosocially is usually secondary to the physical insights that any form of monitoring may provide, and thus until now little to no platform has been provided to athletes themselves to discuss its effectiveness their own understanding even with extended periods of exposure to such methods.

It is with these thoughts in mind then, that, the purposes of this study are to:

1. **Give athletes the opportunity to share experiences and feedback their own thoughts on monitoring methods and on the way, they may have been used or exposed to them in their current setting, in a safe environment in which they will not affect important working relationships with staff members or be penalised for sharing their own reflections.**

2. **Provide a piece of work that applied practitioners in the industry can use to:**

    a. Compare monitoring methods used in a different setting to their own.
    b. Create an understanding of the 'softer' effects of monitoring practices in a sporting environment that is close to their own.
    c. Reflect on their own practice relating to sports science monitoring and identify areas of improvement.

3. **Provide key take homes to all stakeholders on how to effectively implement sports science monitoring practices from the opinion of the players themselves.**

4. **Provide food for thought in an ongoing discussion surrounding the use of data in professional sport and inspire further study in the domain.**

Methods

Participants

4 participants (aged 17-21) from the academy's professional development squad took part in this interview. All players were part of the same English Football Academy that has been granted category 1 status from the Premier League in line with the Premier League's Elite Player Performance Plan. This means that all of the players selected had been subject to leading sports science and medical provision within a academy football and all players had been within this academy setup for at least 3 years.

Participation in the study was entirely voluntary and participants were given full access to a participant information sheet and interview guide before taking part. Participants were also able to opt out of taking part in the study for a period of 1 month post data collection, in which instance none of the responses from that participant would have been reported on in the study nor recorded in the paper's transcripts. Participants were fully briefed with an informed consent and participant information sheet in line with the University of Birmingham's ethical guidelines and participants were only given permission to take part in the interview upon signing and returning the informed consent form to the main researcher.

Procedure

The interview lasted around 30 minutes in length and took place in an academy classroom within the club's academy building. The classroom provided a private discussion place for the participants to share their responses without outside distraction. The identities of the participants have remained completely anonymous within the confines of this report and have been characterised by participant A, B, C and D in the transcript of the interview that is available in the Appendices of this report [Appendix D]. Though, naturally, through the nature of a focus group interview, the participants do not remain anonymous to the other participants of the group. This fact was clearly stated in the informed consent sheet [Appendix A].

The focus group interview was led by the main researcher for this project and took time to go through a personal needs analysis and skill competency check ahead of completing the focus group. A skill competency checklist was created highlighting learning or skills training that would require attention ahead of the interview and were discussed with the project supervisor. This measure was conducted to endure that the researcher undertook the interview with the utmost integrity and neutrality, to help ensure that the data collected was both as reliable and valid as possible in line with literature focus group guidelines for sport specific research (Sevilmis & Yildiz, 2022). Upon the completion of these tasks, the interview was completed.

The main researcher held a strong rapport with the athletes selected prior to the beginning of the interview due to the working relationship previously held between coach and athlete, though it was seen to be beneficial that the working relationship no longer existed and the fact that the researcher was no longer a part of the direct coaching staff of the athletes allowed the athletes to share their views more freely and without concern that any answer may affect the prospects within their given team in the same way that if the researcher held a position of power over them.

A semi structured interview guide that solely acted as a prompt was given to a participants prior to the beginning of the interview [Appendix C] and was used to anchor conversation around points previously agreed by the researcher. Though the questions were open by design, and it was intended that the interview be led by the natural course of conversation to try to yield candid responses that were not pre-meditated or that could have been prepared prior by external stakeholders. Elaboration probes were used to try and extract further information from particular points and the interview was terminated in and around the ending of the pre-agreed time limit.

Analysis

By the nature of the research question and hypothesis, the project will yield qualitative feedback. Due to the novelty and overall lack of other research in the same space, it has decided that all data collected will be coded and explored through a Thematic Analysis (TA). TA is simply an analytic approach that will allow the researcher to identify patterns across the selected data set (Braun et al. 2016). Its use in the sport and exercise science literature base is thorough and is often used in similar studies looking to gain information surrounding stakeholder perceptions on a given subject (Braun & Clarke, 2019. Wiltshire & Ronkainen, 2021.).

A key reason TA has been chosen to lead on the analysis of the data collected on this project is that it is not already tied to another theoretical framework. This therefore allows the analysis to take place without a rigid format of how the data should be collected and ultimately gives the research a level of flexibility in pursuing and analysing the themes that may occur in the project. It is also a type of analysis that does not require an experienced qualitative researcher in order to disseminate the data in this way, but can also draw useful land nuanced conclusions from the data set. In particular, TA allows the research to simply identify patterns through the experiences of the participants and identify trends that may have already been identified in other theories or previous research.

Within the discipline of TA, for the purpose of this project, I have chosen to follow Braun & Clarke's (2006) reflexive TA model and their *semantic* analysis focus. Namely, "coding and reporting on explicitly-stated ideas, concepts, meanings, experiences, etc." (Braun et al. 2016). Consequently, the analysis of this dataset will draw upon explicitly-stated concepts or experiences mentioned by the participant, and then examine their prior discussion in other research. Or if the themes/experiences appear to be entirely novel, theorise the possible reasons for these findings.

Cited as a relevant and appropriate form of data collection for TA, data was collected in the form of a face-to-face, focus group interview (Braun et al. 2016. Maguire et al. 2017). The medium of the focus group was also chosen for a number of different factors; 1) The open-ended nature of a more conversational interviewing methods like the focus group would allow the participants to further expand in any points they may make, and eventually reveal an answer in richer detail to that they may give in a more closed-ended questionnaire type format. 2) Given the football club that the research took place in, and the position held by the researcher within this football club, the researcher already had a level of rapport with the participants that would give the focus

group the best possible chance to develop the perception that the collection of rich and in-depth answers would be meaningful and worthwhile for the participants. Namely through the idea that they could help improve their own experiences with their own sports science end medical department. 3) It was felt anecdotally, given the prior knowledge of the social makeup of the participants, that they would respond better to being asked to partake in an interview process alongside peers, rather than alone.

Following the collection and transcription of the data collected, TA was used to identify themes or important talking points from the data. Notes were made alongside the transcription to highlight which themes particular quotes may belong to, and subsequently were grouped and discussed under relevant theme titles within the results and discussion sections of this report. Themes were cross referenced with similar studies within the current body of literature to draw wider conclusions on the topic of player perceptions of athlete monitoring in elite sport.

Results

For the duration of this chapter in the thesis, I will pick out key quotes from the focus group, link these quotes to similar themes that occurred during the interview and discuss their significance in relation to other studies. Largely, the responses from the players reflected the singular environment that they have been exposed to, in the case of all of these players, the same club. This supports the findings of Weston (2018), who investigated coaches' perceptions of training load monitoring. Concluding that "differences in practices and perceptions likely reflect club infrastructure". Indeed, where it could be argued that the project's findings only reflect the environment that the data has been collected from, its findings of producing useful feedback for an elite footballing environment are still valuable. Particularly from the perspective of how different communication methods can affect the overall buy-in and response of a team's players. I will now go on to discuss some of these findings in more detail:

"Sometimes… if we ask."

This was the response of one of the players to the question "Do your coaches discuss the reasons why with you?", in relation to whether or not players actually understand the reasons why any of the previously mentioned monitoring methods are used. The given response suggests an environment in which player monitoring is not entirely transparent and largely relies on the curiosity of an athlete to reveal its true purpose. The same findings have been discussed in research surrounding feedback methods to coaches and players, with the majority of feedback surrounding sports science practices happening orally or in the form of an informal conversation. When further questioned on the matter, some players suggested that this sort of information would be supplied to them some of the time. In turn, allowing the perception of some methods being seen as more important or better supported than others. Although, it was not discussed in this interview whether or not this matter would then have an effect on the overall application of players to training or any of these isolated testing measures.

Not only in the case of having to pre-empt discussion around the communication of the uses of monitoring, but the feedback of the data that is collected was also said to be communicated in the same way. Players would not regularly receive feedback on the data that may be collected, but continued to state that it would always be available should they ask for it. Additionally, it would seem that understandably where athletes themselves lack the thorough understanding of the sports science principles that the applied practitioner may have, it appears that athletes tend to fixate on one or two metrics that they feel that they understand and then use that as an inaccurate summarising tool, regardless of whether or not it may be correct. This is particularly the case with metrics such as jump height, in the context of performance or fatigue monitoring through jumping derivatives, and total distance in relation to the total external training load of a pitch-based session.

Supporting the findings of Neupert et al. (2022), many practitioners working in the applied field feel that the level of feedback that players/athletes receive is not sufficient. The feedback from athletes in this study could be seen to further support the notion that greater dialogue or feedback is required for players given the perceived

lack of understanding or interaction with the data that is later collected and used. Furthermore, the work of Nuepert et al. reported that applied practitioners feel poor perceived athlete adherence remains a large stumbling block for creating a strong and functioning performance department within elite sport, though conversely, this study would suggest that the poor adherence could be due to a lack of understanding through poor communication channels from player to performance staff or coaches.

Findings from this study have further supported work from Neupert et al. (2019), suggesting that athletes feel the biggest issue they may have with monitoring practices is the abhorrent lack of feedback from the coaching staff. Whilst the participants may not have explicitly cited the lack of feedback as a problem, the theme remains that more feedback would lead to more positive behavioural change, and therefore improve the overall usefulness of monitoring for all relevant stakeholders.

"I think because we've used them for so long now it's just become normal."

This response was given in relation to a question about whether or not the athletes see the daily monitoring practices that they are subject to as useful. Ultimately, as has been discussed in previous papers, practitioners have discussed one of the biggest keys to generating buy-in and integrating sports science practices into a performance culture is simply maintaining the use of these methods over a significant time period. Similarly, previously in the interview, one player said, "I've used the same testing methods for years so to be able to see where and how I've improved has been really good for me". Here, interestingly, we are beginning to see a generation of players with long exposures to these sorts of monitoring practices, often throughout their entire time as academy players.

This exponential increase in the expansive methods used to track the development and maturation of young players has been discussed extensively in the current body of evidence (McBurnie et al. 2021). Current guidelines from the English governing body for academy football require performance benchmark testing through the Premier League's Elite Player Performance Plan (EPPP) from the age of 8 and older, meaning at the time of writing, some of the participants of this study have been subjected to some sort of performance monitoring within the same club for more than half of their lives.

Further research could be required to ascertain what effect this could have had on the relationship between players and a sports science program.

"To see how far we run or how hard we work in training. And in matches as well"

Interestingly, as was the case with most questions faced by the players, the first response without any further probing always hinted towards the monitoring methods being used in relation to giving an indication of player 'performance' on any given day. Usually alluding to the idea that monitoring practices are a form of measure that tells coaching staff or applied practitioners how hard a player may be working. Whether or

not this may be the case, it would appear that players themselves view these metrics as objective markers whereby they can be graded or compared to their peers. One player stated “I use it compare myself with other people”. It was only after later prompting that players acknowledged the notion that monitoring may take place for other reasons such as injury prevention, or player load monitoring. Supporting previous research from Nosek et al. (2020), players appeared to be most comfortable with GPS metrics such as Total Distance, High-Speed Running and Sprinting. Though one player did verbalise concerns that the high variance in output between different positions meant that comparing player-to-player as a gauge of effort could be misleading or unfair. Whilst this is a factor that most applied practitioners would take into account when reviewing training data, it is apparent that such knowledge has not been passed down to the players themselves. This supports similar studies regarding player education on injury risk factors and injury mitigation strategies (Liporaci et al. 2022).

Furthermore, in relation to a discussion around forms of training feedback, multiple players admitted to giving false or modified RPE feedback scores to allow their response to be more closely aligned with the responses of the rest of the group. One player even recalled a previous situation in which the feedback of that information had led to an unwanted interaction with a coach.

From the focus group that took place, it could be deduced that the perception that a player may have of these monitoring practices is entirely down to previous experiences and is highly individual. One participant only suggested that monitoring would take place as a form of feedback to the technical coaching staff, in response to a question probing the notion that monitoring practices are purely performance-based, they replied “Yeah, so the coaches know if we’re working hard”. It was only due to the interjection of another participant that it was suggested that monitoring could be performed to protect the physical welfare and well-being of the players themselves. Interestingly, a key difference between these two respondents is where one player has spent the majority of their time in academy football without facing a spell on the side-lines with an injury, another has spent a significant period working with the sports science and medical department through a period of rehabilitation.

“It gives me an idea of what my body is like”

One player gave this response when discussing the usefulness of neuromuscular fatigue monitoring through the medium of forceframe testing or the use of force plates for jump testing. In this study’s focus group, this was only mentioned by one player, and as such would suggest the overall understanding that this player has of monitoring practices may be more advanced than that of the other players who were selected. This response also gives the indication that the player is choosing to take ownership of the data collected, and using it to inform themselves of their readiness to train or actual bodily state. As a finding, I believe this is a powerful sign of the continuing development of the relationship between players and the sports science discipline. In this case, although the player may not be the key decision maker following the collection of this information, it could provide valid feedback directly to players that could help them to self-manage during training. Furthermore, where any theory on the

subject is currently unexplored by the current base of the literature, it may be of interest to investigate any possible relationship between player understanding of some of these monitoring methods and the data it gives the, alongside perceived effort levels in subsequent training sessions.

"Does it really matter?"
"what's the point?"

One of the key findings from the focus group interview was that players wanted to be sure that as a result of the monitoring being conducted, decisions were being made based on this data that had a tangible purpose. Cited during the interview, one respondent questioned the importance of fatigue monitoring if it only has an effect on the outcome of training *some* of the time. Conceptually, this is a theory mutually agreed upon by both applied practitioners and now players. Ultimately, to provide a proficient and thorough fatigue monitoring and injury prevention program, decisions need to be made based on the data provided. Although it is not the case in all high-performance environments, within elite football, the final decision is often made by a part of the technical coaching staff, often with a more limited understanding of the data collated than the practitioner opting to feed in this information. It would appear that because of the ad-hoc championing of some of these monitoring systems is affecting the overall levels of understanding and buy-in from players is being affected. Though this is something that has been hypothesised in previous research, this study would appear to confirm this hypothesis.

Players also questioned the validity of neuromuscular screening and external monitoring methods over subjective internal feedback. Though discussed in an earlier chapter of this thesis, the players taking part in this study are not subject to a subjective feedback questionnaire to report on their physical status before training. As a result, in this case, self-reporting is taken less seriously as a form of monitoring practice and therefore holds less weight in the decision-making process. One player said "If I jump after a game and it shows I'm still fatigued then I might have a slightly different training session, but if I feel that tired again during the week I don't do the jumps and I train as normal. Sometimes I'll even feel worse!". Interestingly, although players may be aware that these forms of monitoring are not necessarily hard caps that trigger decisions on training availability, but rather a guiding factor in a larger decision-making process, when overlooked it could affect the overarching relationship between sports science staff and athletes negatively.

Themes

In summary, the results from the focus group interview have helped formulate the following themes in relation to player perceptions of performance monitoring practices.

1. Player perceptions of these practices are largely dependent upon previous experiences and previous exposure to them. With particular emphasis on the way in which they have been introduced or communicated by an applied

practitioner or coaching staff. In this study, we were able to see differing views on these monitoring methods, despite the fact that they were all a part of the same team and had been training at the same club for a significant period of time. It highlights that even within the same team, players are heavily influenced by more intimate communication channels on the subject, whether with applied practitioners or coaching staff. Players are also heavily influenced by whether or not they, themselves, can see the monitoring that takes place making a tangible impact on training.

2. Players largely view monitoring practices as being used as a comparison tool in which players can be judged against their peers in relation to performance ability. With less of an understanding of how monitoring may be used in a load monitoring or injury prevention capacity. This could be a bi-product of the ultra-competitive inter-player environment that has been cultivated within English football academies, in which players are acutely aware of the fact that they are competing with each other for game time or the ultimate goal of professional contracts, and less of a reflection of the way the information has been communicated. Or equally it could be a result of miscommunication from staff to player if the monitoring method is largely used in the context of load monitoring.

3. Extensive monitoring practices that are less sporadic appear to improve the chances of player buy-in or adherence. Players appear to be more sceptical or less convinced of the usefulness of methods that are not consistent, but become more accustomed and accept the use of methods that are present the majority of the time. This could also be affected by the way in which the method is collected. For example, the way in which wearables that are used whilst training (GPS, HR monitoring) is perceived more positively in comparison to methods that require extra/individual actions (e.g. jump testing).

Discussion

As a result of the thematic analysis conducted in this project, and the dissemination of the current literature base, I will now go on to discuss three main themes that are reflected in this research and that are supported by other literature on related subjects, in relation to improving performance monitoring provision within an applied setting. The three themes chosen for discussion are:

- Using Monitoring as an Educational Tool
- Improving Communication Channels
- Using Monitoring Information to Inform Practice

These themes and suggestions for improving applied practice are not exhaustive and are not necessarily the sole findings of the study. However, each of these themes have been chosen on relation to their relevance to the applied environment, and particularly these that can be affected by applied practitioners or coaching staff, to ensure a healthier data culture can be maintained.

1 – Using Monitoring as an Educational Tool

Firstly, as mentioned briefly in the previous section, from our findings, it would suggest that the level of understanding that athletes have regarding the reasons for using sports science monitoring practices, drastically affects both their perceptions of its use as well as level of support for its practice. It has been discussed in other research papers that, within the sports science and medical space, an athlete's understanding of sports science and medical provision is heavily influenced by the practices that they are exposed to as well as the information provided to them by informed staff (Crowther et al. 2017). In other words, the likelihood that athletes will take the time to further study the discipline to improve their own understanding of human performance without external influence is low. Therefore, it remains of paramount importance that sports science practitioners ensure that monitoring methods are used as an opportunity to improve player knowledge and understanding of their own bodies in relation to human performance.

This is supported by research by Saw et al. (2015) citing education of athletes as a key factor for implementing self-reporting monitoring methods into professional sports teams. It is thought that the improved understanding of sports science monitoring practices not only helps to benefit player buy-in, but also the validity of the measure. For example, through appropriately exhibiting an adequate amount of effort in an exercise-type neuromuscular screen or through choosing to accurately report self-reported fatigue levels. This study would appear to support this notion given the positive responses in relation to testing feedback giving athletes an accurate gauge of what physical state their bodies may be displaying on any particular day, though participants that displayed lesser understanding of the measures cited that they still needed convincing that some of the measures would in fact benefit their physical performance or portray their own bodily state more accurately.

Furthermore, it could be suggested that improvement in player knowledge around the discipline as a whole would not only be of benefit to the task at hand of performance

monitoring, but could help to improve and instil other habits that could have a positive effect on human performance. This domino effect could be beneficial particularly in the space of promoting good practice when away from a training centre or away from the advice of an expert in the area. For example, through improving knowledge in the areas of nutritional habits or recovery, that could largely be handled by players at home.

Therefore, the benefits of using monitoring methods as an educational tool could be multi-faceted and could yield benefits outside of the immediate actions that it may be trying to affect.

2 - Improving Communication Channels

Prior studies have suggested that members of coaching staff from a number of different sports are concerned that one of the key issues surrounding performance monitoring is ensuring that it is completed and communicated effectively (Rauff et al. 2022). Indeed, it could be argued that there could be alternative motives to such concerns from technical coaching staff. Namely, does the involvement of hard, objective data undermine the perceived influence that a technical or lead coach may have politically over a team? Perhaps dependant on the environment, that could well be the case. And such could be a result of previously researched issues with knowledge transfer between applied sports scientists and technical staff (Reade et al. 2008., Esteves et al. 2010.). What can be said though, is that the levels of communication between the stakeholders collecting this data and those having data collected is vitally important to maintaining healthy working relationships between the sports science department and players as well as improve compliance with future monitoring practices.

Additionally, it could be argued that someone who is subject to the collection of personal data has every right to be kept up to date and receive constant feedback on the information collated from them daily, not to mention be given thorough evidence and explanations for data collection on demand. As previously discussed in the literature review chapter of this thesis, at the time of writing the elite sport landscape has done little to discuss or address the how players actually feel about daily performance monitoring.

Outside of the sporting world, in an office working environment, one paper theorised that “close performance monitoring had significant negative effects on job attitudes such as job satisfaction and affective commitment.” (Jeske & Santuzzi 2015). The paper had particular emphasis on fact that whilst any performance monitoring was seen to mostly be viewed as unnecessary, subjects were more frustrated at the notion that they were not consulted or did not entirely understand the motives behind the strategy. This was amplified if monitoring was more sporadic by nature.

Interestingly, the study we have conducted would appear to support similar findings in the office environment. This study has supported the idea that should monitoring take place, and the practitioner would wish to improve player buy-in or understanding, it should not be sporadic, and practitioners should be as transparent and open with

reasoning and results where possible. This study would suggest that some players that find benefit in the monitoring practices may use the method as form of feedback for themselves, to identify what they may need to do improve physical state. But also feel, particularly in the case of external load monitoring, that it is a good way to keep coaching staff accountable for the demands that are placed on players during training. It has been discussed in this study that players would like to be able to view this information daily, most likely in the form of a pin up report or available at request, to help emphasise the idea that the data collection is for positive purpose, and are there to help players, as opposed to something hidden without reason. Thus, the maintenance of strong communication channels between key stakeholders as well as transparency regarding the scientific reasoning for the collection of data, is imperative for not only creating a healthy data culture, but also for the wellbeing of players themselves.

3 – Using Monitoring Information to Inform Practice

Interestingly, a 2018 study from Brink et al. completed a questionnaire-based study with technical football coaches, finding that coaches felt that amongst 4 others, poor application to practice was one of sports sciences biggest issues in the current football world. Supporting Brink's study, this study suggests that players themselves also believe that poor application to practice is one of performance monitoring's biggest issues. One player taking part in this study suggested "what's the point" in relation to not seeing any meaningful change as a result of the monitoring taking place. We have discussed previously in this discussion section, that it is vital that players understand the reasons for monitoring to help improve the overall adherence to the testing protocols. Though ultimately, players also need to see tangible changes in training regime or at least evidence that these changes could in fact take place in order to truly buy-in to the process.

Indeed, it is hard to disagree. It is widely suggested around the sports performance world that modern performance teams should be multidisciplinary or interdisciplinary by nature, meaning that they are comprised of specialist practitioners who work collaboratively to provide performance support to individual athletes or teams. In this collaboration, though different members might hold more influence than others, it is discussed that in best practice environments, the expertise or each member is respected and supported by other group members to ensure that athletes are provided a well rounded and top support program. The reality of the applied world means that this theoretical utopia does not always exist. Modern performance science and medicine dsisciplines in professional sport may no longer be in their infancy, but many of the same political or interpersonal obstacles that occur in any team or group setting still provide challenges to practitioners daily. Despite this, the ability to apply sports science practices to the applied setting remains the most important aspect of the monitoring practices. Previously thought by coaches, and now seemingly supported by players.

The ability to demonstrate that monitoring is in fact informing practices appears to both give the coach themselves credibility and would improve player relationships.

Subsequently improving adherence to these practices. Meanwhile, the act of collecting player information that does not appear to inform practice does not necessarily mean that adherence will change but would affect player perceptions of the practices negatively. Interestingly however, in the case of some methods that are more omnipresent, such as daily tracking of GPS load monitoring, even if they do not appear to inform practice all the time, given that the practice has been embedded as a non-negotiable collection method in this particular applied setting for an extended period of time, perceptions of the method would appear to be more positive. Therefore, we could draw the conclusion that ultimately prolonged exposure to a particular method is one of the leading theories for improving overall adherence or improving perceptions to the method.

Conclusion

This study is one of the first in current literature base to seek the subjective opinion of footballers within a professional football academy relating to sports science monitoring practices. It has found in the case of this football academy, that some players who have been subject to extended periods of monitoring (in most cases for as long as they have played football in a professional academy) have become desensitised to the collection that takes place daily. In the case of this academy, GPS tracking is one of the constant monitoring practices.

Players appear to be more vocal or more opposed to methods that are more sporadic in nature. Or that require individual or separate actions to take place in order to collect the data. Particularly fatigue testing, that may only occur once a week to gain a snapshot of players at any given time during a week. It has also been discussed by players that they feel that at times the monitoring methods make little to no impact on training or their experience of training as a whole, and therefore showed reluctance to support the use of monitoring moving forward. There was however a big difference in perceptions between players that appeared to have a greater understanding of the reasoning behind the practices as opposed to those that had little to no understanding. Players also suggested that all data that is collected should be available for subjects to view should they wish, and best practice would involve direct feedback of the data following collection, either directly via word of mouth or in the form of a report. As a result, it would be advised that applied practitioners do their best to adequately educate their athletes/teams on theories behind testing and monitoring, and maintain open communication channels with their players.

Whilst this study only takes into the account similar/shared experiences from players at one category 1 academy in the English football league system, further study should be considered to gain perceptions of players at more than one club to ascertain whether some of these findings correlate with other clubs and sports science monitoring methods as a whole, or whether the majority of factors affecting player perceptions are entirely contextual and will change depending on the differing soft factors of each environment.

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Appendices

Appendix A: Participant Consent Form

UNIVERSITY OF BIRMINGHAM

Participant Consent Form

Player Perception of Sports Science Monitoring Practices in Elite Football

This information is being collected as part of a research project concerned with improving player experiences with monitoring processes in elite football by the Department of Sport and Exercise Science in the University of Birmingham.

The information which you supply and that which may be collected as part of the research project will be entered into a filing system or database and will only be accessed by authorised personnel involved in the project. The information will be retained by the University of Birmingham and will only be used for the purpose of research, and statistical and audit purposes.

By supplying this information you are consenting to the University storing your information for the purposes stated above. The information will be processed by the University of Birmingham in accordance with the provisions of the Data Protection Act 1998. No identifiable personal data will be published. Statements of understanding/consent As appropriate to the study, for example these may include:

- I confirm that I have read and understand the participant information leaflet for this study. I have had the opportunity to ask questions if necessary and have had these answered satisfactorily.

- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. If I withdraw my data will be removed from the study and will be destroyed.

- I understand that my personal data will be processed for the purposes detailed above, in accordance with the Data Protection Act 1998.

- Based upon the above, I agree to take part in this study.

Please Turn Over For Signature and Date.

Name, signature and date

Name of participant…… **Date**……

Signature……..

Name of researcher ……..... **Date**……

Signature……..

Appendix B: Participant Information Sheet

UNIVERSITY OF BIRMINGHAM

Participant Information Sheet

Player Perceptions of Sports Science Monitoring Practices in Elite Football

Researcher: Ben Ellis

Description of the Study

This study is to gain further insight into how players perceive sports science monitoring (e.g. GPS, HR Monitoring, Daily Wellness), into how they feel it aides their performance and more importantly how these processes could be improved to benefit players themselves. This study provides the platform for players to share their experiences and feelings surrounding how they are monitored freely in order to improve the level of sports science support provided to them.

What will I have to do?

You will take part in one 30-minute focus group meeting with up to four other players. This will give you ample opportunity to provide other feedback and discuss with your peers how you feel monitoring practices will be improved. The questions will be open ended and you will not be forced to answer any questions should you not wish to.

Who Can Take Part?

Players training in a full-time capacity at *insert team name here* above the age of 16. This is to ensure you have experience in using monitoring techniques full-time have been exposed to similar techniques.

Do I have to Take Part?

No. It is completely voluntary. You also reserve the right to withdraw from the study up to two weeks after the focus group interview should you wish. This is because after the two-week period the feedback will be analysed and the write up will begin. Should you wish to withdraw all the feedback that you have provided will be deleted.

Will my responses be kept confidential?

Whilst your responses will obviously be shared with both the researcher and other players in the focus group, in the official write up all feedback will be kept entirely anonymous, and any information shared within the focus group will not be shared directly with any other players or coaching staff. Confidentiality of the participants will be treated with the utmost importance.

What Will Happen to my Feedback?

The feedback will then be included into a write up within the following months including recommendations for future practice in the industry. Access to this paper will be free to all participants should they wish. If a copy of the finished article is desired, please contact the email address in the contacts section of this leaflet.

Contact Information

Should you have any questions or queries about any of the information on this sheet, or would like to know more about the study – please use the following contact information.

Email: [redacted]

Phone: [redacted]

Appendix C: Focus Group Topic Guide

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Focus Group Topic Guide

Project: Player Perceptions of Monitoring Methods in Elite Football

The focus group will take on a semi-structured design, with the moderator ensuring that the themes stated on this sheet are covered during each interview. This will be ensured through asking the same 5 questions to each focus group at some point during the interview. Due to the nature of focus group discussion, it is expected that topics that are not predicted may also come up and provide further participant feedback. But the moderator will ensure that the interview will return to one of the following themes should the conversation digress for significant periods.

The topics will cover:

- What monitoring practices have the participants been subject to during their careers so far

- What do they think monitoring is used for?

- Do they feel that these monitoring practices help them to maintain levels of high performance?

- If at all, do they feel that monitoring has negative effects on their ability to perform?

- What sort of relationship do the participants have with monitoring practices and the people doing the monitoring?

- How do they think it could be improved?

It will be ensured that each topic is covered within designated time frames. I.e. where the focus group is expected to last 40 minutes, the moderator will be encouraged to lead the conversation to the next theme every 6 minutes. Though it is up to the judgement of the moderator to decide how much rime they wish to dedicate to each theme.

Appendix D: Interview Transcript

UNIVERSITY OF BIRMINGHAM

The interview was held in an academy classroom and the total interaction took place within a set 30-minute block. This included a period at the beginning in which the head researcher went through the terms of the informed consent form and some background to the research project and clarified any questions that may have arisen from the participant information sheet.

The Intelligent Verbatim Transcript is written below, in which information or conversation that was deemed not relevant by the head researcher to the study was left omitted from the transcription.

Key:
HR – Head Researcher
P1 – Participant 1
P2 – Participant 2
P3 – Participant 3
P4 – Participant 4

HR: To begin, could anyone name some of the sports science monitoring that are used to monitor you physically?

P1: GPS, Jumps or the jump plates.

P2: The groin squeeze, RPE

HR: Ok, and how often would you say that any of this data is collected?

P1: Well, GPS is every session. The jumps and the squeezes are mostly at least once a week.

HR: Ok, what do you think these are used for?

P1: To see how far we run or how hard we work in training. And in matches as well.

HR: So performance related you'd say?

P1: Yeah, so the coaches know if we're working hard or…

P3: But also to stop us from getting injured. Like making sure we're not doing too much in training. Like in rehab or something like that. Just making sure we're not working too hard too early in rehab.

HR: And what about the other ones you mentioned?

P2: That's for testing how strong we are or how powerful. I guess to check whether or not the work that we are doing in the gym in working, or to look at what we need to improve on. Or sometimes we do it after games as well, to see if we have recovered from matches before training.

HR: Do you feel like these methods help you maintain levels of high performance?

P3: Physically?

HR: Yes, sorry. Do you think these methods help you maintain or improve yourself physically?

P3: I think for testing how strong we are, I definitely get it. Like I've used the same testing methods for a while so to be able to see where and how I've improved has been really good for me. I think I also understand what score is good for me and what's not so good, so it gives me an idea of what my body is like on any particular day.

P1: I find the GPS stuff interesting too, to see who's run so far in games and things, but sometimes I think it's a bit skewed because of course some positions will do more or less than someone else. So sometimes I think it can be a bit unfair when you get compared or told that you're not working hard enough.

HR: Do you feel like this is used to compare you with other players then?

P1: Maybe. I would probably say I use it compare myself with other people.

HR: How often would you say you receive feedback on this information?

P4: It's probably quite random. Or it feels quite random. If I ask *name of coach* for the data, then normally it will get given to me. And I'll see a report. They did put the sheet in the changing room after training for a bit, but they don't do it anymore.

HR: Would you say that's frustrating? Would you prefer to get this information daily?

P4: I don't think it's frustrating but I think it would be good if it was the same all the time. Like always get the report or always get it if you want it.

P3: We always get jump heights and squeeze scores in the gym. *coaches name* gets us to ring a personal best bell in the gym if we get a max score.

P4: Yeah he does.

HR: Is that a good thing?

P2: Yeah I think so. It's nice to know that you're always improving and its not just I can lift more weight. I can jump higher or whatever.

P1: I quite like that as a way to use the data because that way I feel like I'm just competing with myself. And *coaches name* has all my old tests there with him too so I can see how I compare to my old tests. So that's quite helpful.

HR: Do you feel there are any ways that monitoring or tracking could affect you negatively? Do any of you think?

P3: The vests are annoying.

P2: The heart rate straps are worse. They're so annoying when you're playing or training.

HR: So do you feel like they affect you when you play?

P2: I mean I'd prefer not to use them.

P1: I think because we've used them for so long now it's just become normal. I don't mind the vests so much.

HR: Less about what you're wearing, what about the tech that you might be wearing? Do you think this could be affecting you negatively in any way?

P1: Again, I feel like we've used it for a while now. I think I started wearing it all the time when I was an U15 and I don't think its been a negative. But maybe there has been points where I don't get why I'm wearing it.

P2: The thing I don't really get about GPS is what about if I go for a run tonight, or at the weekend and I don't track it. Then surely it can't be used to work out how much work I've done, because I do things outside of here too. And sometimes if a coach hears about it, then they want to know how far or what I did, but lots of times they won't hear so they won't know. So does it really matter?

P3: I would say though that when I was injured it was quite important. *physio's name* was always talking through with me how much work I would do each day and making sure I didn't have a big jump each week before I was training again. So I do see where it can be helpful for us.

HR: And what about some of the other methods?

P1: I don't know really. Because a lot of those are kind of separate. Like GPS is done whilst we're training but I feel like a lot of the other stuff is by itself or in the gym or something, so it's like a separate thing. I don't like the fatigue testing very much but its only once a week or something like that.

P2: One of the things I don't get about that is if I jump after a game and it shows I'm still fatigued then I might have a slightly different training session, but if I feel that tired again during the week, I don't do the jumps and I train as normal. Sometimes I'll even feel worse! Or we end up training with the first team a day after a game and the tests show I'm a bit fatigued. So, it makes you think what's the point!

HR: I see, so it's important to you that the information collected actually changes training if its possible.

P2: Yeah I think so. Otherwise what's the point. Or even I feel really tired and I can still jump high. But I feel really tired, so does that mean I'm not?

HR: How well do you think you understand the reasons the some of these monitoring methods might be used?

P3: There's stuff I obviously don't understand because I don't know everything about the human body, but I think I get it.

HR: Do your coaches discuss the reasons why with you?

P3: Sometimes…

P2: Or normally if we ask.

P1: I'd say they normally tell us when we do it for the first time. *coaches name* normally tells us why we are doing the tests. But maybe less the more we use it. Because it's just normal then.

HR: Ok, that's interesting. Do you think any of the things you've just mentioned could affect the relationship you might have with coaches? Or sports science staff or physios?

P3: I would definitely be worried if I was being bottom of the GPS table every day. Like I would think *coaches name* will think that I'm being lazy.

P2: Yeah same.

P1: Or like with RPE sometimes I like to see what other people have said so that I don't give a number that's really high or really low.

P3: Yeah I've done that before.

P1: Because what if I say the session was a 9 out of 10 and everyone else says 4? I feel like we're better off all being around the same number.

HR: So would you ever talk to each other about this before giving your response.

P1: Nah I'd just ask someone else in the room what they gave, or ask *coaches name* what everyone else had given.

P4: You're not supposed to do that though.

HR: The response is supposed to come from you though? Isn't it? It's supposed to be a measure of how hard you found the session? Do you not think that's a helpful way to feedback to coaches how difficult you found their session.

P2: I just think *coaches name* would be mad though if the I said his session was easy when he thought it was hard.

P4: I think that actually happened once, I remember *coaches name* shouting at *players name* for telling him the session was a 2 out of 10. Even though it was clearly like an 8 or 9.

P2: Oh yeah I remember that.

HR: Fair enough. Finally I wanted to give you all the opportunity to give a bit of feedback on how you think any of these processes could be improved. From your point of view?

P1: I think it would be good if we were able to see the information when we want. Like after training each day if it was sent to our phones or was in the training ground.

P4: I like the leaderboards that we do in the gym sometimes. So like there will be certain exercised or tests that we might do but they put the scores up on the board that updates so that we can have a little competition. I quite like that. I just think to mirror what some of the other boys have said so far, sometimes it can feel like we get asked for information or data gets collected and then nothing happens with it. Which seems kind of pointless.

P2: Yeah I agree

P3: Same

P4: Which I'm not necessarily saying that it is, but sometimes we won't hear any results or anything and it's like what was the point in that. Or what is that being used for. Do you know what I mean?

HR: Absolutely yeah. Anything else?

P3: I wish we could get the pouches for the GPS on the shirts like the first team squad has. That would be nice. I hate the vests.

P1: I think maybe we should just be told a bit more about why its done. Just so that we know. Because I feel like we get more information on some tests than we do on others.