THE RELATIVE IMPORTANCE OF TRAINING SESSION COMPOSITION TO TRAINING PERIODISATION MODELS IN PROFESSIONAL FOOTBALL

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Declaration

I, Christopher William Neville, do hereby declare that, with the exception of my reference to other people's work which have been duly acknowledged, the work contained in this thesis, "The relative importance of training session composition to training periodisation models in professional football" is the result of my research carried out under the supervision of the School of Sport and Exercise Sciences, Liverpool John Moores University, Liverpool, UK from February 2016 to December 2020. I further declare that this thesis work, either in whole or in part, has not been presented for another degree in this University of elsewhere.

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Abstract

Introduction. Training sessions in professional football have typically been designed by technical coaches to achieve pre-determined outcomes. Various activities are combined to form individual training elements and the product of these elements form a training session. Commonly four categories have provided the foundation for team and individual player development (Ade et al., 2016; Buckthorpe et al., 2019). The efficiency in which physical, technical, tactical and psycho-social categories are combined in match play often leads to success. It is therefore prudent for clubs to design training sessions with these factors in mind, both in the short and long term. The level of focus attributed to the four categories during routine training sessions remains largely unknown. The purpose of this study was to assess the relative importance of training session composition to training periodisation models in professional football.

Methods. A quantitative study design was used to determine the level of focus placed on each of the categories from 72 training session throughout the 2nd half of a Championship (UK) session. An expert panel (1 x coach, 1 x sports scientist, 1 x training analyst) was formed to provide a rated interpretation of the level of focus placed on each category of each element of the full training session. The rated values were combined with the element duration to provide a relative value. The level of overall session focus could then be established relative to matchday (MD). Inter-rater reliability was carried out using a Cohens Kappa.

Statistical analysis. Statistical analysis was carried out on all training sessions from December to April. The 4 training sessions in May weren't truly representative of a full training month. Analysis was used to determine whether differences existed in total training sessions values between months and between day prior to MD. To determine the difference in months, a one-way ANOVA was carried out and significance set at p=<0.05. Where an effect was found a Dunn post hoc test was used (p<0.05) to establish where the differences were found between months. To establish comparison between categories separate analysis was carried out. Normality of distribution using a Shapiro Wilks test (p=<0.05) was carried out and data found to be not normally distributed (p=.781). Therefore a Kruskal-Wallis non parametric test was used. Where an effect was found a Dunn post hoc test was used (p<0.05) to establish where the differences were found between categories. A one-way ANOVA was also carried out to assess category variation existed between training days and

significance set at p=<0.05. Where an effect was found a Dunn post hoc test was used (p<0.05) to establish the differences between training days.

Results. The mean total value for all training sessions = 440.4 a.u ± 126 and 62.5% of sessions fell within a single standard deviation of the mean. When viewed across training months, significant difference was observed December and April (p=0.002), December and March (p=0.004) and December and January (p=0.028). Analysis between categories demonstrated a significant difference between physical to technical (p=0.013), physical to tactical (p=<0.001), physical to psycho-social (p=<0.001), technical to tactical (p=<0.001), technical to psych-social (p=<0.001) and tactical to psycho-social (p=<0.001). Results also indicated that there were significant differences in category focus relative to match day. Significant differences were demonstrated between 4 days before a match (MD-4) and the day before a match (MD-1) in all categories apart from tactical.

Conclusion. The current study was able to demonstrate that differences exist in the time and focus of training session content. Further, it was evident the significant differences in the level of focus applied to categories exist month to month. Finally, significant differences were identified in the level of focus applied to categories between the early to late days of a weekly micro cycle, but not between days later in the week leading to match day. The results of this study go some way to providing insight onto the level of focus applied to each of the four categories.

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Chapter 1

Introduction to thesis

With the average tenure of an English Championship league manager reportedly 1.18 years (League Managers Association, 2018), the pressure to gain results is increasingly greater. In modern professional football the focus of 'on field' success often leads to managers and head coaches prioritising factors that create instant results, therefore potentially neglecting the long-term player development process. For example, recently appointed head coaches of an under performing team may well focus on reducing goals conceded before developing goal scoring opportunities. In other words, initially concentrating on 'not losing', and in doing so potentially regaining player confidence, points accumulation and consolidating league position. Training sessions may therefore focus on tactical organisation and team structure, ahead of long-term multifactorial development. Multifactorial development refers to a structured combination of key performance elements, such as physical recovery and preparation, technical skills, tactical strategy and formation and psycho-social individual and team cohesion factors.

In order to mitigate these circumstances, head coaches may aim to integrate multiple factors into single training sessions to reduce the isolated category focus and ensure that players are exposed to multiple physical, technical, tactical and psycho-social elements. This has resulted in more frequent, often congested training sessions. In addition to technical and tactical staff, sports scientists and medical staff have also become more aware of tactical and technical coaching requirements, integrating the coaching philosophy into their specific practice. Rehabilitation, strength and conditioning, performance and training analysis and recovery strategies often reflect the needs of the team and playing style in order to reinforce the physical, tactical and technical strategy (Ade et al., 2016; Buckthorpe et al., 2019).

Training sessions typically form a routine structure according to the contextual needs of the team (Walker and Hawkins, 2017). This said, a number of factors could result in the need to adjust training plans. Changing player demographic, league position, player availability (injury/national team commitments), time in the season (residual fatigue) and playing philosophy all have an impact on the session planning process. Therefore, although the content of sessions are routinely designed by managers or head coaches, and may form a periodised approach, the input of interdisciplinary stakeholders has become commonplace. The availability of data and objective information provided to the management team from sports science, medical and performance analysis staff has gained increased acceptance and influence on session design. However, as coaching sessions often develop organically and evolve in both content and objective, the coach's intuitive and instinctive abilities should not be ignored.

Strategically, some clubs and head coaches may adopt a defined period in which to carry out focussed area's of development. This periodised approach can be referred to in the short (microcycle), medium (mesocycle) or long term (macrocycle) sense. In the short term the coach may consider the days leading up to matches as crucial for short term success. However, they may also take into consideration the longer-term benefits of player development where purposeful and regular practice may improve players technical and tactical performance. Some authors have attempted to analyse these short and longer periods of training. Jeong et al., (2011) provided some insight into training elements of 2 single week microcycles during a Korean professional football season. They define four key categories of training, physical, technical, tactical and psycho-social. In analysing the training sessions, the authors provided a generic breakdown of sessions into physical, physical and technical/tactical and technical/tactical only. The data provides some insight into the physical load associated with some specific elements of training, although these categories may not truly reflect the complexity associated with a training session. They were also collected over a short microcycle period that may not be fully representative of a competitive season. In another recent study, Martin-Garcia et al., (2018), provided some quantification of external training loads associated with distinct period of a microcycle within professional football. Whilst the insight provided by this study is useful in understanding the fluctuation in external physical demand placed on players during elements of a training week, there is limited evidence specific to each particular training category.

Whether the training element is primarily focussed on a technical or tactical outcome, there is usually a physical consequence to the activity. The level of energy expenditure is dictated by the physical demand placed on the element of training. A clear understanding of the focus placed on physical demands during a training session is important as such information will influence the prescription of training actions and intensities to better replicate the overall demands of matchplay. They may also result in sessions that better meet the tactical requirements of the sport and therefore potentially improve the efficiency of the player development process. Whilst players are required in matches to move in both linear and multidirectional fashion, the demands of the game also require players to jump, kick and tackle (Stolen et al., 2005). Practicing movement patterns relevant to the demands placed on players during matches improves the adaptation process and allows players to develop multifactorial competencies. The demands of training in professional football have also been quantified by Malone et al., (2015), who reported training loads in professional footballers over 6 weeks of pre-season training and 6 weeks in season training. Whilst this study provides a clear and useful understanding of training load, it did

not differentiate in the level of focus placed on specific tactical, technical or physical training elements within individual sessions. It should be acknowledged that achieving greater physical capacities alone will not dictate success in matches. A inter combination of physical qualities, technical abilities, tactical strategy and psycho-social elements will provide the basis for success. This type of multifactorial development largely takes place during training or practice sessions irrespective of the level of play.

In a typical training period, tactical preparation for competitive matches occurs on days immediately preceding a match. Strategies are not only considered for team play, but also positionally and individually. These positional demands are largely dictated by the tactical formation adopted by the head coach. When analysing the physical demands associated with different playing positions, Di Salva et al., (2007) reported a 1400m variation in total distance covered by players during top level Spanish and European competition matches. Furthermore, Bradley et al., (2013) reported that although overall running performance was not significantly different between 4-4-2, 4-3-3 and 4-5-1 tactical formations, high intensity movements were 30-40% higher in offensive patterns (4-3-3 and 4-4-2) than defensive formations (4-5-1). Studies of this nature provide insight into the variation in physical demands placed on players according to their playing position and tactical formation adopted. Often these formations change during match play, therefore establishing a 'typical' movement profile is often problematic. These considerations should be taken into account by coaches when planning training sessions relating to tactical match-play strategies.

The composition and design of training sessions with its distinct outcome focus is therefore multi-factorially based on the needs of the team and playing philosophy. This approach may vary according to factors including league position and playing form and player availability and recruitment. Viewing the composition of training sessions over a longer period of a competitive session will enable coaches and other practitioners to gain a better understanding of session design and the discrete combination of areas of focus.

The aim of the current study was :

To investigate the multifactorial content variation in 72 training sessions over 22 weeks during a professional football season to evaluate the relative importance to training periodisation models in professional football.

Chapter 2

Review of literature

2.1 *Introduction*

The growth in popularity of professional football has been documented in the popular media and there has been a parallel increase in media attention, commercial demands and supporter engagement with the increases in available financial rewards as reported by Deloitte (2017). The increase in potential financial reward related to match outcomes, competitive success and players residual value has increased the level of expectations placed on coaches. As a result, coaching staff have adjusted their principles from traditional training philosophies which largely relied on subjective evaluation, previous playing experience and intuitive decision making, to contemporary training methodologies influenced by specialist practitioner input and objective performance measurements. These performance analytics have enabled coaches to adjust their training philosophies and provide a more detailed, bespoke and individual development model. It appears that literature referring to the rationale in planning training sessions in professional football is limited. The purpose of this literature review is to evaluate the extent in which a periodised approach to session planning exists in practice in modern professional football, and to what extent the composition or balance of physical, technical, tactical and psycho-social elements of a training session are evident.

2.2 *Professional Football – Match demands*

Training sessions are routinely planned to replicate in some way the multifactorial demands placed on players during matches. In describing match play performance, there have been a number of studies that have commented on the 'interaction of different physical, technical, tactical and psychological factors' (Ade at al., 2016; Arnason et al., 2004; Abbott et al., 2017, Sarmento et al. 2014). These reports help form the view that effective performance can be defined by its multivariate needs. It has been proposed that every game action involves a decision (tactical), an action or motor skill (technical) that required a particular movement (physiological) and is directed by volitional and emotional states (psychological) (Oliveira, 2004 in Delgado-Bordonau and Mendez-Villanueva, 2012). It also appears that an increase in qualified professional coaches (BBC, 2017) has resulted in adaptation of training session planning and the balance of the key physical, tactical, technical and psycho-social factors. These four principles (Table 1) were proposed as the 'four corner model' by The Football Association (2019) and are characterised by their specific aims (Morley et al., 2014; González-Villora et al., 2015). Physical refers to a combination of physiological and biological factors including balance, co-ordination and conditioning. Tactical provides players with a

'comprehensive knowledge, understanding and experience of the game'. Technical skill enables players to create, score and prevent goals and psyho-social defines the key behaviours associated with the demands of the game.

Table 1. Defines the pillars of performance proposed by The Football Association. Technical, tactical, physical and psychological categories are described with key sub elements associated with each category.

	Technical	**Tactical**	**Physical**	**Psychological**
Sub elements	Receiving skills	Recognise and adapt to the state of the game	Agility, balance and coordination	Behaviour
	Turning skills	Achieve winning performances by maximising strengths and exploiting weaknesses	Speed/Speed endurance/aerobic endurance	Reflection
	Travelling with the ball	Understand and apply individual, unit ad team roles and responsibilities	Flexibility	Teamwork
	Passing over various distances	Adopt varied playing styles and formations	Power	Relationships
	Attacking and defending skills	Perform effectively against varied playing styles and formations	Strength	Accountability
	Aerial ability	Deal with varied environmental conditions	Nutrition and lifestyle	Responsibility
			Physical resilience	Independence

To understand the interaction of these elements, it is worth considering match play demands and dividing the research into decrete categories.

Physical

In matches, players are exposed to high physical outputs (Jeong et al., 2011) which are divided into a number of associated variables (Bangsbo et al., 2006). This is dictated by a number of factors, including the teams playing style or philosophy adopted by the head coach, the environmental conditions, the opposition strategy, the technical ability of the players and the tactical formation. All

have an impact on physical output during match play. The aerobic capacity of a player is considered to be an extremely important component in order to fulfil these demands (Modric et al, 2020, Chamari et al., 2005, Arnason et al., 2004) as it underpins an individual players ability to achieve improved field position through both greater distance covered and increased ball involvements (Dellal et al., 2008). It has been reported that typically a player will cover around 10-13km in a match at an intensity close to 70-80% of their maximal aerobic capacity (Hoff et al., 2002). This said, both mechanical and metabolic demands can result in varying physical output (Colosio et al, 2020). Whilst metabolic demand refers to the players ability in physical movement, mechanical demand could be defined as the effciency of movement related to football specific technical and tactical movement such as tackling, heading and various involvements with the ball (Jack et al, 2016). For the purposes of this review, technical and tactical demands will be covered in the following sections. From a purely physical standpoint, total distance can be sub-divided into walking, jogging, running, high speed running and sprinting. In a further study, Dupont et al., (2010) divided the 'high intensity elements' of match play demand. They observed that on average there was some 2011m difference in total distance, 365m in high intensity running and 175m in sprinting between midfield players and central defenders. Positional demand variation should therefore be considered when describing physical match play demand. Whilst the aerobic contribution of energy utilisation is important during a match, actions such as sprinting, which equate to around 1-11% (Stolen et al., 2005) of activities depending on playing position, are supported by anaerobic metabolism. These are considered a key contributory factor to success. Djaoui et al., (2017) reported that outfield players regularly reach speeds exceeding 80% of their individual maximal sprinting speed (MSS). Whilst this provides some insight into the speed exposure during matches, the authors also acknowledged that a range of 85.3% to 92.9% of MSS also exsits between playing positions. This further supports the need to consider different playing positions when considering the match demands placed on players. Movement of this nature and intensity potentially leads to injury if players are not adequately prepared. Buchheit et al., (2020) investigated near maximal sprinting efforts (80%, 85% and 90% of Maximum Sprint Speed) and the effects on training prescription and injury 15eriodized. Results from this study support previous research and indicated that near sprint exposure was determined by positional demand and as a consequence provides an argument for differentiation in physical components of session design. For example, in a full match the range reported in number of >90% MSS exposures was 0.2 (central midfield) to 0.5 (central defender) and distance range of 2m (central midfield) to 5.6m (central defender). In order to prepare adequately for both maximal and submaximal actions during matches, exposure to repetitions of the required linear and multidirectional movements results in repeated stresses on the relevant muscular and energy systems and as a consequence

allows players to adapt and develop the required physical capacities (Morgans et al., 2014). These movements specific to match play routinely take place during training sessions.

At the highest level of club football, players are routinely playing matches every three days with frequent overseas matches involving extensive travel. This can effect the quality of adequate recovery and if compromised, potentially effect the physical outputs during matches. Optimal recovery was reported by Dupont et al., (2010) as 96-120 hours post match before players returned to pre match physical values, although Nedelec et al., (2012) commented that 72 hours may be periodised to 'return to pre match values for physical performance'. In these studies there appears to be no acknoweldgement of positional differences in match demand, which may have a subsequent effect on the optimal recovery period. Reducing recovery time between matches 'may result in players experiencing acute and chronic fatigue potentially leading to underperformance and/or injury' (Nedelec, 2012). Match related fatigue may be characterised by reduction in muscle glycogen, increasing evidence of muscle damage (creatine kinase), reported muscle soreness, lower mood state and reductions in field based performance measures. In a field based evaluation, Carling et al., (2015) reported reductions in repeated high speed running performance in 72 hours post match. In order to mitigate fatigue related symptoms, reducing injury risk and improve subsequent performance, practitioners have used various recovery methods like cold water immersion, compression garments, massage. It appears however, that evidence supporting the use of these methods is currently limited (Carling et al., 2011). In order to evaluate the level periodiation in order to achieve optimal recovery it is useful to monitor the players response to both match and training demands.

Physical training demand

In order to optimise the training and recovery process, it is useful to implement load monitoring strategies. Oliveira et al., (2019) cited this as the balance in 'effort and fatigue'. Brink et al., (2010) described training load as the product of 'training duration' and 'training intensity'. Whilst training duration is relatively easy to identify, training intensity appears to be more problematic. Challenges in identifying training intensity exist due to the variety of contributory factors. For example, a typical training session may contain a number of elements, each with a specific focus. Within each of these elements, individual players physical response to the training demand may differ. This individualisation can cause difficulties in classifying overall intensity of a session. In order to gain a clearer understanding of each players response to the demand placed upon them, it is generally agreed that training load is divided into specific external and internal training periods.

Internal load

Some studies have attempted to quantify internal load that is characterised by the physiological and psychological responses to training session content. Blood analysis can be useful in assessing a players reaction to matchplay or training stimulus. Djaoui et al (2017) cited blood lactate concentration (B_{Lac}), Creatine kinase (CK), Urea, Creatinine, Haematocrit, Iron status and Immunologcal status as all providing useful insight into a players physical status. One of the most commonly used forms of evaluating the intensity of physical demand is B_{Lac}. Castagna et al., (2011) identified training intensity in elite Italian players by blood lactate concentration over a 6 week period. The authors reported that players spent 73% of training session duration at a low intensity, 19% at a medium intensity and 8% at a high intensity. Although this broad insight into internal load may be useful, the proportion of intensity divided into the different elements of a training session was not reported. The use of heart rate monitoring in order to assess internal training demand is commonplace in professional football. Additionally, internal training demand evaluation has been carried out using less invasive methods such as Session Rate of Perceived Exertion (sRPE) (Malone et al., 2015; Little and Williams., 2007). Scott et al., (2013) carried out a comparison of internal load (TL) measures during a combination of physical, tactical and technical training sessions. The authors reported that 'Measures of TL were shown to fluctuate greatly across the training sessions reflecting the team's periodised training schedule'. Akenhead and Nassis (2016) also provided further insight into monitoring protocols adopted by high-level football teams. Their study reports that even though clubs adopted similar monitoring tools (Global Positioning System, heart rate monitors and RPE) the differences between actual and perceived effectiveness for injury prevention and performance enhancement, were 23% and 20% respectively. The study asked 48 practitioners to rank 10 training and match play variables in order of perceived importance using a points system. The results suggest that although there are agreed parameters used to measure TL, the importance placed on each appears to lack consensus. The authors suggest that this discrepancy may be brought about by the 'suboptimal integration by coaches'. It appears therefore that in order to design and implement effective training programmes to provide stimulus for players to cope with the demand of match play, it is crucial for coaches and fitness coaches to be aligned in their strategies. The perceived intensity of training sessions were also investigated by Brink et al., (2014). In their study of training intensity of young elite footballers, they reported that player's perception of training intensity was harder than the coach intended. It may have been that in this study the subjects were a young group of players progressing from part time to full time training who lacked experience of professional training intensities. This said, the study also questions the difference in the intended level of training load

prescription and that perceived by players. The authors argue that a balance in objective measures of internal load such as heart rate analysis, could be combined with perceived player load. This would provide a broader understanding the intensity of training elements relative to the intended session plan. Understanding the planned training content and associated variables and the players perception of those intensions may provide coaches with a insights into objective / subjective balance.

External Load

Global Positioning System (GPS) units are worn by individual players during training and match play activities and then downloaded once the session or match has concluded. These devices provide information on a number of variables that are relevant to the match and training sessions that has been completed by players including distances covered at different speeds, turns, jumps, accelerations and decelerations. The information collected from the external load monitoring devices during match play provides context to plan training sessions according to the demands placed on the players. Quantifying match play movement distances into discrete thresholds like walking, jogging, running, high speed running and sprinting provide a baseline measurement in which to prescribe external training loads. However, if a player doesn't have 18eriodized internal capacity to reach the intended training outcomes, then potentially external aims won't be met. Although some authors report between-unit error which creates greater variability of results between suppliers (Jennings et al., 2010; Lambert and Borresen., 2010), microsensor technology, such as GPS, has been adopted by professional football clubs to provide comprehensive information on external physical responses to training. The reliability of the GPS units has been the subject of some discussion, and in their review of the use of small sides games in football, Hill-Haas et al., (2011) reported between 3-5% error in total distance measurements. However, the authors did also acknowledge that the data provided by these devices remains useful to informing session planning. When assessing shorter faster (peak velocity) movement, Beato and de Keijzer (2019) reported some consistency in measurement within models, but some discrepancy between models of the same manufacturer. The coeficient of variation (CV) appeared to increase with shorter more defined distances. In a further study carried out with non elite athletes, Beato et al (2018) found a small error of 1-3% when assessing the validity of units at difference sampling frequencies over 400m, 128.5m and 20m trials.

Although some such studies have tried to provide a clearer picture of external training load in elite soccer, it appears that dividing these studies into distinct training components, providing greater detail, is limited. A study by Malone et al., (2015) investigated the physical training loads in professional players over 6 x single microcycle weeks of pre-season training and 6 x 6 week mesocycles of in season training. The results from this study suggest that whilst there appears to be little fluctuation in typical load parameters (total distance, high speed distance, % maximal heart rate and rate of perceived exertion) in the pre season period, in season discrepancies (total distance and $\%HR_{max}$) were apparent from early to late in season mesocycle. The results also indicate that there were TL variations within the weekly microcycle relative to match day. While this study provides us with a broad understanding of physical training demand, and some of the subtle TL variation in the short and longer term training cycle, it did not provide details of why the differences in specific training elements within individual sessions exist. Other literature that has attempted to quantify demand to specific aspects of training have been limited by both the detail of the insight (i.e. limited by both internal and external load variables measured) and the extent of the time periods that the data has been collected over (eg short 7 day). For example, Jeong et al., (2011) attempted to evaluate training elements of 2 single week periods of training during a Korean professional football season. They provided a generic breakdown of sessions into physical, physical and technical/tactical and technical/tactical only. The data provides some insight into the physical demand associated with some specific elements of training, although these categories may not truly represent the complexity associated with a training session. They were also collected over a short microcycle period not fully reflective of a full season.

Therefore, monitoring and combining external training loads and the resulting internal load reaction, allows coaches to gain a broader view of the physical consequence of all categoies of training and the individual players capabilities. Technically or tactically focussed components of a training session often require specifically tailored player movement patterns, therefore iliciting a specific physical response. Understanding the physical components associated with these categories provides coaches with details to align multivariate components during training session design, and promote a balance of effort (progressive overload) and fatigue (promote recovery)

Technical

Physical fatigue has also been shown to effect the volume of technical involvements with the ball during match play. Bush et al., (2015) reported that ‘although the physical and tactical aspects are

central to performance, a team's technical ability has been identified as the best indicator of success'. The authors suggest that the increase of passing variation has been evident over the last 'four decades'. These increases have been apparent with number of passes (+40% in world cup matches), passes per player position (central defenders +66%, central midfielders +44% and full backs, wide midfielders and attackers +25%) and distance of short to medium range passes (30-72%). This study provides some insight into the development of non physical factors associated with success. However, the effect of physical element of non physical components shouldn't be ignored. In a study of professional Italian players, Rampinini et al., (2009) reported that the effect of fatigue during a match was somewhat dependant on the level of play. Teams in the same league, but of lower success, were shown to cover greater running distances at higher speeds during a match. The report suggests that accumulating fatigue resulted in greater decreases in involvements with the ball, long passes, short passes, crosses, headers, tackles and shots on goal throughout the second half of a match compared to the first half for less successful teams compared to those with more success. It appears therefore that the effects of both physical and technical abilities are interlinked. In another report by Bradley et al., (2013), total passes were seen to be greater in the English Premier League compared to the English Championship and League 1. However, the lower leagues also saw greater headers and interceptions than the Premier League. This research suggests that the level of play and the technical abilities of the players determines the volume and type of technical involvements. This type of information from matches may provide coaches with knowledge in order to plan sessions that replicate physical demand, whilst also integrating match related technical components. The importance of technical involvements in a contemporary sense was further demonstrated by Bush et al., (2015), who reported that there had been a 40% increase in passes during world cup matches over the last four decades. Furthermore, it appears that 66% increase in passes came from central defenders and 44% from central midfield players respectively. These increases in technical parameters may be a result of the evolution of tactical formations adopted by the teams and the demand placed on players of certain positions. This type of research further supports the observations of individual position based variation. When assessing the skills based technical components of training sessions in the top professional league in Italy, Castanga et al. (2013) reported that training time was 15% and 13% devoted to ball drills and generic aerobic training respectively. They also cited that 21% and 8% of training time spent on technical-tactical skill development and match preparation respectively. This study provides some insight into the balance and priority assigned to different multiple categories of training although factors like training duration weren't clear.

Tactical

A tactic is described as 'an action or strategy carefully planned to achieve a specific end' (Rein and Memmert, 2016). In football terms, tactics are defined as a strategy adopted for the purpose of mitigating weaknesses in a team and maximising the potential scoring opportunities against the opposition. In modern elite football, there is now a greater variation in tactical formations adopted by teams. In countries like England, where teams have traditionally adopted 4-4-2 (4 x defenders, 4 x midfielders, 2 x forwards), 4-3-3 (4 x defenders, 3 x midfielders, 3 x forwards) or 4-2-3-1 (4 x defenders, 2 x midfielders, 3 x advanced midfielders / attackers, 1 x advanced attacker) formations, there has been a greater influence of formational changes with the emergence of overseas coaches. These formations could be classed as 'fluid' as teams adopt different position related to their retention of possession. To illustrate this, Carling (2011) reported observations from French Ligue 1 matches during 3 competitive seasons using a variety of tactical formations across four positions, full backs, central defenders, central midfielders, and wide midfielders. *In possession* of the ball, players were shown to 'cover greater distances in matches against a 4-2-3-1 formations compared with 4-4-2, although high-intensity (14.4 – 19.7km.h^{-1}) and very high-intensity (>19.7km.h^{-1}) running was not affected by opposition formation'. The author also cite that 'players covered more distance in total high-intensity performance when *out of possession* against a 4-4-2 compared with a 4-2-3-1 formation'. From a technical perspective, more passes were observed against a 4-4-2 formation than a 4-2-3-1 formation. Tierney et al., (2016) also investigated the variation in demand on players whose teams adopt variation in playing formations. Evaluating the five most common tactical formations, the authors provided a useful insight into the positional demand variation when formations are changed. For example, 'forwards' cover 25% more high speed running (HSR) distance in a 3-5-2 formation than a 4-2-3-1 formation. The study provides evidence of the multifactorial nature of match play and the authors comment that the 'different demands for each position is arguably a valid reason to structure a position specific periodised training model that could replicate the physiological demands for each positional group'. However, it should be noted that in matches, the tactical strategy adopted, may change multiple times and could have implications on the reliability of providing positional demand. Abbott et al., (2017) reported that considering positional demand of soccer training games given the variation in match play, 'a one size fits all approach to training must be avoided, instead focussing on specific requirements of athletes to maximise training efficiency'. This type of research suggests the need to conduct multivariate analysis on matches and for coaches to consider the tactical requirements placed on players during differing match play formations.

Tactical preparation can be considered by various classifications. Rein and Memmert (2016) reported hierarchical organisation of players into *individual tactics* by describing how individual players behave related to the teams requirements and *group tactics* describing the interaction of players within a sub group i.e. defending group, midfield group or attacking group. In addition, *team tactics* refers to formations and positioning on the pitch and *match tactics* is the style of play associated with the team i.e. a counter attacking team or a possession-based team. This type of analysis gives support to those that suggest that a 'one size fits all' strategy for tactical training no longer exists. Identifying the tactical strategies being adopted and the variation in tactics deployed in a match results in implications to training session design and how to expose the players to this variation. It appears to be important for coaches to provide a variety of scenario's to allow players to adapt to team tactical behaviours by practicing in sub groups as well as individuals. The degree by which a team adopts and practices various tactical behaviours may well provide more chance of success. Kempe et al, 2014 investigated whether game control was more effective than offensive behaviours for match outcome in German football. Game control was defined using passes per action and direction, target player passes, pass success rate and success in a forward pass. Offensive behaviours were considered using ball possession, gain of possession, quality of possession and duration and distance covered with each possession. The authors demonstrated the most successful style of play using a defined index of behaviours (IOB). Whilst the study supported previous research in acknowledging that possession is linked to team success, the research also indicated that distance covered per attack and ability to gain possession are also crucial to success. This type of research goes some way in demonstrating that tactical behaviours are complex and are influenced by multiple factors.

Despite reports describing tactics as a central component for success in modern elite football (Rein and Memmert, 2016), it is clear that success is determined by a teams strength across their multivariate components. It could be suggested that players tactical success is largely determined by positional efficiency related to other playing positions. Decision making, problem solving and communicating with other players (Luxbacher, 2010) in order to adopt efficient playing strategies are therefore crucial. It could be argued that authors failing to acknowledge the value of inter-player relationship and the importance of psycho-social engagement is potentially neglectful and indeed could be a valid area for future research.

Psycho-Social

It has been reported that in contemporary elite soccer coaches are increasingly aware of the importance of psychological factors like motivation, confidence, anxiety control, mental preparation, concentration and congition (Razali et al., 2016). Nedelec et al., (2015) also reported that modern players are 'facing more mental, emotional and social demands than ever before'. During matches, players are expected to perform at the peak of their 'pyschomotor vigilance and aleartness'. The authors go on to state that some stressors are associated with 'personal relationships, media demands, and public interest', which when combined with match related elements have increased both psychological, social and physical consequences. For example, the match result may have an effect on the players mood state and subsequently effect sleep patterns and the quality of periodised recovery. It could be argued therefore that this combination of both psychological and social factors can influence not just a players mindset but also consequential effects of other aspects of training and match play. However, it appears that quantifying psychological demand placed on players during matches is problematic. In their book, Science in Soccer, Gregson and Littlewood (2018) acknowledged that the first team environment is considered outcome orientated and ruthless. The authors state that whilst the physical, tactical and technical components are 'visible', the psychological component remains 'invisible' and therefore harder to plan, execute and evaluate.

When planning psychological elements of training sessions, Brink et al., (2014) attempted to access coaches perceptions of their own knowledge and perceived barriers to psychological application. The article reports that coaches feel their knowledge of physical, tactical and technical skills are stronger than mental skills. It could be argued therefore that coaching session design appears to reflect these areas of relative coaching 'comfort'. This was supported by De Freitas et al., (2013) who reported that 98.4% of coaches interviewed recognises the need for more suppprt in Psychological Skills Training (PST). The authors also state that PST is excluded from training sessions as coaches are unwilling to implement appropriate strategies or the use of a sports psycologist. It also appears that the coaches attitude towards psychological aspects of training can influence player behaviours. A coaches attitude towards a player can create a positive or negative response. In their study on controlling coaching behaviours, Cheval et al., (2017) reported that coaches with a controlling style became coercive, pressuring and authoritarian in their approach. This strategy is reported as resulting in athletes having lower satisfaction, higher frustration, maladaptive health and perturbed arousal before training. It could be argued therefore that coaches may adopt the appropriate training philosophy with planned outcomes, using a style of delivery suitable for the athletes and team needs combining all components required for successful team play. Whilst the importance of an elite

player's psychological preparation is not in doubt, there appears to be limited research referring to the interaction of psycho-social factors with physical, technical and tactical elements during training and match play.

2.3 *Theoretical approaches to planning training in football*

At governing body level, the combination of technical, tactical, physical and psycho-social elements where considered using the 'core attributes' model. This model was proposed by The Football Association in their 'England DNA coaching fundamentals' (The Football Association, 2019). Launched in 2014, the strategy provides a framework for coaches to build sessions based on these core attributes and coaching fundamentals including the use of games in related practice, using varied coaching styles based on the needs of the group and spending equal time delivering, planning and reviewing the practice. In addition, The Football Association recommended that 70% of time attributed to training should be 'ball rolling time' or football related. This coaching philosophy is in contrast with other literature researching coaching behaviours. In their investigation of the practice activities and coaching behaviours of professional top-level youth coaches, Partington and Cushion (2013) reported that practice activities were guided by a combination of tradition, intuition and emulation of other coaches. The authors also characterise coaching styles as highly directive or autocratic and prescriptive in nature. Further, coaching philosophies have focussed on the opinion and requirements of the team manager or more recently, the head coach. This role has been supported by an assistant and a varied number of technical coaches and analysts. Despite the apparent discrepancy in agreement over coaching framework for delivery, it appears there is a need to plan effectively. Furthermore, planning outcome-based sessions, allows coaches to assess the progress of their players within a distinct development pathway.

Preparation and planning are crucial elements to successful coaching in team sports. It has been reported that success over a season in team based sport is largely reliant on the preparatory phase of pre-season training which elicit both mental, technical, tactical and physical adaptations, whilst training loads remain optimal for performance enhancement and injury prevention (Burgess, 2014). Using a theoretical model of planning over 'phases' or 'periods' provides a controlled basis for peak performance to occur as a result of the summation of particular adaptations. Combining the short term (acute) phases of training into a longer term (chronic) plan that divides periods of training into distinct smaller parts that have a specific focus is known as 'periodisation' (Rowbottom, 2000). Rosenblatt (2014) defined periodisation simply as the 'strategic planning and monitoring of training in order to facilitate the right adaptations at the right time to lead to competitive success'. Loturco

and Nakamura (2016) reported periodisation as the most important and fundamental concept in sports training. The concept has been used in football with various models proposed. In their report on the principles and practices of training for soccer, Morgans et al., (2014) cited periodisation as a 'theoretical model that offers framework for the planning and systematic variation of an athletes training prescription'. Furthermore, Kiely (2018) described the periodisation planning process as requiring variation as being 'a critical design feature'. Some authors have attempted to investigate short term models of combined physical, tactical and technical training periods, or microcycles. In one such study on periodisation by playing position, Owens et al., (2017) concluded that using a structured tapering model during a mesocycle (mid-term period) in professional football may induce significant variation between playing positions. The authors demonstrated that although there was no significant difference in physical parameters between training microcycles over a 6 week period, between positional variation was evident. For example, it was shown that central defenders achieve lower values compared with central midfielders and wide forwards in total distance covered and average speed. In addition, the authors also report across squad average variation in physical parameters in days preceding a match (MD-1, MD-2 etc). This type of study may give rise to the need for practitioners to consider an individual approach to training session planning. There are however, fundamental challenges presented in a theoretical model of training structure. In their article investigating the use of periodisation over an entire Australian Rules Football season, Moreira et al., (2015) reported that there is little evidence to support a periodised approach in team sports. In addition, Loturco and Nakamura (2016) acknowledged that for team sports, the congested competition and training schedules often makes it extremely difficult for strength and conditioning coaches to adopt a classic and theoretical method of training due to the complexity and wide range of unpredictable and changeable factors. Kiely (2017) described the complexities associated with periodised models. The author cited that 'few dimensions of elite sports performance are as important, as complex, as experimentally impenetrable, and as shrouded in historical myth as the topic of training planning'. It appears therefore that even though adopting a model provides structure to training, it also may consist of multiple variables in a constantly changeable environment, leads to both theoretical and applied challenges for coaches.

2.4 *Application of theoretical training models in professional football*

Accepting that training sessions are multivariate in nature and contain elements from multiple categories, Owens et al., (2017) provided an Illustration of a typical single match training week microcycle for a professional team with associated aims (table 2). Although this model provides an

outline of a possible weekly training strategy, the authors did acknowledge the need for further investigation into periodised programmes where different clubs adopt different programme design and tactical strategy.

Table 2. Single game weekly training microcycle. AT = activation training, WU = pre session warm up, PTT = physical, technical, tactical, TT = tactical technical, CD = cool down, GT = gym training.

	MD-5	MD-4	MD-3	MD-2	MD-1	MD	MD+1
AM	REST	AT	AT	AT	AT	REST	REST
		WU	WU	WU	WU		
		PTT	PTT	TT	TT		
		CD	CD	CD	CD		
PM	REST	GT	GT	REST	REST	MATCH	REST

It has been demonstrated that various match play components have an interdependent relationship. Therefore, it could be argued that training methods should be adopted to accommodate all elements related to effective match play. During their study on positional variations in match play parameters, Bush et al., (2015) cited that 'individual activities, commonly known as drills, [are designed] for each position or ideally during exercises that simulate intense periods of match-play. These may be designed where all positions are working in tandem and tactical and technical aspects are combined with the unique physical demands of each position. This said, Morgans et al., (2014) also reported that coaches often choose to take a technical and tactical precedent over other factors during training sessions. The need to include tactical variation in training session design was further supported by Rampinini et al., (2009) who commented that tactical and not just technical abilities were important factors for success in football. With the apparent need for instant results and outcome-based objectives, this trend is somewhat understandable given the nature and time allocated to the development model. However, an integrated approach to including multiple factors in coaching strategies have been proposed and adopted by some coaches. In their report on tactical the periodisation model, Delgado-Bordonau and Mendez-Villanueva (2012) proposed a strategy based on four tactical situations (moments) of a match. Defensive organisation, attacking organisation and both transitions from one to another were cited as being the main determining factors in match outcomes. According to the authors, a tactical periodisation approach allows coaches to focus on a variety of tactical elements throughout a training week relative to match day. Although the overall focus of this strategy is tactically driven, there may also be an intent to integrate other key performance elements including technical, pyscho-social and physical factors.

Scott et al., (2013), argued that field-based training programmes were designed entirely by coaching staff to elicit technical, tactical, and physiological responses in the playing group. However, it should be noted that to achieve the aims of training in accordance with the team's periodised training plan and residual player fatigue on a week to week basis, collaboration may need to be sort between technical coaches, fitness coaches and performance analysts, as there are a number of factors that will affect these plans. Typically, in elite football, fitness coaches prescribe the physical preparation and development of players in order to generate the required level of physical conditioning and robustness for effective match play. During the planning of training, coaches typically discuss with fitness coaches the structure and content, planning and delivery of a session. This will include deciding the number of available players and the aims and objectives of each session element. With the multivariate needs considered, it therefore appears important that coaches, fitness coaches and performance analysts collaborate in designing the discrete elements of a training session and its specific primary and secondary objectives. Periodising the structure of a training week (microcycle) into days of varying physical demand and differing tactical / technical practice ensures that players are optimally prepared for upcoming match play. Mara et al., (2015), described physical periodisation in female soccer as being comprised of 'phases or cycles of varying training demands and goals programmed across pre-season, early competition, late competition and transition phases'. Brink et al., (2014) described the periodised approach to physical loading in football as the interaction between load and recovery or fitness and freshness as previously reported. This was defined by Los Arcos et al., (2017) as the dose - adaptive response relationship. However, in this study the authors also acknowledge that within group complexities also exist. The authors explain that complexities can be generated by the extensive use of football-based training methodologies which create within group differences in training dose depending on playing position. The increased use of tactical training methods therefore results in greater variation in training loads across playing positions making the prescription and optimisation of the individual training dose problematic. Therefore, implementing a theoretical training methodology becomes increasingly complex with the higher the level of play and the coaching philosophy adopted. One method adopted by some coaches designed to expose players to multivariate demands, replicating those of a competitive match, is the use of small sided games (SGG). In this literature review it was thought useful to investigate current training methodology incorporating SSG's to provide context to training prescriptions.

The use of Small Sided Games (SSG's) as a training methodology

Recently, there has been an increase in the prescription of SSG's (Hill-Haas et al., 2011), or game-based training, as a method of combining all football related elements. Morgans et al., (2014) suggested SSG's are an effective and specific approach to training. They stated that the effectiveness is a result of combining physical, technical and tactical skills and the manipulation of typical variables such as size of the pitch, number of players and duration of games. Further studies on the use of SSG's as a training methodology have been carried out by Owens et al., (2014), who reported significant differences between the training effect of varying sided games. For example, they reported that SSG's produce a higher physical response than larger sided games (LSG) where the output is dictated by the tactical demands on playing in larger sized teams. The authors also acknowledge the need to consider the overall training aim and therefore the use of small sided games within a periodised training model. Despite some reports suggesting SSG's is an effective training method to combine categories required in match play, Hill-Hass et al., (2011) conclude in their systematic review that the effectiveness of SSG's as a training tool remained incomplete. SSG's however have been a subject of much research due to the number of manipulated variables. In their study of evaluating both number of players and pitch size, Owens et al., (2014) reported that technical involvement were greater in SSG's than LSG's in a larger area. This not only has implication to physical output but also technical demand. Variation of GPS derived physical output across different sided games were reported by Gaudino et al., (2014). The data (Table 3) demonstrates the variation of GPS output from the changes in player numbers over a 4 minute game with consistent pitch size and rules, although the data was only published with team numbers of 5 of above.

Table 3. Distance and speed parameters obtained during SSG's. Results have been normalised by time (for a 4 min period) and then expressed as mean ± SD. TD = total distance; TS total high speed running (>14.4km h^{-1}); HS = high speed (14.4-19.8 km h^{-1}); VHS = very high speed (19.8-25.5 km h^{-1}); MS = maximal speed (>25.2km h^{-1}). *Significant difference (p<.001). G = game where goalkeepers were present. P = possession only, where no goalkeepers were involved. Reproduced from Gaudino et al., (2014).

	5v5 SSG-G	5v5 SSG-P	7v7 SSG-G	7v7 SSG-P	10v10 SSG-G	10v10 SSG-P	Follow-up tests (LSD)
TD (m)	402 ± 47	419 ± 28	412 ± 38	443 ± 37	441 ± 31	466 ± 45	10v10>7v7.5v5* SSG-P.SSG-G*
TS (m)	42 ± 17	31 ± 10	57 ± 14	50 ± 18	76 ± 14	85 ± 24	10v10>7v7>5v5* SSG-G=SSG-p
HS (m)	39 ± 15	30 ± 10	47 ± 10	47 ± 16	57 ± 10	73 ± 20	10v10>7v7>5v5* SSG-G=SSG-P
VHS (m)	3 ± 3	1 ± 1	10 ± 5	3 ± 3	16 ± 5	12 ± 7	10v10>7v7>5v5* SSG-G>SSG-P
MS (m)	0 ± 0	0 ± 0	1 ± 1	0 ± 0	2 ± 2	0 ± 1	10v10>7v7>5v5* SSG-G.SSG-P*
Max Speed (km h^{-1})	20 ± 1	19 ± 1	23 ± 2	20 ± 1	26 ± 1	23 ± 1	10v10>7v7>5v5* SSG-G>SSG-P*

The increased popularity of SSG's as an effective multivariate training method has been characterised by the adaptation of the variables and the combination of physical, technical and tactical demand. Owens et al., (2014), also reported that during 4v4 games, intensity ($m.min^{-1}$) of play was 38% and 25% higher during SSG's compared with mid sided games (MSG's) (5v5 – 8v8) and LSG's (9v9 – 11v11) respectively. It may therefore be important for coaches to consider the session aims when including game play as a training method to achieve the desired outcome. However, designing specifically tailored activities to include multiple aspects of match play in training sessions remains popular amongst coaches. In order for training sessions to promote relevance to match play, some authors have investigated the specific movement patterns associated with competition in order to design specific drills incorporating relevant physical, tactical and technical parameters. One such article was published by Ade et al., (2016), in which the match demands of 20 individual English Premier League players were assessed during high intensity (HI) activities across an entire season. Results using a camera-based tracking systems indicate that wide midfielders (WM) exhibited greater high intensity efforts when in ball contact than centre backs (CB), centre midfielders (CM) and centre forwards (CF). Wide midfielders executed more repeated HI efforts than CB's and CM's. Full backs (FB) and WM's performed more crosses post HI efforts than other positions. Out of

possession, CF's completed more efforts in closing play down, but less tracking back with opposing runners. Even though the authors verify the validity of using camera based systems as a form of match analysis, it is questionable whether the data can be successfully incorporated into training drills where the same tracking systems are not widely available. Although the authors did acknowledge a high level of match to match variability, the results provide an interesting insight into positional variation of players during matches. In order to understand more about contemporary training session configuration and the focus applied to each training element, it is useful to establish a clear understanding of the needs of coaches and players in the development of specific models created over specific time periods.

In order to accommodate multiple complexities, some authors have suggested that programmes should be designed to meet the psychological, tactical and technical requirements of the sport as well as the physical to create optimal performance (Smith 2012). Coaches have a duty to assess the needs of players based on both match demands and facilitate the tactical and technical skills required to achieve player development and optimum team preparation whilst being mindful of the physical and psycho-social demand being placed on the players. Although evidence of support for periodisation theories have received some criticism, it also appears the coaches accept the need to provide flexibility and structure in combining different training methods (Mujika et al., 2018). As preparation strategies need to include a varied approach to training session design, a number of training methods and activities can be utilised to produce the desired outcomes.

Chapter 3

Do different training sessions exist in elite football and what level of focus is applied to physical, technical, tactical and psycho-social sub categories?

3.1 Introduction

In order to achieve the desired outcomes, training sessions may be designed with one primary objective – physical, tactical, technical and psycho-social. A training session typically consists of a number of individual elements or exercises that are individually designed to achieve as desired outcome. Each element within the session, when combined with other elements, is designed to contribute to the overall session objective, be that physical, tactical, technical or psycho-social. In addition to the primary purpose of a session, elements may also contain a secondary. Coaching priorities can be defined by the level of focus placed on one or all of the 'pillars of performance'. A combination of session elements and the level at which they are carried out will dictate success during practice and the preparedness of players for matches and the player development process. In designing a multifactorial training session, coaches need to consider a number of factors. Session content, duration, player availability, day relative to match day and coaching priority, will all affect the planning process and influence session outcomes. Analysing the breakdown of training sessions, including the specific classification of the training elements that may be included, provides a better understanding of the distribution of each type of activity and its associated objective. Such information can lead to more efficient overall planning strategies for players in both an acute and chronic sense.

In order to establish whether different training sessions exist in professional football it is important to evaluate the selection criteria for each element of a session and establish how the resultant programme reflects particular training priorities and outcomes. This provides a greater understanding of the composition of each training sessions and any variation through both the short- and long-term planning process throughout a season. It could be argued that in professional football, in-session variation and adjustments routinely take place. Factors like player motivation, in-session injuries, player feedback and effectiveness of coaching points can result in coaches adjusting a plan mid-session. Therefore comparing the completed session relative to the planned session can also provide some insight into the coaching process and provide context to each session.

The aims of this study were to:

Evaluate if different training sessions exist in elite football and what level of focus is applied to physical, technical, tactical and psycho-social sub categories?

3.2 Methodology

Study design

A quantitative approach was adopted to investigate whether different training sessions exist and whether they provide a different level of category focus. In order to quantify the level of focus of each training session, a novel rating system was developed. By considering the duration of each element contained within a training session, and the level of focus of categories within each element, a clear observation of the focus of sessions could be demonstrated.

Participants

Full time professional players were recruited from the sample club (n=20) with a mean age of 25 ± 5 years. Participants were briefed on the objective and protocol of the investigation and were notified that they could withdraw from the study at any time. Subjects were recruited from all outfield playing positions, 9 = defenders (D), 7 = midfielders (M) and 4 = forwards (F). Goalkeepers were excluded from the study as routinely they adopted a separate training protocol to the outfield players. Training data was collected and analysed on all senior outfield players taking part in training sessions where n>10. Senior players were defined as those taking part in the senior team training sessions.

Prior to the commencement of the study, a full protocol was submitted according to the requirements of the Declaration of Helsinki and was approved by the university ethics committee of Liverpool John Moores University (Ref 16/SPS060). In addition, gatekeeper authorisation was approved by the team manager (Appendix A). The team were competing in the English Championship (2nd highest professional league in England). For clarity, as the team management changed at the mid-point of data collection a separate approval from the incoming manager was obtained. All players involved in training sessions were asked to complete an informed consent form (Appendix B) and were provided with a participant information sheet (Appendix C). Those players that did not wish to provide informed consent were excluded from the data analysis. To ensure confidentiality, all data was anonymised before being reported.

Training session design

To establish an understanding of daily training structure, a coaching meeting was routinely held and a session plan agreed between the team manager, assistant manager, technical coach and head of

athletic performance (sports scientist) prior to the commencement of the session. The structure was agreed in order to achieve predefined physical, technical, tactical and/or psycho-social outcomes.

Training session categorisation

Each training session contained a number of elements. Each element of a session contained a variation in level of focus per category (physical, technical, tactical, psychosocial). An element was defined as *an individual portion of a session that is combined with other elements to form a complete training session*. The sports scientist in attendance recorded the description and duration of each element, the individual lead staff member (i.e. coach), and the number of players taking part.

Following a training session categorisation of each element of training was carried out to establish the primary focus. In order to complete this categorisation, an expert panel was formed. The panel included full-time professional technical coaches (n=1), sports scientists (n=1) and training analyst (n=1) all having observed the preceding training session. 72 of 76 observed training observations were used over a 22-week period of the 2016/17 season. The 4 training sessions during May were excluded from the analysis as they were deemed not truly representative of a full month. The categorisation of each specific element of the session were collaboratively agreed by the expert panel following the session and used as a basis to classify each training element. The agreement of classification or level of focus of each element was defined based on a combination of the perceived importance of that element to the overall aim of the session, how much category contribution was observed during the element, and the duration of the element. This provided a framework by which each element of a training session was defined and therefore an overall session focus could be established. Once the level of focus of each element had been agreed and recorded on the training report and data collection sheet, a hard copy of the report was secured to the training session plan and data collection sheet and all were securely filed.

Table 4. Classification definitions. Definitions of classifying each element of a training session plan. This was used to agree the level of focus on each category in each training element related to the overall aim of the session.

Level of Focus	Description
Total	Classification where no other categories were apparent in the element
High	High focus where other categories were also involved in the element, but not dominant
Medium	Moderate focus where other categories were also involved in the element and of equal value
Low	Lower focus than other categories
None	Category was not involved in this element

Table 5. Element definitions. Definitions used to classify each specific element of a training session plan. SSG = Small sided game, MSG = Medium sided game, LSG = Large sided game. Unless contained within the table, all other elements of a training session were considered to have no category contribution.

LEVEL OF FOCUS	CATEGORY			
	PHYSICAL	TECHNICAL	TACTICAL	PSYCH-SOCIAL
TOTAL	Jog and stretch	Shooting	Set plays	
	Linear runs	Static passing		
	Warm up with no ball			
HIGH	SSG 6 v 6 (+6)	SSG 6 v 6 (+6)	Coached 11 v 11	Skills game
	Warm up with passing	Warm up with passing	Waves of attack	
	Possession 6 v 4	Possession 6 v 4	11 v 11 walk through	
	SSG 4 v 4 + 2	SSG 4 v 4 + 2	LSG 11 v 11 / 10 v 10	
	LSG 11 v 11 / 10 v 10	MSG 7 v 7		
	MSG 7 v 7	Boxes 7 v 2		
	Possession 5 v 5	Possession 5 v 5		
	1 v 1 shooting practice	1 v 1 Shooting practice		
	LSG 9 v 9	Crossing and finishing		
	Possession 1v1, 2v2, 3v3	Passing patterns		
	Agility runs	LSG 11 v 11 / 10 v 10		
	Possession 8 v 8 + 3			
MODERATE	Warm up – grids (in 3's)	Warm up grids (in 3's)	3 zone progression	Boxes 7 v 2
	3 zone progression	Coached 11 v 11		
	Passing (Warm up)	3 zone progression		
	Waves of attack	LSG 11 v 11		
	Boxes 7 v 2	Possession 8 v 8 + 3		
		Possession 1v1, 2v2, 3v3		
		Waves of attack		
		Agility runs		
LOW	Coached 11 v 11	Skills game	Possession 8 v 8 + 3	Warm up – grids (in 3's)
	11 v 11 walk through	Warm up with passing	LSG 9 v 9	SSG 6 v 6 (+6)
	Crossing and finishing	11 v 11 walk through	SSG 6 v 6 (+ 6)	Possession 6 v 4
	Passing patterns		Possession 5 v 5	SSG 4 v 4 + 2
			Boxes 7 v 2	Coached 11 v 11 / 10 v 10
			1 v 1 shooting practice	3 zone progression
			Crossing and finishing	LSG 11 v 11
			Passing patterns	Possession 8 v 8 + 3
			Warm up with passing	LSG 9 v 9
			MSG 7 v 7	MSG 7 v 7
				Possession 5 v 5
				Warm up with passing
				1 v 1 shooting practice
				Crossing and finishing

Session rating value calculation

To establish training session priority, it was necessary to calculate the product of both weighted value and duration of each element. A methodical approach was taken to calculate a) each element rating value and b) the total training value. This was divided into 6 phases:

1) To provide duration of each element a record of the start and completion time was recorded by the sports scientist in attendance.
2) At the conclusion of the training session, using element definitions (table 5) the expert panel agreed on the level of focus applied to each element across each category – physical, technical, tactical and psycho-social.
3) A weighted score was then assigned to each element as Total = 4, High = 3, Moderate = 2, Low = 1 and None = 0.
4) The product of the weighted score and duration was then calculated for each element and for each category.
5) All elements of the training session were then combined to form an overall value per category. Each category value was then combined to form an overall training session value.
6) This process was repeated for 72 recorded training session.

Table 6. Calculation of session value. The overall training session priority was calculated as the product of element rating based on weighted value, and element duration, and displayed as arbitory units (a.u.). In this example, total weighted score x element duration = physical 181 a.u, technical 201 a.u., tactical 119 a.u. and psych-Social 67 a.u. Therefore, the total session value = 568 a.u.

Element	Time (mins)	Category Rating				Weighted Value (a.u.)				Session Priority (value x duration)			
		Phy	Tech	Tac	Psy	Phy	Tech	Tac	Psy	Phy	Tech	Tac	Psy
Warm up w/ball	16	H	H	L	L	3	3	1	1	48	48	16	16
Crossing and Finishing	10	L	H	L	L	1	3	1	1	10	30	10	10
7 v 7 Possession	15	H	H	L	L	3	3	1	1	45	45	15	15
Coached 10 v 10	26	H	H	H	L	3	3	3	1	78	78	78	26
									Total	**181**	**201**	**119**	**67**

By calculating a numerical value for each training session, the level of variation between training sessions could be quantified. Establishing the values for each category in each training session, provided a numerical variation in focus. This provided the foundation of comparison in training session composition within training periods (Meso-Macrocycles).

Statistical analysis

To establish the variation in category content in all training sessions across each full training month statistical analyses were carried out using JASP (University of Amsterdam, Netherlands) where

p=<0.05 was indicative of significance. 95% confidence intervals (95% CI) were calculated and presented in the results.

For inter-rater reliability a Cohens Kappa was used as suggested by McHugh (2012). In order to provide breadth to the analysis, this sample was taken from four sessions at the start of the study, four from the mid-point and four from the end and was analysed using a single score per variable. According to McHugh (2012) a fixed marginal Kappa of <0.20 show poor agreement between raters, 0.20 – 0.40 is described as fair, 0.40 – 0.60 moderate, 0.60 – 0.80 good and 0.80 to 1.00 very good.

A between months (December, January, February, March and April) comparison in total training session value was carried out. All session data was tested for normality of distribution using a Shapiro Wilks test and normality set at *p*=<0.05. All dependent variables were shown to be normally distributed. A one-way ANOVA was carried out to test between months and significance set at *p*=<0.05. Where an effect was found a Dunn post hoc test was used (*p*<0.05) to establish where the differences where found between months.

To establish comparison between categories (physical, technical, tactical and psycho-social) a separate analysis was carried out. Data for all dependent variables were tested for normality of distribution using a Shapiro Wilks test and normality set at *p*=<0.05. All dependent variables were shown to be normally distributed apart from tactical. As a result, the mean total monthly values were shown to be not normally distributed (*p*=0.781). It was therefore appropriate to carry out a non-parametric test between categories for physical, technical, tactical and psycho-social values using the Kruskal-Wallis method. Where an effect was found a Dunn post hoc test was used (*p*<0.05) to establish where the differences were found between categories.

3.3 Results

Table 7. Training session data collected over the 2nd half of a competitive season. The team undertook 72 training sessions, averaging 3.3 ± 1 training sessions per week. During this period, the total training time was 4611 $mins^{-1}$ with each training session lasting on average 60.1$mins^{-1}$ ± 15 $mins^{-1}$. Sessions consisted of 282 individual elements or 3.7 ± 2 elements per training session.

		Standard Deviation
Totals number of training weeks	22	
Number of training months	5	
Total number of matches	28	
Total number of rest days	48	
Total number of training sessions	72	
Total number of training sessions per week	3.3	± 0.8
Mean length of each session ($mins^{-1}$)	60.1	± 15.1
Total number of session elements	266	
Mean number of elements per training session	3.7	± 1.9

Inter-Rater reliability

Of the training sessions recorded, 12 (15.7%) were chosen as a sample of inter-rater reliability. The inter-rater reliability range of 12 randomly chosen sessions was 0.33 to 1. Mean scores were 0.49 at the start, 0.46 at the mid-point and 0.72 at the end of the study. Study mean of 0.56 provided a 'moderate' reliability according to McHugh, 2012.

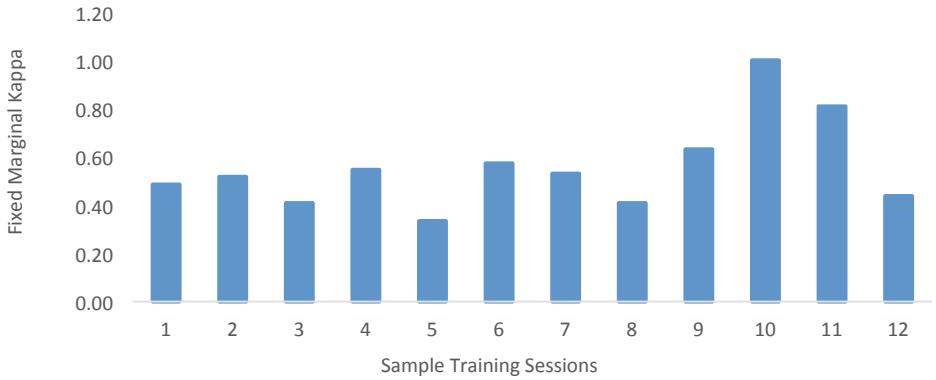

Figure 1. Fixed marginal kappa displayed for each of 12 training sessions chosen to assess the expert panel inter-rater scoring reliability. A graphical illustration of the scoring drift throughout the scoring process is displayed above.

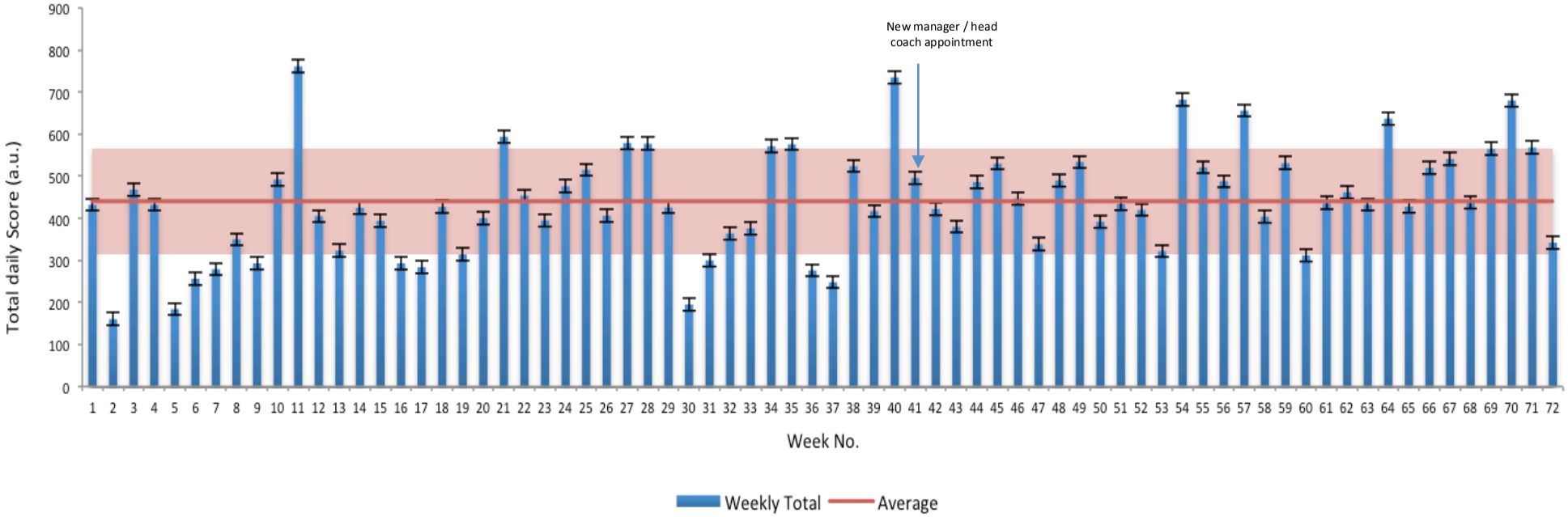

Figure 2. Relative training session values. Individual session values with mean line and ± standard deviation (SD) above and below the mean which is represented by the pink band. Individual session mean = 440.4 a.u ± 126. The data demonstrates that 37.5% of training sessions fall outside a single standard deviation of the mean.

Table 8. Mean total session values for each full training month. Data is presented in mean aubitory units (a.u.) ± standard deviation (SD). Data displays upper and lower boundaries and standard error (SE). When viewed across the full training period, significant difference was observed between December and April (p=0.002), December and March (p=0.004) and December and January (p=0.028)

MONTH	NO. OF SESSIONS	MEAN	SD	LOWER	UPPER	SE
DECEMBER	17	366.5	139.5	307.9	425.1	29.4
JANUARY	13	442.9	111.7	375.9	509.9	33.5
FEBRUARY	14	440.8	133.8	376.2	505.3	32.3
MARCH	15	479.3	102.5	416.9	541.6	31.3
APRIL	13	489.3	108.1	422.3	556.3	33.6

Data in figures 3 displays within month category variation for each full training month. Data displayed in arbitory units (a.u.).

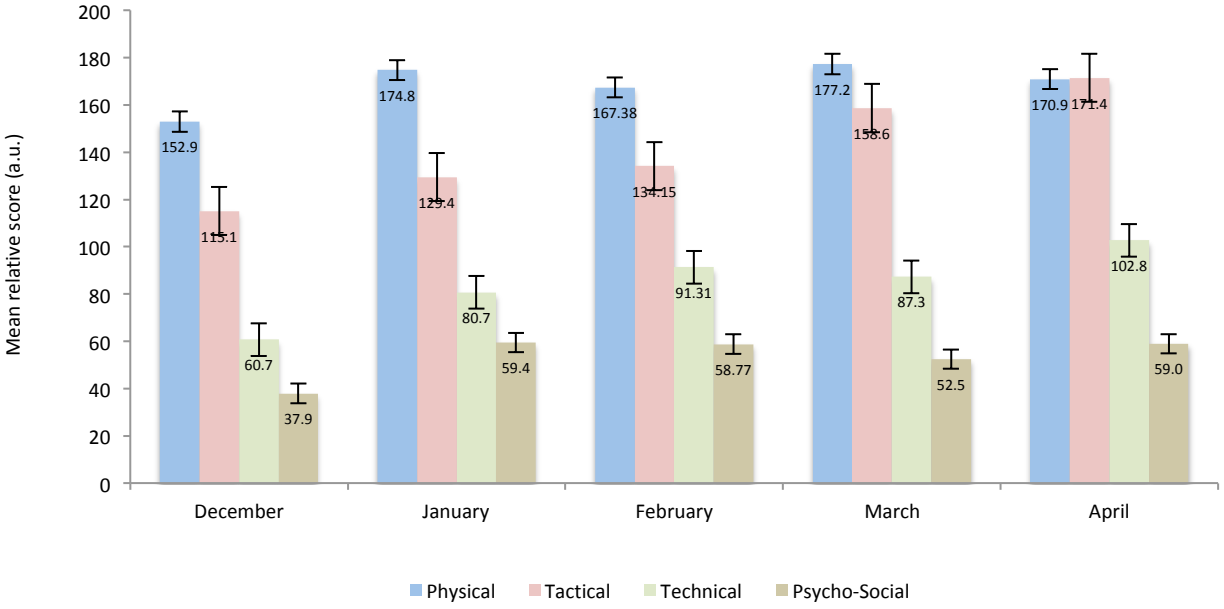

Figure 3. Category focus throughout a 22-week macrocycle. Results demonstrated a significant difference between all categories, physical to technical (p=0.013), physical to tactical (p=<0.001), physical to psycho-social (p=<0.001), technical to tactical (p=<0.001), technical to psych-social (p=<0.001) and tactical to psycho-social (p=<0.001).

3.4 Discussion

The purpose of the current study was to establish if differences exist between training sessions during a professional football season, and if so, what level of focus are directed to sub-categories. When applying a rating system, combining session content focus with total session duration, it was established that differences existed in 70 of 72 observed sessions. Furthermore, when considering the category content in training sessions between months, significant differences were established.

In planning training sessions in contemporary professional football a number of stakeholders will contribute. Coaches and assistant coaches will typically be supported by medical and sports science staff including physiotherapists, strength and conditioning coach's, sports scientists and performance analysts (Nesti in Schinke and Hackfort, 2016). Drawing on this specialist knowledge provides multivariate contributions to each planned session. These contributions can be combined to reflect the strategy adopted by the head coach and/or club. Training session content reflects the coaching philosophy by adopting differing training methods (Kiely, 2018; Walker and Hawkins, 2017). The number and timing of competitive matches, often during congested periods, provide coaches with challenges to establishing a regular, methodical training approach (Anderson et al., 2016). Player's cumulative and residual fatigue throughout a full season can also influence how training sessions are planned and the characteristics that predominate. In addition, injuries and players returning to training can result in coaches adjusting sessions to accommodate key individual needs. This said, football seasons rarely progress in a linear fashion and training reflects the changing needs of the team and individuals. In-session adaptations occur for a variety of reasons, which results in differences in both training content and duration.

Using a weighted scoring system relative to the duration of each training session in combination with the level of the content focus, results from the current study, demonstrate that 97.2% of training sessions differed in either the level of content focus or volume (figure 2). When analysed within a single standard deviation of the mean for session-to-session values it was established that 62.5% of sessions fell inside the mean. Therefore, although differences between sessions were observed, it was important to consider how the sessions were structured in order to establish the range in content focus.

In the current study it appeared that the structure of individual training sessions were broadly designed around 'building' in the early stages of the session to a 'team-based' element towards the

conclusion. Initially, the warm up largely focused on physical preparation and were either designed entirely around physiologically specific exercises, or incorporating a ball, increasing technical contribution. The initial section of the football elements centred on technically focused activities like ball possession, passing activities or skill related components. Finally, the session generally concluded with team-based activities. These formed the structure of LSG's (9 vs 9 to 11 vs 11), MSG's (5 vs 5 to 8 vs 8) or SSG's (2 vs 2 to 4 vs 4) (Owens et al., 2014). This type of training session structure appears to support some of the literature in its planning. The "game training phase", cited by O'Connor et al (2017), described a similar structure in youth football. The authors report the progression of activities for youth players from repetitive instructional activities based around skill development at the early years (U10-U13) to game-based activities at the later ages (U14-U17). Game based activities are designed to recreate and simulate match scenarios, therefore requiring greater problem solving and decision making. This in turn created greater exposure of players to psycho-social and tactical elements of match play practice. It could be argued therefore that exposure to the multivariate category contents of training session may become more commonplace in the future (Nassis et al., 2020).

In the current study, whilst establishing that different training sessions do exist, it was useful to determine how they differed in both content focus and duration, and over what period. It is also interesting to note that there was a managerial change during the final third of the season (Figure 2, session no. 41). In addition, the team were positioned in the lower part of the respective league table and as a result were competing to remain in the league and avoid relegation to the league below. In the author's subjective observations, there appeared to be a distinct shift in training priorities as the incoming manager adopted a strategy more tactically focussed. Although determining the reasons for the differences in sessions or the level of session content similarity remains problematic, it was demonstrated that there were significant differences in mean total session values between December and January (p=0.028), December and March (p=0.004) and December and April (p=0.002). From a coaching perspective, understanding the level of focus placed on training session content can potentially impact the planning process to ensure that each of the categories of performance are being challenged optimally, both collectively and individually. However, the optimum level of focus on each area appears yet to be established in the literature given the difficulties in analysing the individual categories during match play. Whilst some authors have adopted plans to periodise different categories during different times of the training period (Mujika, 2018) others have challenged the effectiveness of these periodised plans (Kiely, 2012). Therefore in order to view the

subtle differences in category focus in training sessions, it was useful to divide the session content further.

When analysing between categories, significant differences were observed between all categories, physical to technical, physical to tactical, physical to psycho-social, technical to tactical, technical to psych-social and tactical to psycho-social. Physical remained the highest category of focus with an average 38% of sessions dedicated to physical components, 31.7% to technical, 18.6% to tactical and 11.7% to psycho-social. Whilst this provides some insight into the overall level of focus in each category, it was interesting to view the changes in focus over the period. When comparing the start of the period with the end (December to April) there appeared to be a shift in proportionate representation. Increases in focus during this period were observed in tactical (17%), psycho-social (11.3%) and technical (9%). These observations were noted as aubitory values for each of the categories fluctuated across the study period. Although physical remained the highest proportionately represented category, there was also a decrease in apparent focus through the period (16.5%). This shift may have been as a result of the somewhat congested match period around Christmas which may have provided an additional focus on physical recovery and preparation and reducing training duration. Some research has indicated that there are a number of limiting factors existing when planning training sessions. These include fixture congestion characterised by repetitive matches separated by 3-4 days (Walker and Hawkins, 2017). Whilst in the current study 2 game weeks were limited, the effects of a congested match schedule and the subsequent impact on microcycle planning should not be discounted. Congested match schedules often mean that MD+1 / MD+2 'recovery' period is also MD-2 / MD-1 'tapering or reduced load' period. This potentially has an effect on the level of focus across each of the 4 categories. The time of the season may also effect between-session variation in content focus. In addition, the current study suggests that tactical focus increased later in the period. Given the teams' league position, this may have resulted in the adoption of a defensive tactical formation designed 'to avoid losing', maximising points accumulation. However, the inclusion of tactical practice activities may be complex. Rein and Memmert (2017) suggest that there are three tactical classifications. Individual, group and team. Therefore, although the current study suggests that there was a general increase in tactical focussed training activities, it is not clear if these were at an individual, group or team level.

Data of this nature can be useful in forming a periodic view of the changes in training session content, duration and focus. This can provide coaches with a broader view of a) the player development process and b) the preparatory period relating to a match. The differences in training sessions appear

to be related to the shift in category focus throughout the training period. Whilst in the current study this may partly have been as a result of a head coach change, this data may be insightful in establishing the level of priority devoted to specific area's in team training, which may have a significant effect on both individual player and team development. These broader values however, are largely as a result of the accumulation of microcycle values of each day of each training week in relation to the match schedule. In order to understand these discrete daily changes in training sessions it was useful to view the focus in categories within these microcycles.

Chapter 4

How does training session content vary relative to match day in elite football over long periods of a season?

4.1 Introduction

The strategy of adopting a periodised approach to weekly training is in direct relation to specific phases of the competitive season, and the period before and after a competitive match. This strategy has become more commonplace in professional football. This has enabled coaches to establish different planning priorities in the days leading up to competitive matches. Training session elements are configured so that the focus of the overall session is related to either past or future competitive performances. One or two days before a match, coaches may broadly focus on tactical content that are relevant to the preparation strategy for the forthcoming match. In contrast, following a match, the focus may shift to physical aspects such as elements of recovery, mitigating fatigue. For example, the warm up is an element that focuses on the physical preparation of players for the effective completion of other aspects of the training session (Needham et al., 2009). This introductory part of the session is typically followed by technical and/or tactical activities that are associated with either the deliberate practice of certain technical skills and/or the coaching of tactical strategies for an upcoming match.

Some studies have attempted to demonstrate the relationship of different performance variables during matches (Bush et al., 2015) and training (Morgans et al., 2014). Although studies of this nature provide some insight into a multivariate approach to match related training methods, they fail to demonstrate the level at which prority is given across all variables during longer periods of weekly training microcyles. Therefore, analysing training session content for each microcycle over a longer period of a season, including the specific classification of all training elements that may be included, provides a better understanding of the distribution of each type of activity and its associated aim relative to an upcoming matchday. Such information can lead to more efficient overall planning strategies for players in both an acute (microcycle) and chronic (macrocycle) sense, and lead to developing greater understanding of the multi variate category application.

The aims of this study were to :

Establish how training session content varies relative to match day in elite football across longer periods of a season

4.2 Methodology

As the data collection was carried out at the same time, the methods used in this study replicate in large parts those in the first study of this thesis. In order to calculate the session values related to match day, sub section methods that are not replicated in chapter 3 are described below.

Week to week training structure

Training structure is typically designed as a result of fluctuating match to match schedules, breaks in league matches caused by international competition and additional Christmas and Easter period matches. Training sessions preceding or following a match have been referred to by the number of relevant days. Table 9 provides examples of 'typical' training weeks that contain either 1 or 2 competitive matches.

Table 9. Weekly training structure. Days prior to match day (MD) are referred to by the period preceding ie MD-4 = 4 days before MD, MD-3 = 3 days before MD, MD-2 = 2 days before MD and MD-1 = 1 day before match day. In a 2-match week, a 'catch up' training session may be included to provide non selected players with a training stimulus allowing them to 'catch up' with the players that played in a preceding competitive match.

	1 MATCH WEEK		2 MATCH WEEK	
SUNDAY	MD+1	REST	MD+1/-2	CATCH UP
MONDAY	MD+2	TRAIN	MD-1	TRAIN
TUESDAY	MD-4	TRAIN	**MD**	**MATCH**
WEDNESDAY	MD-3	REST	MD+1	REST
THURSDAY	MD-2	TRAIN	MD-2	TRAIN
FRIDAY	MD-1	TRAIN	MD-1	TRAIN
SATURDAY	**MD**	**MATCH**	**MD**	**MATCH**

In order to evaluate the level of category focus on each day relative to MD, a mean value was calculated. Table 6 demonstrates how weighted values were calculated. Individual category values were displayed relative to the period preceding MD. Data was identified using the match schedule and training days where players n>10. There were 28 matches observed during the study. MD-3 was excluded from statistical analysis as this was a rest day from training where no data was collected. In addition, training sessions on MD+1 were also excluded as they appeared inconsistent in design and

number of players. In addition, these sessions were only relevant to 2 game weeks. Days preceding MD were assigned as MD-1, MD-2 and MD-4.

Statistical analysis

Statistical analysis was carried out to assess data related to training days preceding MD. All session data was tested for normality of distribution using a Shapiro Wilks test and normality set at p=<0.05. All dependent variables were shown to be normally distributed (physical p=0.702, technical p=0.143, tactical p=0.252, psycho-social p=0.101). A one-way ANOVA was carried out for each variable to test whether variation existed between training days and significance set at p=<0.05. Where an effect was found a Dunn post hoc test was used (p<0.05) to establish the differences between training days. MD-3 was excluded from statistical analysis as this a rest day where no training data was collected. In addition, MD+2/-5 was also excluded from the study as this was defined as an 'additional' recovery day and therefore the training ground was typically divided into players that played two days previously and players that didn't. It was therefore thought that this day wasn't truly representative of a team training session.

4.3 Results

Data collected from all training sessions between December and April inc (MD-4 n=10, MD-2 n=22, MD-1 n=27). Data demonstrates the specific level of focus of each category and the relationship between each training day leading to MD.

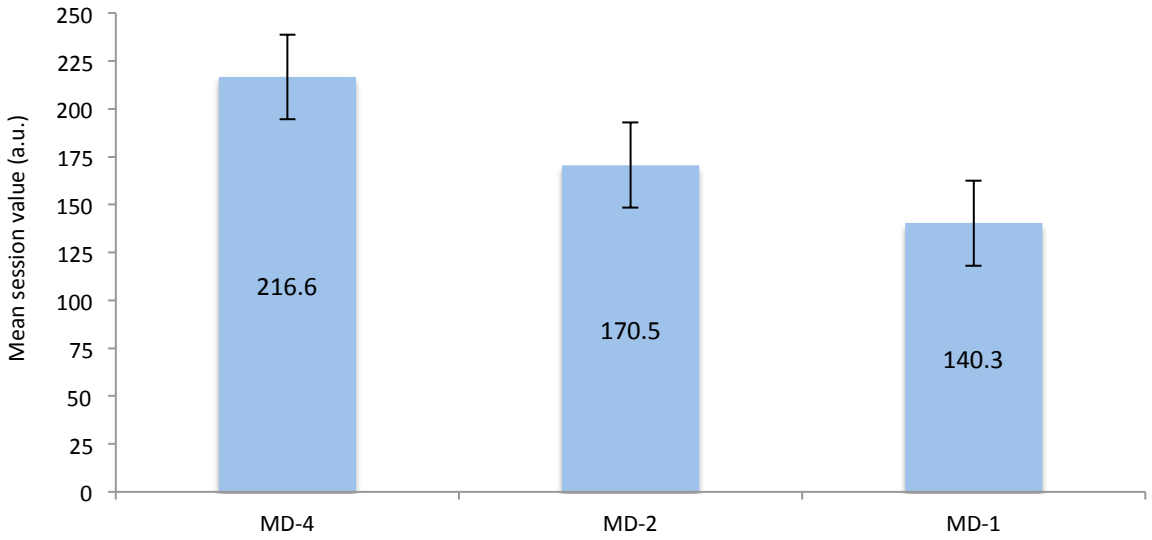

Figure 4a. Mean physical values. Values are displayed in aubitory units (a.u.). % of total training value, MD-4 = 39.9%, MD-2 = 36.0% and MD-1 = 13.5%. Significant difference was identified between MD-1 and MD-4 (p=0.004) but not between MD-1 and MD-2 (p=0.158) or MD-2 and MD-4 (p=0.122).

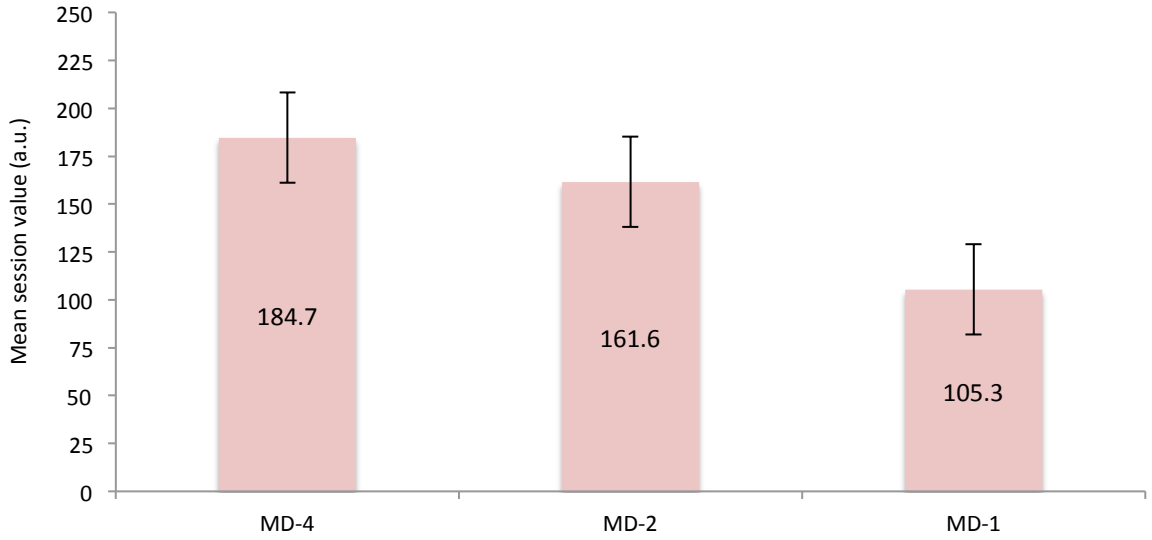

Figure 4b. Mean technical values. Values are displayed in aubitory units (a.u.). % of total training value, MD-4 = 34.0%, MD-2 = 34.1% and MD-1 = 11.4%. Significant difference was identified between MD-1 and MD-4 (p=0.024) but not between MD-1 and MD-2 (p=0.057) or MD-2 and MD-4 (p=0.879).

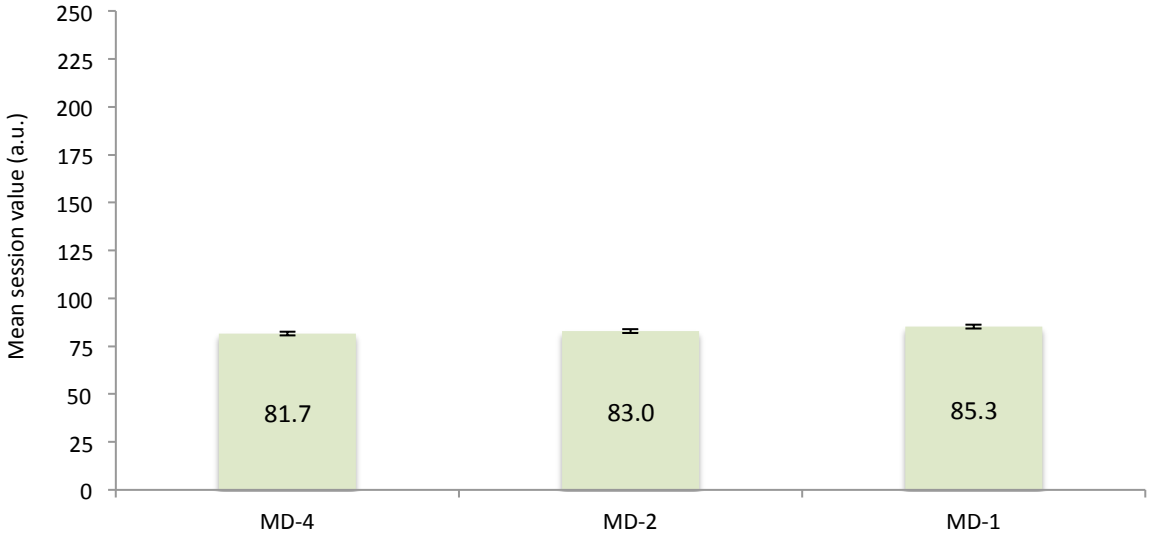

Figure 4c. Mean tactical values. Values are displayed in aubitory units (a.u.). % of total training value, MD-4 = 15.0%, MD-2 = 17.5% and MD-1 = 17.0%. No significant difference was established between any training days leading to MD (p=0.907)

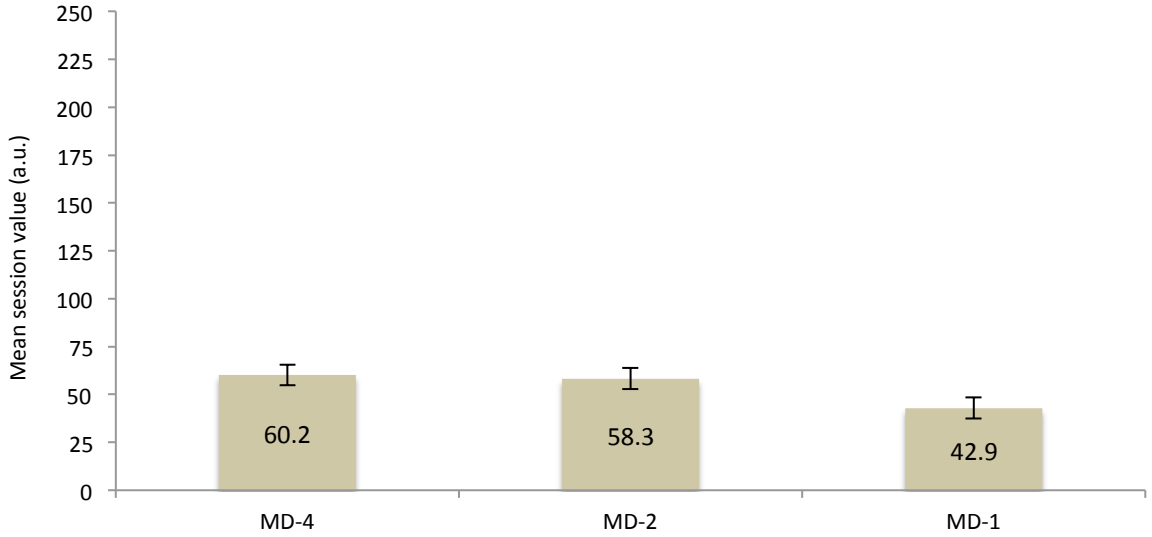

Figure 4d. Mean psycho-social values. Values are displayed in aubitory units (a.u.). % of total training value, MD-4 = 11.1%, MD-2 = 12.3% and MD-1 = 5.7%. Significant difference was identified between MD-1 and MD-4 (p=0.027) and MD-1 and MD-2 (p=0.042), but not between MD-2 and MD-4 (p=0.965).

4.4 Discussion

The values presented in chapter 1 of this thesis provide insight into whether different training sessions exist in professional football and the level of focus of the different categories associated with performance. There values are largely a result of the accumulation of microcycle values of each day of each training week which may fluctuate as a result of changes to competitive match schedules. In order to understand these discrete daily changes in training sessions it was useful to view the focus in categories within these microcycles. Data of this nature can be useful in forming a periodic view of the changes in training session content, duration and focus, and can provide coaches with a broader view of a) the player development process and b) the preparatory period relating to a match. From previous research it is apparent that training sessions in professional football require a combination of technical, tactical, physical and psycho-social attributes, both individually and collectively (Stolen et al., 2005; Liu et al., 2016; Gledhill et al., 2017). The purpose of the current study was to establish how session content varies relative to match day in elite football and how the combination of these factors are prescribed during the training period (Bradley et al., 2013) leading to a match.

From the current study it is clear that differences in training session structure existed preceding a competitive match with a single rest day at the mid-week point (Figure 4a-d). Mean category values (a.u.) relative to MD throughout the full training microcyle were, physical = 175.8a.u. ± 38.4, technical = 150.5a.u. ± 40.8, tactical = 83.3a.u. ± 1.8 and psycho-social = 53.8a.u. ± 9.5. The data demonstrate that levels of duration, content, and focus effect the overall category focus during training sessions. Using a weighted scoring system to quantify the level of importance placed on each category relative to the total time of each element during a typical week, we were able to establish that the composition of the sessions changed throughout the training period. Throughout the data collection period, the general 'pattern' of the weeks remained similar and was largely determined by the match schedule. This was periodically interrupted by forced 'no game' weeks or 'international breaks' where domestic leagues were suspended to accommodate players selected for national team matches. Typically, a single game week may broadly focus on physical maintenance on MD-4, tactical preparation on MD-2 and MD-1 with a reduction in physical focus also apparent on MD-1. This said, in the current study there appeared to be a consistent tactical focus, and to a lesser degree, psycho-social focus throughout the training week, where no days were specifically assigned to achieving pre-defined outcomes in either category. The level of focus in these categories appeared to be largely a consequence of other elements of training and not a specific objective. It is therefore useful to observe the individual categories and their inclusion in training sessions.

When discussing multivariate training focus and the implications on a full training session, it is useful to refer to an example training session to provide context to our assumptions (Table 6). In this example, the greatest amount of time (26mins) was spent coaching 10 v 10, equating to 39% of the total training time. As a consequence, the element was rated as 'high' in tactical focus. However, the remaining 61% of the training time was considered to have high technical contribution. Given that the largest single element was tactically focussed, it could be argued that the preceding elements were included as a means to reinforce elements required in the 'build up' towards the overall session theme - tactical. The author notes that this has been described by previous coaches as the 'main session', meaning training elements around the main session are merely preparatory elements, regardless of duration. It could however, also be argued that even though the coaches focus may have been on the 'main' 26 minute tactical element, which had combined high physical, technical and tactical focus, the session as a whole had a technical outcome due to the duration of time spent performing those activities. The broad composition of training sessions and establishing the importance and time prescribed on each category, gives coaches a global view of training and player development strategies over the longer term. Determining how a training session is distributed between each of the categories provides coaches with a clear evaluation of the reported outcome versus the intended session plan. In the current study it was useful therefore to assess each of the categories individually. The following sections will discuss the individual category outcomes.

Physical

Physically focussed sessions accounted for 39.8% of total training time compared with technical (32.2%), tactical (16.3%) and psycho-Social (11.7%) respectively. Although outside the scope of this study, it is useful to note that there appears to be some consistency in the total distance the players ran during training sessions throughout each month (4340m ± 213m). However, when viewed in more detail across a weekly microcycle, we were able to demonstrate the fluctuation in focus relevant to MD (MD-4 = 39.9%, MD-2 = 36.0% and MD-1 = 13.5%). When viewed between training days, significant differences were established between MD-1 and MD-4 (p=0.004) but not between MD-1 and MD-2 (p=0.158) or MD-2 and MD-4 (p=0.122). Even though these general 'patterns' were seen across training weeks, it was also apparent that some fluctuation in physical focus could be seen. There are a number of factors that might explain this fluctuation including competitive match schedule, additional cup matches, international fixtures and the inclusion of additional rest days to compensate for residual player fatigue. In addition, due to the international match period in March where no competitive league matches were played, the structure of training days/weeks were adjusted. It should also be acknowledged that physical focus represents physical recovery, physical

maintenance and physical load reduction or tapering prior to a competitive match. Therefore, the likelihood that sessions have a high degree of physical focus, even if the focus is not complete, appear to be more commonplace. When evaluating the importance of training composition in periodised session planning, providing coaches with contextual knowledge of the of the sub areas of each category may provide greater detail and lead to efficient activity planning. For example, in an element of training that is of low intensity and another of the same duration and high intensity, the elements are both considered physically focussed. However, the additional elements of training may be adjusted to accommodate the increase or reduction of physical demand. Therefore, future studies may consider not just the level of focus and importance of the composition of training planning, but also why the specific content of a training category are selected.

Recent reports suggest that optimal physical preparation and injury risk reduction can be carried out during appropriate chronic periods where players are exposed to high levels of physical demand during training (Malone et al., 2018). The day in the current study that supports this with the highest evidence of physical focus, appears to be MD-4 where higher physical loads relate to players fitness maintenance. Players were considered sufficiently recovered from the previous match (MD-4 is also MD+3) and far enough away from the next match for high physical components not to compromise the recovery and preparation strategy. When comparing values between training days, our results (Figure 4a) indicate a significant adjustment in physical focus from MD-4 to MD-1 (p=0.004). This may be explained by the shift to balance tactical and technical elements of preparation as a competitive match day approaches. Whilst a taper or reduction in physical values may be expected towards the end of the weekly microcyle, our data also demonstrates no significant difference in physical focus from MD-2 to MD-1. This focus appears consistent with other studies investigating total volume and intensity of physical output markers on the same days preceding a match (Owens et al., 2017). As previously mentioned, during the initial weeks of a new management team structure, players behaviours may change and training often displays greater physical outputs where players' motivation levels appear to increase. This said, data from the current study during a management change in week 41, demonstrated a reduction in physical output by 4.2% over the effected month and an increase in technical focus by 5.8%.

Technical

In the current study technical elements of training remained high across the full training period relative to the session duration. It appears that this is as a consequence of other elements and not specifically assigned to technical development. The results (Figure 4b) suggest that significant

differences were observed in technical focus from MD-1 to MD-4 (p=0.024), but not between MD-2 an MD-1 (p=0.057). This may in part be caused by the additional technical focus applied to SSG's included in training in the early part of the week. Our results provide evidence of greater values observed in both physical and technical categories than tactical and psycho-social during the early (MD-4) part of the week (Figure 4a-d). This may be explained by the inclusion of larger side 11 v 11 or 10 v 10 games in the later part of the week. Where LSG's are included in training sessions, the coach's intensions can provide different outcomes. In the current study, LSG's were considered either 'open play' or 'coached'. A 'coached' game was defined as the coach observing from the middle of the pitch, and stopping play throughout to provide coaching points, often tactical. Therefore, this type of LSG's was higher in tactical focus, but due to the stop start nature of play, the physical and technical elements were reduced. The 'open play' game was defined by the rules of play where the two teams were permitted to compete in a 'normal' match. As the matches were interrupted less and players overall movement greater, with greater touches of the ball, the games were observed as higher in both technical and physical components. Therefore, the two LSG types observed provided different category outcomes.

Although 11 v 11 may be considered a realistic training method, according to Franks and Hughes (2016) there were several reasons why 11 v 11 may not be an optimum individual learning environment for developing technical competence. The authors report that an 11 v 11 game is "too complex to isolate and improve individual technique", and that there may be an "information overload" where players are "faced with too many match related decisions". They also report that coaches "can't manipulate the session to guarantee technical success for each player as there is limited involvement and in large sided game situations individual involvement is reduced". However, the observations in the current study were in contrast to Franks & Hughes (2016) with the coach's use of a 'coached' version of 11 v 11 allowing for a more systematic method of stopping open play in order to coach specific aspects of 11 v 11. In the current study, LSG's (either open play or coached) were observed on 26 occasions. 6 open play games were observed on MD-1 and 4 on MD-2. This is surprising given the potential physical demand of large sided games; however the additional physical load may have been offset by a reduction in time allocated to each game. The coach's impact on the overall category focus was observed during the later part of the study period. Following the team management change at the mid point of the study, LSG's on MD-1 were observed in a coached format (84%) in comparison to non-coached version (16%).

Our data also demonstrate that technical contribution in training days leading into match day (MD-4 to MD-1) increased 9.9% from February to April. Significant difference was identified between MD-1

and MD-4 (p=0.024) but not between MD-1 and MD-2 (p=0.057) or MD-2 and MD-4 (p=0.879). Results also indicate that significant differences in technical focus were evident between MD-4 and MD-1. This has potentially interesting implications to training session design. Although during the last 2 months of the season there remained a high physical focus, it could be argued that physical and technical elements can be complimentary in content. It has been suggested that a change in leadership results in a change of player behaviours and an alteration of category outputs (Kattuman et al., 2019). It may be that a new tactical strategy includes players maintaining possession of the ball, therefore requiring a greater reliance on their technical abilities. In order to promote this strategy, the coach may have included an increase in technically focussed elements to embed this tactically philosophy.

The results of the current study provide a broader understanding of technical elements associated with training session composition and go some way to illustrating the variation in weekly training content. However, mean values were associated with the team as a whole and not at group or individual level. Previous research by Lui et al., (2016) provided evidence of technical contribution of matches in subgroups, i.e. midfielders, defenders and attackers. As this contribution is directly linked to tactical and physical performance in matches, it could be argued that training session composition should be planned to replicate these group-based outcomes. Future investigation of training sessions could therefore be applied relative to individual, group and team based technical performance.

Tactical

Results from the current study demonstrate that tactical focus appeared to peak in MD-2 (Figure 4c) at 17.5% for total training time dedicated to this category. MD-4 demonstrated a 15% contribution and MD-1 = 17.0%. This was characterised as physical elements were tapered by gradual reduction in training loads and intensities, whilst the tactical elements increased in volume. When viewed over a monthly period, our study demonstrates a 43.7% increase in tactical focus from the initial period of the study. However, when observed over a microcycle period, there was no significant difference in tactical focus over each of the training days (p=0.907). This is somewhat surprising given the perceived increase in match day tactical preparation towards the later part of the week. Our results demonstrate a general reduction in overall values throughout the training week, but due to our values being calculated using both focus and time, it might be concluded that this parity may be due to the reduction in overall training time and not a reduction in focus. This said, there are a number of additional factors to consider.

According to some studies, as tactical formations differ, there are also implications on physical, technical and psycho-social elements. For example, when considering attacking styles, according to Bangsbo and Peitersen (2016) there appears to be two distinct options. Firstly, teams may adopt a strategy of moving the ball quickly to the target area of the goal. This involves 'directly' passing the ball from one position in the defending area to that of the attacking area, typically in one pass. This type of play, removes the midfield section of the team and relies on the effectiveness of the strikers to win floor or aerial duals. The other typical attacking style is to maintain possession and patiently use combinations of passes and player movements to direct the ball in passing patterns into the attacking area of the pitch. This style requires players to be technically competent whilst maintaining efficient physical movement. In a training week, typically a coach will include strategic tactical planning in days preceding competitive matches to achieve these desired outcomes. In the current study, this was demonstrated on MD-2 and MD-1 (Figure 4c) possibly with the inclusion of coached 11 v 11 large sided games.

Psycho-Social

It is reported that there is a general lack of psycho-socially focussed training elements in professional football (Gledhill et al., 2017; Ivarsson et al., 2019). Psychological elements like confidence, motivation and resilience are thought to be important factors associated with successful professional players. Given the apparent importance of player-to-player cohesion in team sports, and the relationship to player development, it was somewhat surprising that the results in the current study provide no evident of psychosocially combined pitch-based elements of training. Our data suggest that only 11.7% of time and focus was placed on psycho-social elements. Whilst it could be argued that social skills like peer-to-peer relationships are routinely established and nurtured during technical and tactical practice, particularly when practicing match play and SSG's, there was no evidence of outright priority in any of the session elements recorded. Our data also demonstrated that MD-1 (Figure 4d) displayed the lowest focus on psycho-social elements. This is also surprising given the day before a competitive match may be considered as one requiring particularly high levels of team cohesion and co-operation. Elements that appeared to contain the highest psych-social focus were those that were deemed enjoyable to the players ie those elements that included non football based small competition (ie relay races), very small possession exercises (ie boxes/rondo's/7v2) and isolated skills games. Although technical coaching during these elements may be argued as limited, it could also be argued that the broader cohesive requirements of coaching could be met.

The apparent lack of psycho-socially focussed elements may in part be explained by the fact that with the exception of technical practices that is largely carried out on a field-based setting, other categories can be carried out in an isolated fashion, away from the field. For example, physical conditioning were also carried out in a gymnasium using exercise equipment or a running track. On field tactical preparation was complemented within a classroom setting, utilising evaluation techniques like notional and video analysis. It is therefore surprising that given the apparent lack of focus on psych-social elements of preparation, elements of training designed to improve or create team social cohesion are not evident. In drawing conclusions to their meta-analysis of psycho-social development in football, Ivarsson et al., (2019) cited that "psychological factors should be discussed, trained and researched as one of several aspects that might be relevant to future football performance and ideally alongside other factors like technical, tactical and physical". The lack of focus of psycho-social development was further reported by Gledhill et al., (2017) who state that in relation to young player development, technical and tactical outcomes are the most valued factors by coaches in deciding the progress of a player through the club.

Chapter 5

Conclusion of thesis

Performance outcomes in professional football are largely dictated by the effectiveness of the inter-relationship of player-to-player multi-factorial categories. These categories are sub-divided. Physical refers to the physiological preparation, maintenance and recovery of players. Technical performance refers to the number of ball contacts including passing, shooting, tackling, heading and dribbling. Tactical can be defined by the positional organisation and strategy adopted by the coach and players on the pitch during competitive matches. Finally, psychosocial refers to the combination of psychological and social factors that underpin inter-relationship and communication of players. Development and optimisation of these key areas largely takes place during routine training sessions in a structured training week or microcycle. The purpose of this study was to assess if different training sessions currently exist and whether there was a difference in the level of focus applied to the training content throughout periods, both in the acute and chronic sense. When quantifying training session focus and duration using a rating system, the data from study one provides some evidence that by combining both volume and content focus, different training sessions do exist throughout 22 weeks of a professional season. Due to the nature of professional football there is often a need to adjust coaching priorities mid-session for a multitude of reasons. Quantifying these adjustments, at times proved problematic as they were routinely carried out as a result of intuitive decision making by the coaching and management team. However, we believe our data goes some way to demonstrating that the differences in training sessions is provided by distinct variation in focus applied to different categories leading up to competitive matches.

Whilst there are several factors that need to be considered when designing programmes relative to match day, understanding these challenges will enable coaches to be more efficient with their programme design and application. Results from study two demonstrate general reduction in values across each category leading from MD-4 to MD-1. Rather than a reduction in focus, this may have been explained by a reduction in training volume. This said, our results also indicate that there is greater focus on physical output throughout the training microcycle relative to match day. It also appears the physical and technical elements of training provide complimentary content. It could be expected that priority assigned to tactical training may peak in days preceding match day, but it was somewhat surprising that focus in the category was consistent throughout the training week. The use of 11 v 11 appears to be an attractive method for coaches to replicate multivariate demands of match play within a controlled training environment. By balancing both ‘open play’ and intermittent ‘coached’ methods, the volume and exposure to all categories can be controlled and maintained. Finally, even though research suggests that psych-social cohesion in team sports is

vital to success, there appeared to be no priority assigned to developing this area in the current study. It could therefore be suggested that further studies may focus on the specific inclusion of team cohesion and psycho-social development, providing some additional balance to the multivariate training content.

We acknowledge limitations in attempting to quantify structured and methodical approaches to training and the 'artistic license' employed by coaches during training sessions. We established a broad insight into differences over a macrocycle period to advance coach's appreciation of the effects of specific content of training sessions. This said, future studies may assist in developing a clearer understanding of the interaction of discrete session content. The interaction of these elements can then be applied to achieve specific training and development outcomes, both from a team, sub group and individual sense.

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Appendix A

LIVERPOOL JOHN MOORES UNIVERSITY GATEKEEPER INFORMATION SHEET

Title of Project: The relative importance of training session composition to training periodisation models in professional football

Name of Researcher and School/Faculty

Christopher Neville from the School of Sports and Exercise Science

1. What is the reason for this letter?

The purpose of this letter is to outline the proposed research project, its aims and how the protocol will effect the participants under your responsibility / management.

2. What is the purpose of the study/rationale for the project?

The aim of the research is to evaluate the influence of specific training content on periodisation models and the physiological responses to training in professional football. This will be achieved by classifying specific elements of training into separate categories associated with planned training aims. In addition the researchers intend to evaluate the physical cost associated with each element of a training session to describe the contribution of these distinct training components to an overall periodised training plan

3. What we are asking you to do?

In order to comply with ethical regulations and LJMU research project protocol, each participant (Senior team players) will be required to complete a Consent form. The researcher would like to provide a short presentation to the players to explain the reasons for the research and what the players involvement is. He will also provide a Participant Information sheet to each player. To carry out the presentation, the researcher would like to request access to the players on a group basis.

4. Why do we need access to your facilities/staff/students?

All data collection, analysis and storage will be carried out at Blackburn Rovers Football Club Senior Training Centre.

5. If you are willing to assist in the study what happens next?

In consultation with the researcher, a relevant time for the presentation would need to be agreed. In addition, the researcher would be grateful if access could be granted to senior coaching staff in order to agree the primary aims of each element of a training session. Please see below.

6. How we will use the Information/questionnaire?

The information collected will be used to classify all training session elements into sub categories allowing the research team to collate a view of the distribution of each element over a period from 1st November 2016 to 6th May 2017. The classifications will be dictated by the agreed primary aim each element of a session ie Physical, Technical or Tactical.

In addition, using GPS and Heart Rate data that is routinely collected, physiological responses to each element will also be assigned.

7. Will the name of my organisation taking part in the study be kept confidential?'

Yes. The confidentiality of the organisation (Blackburn Rovers FC), the participants (Senior team players) and Gatekeeper (Team Manager and Coaches) will be assured. All reported data will be anonymised throughout the project. For information and safeguarding of children, no players under the age 18 will be considered for the project.

8. What will taking part involve? What should I do now?

If you no questions and fully understand what is required, please would you sign and return the **Gatekeeper Consent Form** provided

Should you have any comments or questions regarding this research, you may contact the researchers:

Name : Chris Neville
Email address : C.W.Neville@2016.ljmu.ac.uk
Mobile Telephone Number : +44 7921 299989

This study has received ethical approval from LJMU's Research Ethics Committee

In the process of being assessed

Contact Details of Researcher

Name : Chris Neville
Email address : C.W.Neville@2016.ljmu.ac.uk
Mobile Telephone Number : +44 7921 299989

If you have any concerns regarding your involvement in this research, please discuss these with the researcher in the first instance. If you wish to make a complaint, please contact researchethics@ljmu.ac.uk and your communication will be re-directed to an independent person as appropriate.

Appendix B

LIVERPOOL JOHN MOORES UNIVERSITY CONSENT FORM

The relative importance of training session composition to training periodisation models in professional football

Chris Neville School of Sport and Exercise Science
Faculty of Science
Liverpool John Moores University

1. I confirm that I have read and understand the information provided for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and that this will not affect my legal rights. ☐
3. I understand that any personal information collected during the study will be anonymised and remain confidential ☐
4. I agree to take part in the above study ☐

Name of Participant Date Signature

Name of Researcher Date Signature

Name of Person taking consent Date Signature
(if different from researcher)

Note: When completed 1 copy for participant and 1 copy for researcher

Appendix C

LIVERPOOL JOHN MOORES UNIVERSITY PARTICIPANT INFORMATION SHEET

Title of Project **The relative importance of training session composition to training periodisation models in professional football**

Name of Researcher and School/Faculty

Principle Researcher	Chris Neville	School of Sport and Exercise Science Faculty of Science Liverpool John Moores University (LJMU)
Researchers	Chris Rush	Blackburn Rovers FC
	Liam Mason	Blackburn Rovers FC
	Prof Barry Drust	LJMU
	Craig Turner	LJMU
	Tom Brownlee	LJMU

You are being invited to take part in a research study. Before you decide it is important that you understand why the research is being done and what it involves. Please take time to read the following information. Ask us if there is anything that is not clear or if you would like more information. Take time to decide if you want to take part or not."

1. What is the purpose of the study?

The purpose of the research project is to separate the individual elements of a full training session so they can be classified into various groups. Following a training session, each element will be classified :

PHYSICAL
TECHNICAL
TACTICAL
PSYCHO-SOCIAL

The reason for the classification means that we can view each element (drill) separately and analyse what physical demands are associated with each. Over the course of the remainder of the season we will look at the following information taken from your GPS monitors and Heart rate monitors for each element :

- Total time of element (min)
- Average Total Distance (m)
- Average High Speed (>7.5m.s^{-1}) Running Distance (m)
- Average Maximum Velocity (m.s^{-1})
- Average Number of changes in direction
- Average Number of Jumps
- Average Number of intense Accelerations
- Average Number of intense Decelerations
- Average number of minutes above 85% Maximum Heart Rate (min)

This information will enable coaches to design training sessions in the future with a better understanding of what physical demands are attributed to each element.

2. Do I have to take part?

No. It is totally voluntary for your data to be used in the study. It is up to you to decide whether or not to take part. If you do you will be given this information sheet and asked to sign a consent form. You are still free to withdraw at any time and without giving a reason. A decision to withdraw will not affect your rights/any future treatment/service you receive.

3. What will happen to me if I take part?

The study is expected to last from November 2016 to the end of the season on 7th May 2017. Every training session that meets the criteria (see below) will be included in the study.

You will not be required to carry out anything above or beyond what you are currently expected or contracted to do during typical training sessions. You won't notice any difference in what you currently do. If you are sick, injured or away from training on a particular day, you will not be included in the study for that day.

Criteria required for a training session to be included in the study :

- Only training sessions with 10 or more players will be considered
- All participants will be between the ages of 18 – 38
- All players must wear a GPS Unit and Heart Rate Monitor for data to be included
- Goalkeepers will be excluded from the study

4. Are there any risks / benefits involved?

There will be no additional risks associated with the research.

5. Will my taking part in the study be kept confidential?

Your confidentiality will be assured at all times. If you agree for your data to be included in the study, you will be required to complete a consent form. This form will be held in a locked cupboard in the Department of Athletic Performance Office, The Senior Training Centre, Brockhall Village, Blackburn, BB6 8FA. The research project reports following each training session will be anonymised. Your name will be substituted for a number, so you will not be identifiable. The study training reports and all other relevant documentation will also be stored in a lockable cupboard. Only the Principle Researcher will have access to these documents once analysis and categorisation has taken place.

This study has received ethical approval from LJMU's Research Ethics Committee - 16/SPS/060 18th November 2016

Contact Details of Researcher C.W.Neville@2016.ljmu.ac.uk

If you any concerns regarding your involvement in this research, please discuss these with the researcher in the first instance. If you wish to make a complaint, please contact researchethics@ljmu.ac.uk and your communication will be re-directed to an independent person as appropriate.