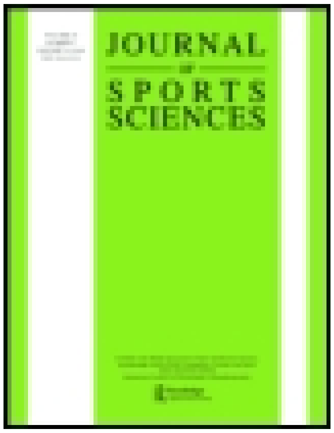

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Characteristics impacting on session rating of perceived exertion training load in Australian footballers

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Characteristics impacting on session rating of perceived exertion training load in Australian footballers

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Abstract
The relationship between external training load and session rating of perceived exertion (s-RPE) training load and the impact that playing experience, playing position and 2-km time-trial performance had on s-RPE training load were explored. From 39 Australian Football players, 6.9 ± 4.6 training sessions were analysed, resulting in 270 samples. Microtechnology devices provided external training load (distance, average speed, high-speed running distance, player load (PL) and player load$_{slow}$ (PL$_{slow}$)). The external training load measures had moderate to very large associations (*r*, 95% CI) with s-RPE training load, average speed (0.45, 0.35–0.54), high-speed running distance (0.51, 0.42–0.59), PL$_{slow}$ (0.80, 0.75–0.84), PL (0.86, 0.83–0.89) and distance (0.88, 0.85–0.90). Differences were described using effect sizes (*d* ±95% CL). When controlling for external training load, the 4- to 5-year players had higher s-RPE training load than the 0- to 1- (0.44 ± 0.33) and 2- to 3-year players (0.51 ± 0.30), ruckmen had moderately higher s-RPE training load than midfielders (0.82 ± 0.58), and there was a 0.2% increase in s-RPE training load per 1 s increase in time-trial (95% CI: 0.07–0.34). Experience, position and time-trial performance impacted the relationship between external training load and s-RPE training load. This suggests that a given external training load may result in different internal responses between athletes, potentially leaving individuals at risk of overtraining or failing to elicit positive adaptation. It is therefore vital that coaches and trainers give consideration to these mediators of s-RPE training load.

Keywords: *external training load, internal training load, prescribing training, athlete monitoring, team sport*

Introduction

To maximise physical capacity and manage fatigue, training should be accurately planned, monitored and adjusted (Borresen & Lambert, 2009; Lambert & Borresen, 2010). Training load is determined by exercise volume and intensity (Smith & Norris, 2002), and can be quantified by external and/or internal parameters with external training load representing the dose performed and internal training load representing the psycho-physiological response experienced by the athlete (Impellizzeri, Rampinini, & Marcora, 2005). Despite the fact that there is inter-individual variation in response to external training load, in team sports, training is typically planned using external parameters and mostly occurs as a collective. Consequently, the prescribed external training load may result in internal training loads that lead to a training imbalance, leaving some athletes at risk of overtraining and others failing to reach a training stimulus adequate for positive adaptation (Borresen & Lambert, 2009; Impellizzeri et al., 2005; Scott, Black, Quinn, & Coutts, 2013). Therefore, to plan an effective training regime, coaches and trainers must understand the internal response an external training load will elicit in each of their athletes.

Microtechnology devices provide external training load measures including total distance travelled and distances in various speed zones. However, in high-intensity intermittent contact sports, such as Australian Football (AF), quantifying training load is more complex than in continuous non-contact sports because the unpredictable change of pace and direction and collisions that occur in AF, all contribute to the overall load (Takarada, 2003; Young, Hepner, & Robbins, 2012). The player load (PL)

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algorithm from microtechnology, which combines rate of change in acceleration from three planes of movement, is suggested to incorporate all forms of activity including skill- and contact-based activities relevant to intermittent contact sports (Aughey, 2011; Boyd, Ball, & Aughey, 2013). However, the large correlations between distance and PL suggest that the foot strikes (vertical plane accelerations) and locomotor activity (forward acceleration) impact heavily on this parameter (Boyd et al., 2010, 2013; Casamichana, Castellano, Calleja-Gonzalez, San Roman, & Castagna, 2013). Recent research differentiated player load slow (PL_{slow}), which removes activity above 2 m · s^{-1}, from PL in elite AF matches (Boyd et al., 2013). It was proposed that PL_{slow} provides different information about low-speed activity (e.g. grappling and ruck contests), which is currently under-represented in traditional speed-based time-motion analysis (Boyd et al., 2013).

While successful performance relies on a specific external training load being reached, it is the internal training load that elicits adaptations (Impellizzeri, Rampinini, Coutts, Sassi, & Marcora, 2004; Impellizzeri et al., 2005; Lovell, Sirotic, Impellizzeri, Coutts, 2013; Scott, Black, et al., 2013; Scott, Lockie, et al., 2013). Internal training load has been quantified using heart-rate-based methods for determining a training impulse for endurance athletes (Banister & Calvert, 1980; Busso, Carasso, & Lacour, 1991; Edwards, 1993; Lucia, Hoyos, Santalla, Earnest, & Chicharro, 2003) and modified for team-sport athletes (Akubat & Abt, 2011; Akubat, Patel, Barrett, & Abt, 2012; Manzi, Bovenzi, Impellizzeri, Carminati, & Castagna, 2013; Stagno, Thatcher, & Van Someren, 2007). However, due to its simplicity and strong validity, many AF (and other team-sport) clubs have adopted the session rating of perceived exertion (s-RPE) method to quantify internal training load (Coutts, Murphy, Pine, Reaburn, & Impellizzeri, 2003; Foster et al., 2001; Impellizzeri et al., 2004; Scott, Black, et al., 2013).

An abundance of literature exists reporting small to very large correlations between external training load measures and s-RPE training load in a range of settings (Akubat, Barrett, & Abt, 2014; Borresen & Lambert, 2008; Casamichana et al., 2013; Lovell et al., 2013; Scott, Black, et al., 2013; Scott, Lockie, et al., 2013; Weaving, Marshall, Earle, Nevill, & Abt, 2014). However, potential mediators (i.e. existing fatigue, fitness and task proficiency) of this relationship have received much less attention (Haddad et al., 2013; Manzi et al., 2010; Milanez et al., 2011). When the internal training load is quantified using s-RPE training load, the relationship is further impacted by an athlete's psychological characteristics and current psychological state including mood and motivation (Blanchfield, Hardy, de Morree, Staiano, & Marcora, 2014). Understanding the potential influence of characteristics impacting s-RPE training load, may provide coaches and trainers with a better understanding of the response that a given external training load might elicit in their athletes and therefore enhance training prescription and athlete monitoring.

Evidence currently exists documenting the influence of fitness on perceived exertion in trained endurance runners and professional futsal players (Garcin, Mille-Hamard, & Billat, 2004; Milanez et al., 2011). Similar results were seen in professional basketball players where those who performed better on the Yo-Yo IR1 reported lower average s-RPE training load (Manzi et al., 2010). Since time-trials ranging from 1500 to 3000 m are common performance measures in AF (Le Rossignol, Gabbett, Comerford, & Stanton, 2014; Lorenzen, Williams, Turk, Meehan, & Cicioni Kolsky, 2009), establishing if time-trial performance has an impact on the relationship between external and internal training load would encourage coaches to consider time-trial results when prescribing and/or monitoring training loads.

Furthermore, a recent Australian Football League (AFL) report revealed higher injury incidence and prevalence in first-year players than more mature players (Ullah & Finch, 2010). The first-year players may not be fully prepared, either physically or mentally, for the high loads of professional AF, compared with the older players who have been exposed to multiple years of training in a professional programme (Veale, Pearce, Buttifant, & Carlson, 2010). It is possible that AFL experience influences s-RPE training load, highlighting the risk of a training imbalance in younger players. A recent study in AF also demonstrated differences in external training load measures between playing positions in both matches and training (Boyd et al., 2013). It was reported that in an elite AF match, midfielders had the highest PL, whereas for the PL_{slow} variable, ruckmen had higher external training load than all other positions (Boyd et al., 2013). This suggests that the different movement patterns of playing positions expose athletes to different physical stress, and external training load variables measuring locomotor activity, such as distance, high-speed running distance and even PL, may underestimate or overestimate exercise intensity for certain positions (Boyd et al., 2013). Understanding how players of different playing positions might respond to the prescribed external training load can advance training design.

This study further examined the relationship between external and internal training load in a high-intensity, intermittent collision sport by exploring characteristics that might impact s-RPE training load. The aim was to determine whether experience, playing position and time-trial performance impacted s-RPE training load.

Methods

Following approval from the University's Ethics Committee, the entire squad of one AFL club (the highest level of Australian Football) was invited to participate in this study. Informed consent was obtained from 41 non-injured male AF players (mean ± *s*: 22.6 ± 3.0 years, 186.4 ± 7.5 cm, 85.5 ± 8.4 kg, 4.8 ± 3.2 years in AFL, 45.4 ± 60.6 senior matches). This study examined external (microtechnology variables) and internal (s-RPE) training load from 14 skill-based training sessions during mid to late pre-season in 2012 (weeks 11 to 22). A 25-min warm-up preceded each training session comprising of different drills (technical drills, tactical drills, small-sided games and match practice scenarios).

During each main training session of the study period, 19.3 ± 1.0 randomly selected players wore a commercially available microtechnology device, with tri-axial accelerometers (MinimaxX, Team 2.5, Catapult Innovations, Scoresby, Australia). The device was worn in a custom-made vest, fitting the unit tightly against the posterior side of the upper torso between the shoulder blades. The satellite data were sampled at a rate of 10 Hz, which is reported to have improved reliability and validity for short sprints compared to the 1- and 5-Hz units (Varley, Fairweather, & Aughey, 2012). The accelerometers were sampled at 100 Hz and were also reported to be reliable and valid (Boyd et al., 2013). Using Catapult Sprint 5.0.6 software, data were downloaded, with transition time in between training drills removed, as to not underestimate the proportion of distance in speed zones or average speed (White & MacFarlane, 2013). External training load was measured using distance, average speed, high-speed running distance, PL and PL_{slow}. High-speed running distance was defined as the distance run above a set threshold (individualised as each player's mean 2-km time-trial speed, with a group mean of 18.1 $km \cdot h^{-1}$ and range of 16.9 to 19.7 $km \cdot h^{-1}$) (Abt & Lovell, 2009). PL is a vector magnitude of the accelerometer data from the microtechnology device. The arbitrary unit of measurement represents the square root of the sum of the squared instantaneous rate of change in acceleration in the X, Y and Z axes divided by 100 (Boyd, Ball, & Aughey, 2011). PL_{slow} is the vector magnitude of the accelerometer data when speed is <2 $m \cdot s^{-1}$.

Internal training load for each session was determined for every player using the s-RPE training load method (Foster et al., 2001). Exercise duration, defined as the sum of individual drill times, was multiplied by a RPE for each player (Wallace, Slattery, Impellizzeri, & Coutts, 2014). Individual drill time, with transition time removed, was used to provide comparable volume to the external training load measures. Players were shown the modified Borg RPE scale approximately 30 min upon completing the session (Foster et al., 2001). Education was provided on the RPE scale, with players encouraged to give a global rating of the session using any intensity cues they deemed relevant. Players had been using the RPE scale for over 12 months leading up to the study period. This commonly used method has been reported to be reliable and has previously been shown to be correlated with other measures of internal and external training load in a range of settings (Casamichana et al., 2013; Coutts et al., 2003; Eston, 2012; Impellizzeri et al., 2004).

As per usual club practices, players completed a series of 2-km time-trials in the early phase of pre-season. The time-trials were completed on an outdoor polyurethane athletics track. A standardised dynamic warm-up consisting of a 5-min jog, 5 min of back mobility exercises, 6 × 80 m strides and 3 × 50 m run-throughs preceded the time-trial. Time was recorded using a stopwatch by fitness staff. The time-trial results from week 11 of pre-season were used in the analysis, as it was during the first week of the data collection period and hence most representative of performance during the time frame being analysed. Ambient air temperature was 20.0°C and relative humidity was 53%. If the player did not complete the time-trial on that day, the result from the previous test (week 6) was used (ambient air temperature of 24.4°C and relative humidity of 57%). The number of years on the playing list of an AFL club was used to classify players into experience groups (0 to 1 years, 2 to 3 years, 4 to 5 years and 6+ years) (Rogalski, Dawson, Heasman, & Gabbett, 2013). In order to obtain a sufficient sample size in each category, players were split into 2-year intervals. To determine whether internal training load was affected by playing position, players were classified as key position, nomadic, midfielders or ruckmen as per their role in the team (Boyd et al., 2013).

Statistical analysis was performed using SPSS (version 19.0.0.1; SPSS Inc., Chicago, USA). Values are reported as mean and standard deviations (s). Statistical significance was set at the 0.05 level, and all effect sizes reported with 95% confidence limits (CL). Pearson's correlation coefficient (*r*) was used to determine the relationships between s-RPE training load and external training load measures (distance, average speed, high-speed running distance, PL and PL_{slow}) and reported with 95% confidence intervals (CI). The magnitude of the correlation was described as <0.1 trivial, 0.1 to 0.3 small, 0.3 to 0.5 moderate, 0.5 to 0.7 large, 0.7 to 0.9 very large and 0.9 to 0.99 nearly perfect (Hopkins, 2002).

To determine whether the s-RPE training load was affected by any of the characteristics when controlling for the variance explained by external training load, the analysis was performed in two stages. First, in order to model s-RPE training load against external training load, principal component analysis (PCA) was performed using the external load variables (distance, average speed, high-speed running distance, PL and PL_{slow}). A correlation matrix of the five external training load measures, Bartlett's test of sphericity and Kaiser-Meyer-Olkin measure of sampling adequacy were used to determine the suitability of the data for PCA (Hair, Anderson, Tatham, & Black, 1998). When a number of related variables are measured, it is possible that some are measuring the same concept leading to redundancy in the variables – violating co-linearity. The purpose of PCA was to reduce the number of related variables into a smaller number of independent principal components. The new components are optimally weighted linear combinations of the original variables and account for most of the variance in the original values. The eigenvalue reflects the amount of variance accounted for by that component. Since the sum of the eigenvalues is equal to the number of variables in the PCA, an eigenvalue greater than 1 accounts for more variance than any one original variable. Therefore, an eigenvalue greater than 1 and the scree test were used as criteria to determine the number of meaningful components to be retained (O'Rourke & Hatcher, 2013).

The next stage of the analysis involved multivariate linear modelling. To examine whether the effect of external training load (X_1) on s-RPE training load (Y) depends on playing position or AF experience (X_2), full factorial linear models were performed and the interaction between the external training load principal component and each characteristic was examined. If there was no interaction, the model was refit allowing the data to be pooled and a single regression line fitted. If there was a significant main effect, post hoc analysis (Tukey's HSD) was carried out to examine where the difference/s occurred. To make inferences about true values of the difference, effect size (*d*) was reported and the uncertainty was expressed as *d* ±95% CL. The magnitude of *d* ±95% CL was described as <0.2 trivial, 0.2 to 0.6 small, 0.6 to 1.2 moderate, 1.2 to 2.0 large and 2.0 to 4.0 very large (Hopkins, 2002). For the continuous variable (time-trial performance), s-RPE training load was log-transformed in order to report the difference in s-RPE training load per difference in time-trial as a percentage change. The coefficient of X_2 was taken as the value of the effect of time-trial on s-RPE training load when external training load was held constant.

Results

A total of 39 players completed the time-trial in either week 11 (28 players) or week 6 (11 players). Players wore a microtechnology device 6.9 ± 4.6 times, resulting in 270 individual data sets being analysed. Mean values for training duration, s-RPE training load, distance, average speed, high-speed running distance, PL and PL_{slow} were 59.2 ± 14.3 min, 485 ± 148 au, 5105 ± 1524 m, 86.1 ± 12.1 $m \cdot min^{-1}$, 933 ± 367 m, 433 ± 130 au and 114 ± 34 au, respectively. There were moderate to very large correlations between s-RPE training load and distance (r = 0.88, 95% CI: 0.85–0.90), average speed (r = 0.45, 95% CI: 0.35–0.54), high-speed running distance (r = 0.51, 95% CI: 0.42–0.59), PL (r = 0.86, 95% CI: 0.83–0.89) and PL_{slow} (r = 0.80, 95% CI: 0.75–0.84).

A correlation matrix of the five external training load microtechnology variables revealed correlations greater than 0.3 among all of the variables (Table I). Bartlett's test of sphericity was significant (P < 0.001), and the Kaiser-Meyer-Olkin measure of sampling adequacy value was acceptable at 0.79. The PCA was then performed using the external training load variables (distance, average speed, high-speed running distance, PL and PL_{slow}). The resultant eigenvalues and percentage of variance explained by each of the 5 components are displayed in Table II. Only the first component displayed an eigenvalue greater than 1 and the results of the scree test supported only retaining the first component.

The relationship between the principal component of external training load and s-RPE training load did not differ as a function of any of the characteristics (experience: $F_{2,\ 265}$ = 1.15, P = 0.33; position: $F_{2,\ 262}$ = 0.70, P = 0.55; time-trial: $F_{2,\ 266}$ = 1.33, P = 0.25). External training load combined with either experience, position and time-trial explained 70%, 69% and 71% of the variance in s-RPE training load, respectively. When external training load

Table I. Correlation matrix (r, 95% CI) for the external training load variables.

External training load variables	Distance	Average speed	High-speed running distance	PL
Average speed	0.73 (0.67–0.78)			
High-speed running distance	0.67 (0.60–0.73)	0.66 (0.59–0.72)		
PL	0.97 (0.96–0.98)	0.71 (0.65–0.76)	0.65 (0.58–0.71)	
PL_{slow}	0.79 (0.74–0.83)	0.38 (0.27–0.48)	0.30 (0.19–0.40)	0.80 (0.75–0.84)

Table II. Resultant eigenvalues and percentage of variance explained by each of the components in the PCA of the five external training load variables.

Component	Eigenvalue	Percentage of variance explained
1	3.7	74.1
2	0.8	16.5
3	0.3	6.8
4	0.1	2.0
5	0.0	0.6

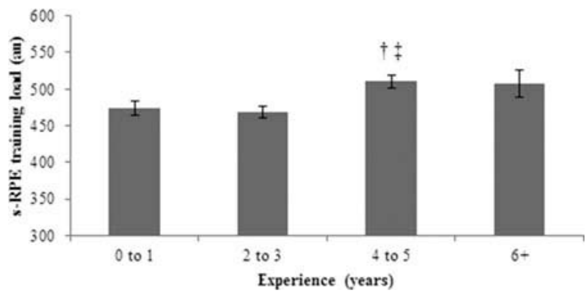

Figure 1. The difference in s-RPE training load between each of the experience groups (0 to 1 year, n = 70; 2 to 3 years, n = 105; 4 to 5 years, n = 75; 6+ years, n = 20) when external training load is controlled. Error bars represent the standard error of measurement.

Notes: †Significantly different (P < 0.05) from 0 to 1 years. ‡Significantly different (P < 0.05) from 2 to 3 years.

was controlled for, the main effect on s-RPE training load was significant for experience ($F_{2,\ 265}$ = 4.62, P = 0.004), position ($F_{2,\ 265}$ = 2.94, P = 0.03) and time-trial ($F_{2,\ 267}$ = 8.96, P = 0.003).

Post hoc analysis revealed that the 4- to 5-year group had a higher s-RPE training load than the 0- to 1-year (d = 0.44 ± 0.33, small) and the 2- to 3-year (d = 0.51 ± 0.30, small) groups (Figure 1). The ruckmen had a higher s-RPE training load than the midfielders when external training load was accounted for (d = 0.82 ± 0.58, moderate) (Figure 2). For time-trial, the X_2 coefficient revealed that there was a 0.2% au increase in s-RPE training load per 1 s increase in time-trial time (95% CI: 0.07–0.34) when external training load was held constant.

Discussion

The relationship between external and internal training load in AF players was investigated. The main finding was that experience, position and time-trial performance all had an effect on s-RPE training load when controlled for the variance explained by external training load. While there is no criterion measure for external training load, PCA was used to control for the variance in the external training load variables of distance, average speed, high-speed running distance, PL and PL_{slow}. The results of this study reinforce previous research that personal characteristics will impact an individual's response to training and emphasises the challenge for coaches when prescribing and monitoring training load in team-sport athletes (Garcin et al., 2004; Impellizzeri et al., 2005; Milanez et al., 2011).

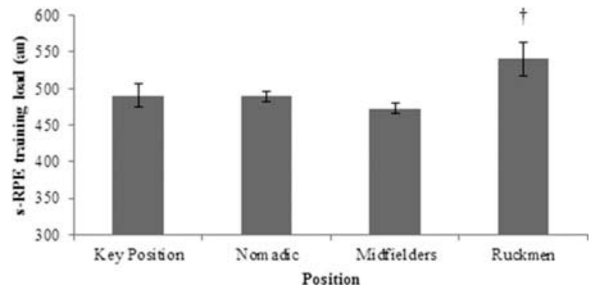

Figure 2. The difference in s-RPE training load between each of the playing positions (key position, n = 27; nomadic, n = 112; midfielders, n = 118; ruckmen, n = 13) when external training load is controlled. Error bars represent the standard error of measurement.

Note: †Significantly different (P < 0.05) from midfielders.

There was a small difference between the 4- to 5-year group and the 0- to 1- and 2- to 3-year groups with the 4- to 5-year group having higher s-RPE training loads for a constant external training load. It has previously been reported that in an AFL club, first-year players and 7+-year players had a lower training load across the season than the 2- to 3-year and 4- to 6-year groups (Rogalski et al., 2013). It is possible that because of the higher training age, the 4- to 5-year players participated in more overall training (or greater intensities) and therefore entered main skills sessions in a more fatigued state, resulting in them perceiving the external training load as harder. Another explanation might be that the 4- to 5-year players took more time (within the session) to achieve the same external output as the less-experienced players who may have been involved in unnecessary and inefficient running. This could be due to better developed physical qualities and enhanced movement efficiency in the closed, set load training drills and/or superior pattern recall, achieved with experience, in the game-related training drills (Gorman, Abernethy, & Farrow, 2012).

When controlling for external training load, there was a difference in s-RPE training load between playing positions. While there are usually only 2 to 3 ruckmen in the squad of an AFL club, limiting the sample size when comparing them to the other positions, the results suggested that the ruckmen had moderately higher s-RPE training load than the midfielders. As reported in a recent study, in elite AF matches, the ruckmen have a different activity profile to the other positions, with more low-speed movement (Boyd et al., 2013). It is possible that the high contribution of locomotor activity (distance) in the training sessions analysed in this study resulted in a higher perception of effort from the ruckmen who are less familiar with high locomotor loads (Boyd et al., 2013; Brewer, Dawson, Heasman, Stewart, & Cormack, 2010). An exploration of the differences in perception of effort between playing positions during a range of training drills including those involving more contact and multi-planar movements at a relatively low speed (i.e. more similar to match activity profile of a ruckmen) is warranted.

The results of the time-trial model showed that as time-trial time increased by 1 s, s-RPE training load increased by 0.2% au for the same external training load. To determine the magnitude of this result, using an effect size of $d = 0.20$ as a minimum, a difference of 6.9% in s-RPE training load would be considered a small effect (Hopkins, 2002). Therefore, a small difference would be seen in s-RPE training load between athletes who have more than 34.5 s between their time-trial results. The larger the gap between their time-trial results, the larger was the effect of the difference in s-RPE training load. The very large correlation between s-RPE training load and distance suggests that the locomotor or running load impacted heavily on the training drills in this study. It is therefore not surprising that athletes with superior running ability perceived the same external training load easier, particularly in the type of training drills examined in this study.

Consistent with previous research in AF, semi-professional and professional soccer and professional rugby league, s-RPE training load had a very large association with the external load measures of distance and PL (Casamichana et al., 2013; Lovell et al., 2013; Scott, Black, et al., 2013; Scott, Lockie, et al., 2013). This further validates the use of s-RPE training load to quantify training load in a high-intensity, intermittent collision sport such as AF (Coutts et al., 2003; Foster et al., 2001; Impellizzeri et al., 2004; Scott, Black, et al., 2013). The very large correlation between s-RPE training load and PL and a nearly perfect correlation between PL and distance also validates the potential use of PL as a surrogate measure of locomotor load (Aughey, 2011; Boyd et al., 2013; Casamichana et al., 2013). Using both the satellite-derived information and the accelerometer data to capture a complete picture of load would be ideal; however, in cases where satellite variables are not available (e.g. indoor sessions or sessions in urban canyon environments), PL could remain a useful indicator of load when comparing it to PL from other sessions. Although it is likely that the strength of this relationship would depend on the type of training performed (Weaving et al., 2014), training drills with high locomotor doses would result in stronger correlations between distance and PL than drills with more impacts, collisions and/or multi-planar movement.

While PL_{slow} also had a very large correlation with s-RPE training load, it was not as strongly correlated to distance as PL. Similar to previous results, this suggests that PL_{slow} provides different information to PL (Boyd et al., 2013). Specifically, this variable may be a more representative measure of load in training drills where little distance is covered, but there are large amounts of multi-planar movements at a relatively low speed (Boyd et al., 2013). Another variable available from the microtechnology device, which was not examined in this study, is the 2D PL. This version of PL incorporates the acceleration vectors from two planes only (medio-lateral and anterio-posterior) and could also provide insight into non-locomotor load aspects. Excluding the vertical vector potentially reduces the influence of foot strikes and hence locomotion on the PL parameter. High-speed running distance was strongly associated with s-RPE training load. This association is larger than reported by Casamichana et al. (2013) who used a similar definition of high-speed running distance ($18\ \text{km} \cdot \text{h}^{-1}$) in semi-professional soccer players. It is likely that the method of measuring high-speed running distance relative to each athlete's own 2-km time-trial speed impacted this result. Using relative thresholds to calculate high-speed running distance in training seems appropriate as a measure of effort as it represents dose performed relative to capacity (Abt & Lovell, 2009). However, because this method individualises the external training load to each athlete's capacity, it is likely to improve the correlation with s-RPE training load because RPE is also relative to an individual's capacity.

It is evident that prescribing training based on absolute external training load measures will result in different internal responses that may lead to a training imbalance, leaving some athletes at risk of overtraining and others failing to reach a training stimulus sufficient to elicit positive adaptations. However, prescribing training intensities individually using internal physiological measures, such as heart rate, is not feasible in skill-based training sessions in a team sport, where these sessions aim to improve physical capacities and skill, game sense, decision-making, and team tactics. Despite this, RPE as an alternative internal training load parameter to prescribe training may be innately flawed because players will adjust their output based on a global perception that includes individual characteristics, current physical condition (fitness/fatigue) and their psychological state (mood, motivation) (Blanchfield et al., 2014; Garcin et al., 2004). This may result in different external training loads between players but also variations within a player on different days and may leave some athletes at risk of too high a training dose and others failing to reach a threshold of training required for success. Planning training based only on RPE may overlook the absolute capacity the athlete requires.

Prescribing training using external training load with consideration of individual physiological capacity and other factors (e.g. experience and position) maximises the likelihood of achieving the desired training effect. Coaches might plan relevant sessions for individual athletes based on their positions, experience and/or time-trial performance. For example, for a controlled conditioning session, the squad might be split into groups based on time-trial results with the faster players having less rest or covering more distance in a set time than the slower players. The response to this external training load can then be monitored using s-RPE training load and subsequent training adjusted accordingly to optimise an athlete's stress/recovery balance. By recording and evaluating each athlete's s-RPE training load, markedly high or low, individuals can be flagged for intervention, whether it might be to reduce or increase subsequent training load. The results of this study emphasise the value of using RPE as an individual perception of effort and s-RPE training load to quantify and monitor global internal training load. It also highlights the limitations of using RPE as an intensity rating of an activity for a whole team or s-RPE training load to plan a training regime in a high-intensity, intermittent contact sport.

This study examined 14 skill-based sessions from pre-season training in an AFL club. Further studies may expand on this finding by exploring the impact these factors have through different phases of the season and also during other types of sessions. Given that during the season, matches contribute the heaviest portion of the load, determining characteristics that impact s-RPE training load in matches would provide valuable information to coaches as they can factor in mediators (e.g. playing position and experience) when designing and prescribing training. Due to club procedures, this study was constrained to pre-existing testing protocols, limiting the characteristics able to be investigated. In particular, a limitation of this study is the lack of construct validity of 2-km time-trials in AF; therefore, using a validated fitness test such as the Yo-Yo IR2 or a direct fitness measure such as a laboratory-based VO_{2max} test would be valuable. Other identifiable characteristics such as lower-body strength, anaerobic endurance and psychological state may also impact s-RPE training load and should be explored. Moreover, it is possible that fitness will improve during pre-season, and hence the fitness tests of week 11, or even more so of week 6, may not be as representative by the last week of the study (week 22). Future research might explore the link between external and internal training load, individual player characteristics and its resulting impact on performance (Akubat et al., 2014).

Conclusions

The results of this study suggest that experience, position and time-trial performance are mediators of the relationship between external training load and s-RPE training load. When external training load was controlled, the 4- to 5-year group had a higher s-RPE training load than the 0- to 1-year and 2- to 3-year groups and ruckmen had a higher s-RPE training load than midfielders. For time-trial, there was an increase in s-RPE training load per increase in time-trial time when external training load was held constant. It is vital that coaches and trainers are aware of the relationship between external training load and s-RPE training load and that consideration is given to potential mediators of s-RPE training load such as experience, playing position and time-trial performance.

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