Analysing physiological responses and skill patterns for Under 19 Rugby Union Front Row forwards to determine the implications for training program design.

Stephen Phillpotts, 2001

Introduction:

The growing popularity of Rugby Union Football and the professional era of the game have promoted International events such as the Super Six Championship in the United Kingdom and Europe, Super Twelve and Tri Nations in the Southern Hemisphere, and the World Cup. With a desire to compete at the highest level in these competitions, State and National Rugby Associations are promoting the developmental pathways into the elite professional competitions to ensure sustainable success in the future. The Under 19 age division is one pathway gaining much attention from these Associations. In Australia in 2001 for example, there existed the following representative opportunities for players to be identified and developed in this Under 19 age division:

- State and Australian Schoolboys teams
- State run Rugby Academies in ACT, Queensland and NSW
- State Representation in both a home series (ACT, Qld and NSW) and also a trans Tasman series in the Under 19 age division,
- Representing Australia at the Under 19 World Cup (in Chile)

With an increasing focus on the developmental pathways for players has also come a trickle down effect of promoting coaching expertise in this division. The more effective coaches utilise all available disciplines to aid their understanding of the game and its requirements, and ultimately base their practice on this foundation.

An understanding of the physiological demands on the players is necessary to develop a specific training protocol. The training programme can subsequently be developed to mimic the physiological conditions imposed by the game (Deutsch et al 1998). Each playing position in the team has a slightly different energy requirement profile, and it is imperative that these differences are addressed and training stimuli modified accordingly (Kelton 1999).

An analysis of Under 19 Rugby Union front row forwards (props) was undertaken to examine the physiological demands of the position during match conditions. Two methods of data collection were used: a literature review, and video analysis of matches. From this analysis, implications for designing a position specific training program were made.

Methods:

Data relating to the physiological demands of front row forwards (loose head and tight head props) was collected using the following techniques:

1) Video match analysis.

Three Queensland Greater Public Schools (QGPS) First XV matches were analysed using video footage from the 2001 season (Brisbane Boys' College versus Ipswich Grammar School, Brisbane Grammar School and Toowoomba Grammar School). One video was used and framed to include the general action close around the ball. First Fifteens in this competition play according to the Australian Under 19 rules and play 35-minute halves

with injury time. The roles of the four front row forwards in each match were analysed using match statistics, which were collected for:

Lineouts: The total number of lineouts was calculated for each game and this was further divided into number of lineouts thrown by each team (BBC and opposition) for the purpose of determining defensive and attacking contributions of the props.

Scrums: The total number of scrums for each game was calculated, as well as the number of reset scrums. Reset scrums most commonly occurred from collapses prior to the ball feed and wheeled scrums (more than 45 degrees). The team feeding the ball was noted for the purpose of determining defensive and attacking contributions of the props.

Ruck / Mauls: The total number of rucks and mauls was calculated for each game. The definition in the Rules of the game lawbook, 2001, was applied to differentiate rucks and mauls, and also to define the beginning and end of each ruck or maul.

Kick offs: The total number of centre field kick offs for each game was calculated. The team kicking the ball was noted for the purpose of determining defensive and attacking contributions of the props.

Front Row total contacts: The number of tackles for each of the four front rowers was calculated and then averaged for each match. Likewise, the number of runs with the ball was calculated and averaged. An average total number of contacts was calculated by averaging the sum of tackles and runs made for each front rower.

2) **A literature review**

To supplement the statistical analysis of the videoed QGPS matches and provide some comparative data, current literature was reviewed. The following articles provided data for analysis:

- Deutsch, M.U., Maw, G.J., Jenkins, D. and Reaburn, P. (1997). Heart rate, blood lactate and kinematic data of elite colts (under-19) rugby union players during competition. *Journal of Sports Sciences*, **16**, 561 – 570.

Markus Deutsch et al. examined the physiological responses of Under 19 Brisbane 'Colts One' players during six competitive premiership matches. Six players were chosen at random from four positional groupings. Props and locks were one of the groupings, and data was collected relating to heart rate, blood lactate, and time–motion analysis.

- Livingston, S. (2000). Determining physiological requirements of rugby and its implication for the annual training plan. Handout notes for Level 3 ARU coaching seminar, AIS October 2000.

Stuart Livingston presented seminar notes for the 2000/2001 Level 3 Australian Rugby Union coaching course. These notes contained statistics from his analyses of Super 12 matches in 2000. Whilst not an Under 19 competition, they provide some comparative data for analysing front row contributions at that level.

- Docherty, D. Wenger, H.A. and Neary, P. (1988) Time motion analysis related to the physiological demands of rugby. *Journal of Human Movement Studies*, **14**, 269 – 277

These articles provided raw data to assist in the analysis of front row forward playing profiles.

Results / Findings:

A summary of the key statistics is provided in Table 1.

	Colts 1 Deutsch et al. 1997	GPS 1st XV BBC v IGS 2001	GPS 1st XV BBC v BGS 2001	GPS 1st XV BBC v TGS 2001	Super 12 2000 Livingston
Lineout (total #) Throw BBC (win – lose) Throw Opp. (win – lose)		24 7 10 - 6	27 7 – 4 12 - 4	26 5 – 11 7 - 3	
Scrums (total #) (resets) Feed BBC (win – lose) Feed Opp. (win – lose) Front Row % relative game time	32 +/- 3 4.6 %	22 (4) 11 9 - 2	20 (8) 9 – 3 8	29 (5) 12 – 1 16	22 (5 – 7) 12 10
Ruck / mauls (total #) Front Row % relative game time	72 +/- 7 9.1 %	126	137	129	
Kick offs (total #) BBC kick Opp. kick		9 3 6	9 5 4	7 4 3	
FR total contacts in game (av) Tackles (av) Runs with the ball (av)		5.00 2.50 2.25	4.50 1.75 2.75	4.25 2.00 2.25	9.33 6.78 3.00
Total distance covered: Walking (metres) Jogging (m) Cruising (m) Sprinting (m) Utility (m) **TOTAL**	 1000 +/- 130 3050 +/- 193 363 +/- 102 94 +/- 24 118 +/- 43 4400 +/- 398				
Single effort maximum distance covered: Walking (metres) Jogging (m) Cruising (m) Sprinting (m) Utility (m)	 55.5 +/- 7.6 65.3 +/- 8.7 27.2 +/- 5.3 29.0 +/- 6.9 10.3 +/- 3.0				
Average single effort distance covered: Walking (metres) Jogging (m) Cruising (m) Sprinting (m) Utility (m)	 14.0 +/- 1.8 21.8 +/- 1.7 13.5 +/- 1.6 19.8 +/- 1.0 6.0 +/- 3.3				
Relative time in activity as a % of total game time : Inactive (%) Walking (%) Jogging (%) Cruising (%) Sprinting (%) Utility (%) Static High Intensity (%)	 47.1 +/- 1.9 14.7 +/- 1.8 20.8 +/- 0.9 1.8 +/- 0.5 0.3 +/- 0.1 1.7 +/- 0.6 13.7 +/- 1.2				
Frequency of activity as a total number in game : Inactive (number) Walking (#) Jogging (#) Cruising (#) Sprinting (#) Utility (#) Static High Intensity (#)	 166 +/- 8 73 +/- 5 143 +/- 5 26 +/- 6 4 +/- 1 19 +/- 4 104 +/- 9				
Percentage of time spent in Heart rate zones: > 95% Max HR 85 – 95% MHR 75 – 84% MHR < 75% Max HR	 14.3 58.4 22.6 5.8				
Total work time high intensity **Mean single duration of work** **Mean work: rest ratio**	11.0 mins 19 secs 1: 1.9				

General match statistics:

Analysis of Five Nations rugby matches in 1992, found that in eighty minutes of scheduled match time the ball remained in play for a total of only 25 to 29 minutes, that is 31 – 36 % of game time (McLean *et al* 1992). With the pressure of providing a more entertaining match for the spectators, a focus on increasing the time the ball is in play has been a priority since then. Livingston (2000) found in Super 12 matches analysed, there were on average 68 work periods between set pieces (kick offs, scrums and lineouts) ranging from 9 to 85 seconds each. Table 2 summarises his analysis of phase play developed in this period.

Phases	Work range in seconds	Average work in seconds	Average total work periods	% of total work period
0 to 1 phase		9 secs	22	32%
2 to 3 phases	13 – 37 secs	22 secs	20.6	30%
4 to 5 phases	26 – 51 secs	41 secs	13.6	20%
6 to 7 phases	43 – 75 secs	56 secs	8	12%
8 to 10 phases	65 – 108 secs	85 secs	3.8	5%

Table 2: Work periods, average time spent in phases and % total work period in Super 12 matches (Livingston 2000)

Livingston (2000) also profiled the generic work to rest periods in a Super 12 match (Brumbies V Otago) between the 30.13 minute and 43.02 minute of the first half (total of approx. 13 minutes). The consecutive work to rest periods and the number of phases of play (between set piece, rucks and mauls) achieved in the work period in that 13-minute period are recorded in Table 3. Whilst not profiling individual positions, it does provide a sample of the variance of consecutive work to rest periods at this elite level and records that in 13 minutes of match time the ball was in play a total of 7 minutes 24 seconds (57%).

	Work time (seconds)	Rest time (seconds)	Work to rest ratio	Phases of play achieved in work period
Start (30.13) —	19	23	1 : 1	2
	72	36	1 : 0.5	7
	76	43	1 : 0.5	9
	21	22	1 : 1	2
	53	58	1 : 1	7
	67	90	1: 1.5	8
	72	41	1 : 0.5	9
	4	11	1 : 3	0
	59	6	Half time	6

Table 3: A profile of consecutive plays in the Brumbies V Otago Super 12 match from minute 30.13 to 43.02 (half time) recording work time, rest time and the number of phases achieved in that work period.

McLean *et al* (1992) reported that most work to rest ratios during international match play (Five Nations Championship) were in the range of 1: 1 to 1: 1.9.

Deutsch *et al* (1997) found in the Brisbane Colts competition, players were inactive (stationary) for between 40.7 +/- 3.5% (outside backs) and 47.1 +/- 1.9% (props and locks) of the relative game time (70 minutes). Involvement in high intensity work (static work (eg scrummaging), sprinting and cruising) ranged by position grouping from 3.32 min (outside backs) to 11.49 minutes (backrow) total time. They further found that players analysed performed a mean of 560 individual movements (inactive, walking, jogging, cruising, sprinting, utility, rucking / mauling, scrummaging) during a 70-minute match with a frequency range of 138 (outside backs) - 173 (backrow) number of inactive periods. The average duration of a passage of play in the Colts rugby matches was 19 seconds with the work to rest ratios between 1:1 and 1: 1.9. McLean *et al* (1992) found similar work to rest ratios (average 1: 1.9), and Livingston (2000) reported 75% of the game at Super 12 level was played with work to rest ratios ranging from <1: 0.5 to 1: 4 and 40% of the game played with work to rest < 1: 1.5.

All of these findings reinforce the highly intermittent nature of rugby union match play.

Front Row specific match analysis data:

Set pieces:

Set pieces include lineouts, scrums, kick offs, and 22 metre restarts. Analysis of the videoed QGPS First XV matches revealed an average of 25 lineouts per match. The front rowers in all three matches filled the traditional roles of support and lifting at either position 1 or 3 in a full lineout, and at least one front rower was utilised in the short variations used in these matches (mostly 5 man lineouts with the front rower in position 1). Of the two front rowers positioned in the lineout, the player at 3 was required to provide the greater number of lifts / supports due to his dual role supporting behind 2 and in front of 4. Three of the four teams also utilised a defensive lineout thus increasing the lifting roles of both front rowers. Table 1 summarises the lineout statistics and provides both the number of throws for each team, and the related win – lose statistics. The effectiveness of the defensive lineout is highlighted through these statistics. Neither Deutsch nor Livingston provided specific lineout statistics in their analyses, though Livingston notes that generally lineouts took between 10 and 20 seconds to complete in Super 12.

Analysis of scrum statistics reveal in the QGPS matches an average of 24 scrums with a further 6 (av) of these being resets. Thus a total of 30 front row engagements were made in each of these matches. The pattern of which team fed the ball was shared approximately evenly, thus the different roles of the front row in attacking and defending scrums was shared. Deutsch *et al* (1997) recorded an average of 32 +/- 3 scrums though it is unclear if this is the total number awarded or includes resets. If it includes resets it supports the QGPS data. Analysis from the Colts matches reveals that scrummaging occupies 4.6% of the front rowers relative game time. Livingston (2000) records an average of 22 scrums with between 5 and 7 resets in Super 12 matches analysed. The scrum feed was shared evenly (12 – 10) also.

The number of kick offs was calculated in the three QGPS matches with an average of 8 per match. This statistic will be the most variable in matches due to the number of kick

offs correlating to the number of scores (tries, penalty conversions and field goals). The traditional short kick off to the forwards sees the receiving front rower in a support and blocking role, whilst the attacking team front rower is utilised in a trailing capacity. Any variation to this short kick sees the front rower utilised in a trailing capacity in either attack or defence.

Overall the front rower can be involved in about 60 set pieces per match with at least half involving static high intensity work (scrums). Livingston (2000) records that it generally takes 10 to 14 seconds to set a scrum and engage with each scrum lasting for 5 seconds from the time the ball is fed and leaves the scrum. This time can take up to 10 seconds however, depending on the channel being used.

Rucks and mauls:

The modern game has seen the emergence of predominantly rucking with an emphasis on decreasing the numbers in contact and a quick recycling of the ball. The 'use it or lose it' rule in mauling has been a major contributor to this. The role of the front rower in attack has likewise evolved to include more assessment of whether to join the breakdown, and if so to have predominant skills in clearing out at the breakdown or promote the ball forward through a pick and drive. Defensively at the breakdown the front rower needs to assess his involvement and if not required fill in the defensive line, usually within the two defenders either side of the breakdown (pillar and post roles).

Analysis of the QGPS matches revealed the average total number of rucks and mauls as 131. The quality of video positioning and framing prevented analysis of these in terms of specific player involvement. Deutsch *et al* (1997) specifically tracked players with videos and were able to determine the front row involvement in rucks and mauls as 72 +/- 7 per game. This was 9.1% of the front rowers relative game time.

Total contacts:

The total number of tackles and runs with the ball for front rowers was assessed in the QGPS matches. The average number of these front row contacts was 4.5 per player per game. The most tackles by any front rower in the three games were 4 and the average number by all was 2. Defensively no front rower attempted a tackle from set play, primarily due to restrictions of involvement in the set pieces. In phase defence, most front rowers filled in the pillar or post role close to the breakdown, and all tackles successfully completed occurred in that area. Within these positions most tackles are predominantly short range and front on, for example defending a player who picks and drives. The 12 front rowers analysed in the 3 matches missed four tackles (out of a total of 29 attempted). These missed tackles were all recorded when the front rower had to defend a back (twice trying to tackle a counter attacking outside back, twice off phase defence when positioned wider than key).

All front rowers analysed in the QGPS matches recorded at least 1 run with the ball in each match with a maximum number of 4. Most runs came from either a pick and drive situation at the breakdown, or one off passes from the breakdown (receiving a clearing pass). Of the 30 runs recorded by the twelve front rowers, 22 retained the ball and went to ground to create a ruck, 1 scored a try, 5 passed the ball on and 2 created mauls by staying on their feet in contact with the defence.

Livingston (2000) recorded an average of 9.33 total contacts by front rowers consisting of about 7 tackles and 3 runs with the ball. Even at Super 12, front rowers usually went to

ground with the ball after a run. Seventeen percent of ruck ball was picked up and driven forward. No statistics for missed tackles were provided.

Movement analysis:

The intermittent nature of the game has been highlighted previously. Player's movements can be tracked during matches in terms of distance, speed, time and frequency. Deutsch *et al* (1997) divided actual movements by players into five categories: walking, jogging, cruising, sprinting and utility (sideways or backwards). Jogging was the most frequent movement type (143 +/- 5 repetitions) with an average time of 6.2 seconds and a maximum time of about 19 seconds. The average distance covered was 21.8 +/- 1.7 metres with a maximum distance of 65.3 +/- 8.7 metres for each. Total distance covered was 3050 +/- 193 metres, which was approximately 69% of the total match distance. Time spent jogging comprised one fifth (20.8+/- 0.9 %) of the props total match time. Docherty et al (1988) calculated a similar relative time spent jogging by props at 17%

The distance covered walking averaged 1000 +/-130 metres with 73 +/- 5 repetitions each of 8.5 +/- 1.0 seconds (14.0 +/- 1.8 metres covered). These props spent 14.7% of their relative match time walking. Docherty et al (1988) calculated a higher relative percentage of walking for props (23%).

Sprinting contributed least to the props movement patterns with a total of 94 +/- 24 metres covered in 4 +/- 1 repetitions each of 2.8 +/- 0.2 seconds (19.8 +/- 1.0 metres covered). The maximum distance covered in any one-repetition was 29 +/- 6.9 metres. The total distance covered cruising was363 +/- 102 metres in 26 +/- 6 repetitions each of 13.5 +/- 1.6 metres.

Props completed 19 +/- 4 utility movements (sideways and backwards) each averaging 6.0 +/- 3 metres covering a total of 118 +/- 43 metres.

Docherty *et al* (1988) reported that players spent 85% of total playing time in low-intensity activity (standing, walking or jogging) and only 15% of playing time in high-intensity activity (running, sprinting or static exertion).

Inactivity totalled 47.1% of the front rowers game time. Props were stationary for 166 +/- 8 periods with an average time of 12.5 seconds and a maximum time of 75.8 +/- 10 seconds. This has implications for recovery.

These movement patterns challenge the traditional team sprint conditioning session and the implications will be discussed later.

Energy system contribution and recovery patterns:

Deutsch *et al* (1997) were able to monitor heart rate and sample blood lactate levels during match conditions. Front rowers spent 14.3% of the relative match time in maximum exertion (> 95% of the individuals maximum heart rate (MHR) experienced in the match), and 58.4% time in high exertion (85 – 95% MHR). Thus, front row forwards spent over 70% of the match with a heart rate above anaerobic threshold level, and this contributed to the recorded blood lactate levels (mean of 6 mmol per litre and a peak value of 8.8 mmol per litre). When considering the movement patterns of props, typically they are involved in static high intensity work for short durations followed by periods of low intensity work (stationary, walking, or jogging). The average work to rest ratio for props was 1: 1.8. Whilst most work periods would indicate a reliance on the creatine-phosphate system for ATP replenishment (high intensity, 6 – 8 second duration), the rest

periods would not allow sufficient replenishment of this system. Saltin and Essen (1971, reported in Deutsch *et al* 1997) found that rest periods of less than 20 seconds are not sufficient to allow significant replenishment of creatine phosphate stores following maximal intensity work bouts of 10 seconds (up to 3 minutes rest required for total replenishment). Due to this, anaerobic glycolysis would become the predominant high intensity work energy system with accumulating lactic acid a by-product. Given that a large amount of the time (47.1% relative game time) spent in recovery is passive (stationary), this does not assist in lactic acid removal and promotes venous pooling. An active recovery (jogging) increases the removal of lactates from the blood.
The data of Livingston (2000) quoted earlier in this paper (Tables 2 and 3), reinforce the variance of work to rest periods in a game and the phases developed, especially consecutively as in Table 3.
This data relating to energy system contribution and recovery patterns has implications for the designing of conditioning and the use of interval training, which will be discussed next.

Discussion:

Implications of the preceding analysis for front rowers will be highlighted for the designing of a position specific training program. Most of these implications are drawn from the research undertaken, and many are from Stuart Livingston's notes.
Implications relating to the training of aerobic conditioning, speed, strength, and skills for the front row forward follow.

Aerobic Conditioning:

Athletes engaging in prolonged activities must possess high levels of cardiovascular fitness. This aerobic fitness is imperative to aid the recovery between short bursts of high intensity activity that are intrinsic to field games such as rugby union (Kelton, 1999). The physiological adaptations brought about by aerobic conditioning aid to increase the delivery of oxygen to fatiguing cells thus promoting recovery and removing lactates. Jenkins (1993) has noted that aerobic conditioning may be important for improving lactate removal between sprints. A general aerobic base is therefore essential for all players. Specific movement analysis of the front rower's role in rugby union reinforces the need for a well-developed aerobic system. Of the average total distance covered in a match (4400 metres) by props, 4050 metres were covered either walking or jogging which are predominantly aerobic in nature. The pattern of high intensity activity (scrummaging, rucking / mauling) followed by moderate activity or being stationary with variable work to rest ratios averaging 1: 1.8 highlights the need for efficient recovery processes.
Livingston (2000) prescribes the following training outline for the tight five:

- All conditioning sessions need to reflect 75% aerobic, 15% anaerobic (lactic), and 10% anaerobic (alactic) energy system contributions.
- A general annual plan outline as per Table 4 where maximum session distance is the sum total of all work interval distances, interval range is the distance covered per single repetition, and total number of contacts is the sum of all individual player contacts through tackles or hitting rucks and mauls.

	Off- season	Pre-season	In-season
Maximum session distance	3000 – 6000m	2000 – 4000m	1500 – 3000m
Interval range	1000 – 2000m	400 – 50m	200 – 50m
Total number of contacts	40 - 80	60 - 80	40 - 60

Table 4: General aerobic conditioning prescription for Tight Five by Livingston, 2000

Overlayed on the general aerobic conditioning prescription by Livingston (Table 4) should be a variable work to rest ratio (based on time) that averages 1: 1.8 by the in-season period. The opportunity to replicate match conditions in this aerobic training will assist in specificity and aid player motivation. Some examples of this may be to incorporate high intensity static movements (tackle bags, hit and drive, padded sleds, overhead push press etc) at variable intervals in circuit style conditioning. Adding a form of competition will also assist motivation. The key is to ground your conditioning in sound physiology and replicate specific match related analysis. The principles of overload and over-distance training should also be applied.

Speed

The analysis of data collected here suggests the need for maximum sprinting speed and technique in front rowers is virtually negligible, given that in the Colts matches analysed they sprinted an average of only 4 times covering a total distance of 94 metres (Deutsch *et al* 1997). Within the same paper however the authors do quote studies of international match play (The Rugby Football Union, 1978-79; Williams, 1976; Treadwell, 1988) that note players at that level are required to sprint considerably more than those at the club level. For example, props playing at club level sprinted a total of 204 metres whilst their counterparts at the international level covered 1600 metres sprinting (The Rugby Football Union, 1978-79). They further quote,

'The apparently short time spent sprinting in Colts match-play may suggest the need for increased volumes of sprint training in the development of younger players to meet the demands of senior, and especially representative, competition.'

(Deutsch *et al*, 1997, p.568)

Livingston (2000), who at the time was working as the Athletic Performance Co-ordinator of the Brumbies Super 12 team, has removed formal sprint training from the Brumbies tight five regime. He reasons the minimum time tight five spend sprinting, as compared to most of the game spent cruising (70% of this in a horizontal plane) justifies this decision. Instead his program focuses on developing leg drive in and out of contact, which is required at the breakdown. The use of sled runs at 30 – 40% of body weight encourages body lean (lower body height) and conditions leg drive. Further to this the tight five incorporate these sleds using specific movements of hit and drive, pick and go and off the deck drills to replicate predominant movement patterns at the breakdown. The use of a padded sled is also used in conditioning sessions to simulate clean out and pick and go at the breakdown between conditioning intervals. The frequency of contacts and distance travelled between each repetition would replicate match conditions (sample Table 2 and 3). The prescription of work to rest ratios could mimic match conditions.

Livingston (2000) uses the following generic (backs and forwards) guidelines for conditioning based on his analysis of physiological requirements to play the Brumbies style of football:

- Work intervals should predominantly range between 10 and 90 seconds
- Players must also be able to sustain work (equivalent to 12 phases) up to 2 mins 15 seconds
- 30% of conditioning should concentrate on 10 second efforts
- 30% of conditioning should concentrate on 22 second efforts
- 20% of conditioning should concentrate on 40 second efforts
- 12 - 15% of conditioning should concentrate on 55 - 60 second efforts
- 5% of conditioning should concentrate on 85 - 90 second efforts
- 15% of work to rest to be less than 1: 0.5
- 20% of work to rest to be 1: 0.5 to 1: 0.9
- 30% of work to be 1: 1
- 20% of work to be 1: 1.5
- 15% of work to rest to be greater than 1: 2

The implementation of specific cruising and leg drive into / out of contact patterns into the tight five conditioning regime do replicate specific match conditioning. As well this type of conditioning would assist the front rowers to develop lactate tolerance both psychologically and physiologically (improving intra muscular buffering capacity and lactate metabolism). This is sound practice given the lactate levels recorded in the Colts matches by the front rowers (Deutsch *et al* 1997).

Further to this, the incorporation of utility movements (backwards and sideways) into the speed-training regime would replicate the movement patterns recorded in the Colts study. Whilst like sprinting they cover minimal total distance (94m sprinting, 118 m utility), there are far more repetitions (4 sprinting, 19 utility) to warrant their inclusion in the speed conditioning program. The demands of utility movements are significantly greater than for walking forwards, and these movements in a game reflect increased energy demands to overcome inertia during transitions from utility to forward locomotion (Deutsch *et al* 1997). The efficiency of these movements can be increased through agility and flexibility training (Reilly, 1994 in Deutsch *et al* 1997).
The development of speed in young front rowers should focus on increasing the mean speed of jogging to attain more relative time cruising, develop leg drive into and out of contact, develop lateral movement patterns, and promote lactate tolerance. The replication of Livingston's guidelines could be ultimate goals to work towards. Given that these are elite, seasoned athletes, however, the appropriate adaptation of these principles will assist prepare young front rowers for a greater impact in the game.
Strength:
There is a need to individualise strength training in terms of the special needs of players, for example weight gain, upper body maximum strength development etc. Much of this work can be achieved in the off-season or early pre-season (general preparatory stage). The role of the front rower in set pieces requires a specific strength and power base.

The number of lineouts in matches (average of 25 in QGPS matches analysed) combined with the lifting/ support roles of the front rowers in both offence and defence demand strength and power lifting above their head, as well as core stability. The front rower lifting at 3 in the traditional full lineout would be expected to have the higher number of repetitions due to assisting both the 2 and 4 jumper. Specific lifts in the gym weights room such as the push press and snatch will assist in power development, as well as reinforcing the biomechanical principle of summation of forces through correct technique of lifting. Skill and technique repetitions of lifting jumpers in either small units (1 jumper and 2 supports) will provide the most specific training, especially when front rowers are moving as part of a unit, or to a jumper before lifting as many lineout variations require. The use of a weight belt worn by the jumper can provide an overloading effect in these training drills. This strength training would also enhance the support role played in receiving either 22m-drop kick restarts or half way kick offs.

With a general average of 30 scrum engagements per game, the front rower is required to maintain core stability and utilise maximum strength in the specific scrum position. The use of swiss balls; the more traditional free weight exercises of squats (single or double leg), lunges and bench press; or a combination of both, will all contribute to this development of core stability and dynamic strength. Greater specificity will come through incorporating some opposed wrestling movements, as well as structured live scrummaging sessions. The development of neck strength in younger front row players should also be prioritised.

In general play the front row forward is required to exhibit strong and quick leg drive when taking the ball into contact and clearing out at the breakdown, wrestle opposition players to the ground, have the strength to dispossess or tie up opposition ball, and get quickly off the ground to their feet from a variety of positions (Livingston, 2000). All of these dynamic strength and power movements can be developed through specific weight training and simulated exercises.

The hypertrophy of lean body mass through the strength program (and correct nutrition) is a desirable outcome that should be planned into the program. Greater bulk combined with good power development and aerobic capacity will create a front rower capable of a more significant impact on the game.

Livingston (2000) provides the following guidelines in terms of periodising strength training:

- **Off season**; use predominantly dumbbell movements for general core strength, emphasise single leg strength to develop asymmetry, pushing to pulling movements should be of equal proportion, remedy specific weaknesses, focus on hypertrophy.
- **Preseason**; shift to predominantly barbell movements, increase pulling movements to 70% of upper body program, shift from general preparation (8 – 12 exercises per session with 8 – 20 repetition range, 2 – 4 times per week) to specific preparation (5 – 8 exercises per session with 3 – 8 repetition range, 2 – 3 times per week)
- **In season**; increase speed of movements to convert power to strength, maintain maximal strength (3 – 5 exercises per session with rep ranges of 3 – 8, 1 – 2 times per week)

These guidelines, combined with the development of; specific overhead lifting power, neck strength, core stability, dynamic upper body strength, leg power and hypertrophy, should assist with providing a specific strength-training program for the Under 19 front rower.

Skills:

The better coaches have generated a clear match plan or vision of how the game under their coaching will be played and are then able to deconstruct this to coach the required rugby skills. These skills are then reconstructed in match simulated training drills until consistent reproduction of them in a match produces the fruition of that vision.

The discussion that follows is limited therefore to the analysis of matches provided. It records data as it was, not how it can or even should be.

The match analysis data presents a picture of a player (front rower) involved in a ball game, who in reality rarely touches the ball! The average of 2 runs with the ball in the QGPS matches was only just bettered by the 3 recorded for Super 12 matches. Players at both levels predominantly went to ground with the ball to create another ruck. Whilst skill development in catching and passing is essential, it hardly should dominate the front rowers training session given little justification statistically. The skills of pick and drive, or receiving a one off pass into contact then presenting the ball on the ground, are skills necessary to reinforce, though again are infrequent in the matches analysed.

In team defence the front rower predominantly filled the pillar or post roles (first 2 defenders either side of the breakdown) meaning most tackles were front on and in close contact, for example defending a pick and drive or a one off forward runner. A clear understanding of these roles, the necessary skills and practice under supra-match (faster than simulated match) conditions is necessary. The skills of defending a ball runner and holding him up to slow down the opposition ball being recycled is also desirable. In the QGPSA matches, front rowers completed on average 2 tackles (maximum of 4 in any one match) and 7 in Super 12 matches. Again these are not significant numbers but do warrant effective skill learning and practice. The exposure to a variety of other roles in the defensive line is required also given the analysis of missed tackles by the front row forwards. The difference between a tackle being made or missed could be the difference in result between two evenly contested teams.

The most significant skills to be learnt by the front rowers are those of rucking and mauling, lineout support and scrummaging given the frequency of repetition in the statistics analysed. The techniques of these skills can be taught in isolated closed drills initially but need to be broadened to developing the techniques in the open environment using a range of evaluative options and adaptations. Effective feedback will assist in the learning of not only the skill by the player, but the evaluative and analytical processes inherent in highly skilled performance.

The other major skills to be learnt are the range of mental skills. Given the intermittent nature of the game and the high proportion of stationary ‘no play’ time, mental cues could be taught to assist with focus and concentration. These key cue words could assist both in the quick transition between skill types (eg scrum to ruck to lineout) and in the periods of rest (switch off or switch on cues). There is much literature to support the development and benefits of a well-planned mental skills training program.

Conclusion:

This paper has sought to analyse the position specific role of the front rower in rugby union match play, especially at the Under 19 age division. The analysis includes data relating to:

- the frequency of skills performed in the game (lineouts, scrums, rucks and mauls, tackles, and runs with the ball),
- movement analysis (stationary, walking, jogging, cruising, sprinting and utility),
- energy system and recovery analysis (heart rate, blood lactate and work to rest ratios).

Data was collected from both analysis of videoed match play and related current research. From this analysis, implications for the development of a front row specific training program were made.

Whilst this paper is generally front row specific in its analysis, it is intended to also serve as a blueprint for the analysis and design of programs for each position or grouping of positions. The body of research available highlights the diverse roles and requirements of players even in the same match. The better coach has already moved away from the generic team approach to conditioning and skills practices to specific position related squads (Tight 4, Mid 5 and hookers, Back 5) and individual conditioning and skills practices. The best coaches grasp the concept of specificity of training and wholeheartedly incorporate the principle into their planning and practice. The challenge of a paper such as this also begs the coach to move on from analysing the roles of players as they are today (or yesterday) and adapting your training to this, to having a vision of how the game can be played tomorrow and preparing your players specifically for this! The young players of today deserve it, and the future of the game tomorrow demands it!

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