SPEED DEVELOPMENT IN RUGBY UNION PLAYERS

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Introduction

As an essential prerequisite in rugby union, speed can be considered to be one of the foundation physical attributes that are highly correlated with level of performance and success within the game (Meir et al, 2001; Baker, 2001). Although this is widely accepted by coaches and conditioning professionals alike, the inclusion of speed and agility practices during lengthy in-season periods becomes difficult within the limited time frame available. In order to prioritise training methods that can enhance speed and evasion performance within limited practice, a comprehensive understanding of the demands of the game on speed and evasion components should be considered. Then a review of the most successful methods of developing these essential components can be related to practical examples within a rugby union environment.

Speed Training

Before discussing situation-specific speed, the basic physiological and biomechanical principles of speed training should be considered. Firstly the structure and make up of the muscular system will affect an individual's ability to run fast, as certain muscle fibre types (fast twitch) are predisposed to produce higher forces at greater velocities than others. Thus, athletes who possess a higher percentage of these fast twitch muscle fibres have an inherent ability to produce larger power outputs than the individuals with a greater percentage of slow twitch muscle fibres (Costill et al, 1976). In addition to muscle fibre make-up, comparisons between elite and sub-elite sprinters indicate that there are also significant differences between fascicle length (bundle of muscle fibres running from proximal to distal tendons) which, according to Kumagi et al (2000), accounted for a 22% faster shortening velocity. Similarly, Abe et al (2000) published findings comparing sprinters, 10km runners and marathon runners. Not only did sprinters have greater fascicle lengths, but they also possessed smaller pennation angles (degree of attachment with long axis of muscle).

Despite indications that these factors (i.e. muscle fibre type, pennation angles and fascicle length) are not affected by training, several studies have reported significant increase in power output (Hoffman et al, 2004; Baker & Newton, 2006) and decreases in speed (Meir, 2001; 2002; Baker, 2001) after various training programmes were undertaken. Therefore, adaptation does occur as a result of training, namely in neuromuscular and central nervous system (CNS) efficiency, regardless of predisposed biomechanical and physiological factors.

Due to the nature of the energy sources during maximal velocity running and the significant involvement of neuromuscular and central nervous systems, speed and agility should not take place under or during fatiguing conditions if the required effect of the session is solely to improve speed and evasive skills. As the player fatigues, running speed will decrease, thus altering recruitment patterns and ground reaction times that differ between sub maximal and maximal running speed (Kyrolainen et al, 1999). Although speed endurance training is a popular, effective and necessary way of improving repeatability of speed and should take place under fatiguing conditions, it should be noted that improvements in performance during this training occur as a result of improved bioergogenics (i.e. increases in enzyme activity, improved recovery of phosocreatine), *not* as a result of faster shortening velocities of muscle tissue due to increased motor unit recruitment or synchronisation, which are associated with increased speed and power outputs (Stone et al, 2000).

Essentially, the adaptations associated with speed endurance training may appear similar to those of pure speed training. However, they differ somewhat significantly, affecting core factors such as running speed and mechanics. Therefore, if genuine increases in speed performance are to be attained, training conditions must allow sufficient time for the recovery of various energy and neural contributors. The appropriate length of time necessary to replenish these stores is obviously dependent on the length of time an athlete undertakes high intensity activity. Although there is discrepancy in the literature regarding times required for recovery of these components, work to rest ratios of 1:15-20 or 1 minute rest for every 10 metres travelled at 100% effort appear to be sufficient (Beachle & Earl, 2000).

Time Motion Analysis

Resent technological developments in analysis of team sports has enabled accurate assessment of individual performance profiles during matches. Eaton and George (2006) published data taken from six English premiership matches across the course a season and the results of the speed-related data are displayed in Table 1.

Table 1. Speed data of Six Premiership Matches, Eaton and George (2006).

Demand	Variable	Props		Hookers		Locks		Loose		Scrum Half		Inside Backs		Outside Backs	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Sprints >7 m s^{-1}	Quantity (*n*)	1	1	3	1	3	2	6	3	9	4	12	5	14	5
	Mean distance (m)	5.7	4.5	8.3	1.8	8.8	3.7	9.1	2.2	12.8	3.6	13.4	4.0	15.2	3.7
	Mean duration (s)	0.7	0.6	1.1	0.2	1.2	0.5	1.2	0.3	1.7	0.4	1.8	0.5	2.0	0.5
	Relative time %	0.02	0.01	0.06	0.03	0.08	0.05	0.13	0.59	0.26	0.11	0.38	0.19	0.51	0.19

The data indicates that it is uncommon for players of any position to sprint (>7ms^{-1}) further than 20 metres in any single incident in a game; in addition, it would appear that there is a linear increase in the mean sprint distance dependent upon position (i.e loose forwards 8.8m ± 3.7, props 5.7m ± 4.5, outside backs 15.2m ± 3.7, and scrumhalf 12.8m ± 3.6). Due to sample size and the fact that data was gathered from only one team, it is difficult to draw distinct conclusions. However, Duthie et al (2006) published similar findings regarding duration of sprinting activity, reporting average sprint times of 2.5 ± 1.6 seconds and 3.1 ± 1.6 seconds in forwards and backs respectively during the observation of 503 sprints during ten Super 12 games. Duthie et al (2006) also reported on the demand on players to change direction . Interestingly, results indicated only 2 ± 2 evasive sprints per game for forwards, which accumulated as 15% of total sprints, and 6 ± 3 (22%) per game in the backs.

A review of this time/motion analysis has revealed that, despite common perception, it is unlikely that many players will, at any one phase of play, sprint further than 20m or longer than three seconds. Likewise, a large proportion (approx 80%) of the time spent sprinting occurs in relatively straight lines. However, there appears to be significant differences between the amount of evasive sprints and distances attained by forwards and backs respectively. It should be noted that both these studies collected data from only one team over a relatively short period of time, therefore limiting the significance of the findings. However, due to the limited amount of published analytical data, some conclusions can be drawn if these limitations are taken into consideration.

Traditionally, sprinting has been described as consisting of a series of phases (0-10m acceleration phase; transition phase; 36-100m maximum velocity phase) during a

100m sprint. Mero (1988) has described the first 30-50 meters as the acceleration phase, followed by a maximum velocity phase and period of deceleration. Duthie et al (2006) reported that professional rugby union backs and forwards achieved maximum velocity (Vmax) at 5.9 ± 0.7 seconds and 5.4 ± 0.6 seconds respectively. When considering the interpretation of the acceleration and Vmax phases, and the apparent time taken to achieve Vmax in professional players, it could be argued that almost all actions considered as sprinting during a game occur in an acceleration phase.

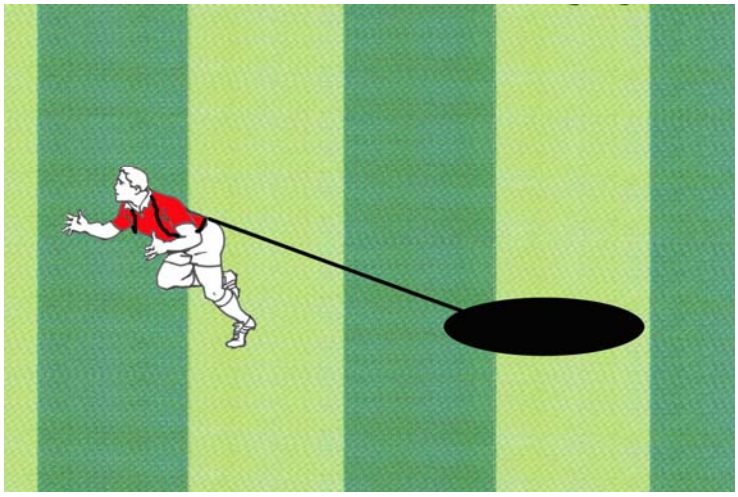
Acceleration sprint training

Maximal speed is developed as a result of increases in step length and frequency; both increase linearly during acceleration (Cissik, 2005). These steps during the acceleration phase are characterised by longer periods of foot contact time (stance phase), a greater contribution propulsion forces and limited braking forces compared to those which occur during maximal velocity running (Mero, 1988). Essentially, the acceleration phase is involved in transferring force both horizontally and vertically from the foot to ground, which initiates movement. The ability of an athlete to move quickly over these distances is, therefore, relative to the amount of force produced and technically how efficiently that force is transferred from the athlete to the ground. Researchers, who compared various levels of athletes over the first three steps of a 15m sprint, found that faster athletes had significantly lower foot contact times and lower knee extension angles, which resulted in a greater stride frequency (Cronin & Hansen, 2006). Although technical improvements will enhance acceleration efficiency and improve speed, it could be argued that the force-producing component of acceleration is of higher priority to rugby players, as often they are required to accelerate into space or contact situations and counteract external forces produced by opposition players, i.e. in tackle, ruck or line-break situations. Technical improvement should not be ignored, particularly in stride frequency and length and, along with increases in force production, could be suggested as the foundation of speed or acceleration training for all players during the season.

Resisted sprint training

Improving force production is primarily the result of resistance training of some description. The use of resistance sprint training is a popular mode of increasing the strength component of acceleration and, although a successful method, it appears certain criteria produce more desirable results. Towing devises such as sleds and tyres are a common method of adding resistance to athletes. Due to the effect heavy resistance has on running mechanics, loads of 10-12.5% of body weight appears to minimise this disruption whilst increasing sprint performance (Lockie et al, 2003). However, these alterations in mechanics, caused by heavy loads, may be of benefit to rugby players. Increased trunk flexion and hip range of motion along with longer stance phases (ground contact) occur during heavy loading and correspond with various actions observed on a rugby field (i.e. maul, ball carry, rucking), though it should also be noted that these actions are short in both duration and distance.

Distances of 5m to 10m appear sufficient

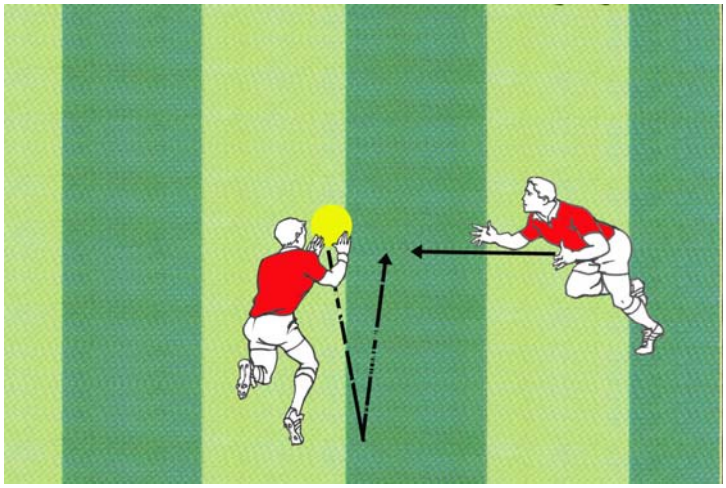


as long periods of towing heavy loads may result in longer ground contact during sprinting, as well as fatiguing the neuromuscular and energy systems responsible for explosive responses. It should also be noted that periods of unload are required during resisted sprint training over similar distances, which causes larger neural recruitment than the athlete would normally experience when sprinting. This induces the athlete to feel faster, which is also caused by faster stance phases than those experienced during resisted work.

Unload sprinting has not been studied in particular detail; however, periods of continual resisted sprint training is likely to negatively affect normal sprinting mechanics, such as increasing ground contact time. It may also positively affect running mechanics in contact situations with heavy loads, and should perhaps be unloaded with particular technical skills.

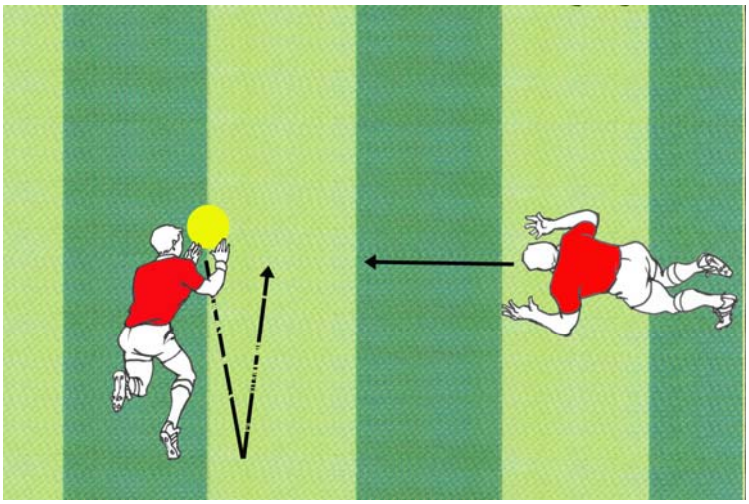
It has been suggested by Seagrave (1996) that, during initial stages of acceleration, the body should be at an angle of approximately 45˚ to the ground. As the athlete's velocity increases, the body becomes more upright. However, application of teaching such a technique could be considered inappropriate for rugby union players as the starting position of maximal efforts varies from sprint to sprint (i.e. from the floor, standing, maul etc.), whilst an 'upright' position is likely to negatively affect a player in a contact situation if the shoulder line becomes higher than that of the attacker or defender in front of him. Both these factors make it difficult to identify an optimal body angle. Therefore, acceleration training should include maximal efforts over various distances that cause the torso to pinnate at different angles, forcing players to adjust body angles and footwork patterns whilst accelerating at maximal intensity. The next examples use medicine balls to force a change in the player's torso before he makes a maximal sprint.

1.



One player bounces the medi-ball (a bouncing medicine ball). As it rises, the player on the right sprints, gathers the ball when it is in the air and sprints with it for a short distance.

2.



One player bounces the medi-ball and the player who is working lies face-down on the pitch. As the ball bounces, he times his effort to gather the ball when it is in the air then sprints a short distance with it.

Like body angles, commencement speed of a maximal sprint is likely to vary during the course of the game. Duthie and Colleges (2006) reported in detail the specific commencement speed of forwards and backs respectively (see table 2). Although it is possible to utilise this information to produce speed training programmes specific to position and units, it is important to remember the limited scope of data collected in

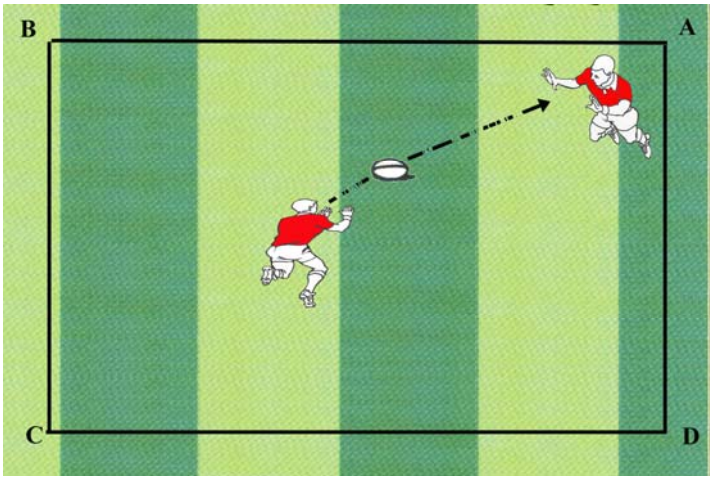
terms of number of sprints analysed and the nature of the competition. Therefore, it is probably more viable to use the information to simply stimulate the use of varied commencement speed within a session to develop a player's ability to 'change pace' by re-emphasising the key points of successful acceleration form (i.e. shorten stride length, lower body angle and fast foot recovery).

Table 2. Initial and maximal velocities (Vmax) achieved during a maximal 60m sprint commenced from different starting speeds in rugby union players, taken from Duthie *et al* 2006.

	Initial Velocity (ms^{-1})			**V max (ms^{-1})**	
Start	**Forwards**	**Backs**		**Forwards**	**Backs**
Standing	0	0		8.50 ± 0.47	9.43 ± 0.40
Walking	1.97 ± 0.55	1.93 ± 0.17		8.49 ± 0.43	9.43 ± 0.45
Jogging	4.97 ± 1.09	5.61 ± 0.51		8.55 ± 0.42	9.39 ± 0.40
Striding	7.14 ± 0.37	7.18 ± 0.27		8.51 ± 0.39	9.42± 0.36

Speed Games

Though the training methods already discussed are effective at developing various aspects of speed, there has been limited involvement with the ball, as each aspect has been discussed and illustrated in isolation. Given limited training time and the need at some point to develop these aspects of speed together in relative environments, some form of concurrent training that develop both speed and ball skills would be advantageous. A simple grid can produce competitive situations that rely on both accuracy of skills (namely handling) and a player's ability to accelerate various distances at differing commencement speed.



The player in the middle passes the ball to the attacking player in corner A. His task is to get to either corner B or corner D to score without being two-hand touched by the defender who initially passed the ball.

Summary

The importance of speed in the success of both individual and team performance can not be underestimated at any level of the game. However, its development can become difficult during the season and a prioritisation process is necessary if this available time is to be used efficiently. Although data is limited, it would appear that a need for distance sprinting is diminished as the majority of maximal efforts take place during acceleration phases at varying commencement speeds and body angles. Improving acceleration occurs as a result of technical (stride length and frequency) efficiency and increased force production. Arguably, the more important of the two in rugby union is increasing force production, due to the varying body positions and external forces players are required to overcome throughout performance. A common method of increasing force production is through the use of resisted sprint training. Loads between 10% and 12% of body weight appear to have the most desirable effects without disrupting running mechanics. However, heavy loads that increase hip and knee flexion and decrease stride length may also be applicable, as players are often required to accelerate through various contact situations in which this position is considered optimal to success. Regardless of resisted load, it is imperative that contrast unloaded sprints are incorporated into these sessions, which allow mechanics and neural contributors to return and improve (i.e. ground reaction). Although, traditionally, these unload efforts consist of sprinting only, it may also be applicable to use skill-based activities.

