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# Execution and outcome differences between passes to the left and right made by first-grade rugby union players

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ABSTRACT

*Objectives:* To examine bilateral ball-passing skills whilst running amongst first-grade rugby union footballers.

*Design:* Within-group design

*Setting:* NSW Rugby Training facilities, Moore Park, Sydney.

*Participants:* One international player used as a case study and twenty, first grade rugby union players.

*Main Outcome measures:* High-speed film was first used to capture the performance of an international rugby player in a reactive test situation. Next the reactive test situation was set up with four video cameras recording the passes that twenty first-grade rugby players threw left or right as directed, towards distant targets. Each pass was assessed for distance, accuracy and head turn towards the target. Reaction Time, Movement Time and Total Time of each pass were also considered.

*Results:* Amongst the twenty first-grade rugby union players, most of the passes to the non-preferred side were forward passes – 57% vs 15% forward passes on the preferred side. For passes to the non-preferred side there was a greater chance of the combination of longer Reaction Time and shorter Movement Time that led to the ball being released before it was sufficiently around the body for the pass to be legal. Non-preferred side passes also travelled less distance than passes to the preferred side (13.5 m vs 15.4 m). Forward passes to either side were accompanied by less head turn, and had shorter movement time, than legal passes.

*Conclusions:* Simply using greater effort to achieve more head turn could increase the risk of injury. Research on specific training of the balance and coordination components of ball-passing on the run is needed to obtain greater equality between sides of this nominally bilateral rugby skill.



## 1. Introduction

Rugby is based on running forwards and passing the ball backwards or behind the player, to either side of the body. Thus there is a demand on players to have good skills bilaterally, and this holds irrespective of their field position (Craven, 1970). In any domain, where there is a discrepancy between the recommended level of performance and the level that is commonly accepted and achieved, then there is also the opportunity for gaining a competitive advantage for those who can successfully train to reduce the discrepancy. Despite exhortation to train so that rugby skills can be executed equally well on both sides of the body (Wallace, 1976), there is evidence of preferential use of one side (Grouios, 2004). For example, during the 2007 Super 14 season, 298 tries were scored outside the posts. Of these, 171 tries were scored on the left hand side, a significantly larger amount than the 127 scored to the right ($p = 0.011$) with the number on the generally non-preferred side representing 74% of the number on the preferred side (ARU, 2007) This suggests that in rugby the ball travels out to the left hand side of the field on more occasions, and with better execution, than when the ball travels out to the right and further implying that handedness and preferential passing execution to the left occurs more than the right. Passing to the left is described by Wallace (1976) as "the easier way."

These data may arise from an inequality in ball-passing skill. Tests of ball-passing to both sides have previously been conducted, but by using the standing pass for distance, ie. passing tested as a closed

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skill, (Peinaar & Spamer, 1998; Spamer & Hare, 2001; Spamer & Hattingh, 2004; Spamer & Winsley, 2003). Distances recorded to the right (25 m) and left (24 m) for right-handed players (Peinaar & Spamer, 1998) would suggest that, in standing passing, non-preferred side performances at better than 90% of preferred side performance level can be achieved. However, passing on the run can be considered to be more difficult than a standing pass (Robertson & Osborne, 1984), because it involves head turning whilst running. That is, the running player is required to turn their head to look across, in order to put the pass in front of the intended receiver. Head turning to see the target has been described as essential for successful passing Wallace (1976) a view supported by laboratory data showing that rapidly turning the head in the target direction in a manual pointing task improved performance and allowed for a more accurate target encoding. (Fogt, Uhlig, Thach, & Lui, 2002)

Because defenders may get in position early and cover possible pass receivers, it can be argued that the ability to successfully pass the ball on the run also demands reactive agility, in that the player may be required to abandon a pre-planned pass and rapidly make the limb movements for passing in a different direction. Therefore, for ecological validity, tests of rugby passing skill should include a cognitive or reactive component. (Sheppard & Young, 2006). A developmental study of reactive agility for netball showed that reactive agility testing was more likely to display differences between highly and lesser skilled groups (Farrow, Young, & Bruce, 2005). The faster decision and movement times displayed by the more experienced groups for both pre-planned and reactive agility tests was later supported in a study of reactive agility in rugby league players (Gabbett & Benton, 2009).

## 2. Pilot study of ball-passing

To gather initial information about rugby ball-passing skill as performed by an expert, one of the authors, an Australian international rugby player who had earned 102 caps, was recorded on high-speed film while performing the task. The international player was 33 years of age, and 91 kg weight. Filming was conducted using a MAGS 1000 fps camera, and the footage analysed with Photron software (Photron fastcam 1024 PCI, Photron Ltd, San Diego). All 10 passes made in response to a random signal sequence went backward from the point of ball release (ie. were legal), with the 5 passes thrown to the right travelling a mean of 19.8 m, and the 5 passes to the left, 21.7 m. Thus the running pass distance observed on the non-preferred side was similarly better than 90% of preferred side performance. However, examination of the 1000 frames/sec video footage showed that the motor pattern employed on the non-preferred side was different to that for the preferred side (Fig. 1). There was more arm abduction used in the non-preferred side motor pattern, although passes to both sides involved a full ninety degree head turn to locate the target.

Accordingly, the current work set out to investigate the basic rugby skill of ball-passing on the run, with first-grade players making passes to both sides of the body in reaction to a signal, in order to determine the nature of any differences between the preferred and non-preferred sides. This was carried out by measuring pass legality, distance, accuracy, reaction time to initiate the pass, movement time taken to complete the pass and the amount of head rotation towards the target.

## 3. Method

### 3.1. Participants

Participants were twenty first-grade rugby union players. The players were recruited from advertisements placed on notice boards at the NSW Rugby Union Head Quarters at Moore Park, Sydney. Twenty first-grade players, ranging in age from 18 to 25 years, from the NSW Waratah Academy who volunteered had mean (sd) on the following measures: Age 20.1 years (2.1), Weight 99 kg (3.20), Skin folds 76 mm (6.2), Forty-metre sprint time 5.58 s (0.89) and Beep Test 11.20 s (1.2) (Higgins, 2007) All participants were first-grade players, with 7 having represented NSW and 6 having been in the Australian U 19 team. The study was approved by the University of Sydney Human Research Ethics committee and all participants gave informed consent.

### 3.2. Procedure

Each participant was asked to throw passes for maximum distance towards targets set 20 m away. To be legal, passes had to be thrown backwards or perpendicular to the direction of travel. Participants started each trial at 10 m away from a rectangular box outlined by white cone markers on the ground in front of them (3 m × 5 m). They entered this zone carrying a rugby ball (Gilbert size 5, official match ball of Super 14 2007) end-up with a neutral grip, and running at a self-selected pace that they perceived to be 70% of their maximum velocity.

Upon entry into the box, the signaller, sitting cross-legged under the camera at the far end of the box, raised one hand and pointed at a predetermined target, randomly left or right, to which the player was to direct the pass (see Figs. 2–4). Each participant completed 10 passes, 5 to the left and 5 to the right. Participants had to set themselves and pass the ball before their momentum caused them to exit the box.

Each participant wore a cloth bib with their number on the front, and was called in to pass the ball in their numerical order, then returned to the start point, waiting to be called again. This process continued until all participants had completed their 10 passes. At completion of data collection, players were asked their side preference for ball-passing.

Four video cameras, synchronised with a clapper board, recorded each pass. Camera one (JVC DY HD111E) was positioned directly in front of the player. Cameras 2 and 3 (SONY DCR PD 150P, SONY DCR IRV 950E) were positioned 20 m either side of the box for the lateral views of the player and Camera 4 (CANON MV94D) was positioned at a 45 degree angle, to show the exact moment at which the signaller initiated the pass signal.

Four volunteers assisted with marking and recording distances. A marker was placed where the ball landed and a Sunlon digital walking measure (WM190R) trundle wheel distance marker was used to determine the exact distance from the position in the box where the pass was executed to the point at which the ball landed. Prior to the test proper, each player carried out a 10 min warm up and went through the pass-sequence once as a trial run.

The footage resulting from the first-grade players was edited using Adobe Premier Pro 1.5 software (Adobe Systems Inc; 345 Park Avenue, San Jose, CA 95110-2704, USA). Footage from the cameras was placed onto a four-way split screen and adjusted to play simultaneously with 4 frames synchronised.

### 3.3. Measurements

Pass Distance was measured at the end of each pass-sequence using a trundle wheel that was rolled from the stance foot position where the ball left the subject's hands, to where the ball landed. Reaction time (RT), Movement Time (MT), and Total Time (TT) data were extracted from the videotape by counting frames. Footage was captured at 25 frames/sec, giving a resolution of 40 ms. per frame. The RT was defined as the time from the moment the signaller's hand moved off the ipsilateral leg to the moment the player

**Fig. 1.** Frames taken from the front-on camera showing when the expert at rugby passing has entered the passing box and received a signal to pass, drawing back the ball, and at ball release, for passes to both sides of the body.

initiated a movement in response. As the signal could be initiated during any part of the gait cycle, the initial reaction pattern was determined as the first observed movement made in response to the signal. MT was defined as the time from onset of player response to the moment of ball release, and TT was therefore taken from the moment the signaller's hand moved until the ball was released from the player's hands. All times were measured by counting 40msec. frames. Determination of whether the pass was legal or illegal was made by examining the footage from the side-on camera to decide whether the pass travelled backwards or forwards after ball release. Amount of Head Turn was obtained by examination of the player's head position at the moment of ball release, and was scored as 0, 25, 50, 75, or 100% of a 90 degree head turn that started from facing directly forward. The stance foot was designated as the support foot at the point of ball release during pass execution.

### 3.4. Analysis

SPSSv14 for Windows was used to obtain descriptive statistics for the measures taken and to conduct repeated-measures ANOVA.

## 4. Results

Upon questioning specifically about their side preference when passing for distance, as distinct from their handedness, 17 players reported a preference for right-to-left ball-passing, and 2 reported a preference for left-to-right passing. Data from one player could not be included as he maintained that he had no side preference, and was equally happy to pass left or right. Removal of this player's data left 190 passes for analysis.

Table 1 summarises the data for passes to the preferred and non-preferred sides. Passes were first considered in terms of distance. The 95 passes to the preferred side had a mean distance of 15.4 m (SD 2.1) whereas a mean distance of 13.5 m (SD 1.4) was recorded for the 95 non-preferred side passes. These distances were significantly different ($p = 0.001$).

The first movements made in response to the signal were either: a head turn towards the target, a step away from the direction of the pass, or a step towards the pass direction. Means (SDs) for the RT, MT and TT latencies in milliseconds and for the proportion of a full head turn for each side are also given in Table 1. The mean reaction time of 408 ms (65) to the preferred side was significantly faster ($p = 0.035$) than the 433 ms (78) on the

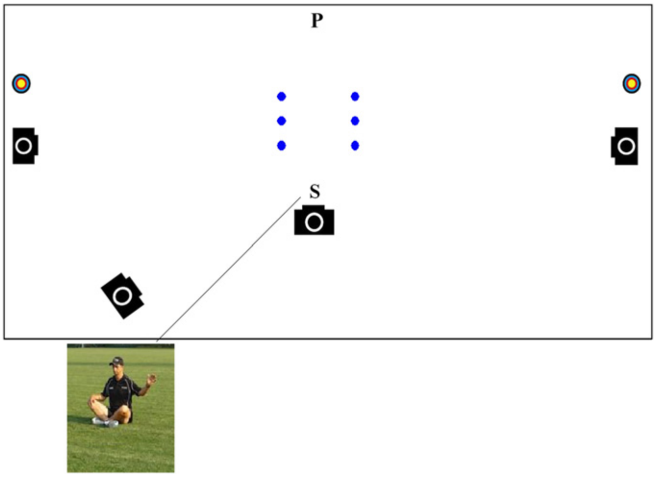


**Fig. 2.** Schematic diagram showing locations of the cameras, signaller (S) and targets in relation to the running player (P) in the group study. The side cameras and targets were 20 m from the side of the passing box, which was marked on the ground by white cones, set out as a rectangle 3 m in width and 5 m in length. A hand signal indicating to pass to the right or left was delivered when the running player reached the first two cones.

non-preferred side. Mean MT on the preferred side was 565 ms (78), significantly longer ($p = 0.012$) than the 523 ms (87) on the non-preferred side. Total Times for passes on the two sides were not significantly different ($p = 0.171$). Head turn towards the target, at a mean 76% of a full turn, was significantly greater on the preferred side than the 68% observed for the non-preferred side ($p = 0.001$).

Finally, passes were considered in terms of their legality. That is whether, at the moment of release, the ball was travelling directly level with, or behind, the player for a legal pass, or travelling forward, making the pass illegal. Of the 95 passes made to the preferred side, 81 were legal passes, whereas only 41 of the 95 passes to the non-preferred side were legal, and these proportions were significantly different ($p = 0.001$). To analyse pass distance and include both the factors of Pass Legality (Legal/Illegal) and Side Preference (Preferred/Non-preferred), passes were considered as individual elements and entered into a $2 \times 2$ ANOVA. Table 1 displays the data for the legal and illegal passes made to the preferred and non-preferred sides and the ANOVA results, with $p$ values for the main effects and interactions associated with the factors Legality and Side Preference. From this analysis, reaction times for the legal and illegal passes were not significantly different ($p = 0.055$). However, the mean movement time for legal passes (560 ms) was significantly longer than the mean movement time for illegal passes ($p = 0.033$). Total times were not significantly different ($p = 0.661$).

Consistent with the turning movement up to the moment of ball release lasted longer, the mean head turn for legal passes was 82% of a complete 90 degree turn, whereas only 54% of a complete turn was made when passes were illegal, and this difference was significant ($p = 0.001$). However, from this analysis there was no significant difference between the preferred and non-preferred side passes in terms of head turn ($p = 0.697$).

Finally, the frequencies of the different motor patterns that occurred as a first reaction to the signal were examined. Three different motor patterns were observed over the 190 passes. On 51% of the occasions the first observable response the runner made after the signal was a head turn towards the target (96 [51%]), the next most frequent first response was a step away (71 [37%]) and the least frequent was a step towards the target (23 [12%). The frequency of occurrence of these responses did not differ significantly between the preferred/non-preferred sides

**Fig. 3.** Three video frames taken from the front-on camera showing a player who has entered the passing box and received a signal to pass from his right across to his left, and has started to draw the ball back to his right side (Frame 1), at the end of drawing back (Frame 2) and after ball release (Frame 3). The group of players in the background are waiting to be called to run in.

## 5. Discussion

Digital video footage of rugby ball-passing performed on the run was examined for differences in performance of the preferred and non-preferred sides of the body, based on the concept of using standardised conditions to capture reproducible expert performance (Ericsson & Williams, 2007). For both the single-case and group data, rugby ball passes made to the non-preferred side – from the left across to the right for right-handed players – travelled approximately 90% of the distance of passes made to the preferred

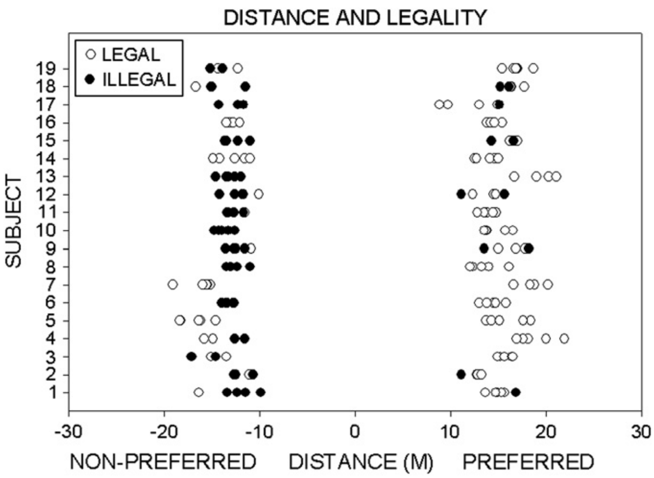


**Fig. 4.** Distances for each player for 5 passes to the left and 5 passes to the right, measured from side of the passing box. For 17 of the 19 players the preferred passing side was the left side, where the preferred right hand is on top of the ball during the action. For the two players who were left-handed (nos. 14 and 16) the non-preferred side represents passes thrown to their left. Open circles represent legal passes, and filled circles represent forward passes.

side. This finding is consistent with the superior performance by the preferred hand observed in many manual tasks (Provins, 1997) and points to the importance of the spin and direction control by the upper hand in ball-passing.

However, another marked asymmetry in ball-passing was found to be associated with side preference in the group of players tested here. Whereas 85% of the passes made to the preferred side were legal passes, thrown behind the ball-carrier, only 43% of passes to the non-preferred side were. When the time components RT and MT were analysed by including the two factors Side Preference and Pass Legality simultaneously, pass legality was more strongly associated with time differences than was side preference. That is, a slow RT and fast MT were associated with passing forward, and this was more likely to occur on the non-preferred side. By this logic, it is a slow RT that is the initial causal factor for a forward pass. A body of research literature exists on the relationship between increased difficulty and associated planning requirements of subsequent movements and the RT taken to initiate the movement sequence (Klapp, 1995). The implication here is that whenever the motor planning for a pass is more difficult then the RT is longer. This is mostly the case on the non-preferred side, although the chance coincidence of the reaction signal with an unfavourable part of the gait cycle could cause the need for more cortical motor planning in order to coordinate arm swing and gait, generate a longer RT, and effectively make the outcome a forward pass. Consistent with this, the time components of all legal passes tended to be alike, whether to the preferred or non-preferred side, with faster RT and longer MT.

For legal passes, the arm swing went on longer and there was more head turn. Both these features are consistent with getting the direction of ball flight to be behind the player when the ball was released. Conversely, forward passes were associated with shorter MTs and less head turn. Movement scientists have previously noted the importance of head movement in whole body movement. (Hollands, Sorensen, & Patla, 2001) and concluded that the body typically follows where the head moves (McMorris 2006). Thus one interpretation of the data obtained here is that the relatively lower level of skill at running balance during a non-preferred side head turn caused an early termination of the movement, when insufficient turn had been achieved to make the pass legal after ball release.

The coordination of movement and head control has been studied extensively (Grasso, Glasauer, Takei, & Bertoz, 1996; Hollands et al., 2001; Lamontagne, De Serres, Fung, & Paquet, 2005; Pozzo, Levik, & Berthoz, 1995) and the coordination of the head, thorax and pelvis found to be a prerequisite for maintaining balance and smooth gait. Further, stabilisation of gaze is achieved by the coordination of the head, trunk and pelvis. If movements to the preferred and non-preferred sides of the body represent separate skills, and develop as separate motor patterns, then each side may need a specific training routine

Newell & Van Emmerik (1989) examined the pen-wrist, wrist elbow, and elbow-shoulder joint angle plots for the dominant and non-dominant hands of subjects while signing their names and found that movement control on the non-dominant side was simplified by reducing the joint degrees of freedom for the movement. This pattern was different to the dominant hand plots, which showed use of the available degrees of freedom to achieve a better quality movement pattern. Reviewing this work, Magill (2006) saw the preferred and non-preferred sides as representing expert and less-skilled performers within the one person. If players have a strong preference for passing to the left then it is possible that they adapt to compensate for their non-preferred side deficiency, and are therefore unable to fully capitalise on the ball-passing ‘affordances’ or movement possibilities that arise in a game (McMorris, 2006).

Two implications arise from comparison of the expert player with the first-grade players. One is that even in a player with a non-preferred side performance at a level of 2 SDs above that of the group, better preferred side performance still occurred. The other implication is that, like two different learners, the two sides of the

**Table 1**
Passing performance in relation to side preference and pass legality. Mean (SD) values for the variables analysed are shown. Times are in milliseconds, distances are in metres.

| Measure | Preferred side | Non-preferred side | p (P-NP) |
|---|---|---|---|
| *N* | 95 | 95 | |
| Distance (m) | 15.4(2.1) | 13.5(1.4) | 0.001 |
| Reaction time(ms) | 408(65) | 433(78) | 0.035 |
| Movement time (ms) | 565(78) | 523(87) | 0.012 |
| Total time (ms) | 973(83) | 947(92) | 0.171 |
| Head turn (%) | 76(14) | 68(23) | 0.038 |

| | Legal | Forward | Legal | Forward | p (L-F) | p (P-NP) | p (Inter) |
|---|---|---|---|---|---|---|---|
| *N* | 81 | 14 | 41 | 54 | | | 0.001 |
| Distance (m) | 15.4(2.2) | 15.3(3.7) | 14.0(1.9) | 13.1(1.8) | 0.211 | 0.001 | 0.298 |
| Reaction time (ms) | 402(100) | 446(102) | 419(107) | 444(101) | 0.055 | 0.669 | 0.619 |
| Movement time (ms) | 574(108) | 517(145) | 533(107) | 499(135) | 0.033 | 0.161 | 0.599 |
| Total time (ms) | 976(127) | 963(128) | 952(113) | 943(153) | 0.661 | 0.352 | 0.929 |
| Head turn (%) | 79(24) | 59(19) | 88(22) | 53(26) | 0.001 | 0.697 | 0.064 |

body may acquire visibly different motor patterns, and not be the mirror image of each other. This suggests that the non-preferred side needs training time specifically devoted to it, rather than a hoped-for performance improvement attained as transfer from the superior preferred side.

The results of this study suggest that there is considerable unilateral bias during passing whilst running, and that one aspect of this is less head turning towards the target when passing to the non-preferred side. Arguably, the early termination of the head turn to the non-preferred side arises from a perceived inability to maintain balance with further turning. With increasing demands for first-grade players to exhibit more bilaterally equivalent skills, the consequences of over-effort to produce more turn before ball release are likely to be either back injury or, if the player increases spinal extension to achieve a legal non-preferred side pass, exposure of the ribs to injury in tackles. To obtain better non-preferred side performance without injury risk, specific training of the task and its components may be necessary. Balance training has recently been used to improve dynamic stability (Rasool & George, 2007) and performance in sport-related activities (Yaggie & Campbell, 2006).

The results of the study suggest that balance training drills, with concurrent head turning to the preferred and non-preferred sides, may be needed to improve non-preferred side balance, then to be incorporated into movement sequence of passing on the run. Future research examining the most effective methods for training non-preferred side performance is needed. Further, it may be suggested that as part of early development of skills, particularly regarding passing, players should train to achieve head control whilst running. Indeed, (Grouios, 2004) has expressed the view that, given the significance of the relation between lateral preference and sporting achievement, it may be appropriate for coaches to design training regimes to compensate for weaknesses resulting from unilateral skill bias. These findings suggest the need for a detailed component analysis of the performance to both sides of nominally bilateral skills.

## 6. Conclusion

Attempts by first-grade players to pass a rugby ball for distance whilst on the run were mostly forward passes when the signal indicating the side for the pass was for the non-preferred, left-to-right direction. Because making additional effort to achieve a greater amount of turn while making a pass may cause injury, research on balance and co-ordination training for improved non-preferred side head turn during passing is suggested.

### *Conflict of interest statement*

With regards to this research, none of the authors have any conflict of interest that could inappropriately affect their work.

### *Ethical approval*

The study was approved by the University of Sydney Ethics committee and all participants gave informed consent.

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