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Bilateral clearance punt kicking in rugby union: effects of hand used for ball delivery.

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Abstract

Clearance kicking for distance is a pre-requisite skill in first-grade Rugby Union, but is seldom performed equally well on both sides. To assess kicking performance in a game-like manner, kick direction to the left or right was signalled to an approaching player in a reactive agility test, so that an active choice regarding the kicking foot was required. Ten kicks were recorded from each of ten right-footed first-grade players, who punted for distance, on the run, toward the left or right far corner flags as signalled. Kicks with the non-preferred foot travelled significantly less distance than kicks with the preferred foot (36m vs 42m) with significantly more trajectory variation. Ball delivery to the preferred right foot came from the ipsilateral right hand on 84% of kicks, however 70 % of delivery for the non-preferred left foot was by the contralateral right hand or both hands together. The resulting shorter clearance punt kick distance and lower directional accuracy on the non-preferred left side may be due to suboptimal kicking biomechanics caused by the involvement of the preferred right hand in ball delivery. Training methods are needed that can improve use of the ipsilateral hand to guide the ball onto the non-preferred foot.

Keywords: preferred/non-preferred

1. Introduction

In Rugby Union, the ability to punt kick is important both for tactical attacking play as well as sound defence (Biscombe & Drewett, 1998; Wallace, 1976). Indeed, a study by Lim, Lay, Dawson, Wallman, & Anderson, (2009) of players' impact ranking of game actions contributing to a team's winning performance suggests that tactical kicking is of relatively greater importance than winning a set piece, such as a scrum or lineout. The introduction of the experimental law variations (ELV's) in 2008 has seen a rise in the number of clearance kicks made during a game, yet it has been noted that some international backs are unwilling to kick with their non-preferred foot (Massie, 2008). The value of being able to use either foot for kicking is well documented (Craven, 1970; Robertson & Osborne, 1984) and it is suggested that players should kick with the foot farthest away from the opposition (Biscombe & Drewett, 1998). Despite encouragement to train skills so that they can be executed equally well on both sides of the body, records of the limb used for sport skills show that preferential use of one upper or lower limb is often observed (Grouios, 2004).

Because defenders may get into position and smother clearance kicks, a Rugby player may be required to abandon their plan and kick with the other foot. The ability to successfully kick on the run, while under attack, demands reactive agility (Sheppard & Young, 2006). Analysis of sports skills should be outcome based (McGarry, 2009), thus a test with greater ecological validity is desirable. To be game-like and have ecological validity, tests of Rugby kicking skill should therefore include a cognitive or reactive component. A developmental study of reactive agility in netball has revealed differences between higher and lesser skilled groups (Farrow, Young, & Bruce, 2005) as did a later study of reactive agility in rugby league players (Gabbett & Benton, 2009).

Although the Rugby Union punt kick for distance has received little research attention (Spamer, 2000) a number of studies of punt kicking biomechanics have been carried out with Australian Rules Football players (Ball, 2008; Cameron & Adams, 2003; Dichiera et al., 2006; Orchard, Walt, McIntosh, & Garlick, 1998). In this work, punt kicking is described as a throw-like motion using the lower limb (Orchard et al., 1998; Putnam, 1991) where the proximal to distal sequential pattern of segment motion (Putnam, 1991) increases momentum in the distal segment just before ball release. However, the use of a metaphor derived from an upper limb motor pattern (throwing) for a lower limb motor pattern (kicking) may obscure the necessary involvement of the upper limb in kicking, wherein the ball is transferred by hand to the foot for release. It has been noted that abduction of the contralateral arm during the final phase of kicking balances the body (Orchard et al., 1998), and this arm abduction feature of punt kicking has been frequently observed (Mcleod & Jacques, 2006; Putnam, 1991). It might be expected that differences between sides in upper body aspects of kicking would affect performance.

Accordingly, the current work employs a reactive test to investigate bilateral performance of a Rugby clearance kick made on the run, and examines the actions of both upper and lower limbs in kicks made on both sides of the body, in order to assess the components of the motor pattern for kicks to the preferred and non-preferred sides made by first-grade rugby union players.

2. Method

Advertisements seeking volunteers were placed on notice boards at the NSW Rugby Union Headquarters at Moore Park, Sydney, and ten male rugby footballers without any current injury responded. All played in the back line, and all were either first grade players, or state and international age group representatives. Ages ranged from 18 –27 yrs (mean 21.8, SD 3.19), with weight 86.85kg (SD 4.24), skin folds 59.95mm (SD 10.17), and 40m sprint times 5.27s (SD 0.99). Upon questioning, all players reported being right handed and had a right foot kicking preference. The University of Sydney Human Research Ethics Committee approved the experimental protocol, and all participants gave informed consent.

2.1. Procedure

On each trial, participants were asked to run in and perform a clearance kick from the centre of the 22m area towards one of the far corner flags, 90m away. Participants started their run for each kick sequence at 3m in front of a 2m x 3m rectangular area outlined by blue cone markers, positioned on the ground directly in front of them (see Figure 1). All participants were tested on the same day to ensure similar kicking conditions.

Figure 1. Frames taken from the front-on camera of a player who has run into the kicking box and received a signal to kick, at ball release, and after foot contact, for right and left foot kicks. For the kicks shown, the right (ipsilateral) hand was used for ball delivery on the right foot kick, and both hands (bilateral delivery) were used for the left foot kick.

Each subject was asked to move towards the test area at a comfortable pace for performing a clearance kick, carrying a Gilbert size 5 ARC match ball with a neutral grip. Upon entry into the test area, the signaller, sitting cross-legged with hands on knees at 5m beyond the 22m line, immediately raised one hand toward the direction for the kick. The signal sequence to the left or the right was randomised, and participants performed 5 kicks to either side. Participants were required to set themselves and kick the ball before exiting the test area, then to return to the start position for their next call. Assistants marked where each ball landed and measured the corresponding X and Y-axis distances using Sunlon Digital trundle wheel distance markers (WM190R).

For identification, participants wore numbered white bibs, and were filmed by three digital video cameras simultaneously. Camera 1 (JVC DY HD111E) was positioned directly in front of the player and 5m from the test area, Camera 2 (Sony DCR PD 150P) was positioned 10m to the left side for the lateral view of the kick, and Camera 3 (Sony DCR IRV 950E) was positioned 10m away from the signaller at a 45 degree angle to capture the moment of initiation of the kick signal. The footage was synchronised from a clapper board and edited onto a three-way split screen using Adobe Premier Pro 1.5 software (Adobe Systems Inc; 345 Park Avenue, San Jose, CA 95110-2704, USA).

2.2. Measurements

Kick distance was calculated as the hypotenuse of the triangle formed by the X and Y-axis distance recordings, and the same X and Y-axis distances were used to give a tangent value from which the kick angle was determined.

Reaction Time (RT,) Movement Time (MT) and Total Time (TT). Video footage was captured at 25 frames.s^{-1}, so all times were obtained by counting frames and multiplying by 0.04. RT was measured from the frame in which the signaller's hand first moved from rest, until the frame containing the first movement by the player for initiating the kick set up that differed from their previous run and ball-carry movements. MT was measured from the player's first response to the signal, until the frame of the ball leaving the boot, and TT measured from the signaller's hand movement to the moment the ball left the boot. From the video replay, hand use in guiding the ball to the foot was classified as ipsilateral, contralateral or bilateral.

2.3. Analysis

SPSSv15 for Windows was used to calculate descriptive statistics and to conduct the 2 x 5 factorial repeated measures ANOVAs, with factors kick Side (Left/Right) and kick Order (1,2,3,4,5), and to conduct the t-test and Chi-square analyses. The orthogonal polynomial trend analysis option was selected in SPSS, to examine trends across the levels of the Order factor.

3. Results

The landing points on the field for all 100 kicks are shown in Figure 2. Kicks to the preferred and non-preferred sides were considered in terms of distance, angle and initiation latency (see Table 1). From analysis of the Side factor it was found that the 5 kicks that each player made to their preferred side travelled a mean distance of 43.2m (SD 5.8), and that this was significantly greater ($p=0.025$) than the 36.7m (SD 8.4) recorded for the kicks made to the non-preferred side. Orthogonal polynomial trend analysis conducted on the Order factor showed that there were no significant trend effects (eg, fatigue or learning effects) across the trials in terms of kick distance, nor were there any differences in trend between the two sides (all $p > 0.12$).

The 50 preferred side clearance kicks were at 17.9 degrees (SD 17.1) from the y-axis, whereas the 50 non-preferred side clearance kicks were at a mean angle of 16.6 degrees (SD 21.3), and these angles were not significantly different, $p=0.615$. Similar to kick distance, kick angle did not change systematically across the 5 trials, or differently between the two sides (all $p > 0.14$). The five kick angles that each player generated on each side enabled a standard deviation to be calculated as a measure of scatter, and this statistic was used as a score to reflect the player's variation in angle for preferred side and non-preferred side kicks.

The mean of these standard deviations for preferred side kicks (8.4 degrees) was significantly smaller (p=0.042) than for non-preferred side kicks (15.8 degrees) indicating greater angular scatter of kicks from the non-preferred foot.

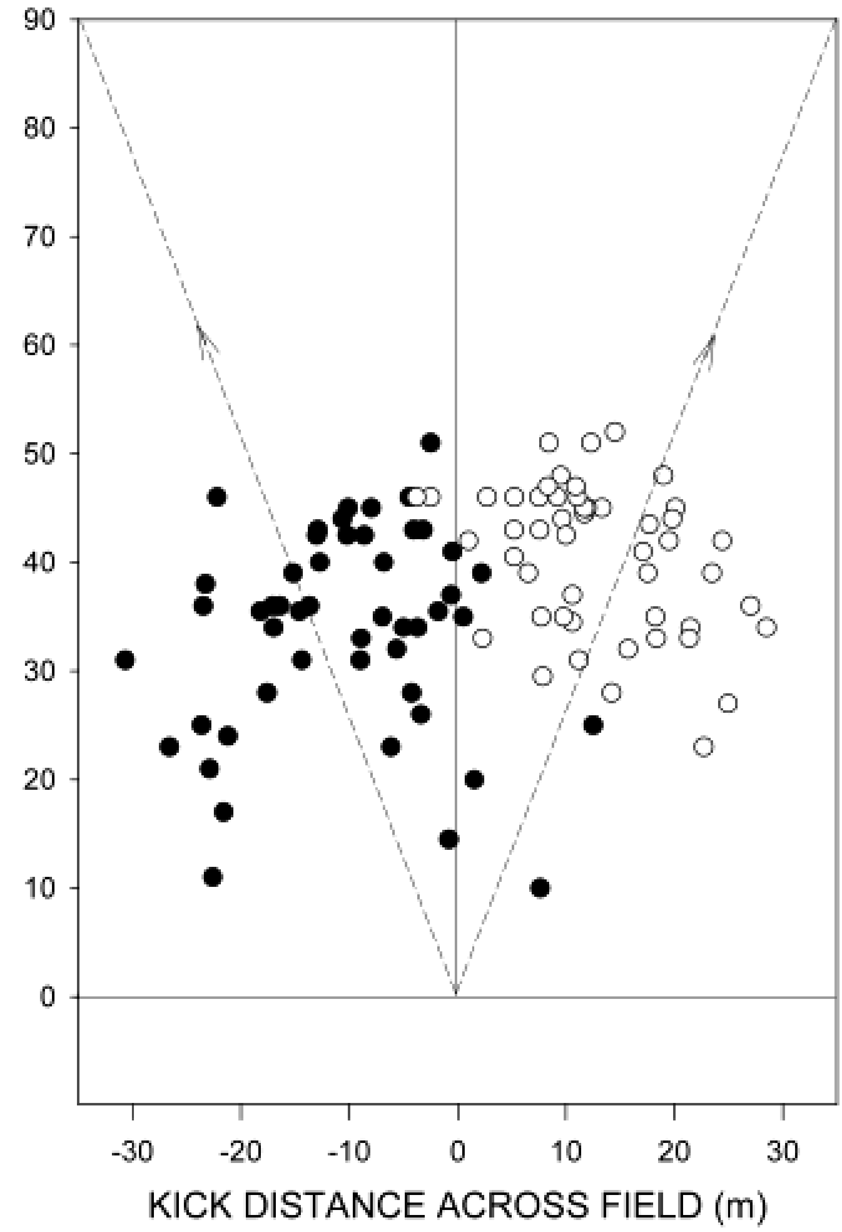

Figure 2. Distances for the ten kicks for each of the ten players, plotted in relation to the length and width of the rugby field. Filled symbols represent the landing position of kicks from the left (non-preferred) foot, and open symbols show the landing position of kicks made with the right (preferred) foot. Five left and two right foot kicks crossed the centre line
Table 1. Means (and between player SD) for Kicking Performance measures, and frequencies for Control Hand categories, for kicks made on the Preferred and Non-Preferred sides. The p

values are for F tests comparing the mean performance measures between sides, and Chi-square tests on the frequency data.

Kicking Performance Measure	Preferred side	Non-preferred side	p(P-NP)
N of kicks	50	50	
Distance (m)	43.2 (5.8)	36.7 (8.4)	0.025
Kick angle (deg)	17.9 (17.1)	16.6 (21.3)	0.615
SD of Kick angles (deg)	8.4 (3.8)	15.8 (8.9)	0.042
Timings			
RT (ms)	353 (49)	305 (113)	0.024
MT (ms)	1207 (240)	1258 (176)	0.103
TT (ms)	1560 (261)	1563 (240)	0.993
Control Hand used for guiding ball down			0.001
1. Ipsilateral	42	15	
2. Contralateral	3	10	
3. Bilateral	5	25	

RT, MT and TT latencies in milliseconds (ms) were derived for each kick. The mean RT to the signal for non-preferred-side kicks, 305ms was significantly shorter (p=0.024) than for the non-preferred side kicks, at 353 ms. For MT, the mean for preferred-side kicks, 1258ms, was not significantly different (p=0.103) from the non-preferred side kicks, 1207ms. The TT's for the preferred and non-preferred side kicks, at 1560ms and 1563ms respectively, were likewise not significantly different (p=0.993). One significant effect emerged from the Order analysis of the time measures, wherein overall RT decreased linearly across the trials by 32ms (p=0.004), from 348ms on trial 1 to 316 ms on trial 5. This effect was not significantly different between preferred and non-preferred sides (p > 0.41)

Significant differences were observed (p=0.001) between the sides in the hand used for guiding the ball to the foot. Of 50 preferred side punts, there were 42 where the ball was guided down to the foot with the ipsilateral hand, compared with 15 ipsilateral guiding hand kicks of the 50 on the non-preferred side. Conversely, the non-preferred side punts had 35 releases made by the contralateral hand or by both hands together (bilateral ball release) compared with 8 on the preferred side. For the left foot, there was sufficient data with the three possible guiding hand patterns for associated kick distances to be examined. Kicks with left hand delivery travelled a mean (SD) of 39.7 (8.0) metres, significantly further (p=0.031) than the 34.9 (6.9) metres for kicks made with right hand or bilateral hand delivery (see Figure 3).

Figure 3. The effect of hand delivery and kick distance. The filled symbols represent the leftfoot and the open symbols represent the right foot.

4. Discussion

Using a method with standardised conditions to capture reproducible expert performance (Ericsson & Williams, 2007), digital video footage of punt kicking was examined for differences between the preferred and non-preferred feet of first-grade rugby players. Kicks on the non-preferred side were found to travel less distance, and were more likely to be executed with bilateral or contralateral hand ball delivery. The hypothesis that such delivery prevents forward reach of the contralateral hand for balance and results in suboptimal kicking biomechanics was supported by analysis showing that those non-preferred side kicks made with ipsilateral hand ball delivery travelled significantly further.

It has been argued that good technique requires the ball to be placed towards the foot with the hand ipsilateral to the kicking leg (Ball, 2008; Carling, 1994; Mcleod & Jacques, 2006; Robertson & Osborne, 1984). Thus for a right foot kick with a right hand ball drop, the forward moving left arm counterbalances the right leg as it swings through after the kick. In an earlier study concerning place kicking in Rugby Union (Bezodis, Trewartha, Wilson, & Irwin, 2007), accurate kickers exhibited greater arm angular momentum about the global longitudinal axis on the non-kicking-side, which opposed the kicking leg longitudinal angular momentum and attenuated the whole-body longitudinal angular momentum. All participants increased the longitudinal angular momentum of the non-kicking-side arm, suggesting that this technique assists accuracy in distance kicking.

The results of the present study showed a tendency to use of the contralateral hand or both hands together when guiding the ball to the non-preferred foot (ie. right or both hands ball release for a left foot kick) however this right hand dominance during a left foot punt kick resulted in poor kick mechanics. Examination of Figure 3 suggests why the involvement of the right hand with a left foot kick results in shorter kick distances. Optimally, the right arm would be abducted and anterior to the torso to provide balance for the follow through (Bezodis et al., 2007; Orchard et al., 1998).

Similar to the signalled ball-passing test (Pavely, Adams, Di Francesco, Larkham, & Maher, 2009) the results with the kicking test showed RT to signals on the left side to be faster. These results and other previous RT asymmetries for aiming movements can be interpreted as being due to right hemisphere dominance for visuospatial attention (Barthelemy & Boulinguez, 2001).

Because the particular neuromuscular resources that are used habitually for motor skills tend to be specific (Provins, 1997), thus preferred side performance superiority results. It has been argued that the benefits of developing highly skilled movements to one side of the body are reflected in an evolutionary bias towards lateralization of function that enhances efficiency of the brain (Tommasi, 2009; Vallortigara & Rogers, 2005). The extent to which there is a biological predisposition toward asymmetry, and the difficulty of training against this, seem to be reflected in observational data (Grouios, 2006) and was evident in a study of the 1998 Soccer World Cup (Carey et al., 2001), where it was noted that while soccer players are able to use their non-preferred foot with accuracy when necessary, they still have a preference for using one foot for critical kicks.

Based on the relationship between lateral preference and sporting achievement, it may be appropriate for coaches to design training regimes to reduce unilateral skill bias (Grouios, 2004). Analysis of the tennis serve showed that not only were the ball distributions into the opponent's service box different for right and left handed players, but the serves were not mirror images of each other. (Loffing, Hagemann, & Strauss, 2009). Pavely et al. (2009) similarly found that the lateral pass in Rugby was not a mirror image between sides. However, the amount of practice required to develop bilateral expert performance may be underestimated (Williams & Hodges, 2004). Some approaches have been made to address the problem of desired, but seldom observed, bilateral skill performance. For example, in a study of exclusively non-dominant leg training over a six week period in soccer players, not only were there significant improvements in non-dominant leg performance, but also significant simultaneous improvement was observed in the dominant side (Haaland & Hoff, 2003). Such considerations open up possibilities for training to obtain the performance gain from having more evenly-balanced bilateralism in fundamental football skills.

5. Practical Implications

1. Despite acknowledgement of the need to develop better bilateral performance of fundamental skills in first-grade Rugby players, side preference effects in performance can be observed.
2. With punt kicking for distance, the intrusion of the dominant hand into ball delivery for non-preferred foot kicks results in sub-optimal kicking biomechanics.
3. The possibility of biologically-determined preference for asymmetry suggests that special training strategies will be needed to overcome side preference and develop a larger cohort of players with equally-balanced skill performance on both sides.

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