THE EFFECT OF STEERING ON STRIDE PATTERN AND VELOCITY IN LONG JUMP

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The purpose of this study was to identify whether visual control strategies (or steering) in the long jump run-up had an effect on the subsequent velocity, or the stride pattern, afler the point of steering. Three Australian long jumpers were recorded on videotape during competition. Six jumps for each athlete were analysed. A point of steering was clearly identifiable, however this point had no consistent effect on the velocity profiles of the athletes. Two of the athletes maintained their velocity, and the third increased his velocity afler this point was reached. Stride pattems from this point were not related to steering. It was found that most of the adjustment in stride pattern occurred in the last two strides, and this may have been responsible for the observed reduction in velocity immediately prior to takeoff. Practical solutions for altering and practising the run-up rhythm are discussed.

KEY WORDS: long jump, steering, velocity, stride length, stride pattern

INTRODUCTION: It is understood by coaches, jumpers, and sports scientists that one of the prerequisites for a good performance in long or triple jump, is the ability to take off with a high horizontal velocity. It is well documented (Hay. 1988; Hay and Koh, 1988; Hay, 1993; Hay, Miller and Cantera, 1986) that the velocity at takeoff is somewhat lower than the maximum velocity reached elsewhere during the run-up. The reduction in velocity observed in the last few strides of the run-up could be caused by a number factors, including the method the athlete uses to manoeuvre into an optimal takeoff position, or the amount of adjustment in stride pattern required in order to hit the board accurately.

Hay (1988) and Lee, Lishman and Thomson (1982) have demonstrated that all athletes in their studies used some form of visual cueing strategies (or "steering") in the long or triple jump approach, in order to hit the board accurately at takeoff. There was considerable variation in where the visual cueing strategies occurred for individual athletes (from 2.08 - 19.11m, mean = 10.71m in Hay's study). Hay suggested that it is possible to ascertain the strengths and weaknesses in individual athlete's run-ups so that corrective strategies can be employed in training to overcome identified deficiencies.

The aim of the current study was to:
1. Measure the accuracy and consistency of the long jump run-up of elite Australian jumpers, and to determine to what extent they use visual cueing strategies in their run-ups
2. Determine the effect visual control strategies have on the velocity profile of the athlete in their approach to the board
3. Use the data obtained to form the basis for training strategies aimed at overcoming identified weaknesses for individuals.

METHOD: Three Australian long jumpers were recorded on videotape at the Commonwealth Games Trials in Sydney 1998. Their best jumps in this competition were 8.14m, 7.83m, and 7.77m respectively. All six jumps for each athlete (including fouls) were analysed. A panning camera (50Hz) was placed perpendicular to the axis of the long jump run-up, at a height of approximately 20m, and 15m back. The run-up was calibrated by placing strips of alternating black and white stripes (0.5m) along the length of the runway. The camera was zoomed to a viewing width of 5m. Video frames containing each foot strike were captured, and one metre squares and the toe of the support foot digitised. The toe to board distance for each foot strike was calculated from the raw data, using the method of Hay and Koh (1988). Errors were previously determined to be ±2%.

A Lasergun (LAVEG) sampling at 50Hz was used to measure run-up velocity. The laser was placed front on to the athlete and aimed at the mid-torso. The zero mark corresponded to the front of the takeoff board. Velocity was calculated from the distance-time data, which had been smoothed using a 25 point moving average (IAF Biomechanics Research Project, Athens. 1997). Velocity profiles were examined and the following variables extracted: maximum velocity, velocity at steering, and velocity I m before the board (the surface of the torso being approximately I m before the board at the moment the foot hits the board). Steering (or visual control strategy) was determined by the method of Hay and Koh (1988), and was defined as the point at which the standard deviation of the toe to board distance for each foot strike begins to decrease. This implies that the foot strikes are then becoming more reproducible as the athlete approaches the board. The six jumps for each athlete were used to determine the average toe to board distance for each foot strike.

RESULTS:

1. Steering

   All three athletes adopted steering mechanisms in their run-ups in order to hit the board at takeoff off as accurately as possible. Athlete 1 steered at 6 strides out, Athlete 2 at 3 strides out, and Athlete 3 at 5 strides out (see Figure 1).

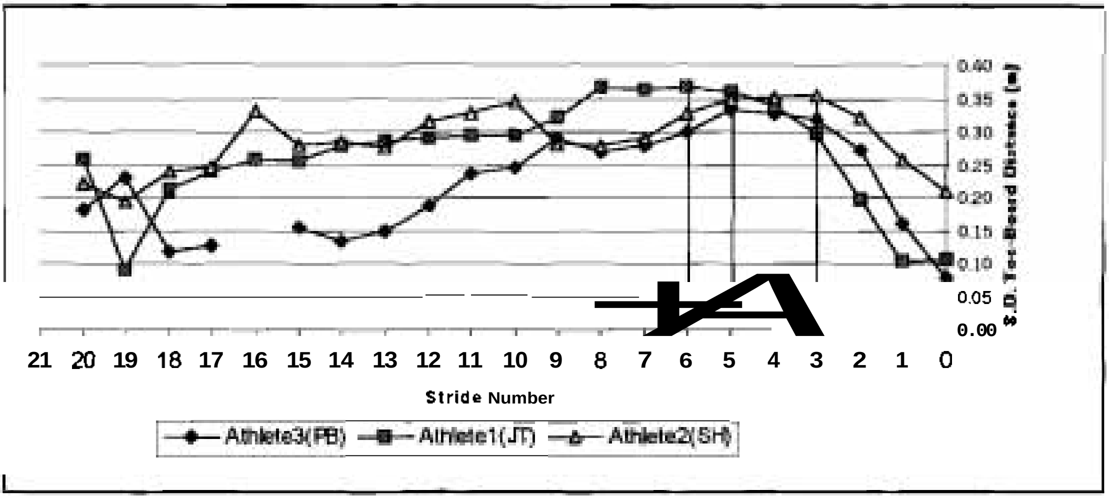

Figure 1 - The standard deviation of the toe to board distance plotted against foot strikes. Zero on the x-axis represents the takeoff board.

2. Effect of steering on velocity profile.

   The velocity profiles of all athletes showed a marked drop off immediately prior to the board. There was no evidence to suggest that the drop off was in any way related to the point at which they began to use visual control strategies. The drop off in velocity (mean = 0.85, $\pm 0.24 ms^{-1}$) from the point of maximum velocity to I m before the board, occurred at a mean distance of 4.52 ± 0.70m, or 2 strides before the board, whereas steering occurred at 15.27m (Athlete 1), 7.35m (Athlete2) and 11.81m (Athlete 3). Athlete 1 continued at accelerate after the steering point was reached, whereas Athletes 2 and 3 maintained a constant velocity from their steering point to approximately 4.5m before the board. A typical velocity profile is shown in Figure 2.

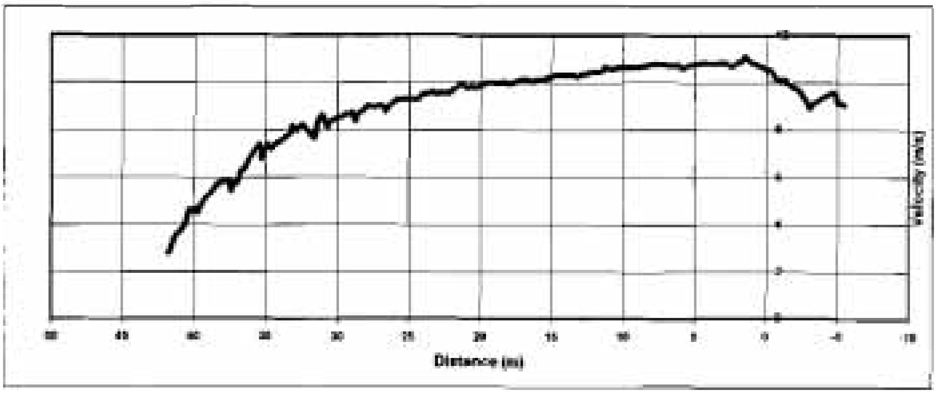

Figure 2 - A typical velocity profile. The athlete steered approximately **7.31m** (3 strides) before the board during this run-up, whereas velocity slowed markedly in the last **3-4m.**

3. Effect of steering on stride length.
Stride patterns of the 3 athletes showed a short-long-short pattern in the last 3 strides, common in the literature (Hay, 1993). Although steering occurred 3-6 strides out for these athletes, the largest adjustment in stride length occurred in the second last stride (SD=0.12 to 0.16m), followed by the last stride (SD = 0.09 to 0.11m) -see Table 1.

Table 1 Stride length (m) for the last 6 strides (mean ± SD). Bold stride lengths are the stride at which steering occurred

	6L	5L	4L	3L	2L	L
Athlete1 (JT)	2.60(±0.06)	2.68(±0.03)	2.64(±0.07)	2.47(±0.11)	2.68(±0.16)	2.13(±0.10)
Athlete2 (SH)	2.44(±0.06)	2.29(±0.04)	2.58(±0.05)	2.31(±0.06)	2.82(±0.12)	2.11(±0.09)
Athlete3 (PB)	2.48(±0.04)	2.40(±0.02)	2.43(±0.04)	2.27(±0.06)	2.50(±0.12)	2.05(±0.11)

DISCUSSION: With the results obtained using this methodology it is possible to determine where in the run-up individuals use some sort of steering. The three athletes in this study varied in where this occurred. The effect it had on their velocity and stride pattern also varied. The results reinforce that fact that the data from different athletes cannot be grouped. and each individual must be studied in isolation in order to determine aspects of the run-up that could be improved. Once the profile of the athlete's run-up has been determined the coach, biomechanist and athlete need to develop practical strategies that address the short and long term goals that will influence performance.
For these athletes it was critical for them to establish a consistent first phase of the run-up. This means that they should reach their steering point as consistently as possible, and would result in minimal adjustments to the final strides of the run-up. Using Hay and Koh's (1988) rating of programming ability, which attempts to rate this skill, the athletes in this study scored well below the 50th percentile. The maximum SD of toe to board distance was approximately 22.5cm at the 50th percentile, compared with 33-36cm in this study. It must be noted here that the wind conditions during this competition were not consistent (range 1.3-4.9ms^{-1}), and may have affected the accuracy of their run-ups. The athletes need to be taught to make small adjustments to each remaining stride length after the steering point, and not to leave this until the last 2 strides. It was noted that two of these athletes had abnormally long 2nd last stride compared with data collected from the World Championships 1997 (mean 2.40 ±0.09m) (IAF Biomechanics Research Project, Athens, 1997). It is

believed that this 'over striding' may have caused the observed reduction in velocity. A systematic approach to developing a better run-up rhythm was deemed essential.

Practical solutions to **effecting** change in run-up rhythm:

1. Place mini hurdles at varied distances causing the athlete to make constant adjustments to stride length. This is for the athlete that has problems with transition from one rhythm to another. Primary focus - the last five strides.
2. The placement of hurdles at set distances (number of stride lengths) to develop a pattern. Starting at 3 strides progressing to 7-9 strides. Replace the hurdles with a takeoff, with the landing continuing into the next run. Primary - focus the last nine strides.
3. Teaching the skill of the basketball lay up, which in the case of long jumper also mimics the takeoff preparation. Other benefits include the basics of the penultimate step and the change from horizontal movement to vertical.
4. Acceleration runs – (generally known as 'Ins and Outs'). Markers are placed at set distances (20m–20m–20m–20m). The athlete then runs the distances at varying paces (easy-hard-easy-hard). This method is used to develop transition running.
5. Placing visual cues on the track, then later the run-up, to mark the transition points, in order to establish the acceleration pattern for the run-up. Note: visual cues cannot be placed closer than 5-6 strides from takeoff-board. These cues should be gradually removed, as the athlete develops a rhythm, and prior to commencing competition. The removal of obstacles and cues is essential to allow the skill to become automated and let the athlete focus on competing.

CONCLUSION: This study has shown that biomechanics can offer the coach meaningful information in relation to the performance of the athlete. The study is an example of 'coach-driven' research to solve the identified problem of long jumpers slowing down immediately prior to takeoff. It shows that information gathered by biomechanists can be used by coaches to develop strategies to improve performance.

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