THE TAKEOFF DRILL FOR THE LONG JUMP

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Dr. Larkins has devised a drill designed to teach horizontal jumpers the proper takeoff action. Included is a teaching progression and the biomechanical rationale for the drill. As Dr. Larkins notes, too little attention is paid to the all-important takeoff action, and any drill that emphasizes the subtle, precise actions with the requisite timing may prove helpful.

REPRINTED FROM TRACK TECHNIQUE #107

The long jump is composed of four distinct but continuous phases: an approach run, a takeoff, a flight, and a landing. Of these four phases, the flight and the approach run receive most of the coach's and athlete's attention during practice. Little or no training time, however, is spent practicing the takeoff actions. Coaches probably avoid teaching this phase because of its complexities. First, many coaches do not realize the importance of this phase to the success of the horizontal jumps. Second, because of the speed at which the takeoff develops, it is very difficult to isolate individual actions without the help of slow motion photography. Third, there are so many important actions that occur over this very short period of time that it is difficult for the coach to identify the most important actions. If the coach can not identify the most important actions of the takeoff phase, he/she can not develop a drill to teach them. This is very unfortunate because the takeoff phase is by far the most critical of the four phases to the success of the performance (Linger, 1980; and Stewart, 1981; Ramey, 1982).

This article, therefore, has three purposes. The first is to identify the most important mechanical variables that occur during the takeoff phase. The second is to identify the takeoff actions used by horizontal jumpers in order to optimize the takeoff variables. The third is to present a step by step teaching progression designed to teach the most important takeoff actions to horizontal jumpers. The presentation of the teaching progression also includes an analysis which explains the relationship between the takeoff actions and the mechanical variables.

The teaching progression is divided into four stages. In Stage 1, the jumper learns the starting or "Power Position." The Power Position simulates the position of the body when the jumper makes contact with the takeoff board and is used during each stage. Stage 2 teaches the jumper how to position the body in order to help control the magnitude and direction of forward rotation generated. Stage 3 teaches the jumper how to perform the trunk and knee extension movement necessary to generate vertical lift. Finally, in Stage 4 the jumper learns to coordinate the swinging body segments with the movements previously learned. The focus of the discussion below is on the long jump, but in fact, this drill is applicable to each takeoff of the triple jump and possibly the high jump takeoff as well.

The Reasons for the Importance of the Takeoff Phase

There are a number of reasons why the takeoff phase is critical to the success of the entire performance. As shown in Figure 1, the total distance jumped can be divided into three subdistances: the takeoff distance, the

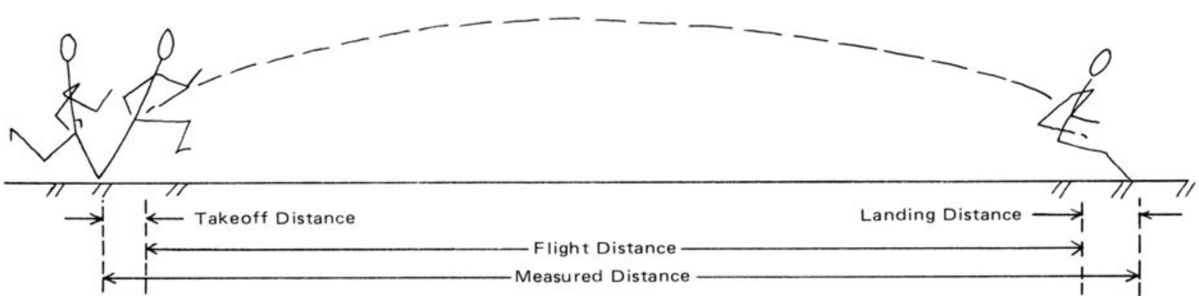

Figure 1: The Division of the Long Jump into Three Subdistances: Takeoff, Flight, and Landing Distances.

flight distance and the landing distance (Hay and Reid, 1982). Each of these distances as well as the total distance jumped is greatly affected by the takeoff variables. The takeoff distance is determined by the athlete's physique and body configuration at the instant of takeoff. Obviously, one can not alter the athlete's physique. However, by controlling the position of the head, neck, and trunk throughout the takeoff phase, the jumper can exert some control over the takeoff distance (Hay and Reid, 1982).

The flight distance, which accounts for most of the total distance, is also determined by a number of takeoff variables, the most important being the resultant takeoff velocity. During the instant between foot strike and takeoff, the jumper must apply forces to the ground in such a way as to conserve the horizontal velocity generated during the approach run while optimizing vertical velocity (Ramey, 1982). The horizontal and vertical velocities are continuously changing throughout the takeoff phase. These changes are in direct proportion to the mean horizontal and vertical impulses (force x time) exerted throughout. Therefore, any training drill or jumping technique that enhances force application also enhances the jumper's ability to maximize the takeoff velocities.

Effective force application is ultimately a result of muscle actions associated with the movements of the body segments (Hay and Reid, 1982). Hay explains this concept more fully below in terms of the high jump.

> . . . the change in the athlete's vertical velocity during the takeoff depends on his or her mass and on the vertical impulse exerted during the takeoff. The vertical impulse is equal to the sum of all the vertical forces transmitted to the ground via the athlete's jumping leg and the time for which they act. These vertical forces are, in turn, the result of the muscular actions associated with the movements of the athlete's arms (A), trunk (I), lead leg (LL), and jumping leg (J L). (p. 276).

From the discussion above it is clear that in order to maximize flight distance, the takeoff actions must be precisely timed and coordinated.

Even though the landing comes at the end of the jump, the distance attained during this phase is also influenced by the actions performed during the takeoff. Similar to the takeoff distance, the landing distance is also determined by the jumper's physique and body's configuration at touchdown. The optimal configuration at touchdown is one which allows the jumper to maximize distance by extending his/her legs as far as possible in front of the center of mass without falling backward (Dyson, 1977). Whatever configuration the jumper can manage to be in greatly depends on the magnitude and direction of rotation experienced by the jumper throughout the flight phase. In-flight arm and leg movements allow the jumper to control the rate of rotation (Ramey, 1973); however, extensive in-flight adjustments can be avoided if the jumper can exert some control over the variables that determine the magnitude and direction of the angular momentum generated at takeoff.

Once the most important variables were identified, it was possible to develop a drill that teaches horizontal jumpers to exert some control over those takeoff variables.

Stage 1: The Power Position

1. Position the takeoff leg slightly in front of the hips with the heel planted on the ground
2. Position the foot of the swing leg slightly behind the hips.
3. Slightly flex both legs at the knee.
4. Place hands on hips.
5. Straighten the back by aligning the head with the spine.
6. Focus the eyes straight ahead.

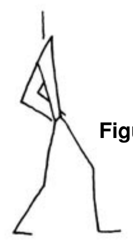

Figure 2: The Power Position

Analysis: The Power Position

The starting position for The Takeoff Drill is shown in Figure 2. It simulates the Power Position, the position of the body immediately after foot strike. However, unlike the actual performance, at this stage of the teaching progression the hands are positioned on the hips. By removing the arms from consideration, the jumper can initially concentrate on the movements of the non-swinging body segments. From the power position the jumper can most effectively apply forces throughout the takeoff phase.

The slight knee flexion observed as the jumper enters the Power Position is a result of previously lowering the center of mass during the lengthened penultimate step. Beginning the takeoff with the center of mass lowered provides a greater range of motion through which the jumper can apply forces to the ground. It also allows the jumper to generate great vertical momentum. During the shortened final step, the takeoff leg is accelerated to the takeoff board and is planted using a quick pawing action. If the jumper does not rush the final step or "stretch" for the board, he/she will reach the Power Position with the flexed takeoff leg slightly ahead of the center of mass. The resulting braking action decelerates the body and allows time for the jumper to execute the takeoff movements.

Stage 2: Positioning the Body for Takeoff

1. Establish the power position.
2. Tilt the pelvic girdle upward while thrusting it forward. See Figs. 3 a-d.
3. Realign the pelvic girdle with the spine and return to the power position.
4. Repeat movements 1, 2, and 3.

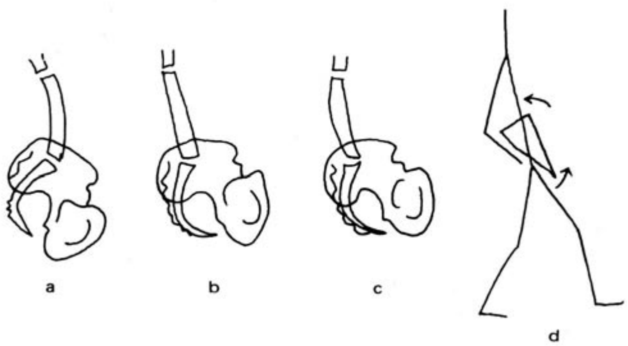

Figure 3 a-d: Positioning the Body for Takeoff.

Analysis: Positioning the Body for Takeoff

In stage 2, the jumper learns to position the body so as to counteract excessive rotation in the sagittal plane about the center of mass. Rotation experienced during the flight phase is caused by angular momentum developed during the takeoff phase and will remain constant throughout the flight phase. If the amount of rotation initiated at takeoff is excessive, it is likely that the jumper will end the flight phase in a poor position for landing.

Different styles of long jumping (sail, hang, hitch kick, or somersault) require different amounts of rotation in order for the jumper to land successfully (Ramey, 1974). No matter which style the jumper uses, however, the usual tendency is for the jumper to rotate forward during the flight phase. With reference to Figure 4, the angular momentum that causes this forward rotation is a function of three variables: 1) the approach run momentum, 2) x(t) and y(t), the horizontal and vertical displacement of the center of mass relative to the takeoff foot as they vary with time, and 3) H(t) and V(t), the horizontal and vertical forces as they vary with time (Ramey, 1974). Because of the importance of H(t) and V(t) in developing the takeoff velocities, it is not practical for the jumper to consciously attempt to control these variables from one jump to the next.

X(t) and y(t), however, are factors that can be controlled by the jumper. The vertical displacement y(t) can easily be controlled from one jump to another by controlling how much the hips are lowered during the penultimate step (Ramey, 1974). There are a number of strategies used by horizontal jumpers to control x(t). The act of reaching for the takeoff board is one such strategy. This action places the takeoff foot further in front of the center of mass than normal, causing a pronounced braking

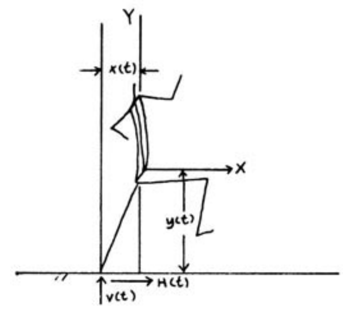

Figure 4: Factors That Cause Angular Momentum During the Takeoff Phase.

effect. An elongated last stride, however, is usually not a conscious effort to control angular momentum. Stretching for the takeoff board is usually a result of an approach run that is too long. It can also be caused by faulty approach rhythm.

As taught by The Takeoff Drill, the most effective strategy for controlling variations in x(t) is to maintain a rigid upper body alignment throughout the takeoff phase (Dick, 1978). Many horizontal jumpers, both novices and elites, have a tendency to bend forward at the waist as soon as they make contact with the takeoff board. This habit must be eliminated. It sets up the condition from which excessive forward rotation is likely to occur. Three to five steps before the takeoff board, the jumper should tilt the pelvic girdle upward placing it in line with the lumbar spine. This movement, shown in Figures 3 a-c, will help counteract the tendency to lean forward. Upward pelvic tilt also places the knee extensors (quadriceps muscles) on stretch which allows them to contract more forcefully (Dick, 1978).

Proper upper body alignment can be facilitated by keeping the eyes focused straight ahead. "The head is the rudder of the body." Therefore, looking down at the takeoff board causes the head to drop, which causes the jumper to bend forward. If the head is thrown backward, the opposite effect occurs. By keeping the head aligned with the spine and the eyes focused straight ahead, rotational effects will be diminished.

Stage 3: Developing Vertical Lift

1. Establish the power position.
2. As the pelvic girdle tilts upward, lift the chest and
3. Extend the takeoff leg (see Fig. 5).
4. Return to the power position.
5. Repeat stage 2.

*Note in Fig. 5 that for this drill, the takeoff foot does not leave the ground.

Analysis: Developing Vertical Lift

In Stage 2 the jumper learned to control rotation. In Stage 3 the jumper learns the movements that generate vertical lift: the extension of the two nonswinging body

Figure 5: Movements That Generate Vertical Lift.

segments, the takeoff leg and the trunk (see Fig. 5). The explosive extension of takeoff leg is the major contributor to the vertical momentum of the whole body. The vertical momentum generated by the takeoff leg increases linearly beginning immediately after foot strike until immediately before takeoff (Ae, et al., 1983). This implies, as previously suggested, that the center of mass should be lowered during the penultimate step. If this movement is not timed properly or if the jumper's extensors are weak, the generation of vertical momentum will be minimized.

Lifting the chest throughout the takeoff phase also aids the jumper in developing vertical momentum. This action "triggers" the extension of the entire trunk segment which develops additional vertical momentum. Lifting the chest also helps to maintain the rigid link system. By not allowing the spine to become a series of small levers the jumper is able to exert some control over rotational effects (Dick, 1978).

Stage 4: Timing and Coordinating the Swinging Body Segments

1. Establish the power position. This time, however, position the swing arm(s) (the left arm for left-legged jumpers) behind the body (see Fig. 6a).
2. While tilting the pelvic girdle upward and extending the trunk and takeoff leg,
   a) Swing the swing arm forward. Keep elbows flexed.
   b) Swing the swing leg forward. Lead with the knee not with the foot.
3. When the thigh and upper arm(s) reach a position parallel to the ground, stop them abruptly (called blocking). See Fig. 6c.
4. Return to the power position.
5. Repeat the drill.

Analysis: Timing and Coordinating the Swinging Body Segments:

The objective of Stage 4 is to teach the jumper the proper timing and coordination of the swinging segments in relation to the takeoff action. In order to simplify the teaching of this complex task, The Takeoff Drill focuses on the position of the swinging segments at three important positions: foot strike, midstance, and takeoff (see Fig. 6 a-c).

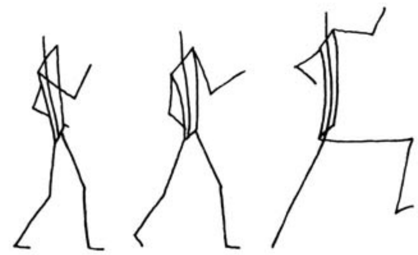

Figure 6 a-c: Timing and Coordination of the Swinging Body Segments at Three Important Positions.

A common error seen in many horizontal jumpers is to enter the takeoff phase with the arm(s) already in front of the body. This is especially true with triple jumpers who use a double-arm swing. This error is usually the result of imprecise timing of the swinging movements or poor running mechanics. Quite often jumpers will start the swinging movements before contact is made with the board. The swing should, in fact, be delayed until after foot strike. Verhoshanski (1972) reported, "an established jumper starts swinging movements toward the end of the supporting phase whereas a novice at the beginning of it. In this detail lies the essential differences in the technique of a qualified jumper and a beginner" (p. 117). The proper arm position at foot strike is shown in Figure 6a.

Once the swinging movements begin, the swing arm(s) accelerates downward and forward relative to the shoulder while the swing leg accelerates forward and upward. By the end of the braking phase just before midstance (see Fig. 6b), the downward momentum generated by the swinging segments should be greatest. Subsequently, the force or weight on the takeoff leg is also at its greatest. This increased load causes the knee extensors to be stretched improving their ability to contract forcefully. For obvious reasons, this phase of the takeoff is often referred to as the "weighting" phase. The forward component of the vigorous arm and leg swing generates horizontal momentum. This helps the jumper to overcome the initial braking effect of foot strike and allows him/her to continue rotating over the takeoff foot.

As the swinging segments move in front of the body, they should decelerate. This action will "unweight" the takeoff leg, freeing the ankle, knee, and hip extensors to contract and propel the jumper into the air. This phase of the takeoff is often called the propulsive phase. When the thigh of the swing leg and the upper arm of the swing arm are parallel to the ground, all swinging movements should be abruptly stopped or "blocked" (see Fig. 6c). This blocking action is stressed during the takeoff drill because it aids in transferring momentum from the swinging segments to the rest of the body.

Conclusion

In spite of the complexities of the takeoff phase, an elementary understanding of the mechanics involved greatly enhances the coach's ability to identify the key takeoff variables. This knowledge will allow him ultimately to develop training methods based on sound mechanical principles.

If practiced daily as a part of the jumper's warmup routine, The Takeoff Drill will ingrain in the jumper's mind the proper motor patterns necessary to execute a successful takeoff. After this drill has been mastered, more explosive takeoff drills should be incorporated into the training routine. These explosive takeoff drills will assure that the newly learned movement patterns carry over to the actual performance. They should be used in conjunction with, and not as a substitute for, The Takeoff Drill.

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