EFFECT OF THE DIRECTION OF THE SOMERSAULT ROTATION ON THE AMOUNT OF TWIST ROTATION IN HIGH JUMPING

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INTRODUCTION

At the end of the takeoff, a high jumper is upright, and facing approximately along the bar. For an effective bar clearance, at the peak of the jump the athlete needs to be horizontal and facing upward. This requires the athlete to make a twisting somersault rotation in the air. The twist rotates the body about its longitudinal axis, and the somersault rotates the body about an axis perpendicular to the longitudinal axis. The twist rotation is generated by the component of angular momentum aligned with the longitudinal axis (H_{TW}) and through rotational action-and-reaction ("catting") (Dapena, 1997). A defective twist rotation can produce a tilted position at the peak of the jump with one hip lower than the other. This will reduce the effectiveness of the bar clearance. To solve the problem, it is first necessary to understand its causes. A tilted position at the peak of the jump can be due to deficiencies in H_{TW} or in the catting (Dapena, 1995). The purpose of this project was to investigate the possibility that the tilt might also be affected by the direction of the somersault rotation.

THEORETICAL CONSIDERATIONS

Figure 1 shows an overhead view of a hypothetical high jumper at takeoff and after 90° of pure somersault rotation (no twist) in three different directions. A typical somersault about an axis parallel to the bar would produce the position shown in image b, which would require in addition 90° of twist for a face-up orientation. A somersault about an axis aligned with the final direction of the run-up would produce the position shown in image a, which would require only 45° of twist for a face-up orientation. A somersault about a horizontal axis perpendicular to the final direction of the run-up would produce the position shown in image c, which would require 135° of twist for a face-up orientation. The implication is that the somersault rotation of image c would require 90° more of twist in the air than the somersault rotation of image a to reach a face-up position at the peak of the jump.

PROCEDURES

Two trials with markedly different orientations of the angular momentum vector relative to the bar (overhead view) were selected for analysis. Body landmark locations were obtained using 3D film analysis. Center of mass location and angular momentum were calculated with a method based on Dapena (1978). The orientation of the longitudinal principal axis was computed for each airborne frame. The cumulative twist rotation of the hips about the longitudinal axis between takeoff and the peak of the jump was calculated, as well as the twist orientations of the hips at takeoff and at the peak of the jump.
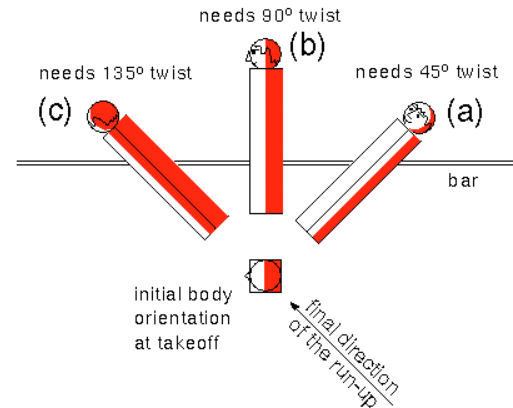
Figure 1: Body positions after pure somersault rotations.

RESULTS AND DISCUSSION

The horizontal component of the angular momentum vector of subjects #1 and #2 pointed, respectively, 21° counterclockwise and 41° clockwise relative to the bar. At takeoff, the subjects' hips faced, respectively, 31° and 27° counterclockwise relative to the bar. In the air, subject #1 twisted through a cumulative angle of 76°, and his hips were level at the peak of the jump. Subject #2 twisted through a cumulative angle of 8°, and ended up with the hips 6° short of level at the peak of the jump. Thus, an additional 6° of twist rotation would have leveled his hips at the peak. If subject #2 had taken off facing the same direction as subject #1 (31° rather than 27°), he would have needed (8+6-4 =) 10° of twist rotation in the air to reach a level position at the peak of the jump, while subject #1 needed 76° of twist rotation for the same outcome.

The results indicate that high jumpers with angular momentum vectors oriented more counterclockwise relative to the bar in the view from overhead may need to twist through substantially larger angles to reach a level position of the hips at the peak of the jump. This could make it impossible for some jumpers to reach such a position.

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