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RESEARCH NOTE

Long Driving: The Sadlowski Case

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Hitting long drives has always been a key component of playing competitive golf at the highest levels. Although long drivers have always been easy to identify on the courses of the world during play, actual long driving competitions have only been held since 1975. Jason Zuback, a muscular 5'10", 225 lb mesomorph, having won consecutive titles from 1996 to 1999, and then again in 2006, set the standard for not only distance but also body shape as well as strength and conditioning. Resistance training, power lifting, and other forms of nonspecific conditioning were then thought to be necessary to compete at the highest levels. However, in 2008, a lean young man, a 5'11", 165 lb ectomorph named Jamie Sadlowski, won the world championship and repeated again the following year. Differences may be explained by principles of human ballistic movement (HBM).

Keywords: Sadlowski, ballistic movements, long driving, mechanics, swing

Since golf involves repeatedly striking a ball with a club, moving the ball from one place to another over long distances, those involved in the game have always focused on the process of driving from the teeing ground. It has long been known that clubhead velocity and contact at the percussion center (sweet spot) with the club face square are the factors that determine distance. However, it has only been in the last few decades that actual long drive competitions have been held.

From the mid ’70s, when the competitions started, to the mid ’90s, a number of individuals emerged as world champion long driver. Observers often commented on the physical characteristics of those who excelled, many convinced that “bigger, stronger, faster” accounted for the competitive outcomes. This became reinforced with the arrival of Jason Zuback, a Canadian power lifter who dominated the competitions, winning four consecutive championships (1996–1999, and once again in 2006). At 5'10", 225 lbs, his highly mesomorphic somatotype was considered indicative of the physical characteristics necessary to achieve supremacy in this activity. This view was cemented when Mike Dobbyn became world champion in

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2007. At 6'8", 300 lbs, this serious power lifter seemed to leave no room for doubt that long driving, like shot putting, required a big, strong individual.

The very next year a lean, ectomorphic young man (165 lbs) of average height (5'11") won the competition and repeated the following year: Jamie Sadlowski. Jamie (another Canadian) consistently produces clubhead speeds in excess of 150 miles per hour. In addition, he hit the ball within the 60-yard boundaries in the competitive grid. Four-hundred-yard total distance drives are common for him in both practice and world class competitive situations. To grasp the concept of a different model for successful long drive champions, the principles are important. In addition, how the differences in human ballistic movement (HBM) influence body morphology (macro and micro) may help explain his elite performance.

Human Ballistic Movements

The concept of HBM has been applied to understand success in various sports and games such as throwing a dart, throwing a shot, striking and kicking (Bosco, Komi, & Ito, 1981; Zehr & Sale, 1994). In a variety of sports there are obviously many different examples of HBM's, including most throwing, striking, and kicking activities.

HBM's are (1) multi-segmented (involving three or more body segments), (2) specifically sequenced (moving from larger to progressively smaller segments), (3) requiring rapid contractions of the prime movers (muscles mainly responsible for the movement pattern required to meet the objective). The rapidity of the concentric (shortening) contractions is such that the body segments themselves, once set in motion, continue moving of their own inertia, until some of their momentum is transferred to the next segment, which is smaller and lighter (less mass), resulting in greater velocity. This process continues until the smallest and last segment (in golf, the clubhead) is accelerated. The transfer of momentum is possible because the muscles involved join each specific pair of contiguous segments. The operation of this "leverage linkage system" culminates in the smallest and lightest segment achieving the highest velocity of the system (Haywood, Roberton, & Getchell, 2012).

The key to understanding HBM is to focus on the object being projected and the ultimate goal of the event. Each has to be evaluated on its own, and each may or may not require specific somatotypes (body characteristics, morphology) and physiological characteristics to reach elite performance levels. To understand the full spectrum of HBM, and where golf driving falls on this continuum, it will be helpful to look at cases where body mass is negligible to performance (as in darts) and cases where body mass is a significant factor in performance (as in shot put).

In dart throwing, the object is extremely light and is projected at a relatively low velocity from the hand. This entire ballistic event requires only a highly refined, extremely accurate movement pattern involving the dominant upper limb shoulder girdle, shoulder joint, elbow, wrist, and intrinsic mechanisms of the hand. Shot putting on the other hand involves two HBM's in one event. The athlete must combine, in proper sequence, accelerating their body through an initial HBM pattern that enables producing a final HBM leading to the release of the shot. In shot putting, size matters: an athlete weighing 160 lbs is trying to impart momentum to an object

that is 10% of his body weight (16 lbs), whereas one who weighs 320 lbs has a distinct advantage in that he is projecting something only 5% of his body mass.

Driving a golf ball effectively requires players to develop the highest controllable terminal velocity of the clubhead before ball contact. Striking the correct location on the clubhead (sweet spot) will result in the largest possible amount of the head's momentum (kinetic energy) being transferred to the ball. However, the difference in the two masses (clubhead 7+ oz, ball 1.62 oz) and their respective constituent materials permits only a small portion of the club's momentum to be absorbed by the ball, and this is one of the two reasons for the swing having such a long follow-through. Since a player can only transfer some of the momentum from any segment throughout the swing to its adjoining smaller segment, and since the ball is limited in the amount of momentum it can absorb from the larger clubhead, the extended follow-through is also necessary to avoid injury by spreading the remaining club and body momenta over a sufficient time and distance. This is one of the reasons why swinging a club at full speed into a bean-bag or some other material that will completely absorb all of the club's momentum instantly (a practice of some professional players) may be an unproductive and dangerous training gimmick.

For the golf drive it is obvious that the highest velocity must be attainable with some degree of control. Sadlowski's size is clearly not a factor limiting his performance, and the ratio of body mass to clubhead mass is the reason. Assuming the weight of a driver head to be 200 g and Sadlowski's weight to be 76 k, he has 380 times the mass of the clubhead. One can speculate at what point this ratio will start to influence the outcome. Perhaps humans under 100 lbs will be incapable of generating the necessary clubhead speed to hit 300-yard drives; research is necessary to determine the answer.

Should Sadlowski decide to pursue hypertrophic training, building his body mass through resistance exercises, it is not likely to increase his clubhead speed, and may in fact decrease it (Holt & Holt, 2010). Ironically, the added benefit expounded by many fitness gurus, that this type of training will prevent injuries, often leads to the exact opposite effect. In many cases an injury is experienced during the training which often has significant, possibly long term negative effects on the career of the player.

One recent example of this is Tiger Woods, whose clubhead speed as measured on the tour has, even by his own admission, noticeably decreased over the last few years (Blake, 2011; Pratt, 2011), despite the fact that he has added 30+ lbs of muscle, primarily to his upper body. It has been argued that this added weight was plausibly a major contributing factor in 2008 to Woods' stress fractures and the exacerbation of his knee injury (Holt & Holt, 2010) by increasing the pounding forces every time he landed during his long runs.

Biological Determinants

If it is not mass or unusual muscularity that is involved in Sadlowski's performance, then what enables him to do what he does? Experts who have analyzed Sadlowski's swing agree that his movements are fast and that he holds his "wrist cock" (an inaccurate term used in many sports and games) for a very long time before release, and that although obviously effective for creating velocity, his swing is "too long" and should not be imitated by most golfers (Kostis, 2009).

Before venturing into this plausible explanation it is important to keep in mind that the authors do not know Sadlowski personally, and are unaware of any significant tests that have been conducted on him. The following is based on formal research (Hoyle & Holt, 1983) and almost forty years of laboratory testing and independent studies (Holt, 1970–2006) on this type of phenomenon conducted at Dalhousie University's Sport Science Laboratory (with relevant other research cited accordingly below). This research has repeatedly demonstrated that those who excel in activities requiring extremely fast movement patterns, including sports such as badminton and table tennis, possess the following physiological characteristics:

1. Very fast nerve conduction velocities to the prime movers (muscles) involved in the patterns of movement performed in the sport (Huang, Chang, & Hsieh, 2005). For the sports mentioned above, this would involve most of the peripheral nerves to the four limbs. As an example, the above athletes' ulnar nerve conduction velocity was 65–75 m/s, whereas nonathletes, or athletes involved in other sports might conduct at 35–55 m/s.
2. High velocity limb movement capability on simple, nonskill dependent uniaxial, single joint rotational movements (simplified HBM rather than three or more segments). They can simply move a limb through space at higher speeds than normal. This means that they have the capacity to recruit more of the available fast-acting motor units (Hoyle, 1974; Hoyle & Holt, 1983).
3. Greater movement speed and agility of their bodies. When given simple, nonpracticed agility tests, they scored significantly faster than other athletes and normal individuals (Sievert, Backus, & Wenger, 1995).

All three of the factors identified involve high-speed conduction along the large motor nerves. Interestingly, although it is intuitive to think that these athletes would also have faster reaction times, they did not (Hoyle, 1974). Further research may shed light on this area of motor nerve conduction.

Kinesiological Determinants

Having the required physiological components is one of two necessary ingredients to producing prodigious drives. The other is obviously having the capacity to sequence and repeatedly execute a movement pattern that will allow one to harness and direct this HBM in the desirable manner. It is clear from his performances that Sadlowski has engrained into his nervous system a swing mechanism that results in clubhead speeds attainable by very few. His swing technique appears to be very similar to that of the great Bobby Jones.

If one closely observes both Jones's and Sadlowski's swings, the similarities between their techniques are unmistakable (compare for example the following videos: for Jones see http://www.youtube.com/watch?v=dMDPIqRf0zs, and for Sadlowski see Kostis (2009) (http://www.youtube.com/watch?v=EZ0dNIP-yoU). However, it would be wrong to think that Sadlowski is the only one to mimic Jones. Other prodigious drivers through the years have also used a similar approach (e.g., John Daly, http://www.youtube.com/watch?v=KQj8VuoGZlI). There is something particularly effective about this swing pattern, as the following brief analysis

indicates. The most striking departure from the norm is the length of both the backswing (preparatory phase) and the downswing (propulsive phase) for both players. The modern swing as taught by most instructors emphasizes that the club shaft should remain parallel to the ground and in line with the intended direction of the shot, at the end of the backswing (Holt, 2004). When driving, Jones is significantly past horizontal and considerably past the parallel to the target line. Sadlowski goes so far past the horizontal that the shaft is almost perpendicular to the ground, close to 90 degrees further than recommended.

Jones was a very long hitter in his day, in spite of the hickory shafts then in use. The extra length of the preparatory phase allows more time and distance for the proper sequential use of their body segments. The narrow angle between the left arm and the shaft is made possible because both have excellent flexibility in their wrists, which permits greater radial flexion (i.e., "cocking"). This leads to a larger angular acceleration at the final release of the clubhead when the player performs ulnar flexion, bringing the shaft of the club in line with the left arm. (The squaring up of the clubface results from interaction of the wrists and forearms at the end of ulnar flexion as well as the club's structural components, not as often thought from vigorous pronation.)

In terms of identifying the commonalities between Sadlowski's and Jones's swings, note the following in particular:

1. Both players begin with an upright posture, the right hip outwardly rotated (right foot turned out) and have a traditional "one piece" take-away. The rotation of the pelvis (inward rotation of the right hip joint, outward rotation of the left) coupled with thoracic rotation (shoulder turn) positions both players with their backs to the target, placing the prime movers of the trunk (left lateral erector spinae), the left shoulder girdle and the shoulder joint in an effectively stretched position at the end of the backswing.
2. At the transition from backswing to downswing, both have unweighted their left leg and foot, with little if any pressure on their front foot. They both accelerate their lower body segments at the beginning of the striking phase by applying downward and rotational forces against the ground with the right leg and foot. The equal and opposite reaction to this force is the rotational acceleration of first the pelvis and legs, followed by the trunk (thorax), which further stretches the muscles connecting the trunk to the left shoulder girdle and joint. It is this fully stretched muscle complex that is responsible for the rapid acceleration of the left arm.
3. Throughout the swing the trunk remains nearly vertical while the pelvis and thorax (chest) rotate horizontally. And unlike traditional swings that begin and maintain greater trunk, hip, knee, and ankle flexion, both have very little lateral movement of the pelvis toward the target throughout the acceleration phase.
4. Both hold the radially flexed wrist joints until the momenta from the previous segments have been successfully transferred, and release the club very late in the downswing. This is common among many elite golfers regardless of swing type.

Conclusion

We speculate that Sadlowski is able to accelerate his body segments and the clubhead to unusually high velocities because within his nervous system are the necessary swing program, nerve conduction velocities, and an enhanced capacity for ballistic movement (including a high percentage of fast-twitch muscle fibers, which are controlled by high numbers of anterior horn cells in the spinal cord). Briefly, then, two factors potentially explain Sadlowski's effectiveness: swing technique and physiology (macro and micro). He has achieved dominance by adopting a swing technique that increases the overall length of the swing, enabling him to more fully use the major segments that contribute to clubhead speed.

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