Original Research

The Influence of Start Position, Initial Step Type, and Usage of a Focal Point on Sprinting Performance

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ABSTRACT

International Journal of Exercise Science 6(4) : 320-327, 2013. For many athletes, sprinting acceleration is vital to sport performance. The purpose of this study was to observe the influences of starting position, type of initial step taken, and a focal point on sprinting velocity, stride length, and acceleration over a 9.1 m distance. Two trials of four conditions were video recorded in which subjects had no focal point (n = 10) or a lateral focal point (n = 9). The four conditions were: forwards (control), backwards, 90° left (90°L), and 90° right (90°R). Lower velocities ($p > 0.05$) were observed with focal point usage from the 90°R and 90°L starting positions. Four initial steps were observed during the forwards, 90°L, and 90°R conditions: backwards step, anterior tilt with forward step, pivot-crossover step, and lateral side step. The use of a backwards step resulted in an increased velocity (+0.80 $m \cdot s^{-1}$, $p < 0.01$) for the 90° turn trials and increased acceleration (+ 0.37 $m \cdot s^{-2}$, $p < 0.01$). Our results indicate that looking at a target can cause a decline in sprint velocity and acceleration over a short distance. Moreover, utilizing a backwards step to initiate a 90° turn may generate more power and force, increasing their velocity for short sprints. We recommend training athletes with a target or focal points to help combat the reduced speed and initiate movement with initial backwards step.

KEY WORDS: Sprint, 90° turn, backwards step, vision point, velocity

INTRODUCTION

For many athletes in sports such as tennis, basketball, and football, the first 2-5 m of a sprint are the most influential and often the furthest they may travel at a time. Unlike track and field sprinters, these athletes require greater acceleration within the first few steps (2, 15, 17). For example, soccer players average sprint distances of less than 14 m during competition (17). Although these sprints make up only 11% of game movement, they are considered a crucial part of performance (16, 18). Whether sprinting forwards, backwards, or starting with a 90° turn, these short, maximal effort sprints may be affected by numerous influences such as the type of initial step taken and what direction the athlete is looking while they accelerate.

An athlete's ability to initiate and change direction rapidly is influential to sprinting performance (6, 10). Hewit et. al. (6) posited that using a pivot-crossover step, in which the rear leg is rotated internally to push off, is the most effective initial step for changing direction. Initiating forward sprinting from a standing position, others have reported that backwards step, in which the back leg is moved in the opposite direction of the sprint to push off into forward propulsion, is effective in increasing force production and velocity over the first 0.5-2.5 m (3, 9). Although these step types have been evaluated individually, no known studies have examined various initial step types on velocity.

An additional factor that may have an influence on performance is where the athlete's visual attention is or where they are focusing on, while accelerating. According to Plisk (2000) and many other coaches and strength and conditioning specialists, athletes should always maintain neutral focus directly in front of them for forward sprints and, if changing direction, should quickly alter their focus to the direction they are running (5, 12, 13, 14). Whether turning the head laterally to maintain focus in a direction alters sprinting velocity has not been explored.

Although sprinting acceleration is a vital part of athletic performance, it is unknown if different starting positions may affect sprinting acceleration. The purpose of this study was to observe the influence of starting position relative to sprint direction, initial step taken, and the use of a focal point located laterally on sprinting speed, stride length and acceleration. These observations would aid in drawing more complete and relative conclusions on the influences athletes may face when sprinting in competition, as well as how to better prepare them in training.

METHODS

We video recorded and digitized two trials of the following four conditions: forwards (control), backwards, 90° left (90°L), and 90° right (90°R). Ten subjects ran without a focal point and nine subjects ran while maintaining a lateral focus point (i.e., their head was rotated). We observed whether starting position, initial step type, or the use of a focal point had an influence on sprinting velocity, acceleration, or stride length for the first seven steps of a 9.1 m maximal effort sprint.

Participants

A sample of 19 subjects (6 Females, 13 Males) volunteered for the study. Of the subjects, 7 had experience in collegiate athletics, 3 were Division II collegiate athletes at the time of data collection, and 9 reported previous experience in sprint training from specific high school sports participation. Overall, the average subject's experience in athletics was 6.47 ± 4.21 sport seasons. Only two subjects reported left limb dominance and the remaining 17 reported right limb dominance. Percentage body fat (BF) was assessed using bioelectric impedance (Omron HBF-306C, Shelton, CT) for the purpose of more accurately describing the sample.

Subjects completed a health screening, for risk stratification, and fitness level questionnaire (range 0 to 10) (4), whereby maximum oxygen uptake (VO_{2max}) was estimated using the regression equation from Ross and Jackson (19). Subjects' demographics are as follows: age: 22.42 ± 1.74 years; VO_{2max}: 49.99 ± 5.72 ml·kg^{-1}min^{-1}; BF%: 14 ± 1.0%. Prior to data collection, subjects were informed that the primary purpose of the research was to investigate the influences starting position and focal point may have on sprint acceleration.

Subjects completed an informed consent waiver upon arrival to the study. All procedures were pre-approved from the sponsoring institutional review board for the protection of human subjects.

Protocol

The sprint trials were recorded using a tripod-mounted video camera (Flip Video Ultra HD, Flip Technology, USA), at a frame rate of 30 Hz. Marked meter sticks were used during filming to allow for pixel-to-meter calibration. All sprint trials were completed in a university gymnasium and subjects were required to wear the same athletic shoes for all trials. The start and finish of the 9.1 m sprint were both marked with tape on the gymnasium floor, as well as with cones placed next to the tape (see Figure 1). Also, two tripods were used to display the focal points, at a height of 94 cm (for focal point locations see Figure 1).

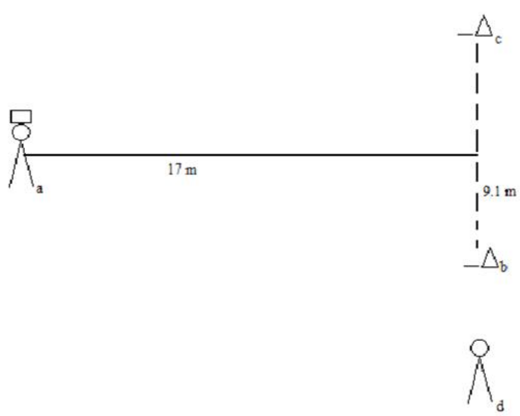

Figure 1. Camera and focal point positioning relative to sprint line. *Figure not drawn to scale. a. Camera location and focal point for 90° left and 90° right starting positions. b. Tape/cone placement for forwards, backwards, and 90° right starting positions; finish line for 90° left starting position. c. Tape/cone placement for Left starting position; finish line for forwards, backwards, and 90° right starting positions. d. Focal point location for backwards starting position.

Participant sprint trials were positioned 17 m from the video camera so that an additional 1 m before the start and after the end of the sprint could be viewed (see Figure 1). All videos were digitized on a frame-by-frame basis using commercial software (Dartfish Prosuite 6.0, Dartfish, USA). Video time was recorded (s) to indicate initial body movements and 5th metatarsal (midfoot) landing strikes of the right and left shoes for data collection. Markers also were used for landing strike placement during digital analysis to measure distance between foot placements and determine participant stride length (m) and velocity ($m \cdot s^{-1}$).

Figure 2. Forwards starting position.

Figure 3. Backwards starting position.

Upon arrival to the gymnasium, subjects were informed that they would be completing a total of 8 short, sprint trials at full speed beginning from various starting positions with an adequate recovery time after each trial.


Figure 4. 90° turn to the left starting position.


Figure 5. 90° turn to the right starting position.

For sprint data collection, subjects completed eight 9.1 m sprints, at maximum speed, beginning from four different starting positions: forwards, backwards, 90° turn to the left (90°L), and 90° turn to the right (90°R) (Figures 2-5). For the forwards starting position, subjects stood with hips parallel to the end marker and their left shoulder facing the camera (Figure 2). When beginning from the 90°L and 90°R starting positions, subjects stood facing the camera and either turned 90° to the left or right to begin the sprint (Figures 4 and 5). For the backwards starting position, subjects stood with their back facing the 'finish line' and their right shoulder facing the camera (Figure 3). In performing the sprint from the backwards position, subjects were to complete the sprint running backwards, without turning around into a forwards run. Subjects were instructed to begin all starting positions in a relaxed stance with their feet parallel to each other, hips aligned with their feet, and arms placed at their sides. No specific instructions were given as to what type of step or initial movement subjects should use to ensure natural initial step choices for observation purposes. All trials began on the subjects' own initiation and subjects were instructed not to reduce their speed until after they had crossed the 'finish line' completely.

Subjects assigned with even numbers were informed they would be required to maintain eye contact with one of two focal points during the sprints beginning from the 90°L, 90°R, and backwards starting positions (see Figure 1 for focal point locations). Subjects who were assigned odd numbers were told to ignore the focal points and to look where they naturally would, or forwards, during the sprint trials. Researchers informed the subjects that they would begin from each position twice. Subjects were given one practice run from each position, which was not at full speed or the full distance, and 1 min full recovery after each sprint trial

Statistical Analysis

Changes in subject stride length, velocity, acceleration, and 9.1 m sprint time during the focal point trials and non-focal point trials represent the dependent variables. The forwards starting position for each group was used as a control trial for the analysis of the 90°L and 90°R starting positions, as well as focal point affects. All results are reported as changes from the forwards control trials. Also, trials beginning from the backwards starting position were compared against each other. No comparison between backward and forward starting position trials were made due to differences demonstrated in previous research (1). Initial step frequencies were calculated based off of all sprint trials. Within-subject reliability for test-retest stride length and velocity were evaluated using intraclass correlation coefficient (ICC) and coefficient of variation (CV) (8). The dependent variables of stride length, velocity, and the amount of time it took subjects to reach 9.1 m were examined using separate ANOVAs with repeated measures and Bonferroni-adjusted post-hoc testing. The criterion used to reject the null hypotheses was $p < 0.05$. All descriptive statistics are reported as mean ± SD.

RESULTS

Subject inter-trial reliability for velocity was strong (ICC = 0.86, CV = 10.96%), while test-retest reliability for stride length was extremely strong (ICC = 0.95, CV = 0.07%). Focal point usage had no significant affect on the backward sprinting trials for stride length (p = 0.87), velocity (p = 1.0), or 9.1 m sprint time (p = 1.0). Focal point usage also had no significant effects on acceleration (p = 0.67) or stride length (p = 0.50). Finally, 90° turns without focal point usage had no significant effect on velocity (90°L: p = 1.0, 90°R: p = 1.0), acceleration (90°L: p = 1.0, 90°R: p = 1.0) or stride length (90°L: p = 0.56, 90°R: p = 0.36) (see Figure 6a).

A significant decrease in mean velocity (Δ = -0.28 $m \cdot s^{-1}$, p < 0.01) and increase in 9.1 m sprint time (Δ = 0.12 ± 0.02 s, p < 0.01) was observed with focal point usage from the 90°R starting position. However, the decrease in mean velocity (Δ = -0.18 $m \cdot s^{-1}$, p = 0.19) and the increase in 9.1 m sprint time (Δ = 0.12 ± 0.04 s, p = 0.07) for focal point usage from the 90°L starting position were not found statistically significant (see Figure 6b).

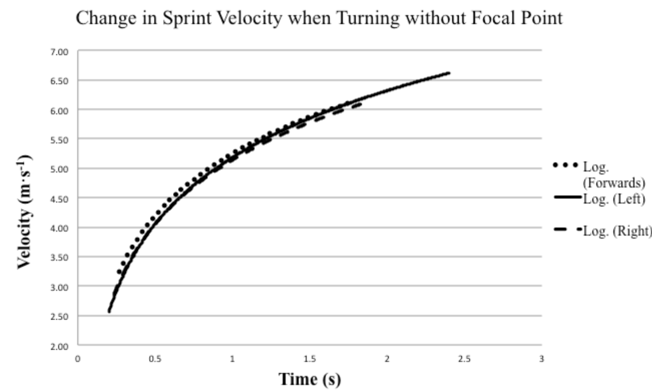

Figure 6a. Change in sprint velocity for 90° turns without focal point usage.

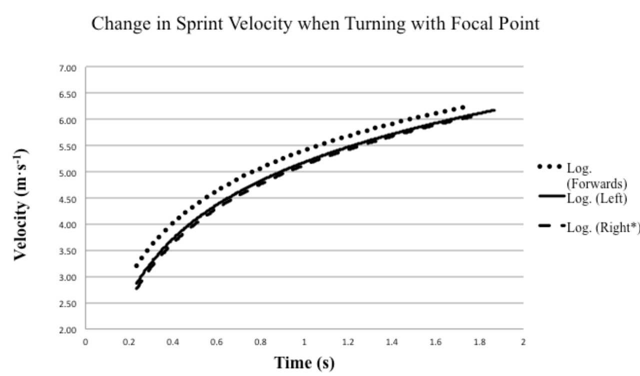

Figure 6b. Change in sprint velocity for 90° turns with focal point usage.

Initial movements were observed during video analysis, revealing four predominant techniques for initiating forwards or turning movement: 1) stepping backwards, in the opposite direction of the sprint, with the dominant leg, transferring weight backwards initially, and then using it as the push-off leg to generate forward movement (n = 10), 2) tilting the body anteriorly along the ankle joint of the inferior leg in a falling motion and bringing the dominant leg forwards for ground contact and push-off (n = 13), 3) pivoting the hips to rotate the torso towards the sprint and rotating the posterior leg internally to crossover and take the first step, while using the anterior leg for push-off (n = 11), and 4) rotating the anterior leg externally, while pushing off of the posterior leg to shift the weight laterally, into a side stepping movement (n = 9). The forwards falling motion was used more frequently (63%) than the back step (37%) during the forward trials. A pivot step was used most commonly when subjects were required to turn during the 90°L (47%) and 90°R trials (42%), when compared to a side step (90°L = 26%, 90°R = 32%) and back step (90°L = 26%, 90°R = 26%). Initial steps for backwards trials were not analyzed due to lack of variance.

Subjects who used the backwards step motion when turning to the left (90°L) had greater velocity, than those who pivot stepped, during the 2nd-3rd step of the sprint (Δ = 0.68 $m \cdot s^{-1}$, $p < 0.01$) and for their overall velocity (Δ = 0.47 $m \cdot s^{-1}$, $p = 0.03$). Subjects who used the backwards step when turning to the right also had a greater velocity than those who pivot stepped during the 2nd-3rd step of the sprint (Δ = 0.92 $m \cdot s^{-1}$, $p < 0.01$). Acceleration was significantly faster for all start positions when a backwards step was used in comparison to all other steps (M = 0.37 $m \cdot s^{-2}$, $p < 0.01$) except the sideways, lateral step (M = 0.22 $m \cdot s^{-2}$, $p = 0.55$).

DISCUSSION

The primary purpose of this study was to observe the influences of starting position, initial step types, and whether use of a focal point affects sprinting abilities with specific attention to velocity, acceleration, and stride length. Minimal differences in sprinting variables were measured between the forwards, 90°L, and 90°R trials without a focal point. Conversely, having subjects view a lateral a focal point resulted in attenuated velocity for both 90°L (Δ = -0.18 $m \cdot s^{-1}$) and 90°R (Δ = -0.28 $m \cdot s^{-1}$) trials, relative to the control trials. Overall 9.1 m sprint time was decreased during both 90°L and 90°R sprint trials equally (Δ = 0.12 s); however due to the larger standard deviation in the 90°L trials, only the 90°R trial change was found significant. Overall, these data support the negative influence of 90° turning on short sprint performance for athletes.

Because stride length was not found to vary significantly throughout the trials, the decreases observed in velocity with focal point usage may be attributed to the decrease in vertical alignment (20). According to Seagrave et al. (20), a "drawn-in" core and shoulders positioned directly above the hips is ideal for optimal generation of forces and efficiency during a sprint. The rotation of the head and neck, to maintain eye contact with a lateral focal point, requires the use of multiple muscles, including the trapezius, sternocleidomastoid, and the splenius capitis, which would in turn result in the mild rotation or offset of the should girdle, and decrease the natural rotation of the shoulders (7, 11).

Another observation made during the study was the types of steps used by subjects to initiate movement into their first step. In line with previous research (3, 9), the use of a backwards step did result in a faster velocity or acceleration for forward propulsion from the forwards starting position in this particular study. The use of a backwards step was also noted to be more effective than a pivot crossover step in increasing sprint velocity when subjects began from the 90°L and 90°R positions. Results of this study support inferences made by Hewit et. al. (6) in that during a 90° turn, the backwards step utilizes the stretch-shortening cycle by increasing force from preloading the muscle with elastic energy. Although some argue that a step backwards is counterproductive, the backwards step may produce greater force and power output (9). Because acceleration and the 2nd-3rd step velocity was increased in both cases, athletes would likely be benefitted from the use of a backwards step for initiating rapid change of direction in sprints of 0.5-5.0 m. According to a study by Kraan et. al. (9), 95% of sprints or trials, when beginning naturally, start with a step backwards; however the study had only male subjects. The results of this study showed the use of a backwards step was used by a majority of the male subjects (77%), but only one female subject (17%) performed the step during one of the sprint trials. Observations of these results give implication for further investigation of training techniques for short sprint acceleration in male and female sports, as well as possible improvements in training for female athletes.

The use of these results could be taken in multiple ways by coaches, strength and conditioning specialists, and athletes. Although the results of this study help support the coaching concepts of maintaining a neutral focus forwards while sprinting, in sports where athletes must maintain eye contact on other players or a passing ball, more training with lateral focus and acceleration is recommended. One suggestion would be to performing acceleration or speed drills with athletes, while requiring them to either receive a pass or maintain eye contact on a specified target.

When training athletes in sports that rely on short, fast sprints, the direction of their focus and the type of initial step used should be taken into consideration. The results of this study have demonstrated that athletes who must look at a focal point while sprinting are slower than those who look straight ahead. Additionally, athletes utilizing a backwards step to initiate sprinting subsequent to a 90° turn are able to generate more power and force, thus increasing their velocity for short distance sprints. Conclusively, it is recommended that coaches and athletes train with target or focal points to help combat the known attenuation associate with running while viewing a focal point. Additionally, training in the use of a backwards step for acceleration is advised.

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