Stepping Backward Can Improve Sprint Performance Over Short Distances

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Abstract

The use of a backward (false) step to initiate forward movement has been regarded as an inferior starting technique and detrimental to sprinting performance over short distances as it requires additional time to be completed, but little evidence exists to support or refute this claim. Therefore, we recruited 27 men to examine the temporal differences among three standing starts that employed either a step forward (F) or a step backward (B) to initiate movement. An audio cue was used to mark the commencement of each start and to activate the subsequent timing gates. Three trials of each starting style were performed, and movement (0 m), 2.5 m, and 5 m times were recorded. Despite similar performances to the first timing gate (0.80 and 0.81s for F and B, respectively), utilizing a step forward to initiate movement resulted in significantly slower sprint times to both 2.5 and 5 m (6.4% and 5.3%, respectively). Furthermore, when the movement times were removed and performances were compared between gates 1 and 2, and 2 and 3, all significant differences were seen before reaching a distance of only 2.5 m. The results from this investigation question the advocacy of removing the false step to improve an athlete's sprint performance over short distances. In fact, if the distance to be traveled is as little as 0.5 m in the forward direction, adopting a starting technique in which a step backward is employed may result in superior performance.

Key Words sprint start, timing gates, false step

Introduction

The ability to accelerate over short distances is of paramount importance to success in many sports (1,13) Because of the paucity of empirical evidence, however, conflicting views remain with regard to the most advantageous starting style (9). Investigators have placed a great deal of effort toward improving our understanding of the sprint start but have focused primarily on the kinetics and kinematics associated with blocks starts (10–12,15,16), making the transference to field-based sports, where athletes begin from a standing position, somewhat problematic (9,13). This fact motivated the present research, with the objective being to provide further insight into the possible mechanical advantages and sprint performance differences associated with various standing starts.

To initiate forward movement from a stationary standing position, the center of mass must be positioned anterior to the base of support (feet) (6). This is achieved in one of two ways: a rotation of the body about the ankle joint, thereby shifting the center of mass forward, or by displacing the support area behind the center of mass (placing one foot backward) (6). However, if we consider a tennis player sprinting from the baseline to pick up a drop shot, a baseball player reacting to a shallow fly ball, or a basketball player attempting to make a steal, they all initiate forward movement from a variation of the athletic ready position that is characteristic of their respective sport (feet parallel) (8,14). With the exception of a stoppage in play, the chaotic nature of most sports rarely allows an athlete to set his/her position before the initiation of forward movement; therefore, most athletes are forced to accelerate from a variation of this parallel foot position.

From this parallel stance, an athlete may choose to initiate movement via a repositioning of their center of mass (lean and step forward – parallel start) or their feet (step backward – false start). Intuitively, the use of a backward step to accelerate forward seems counterproductive and has led to the belief that an athlete should eliminate this unnecessary movement to produce a more time-efficient start (6). However, if the time taken to achieve the backward step does not exceed the time required to shift the center of mass forward, then perhaps the false step is not counterproductive and an athlete may see a performance benefit by employing a backward step to initiate forward movement.

Comparing the parallel and false starts, Kraan et al. (9) found that stepping backward resulted in significantly greater horizontal force and power production at push off via a contribution from the stretch-shortening cycle (SSC). This result led the investigators to conclude that the fastest start achieved from a standing position was in fact one that allows a paradoxical step backward; however, this was stated without any empirical support from sprint times over set

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distances. Consequently, it remains unclear as to whether there are performance benefits from this increased force production, what the minimal sprint distance is to exploit these benefits, and how long can they be maintained. Therefore, the primary purpose of this investigation was to examine the movement (0 m), 2.5 m, and 5 m times between standing starts employing a step forward and a step backward to initiate movement.

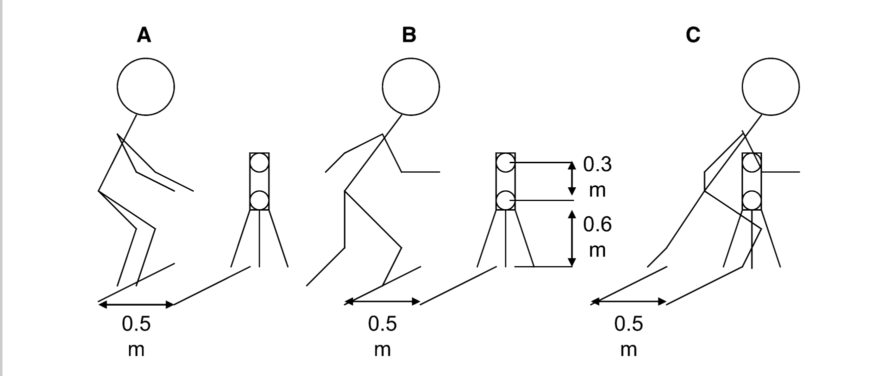

Figure 1. (A) Starting position of parallel and false start. (B) Starting position of split start and representative of the backward step for the false start. (C) First forward step for all each start.

METHODS

Experimental Approach to the Problem

Forward movement from a standing position is initiated in one of two ways: by rotating the body about the ankle joint or by taking a step backward (6). To assess the effect that either starting strategy has on sprinting performance, athletic men from various sporting backgrounds performed three 5-m sprints employing three different standing starts. An audio cue was used to initiate movement and trigger the timing system with the aim of capturing sprint times at the 0-, 2.5-, and 5-m lines. A between-start comparison was conducted for each distance recorded, including or excluding the time taken to the first gate.

Subjects

Twenty-seven men of an athletic background volunteered to participate in this study. Each individual cited previous involvement in an organized running-related sport; however, no one competed at the national level. They were 22.1 ± 2.9 years of age, 180.1 ± 6.6 cm tall, and weighed 76.1 ± 7.7 kg. The investigation was approved by the human ethics committee of Edith Cowan University, and all participants gave their informed consent before data collection.

Starting Styles

The three standing starts employed for the purpose of this investigation are shown in Figure 1. The false start began with participants placing both feet directly behind the starting line. On the audio command, the first movement was a step backward with the right foot. Subjects were permitted to raise their left foot as the right went back, permitting that the first step forward was also with the right foot. This protocol was used to maintain consistency between all starting styles. The parallel start began in the same manner as the false start (both feet directly behind the starting line), but on the audio command, participants were required to adopt a technique in which they rotated their bodies about the ankle joints, shifting their center of mass forward, to allow the first step to be forward with the right foot. No movement backward with either foot was permitted. A split stance starting posture was used as a control condition to allow comparisons with the false start to be made, as it involved a similar displacement of the support area before the commencement of forward movement. All starts required that the subject be absolutely still before the sounding of the audio buzzer.

Equipment

Three pairs of dual-beam infrared timing lights (Swift Performance Equipment, Lismore, NSW, Australia) with a beam height of 0.6 and 0.9 m from the ground (Figure 1) were positioned 0, 2.5, and 5 m from the start line. The starting line was located 0.5 m behind the first timing light to prevent any extraneous movement from prematurely breaking the beams (7).

Procedures

After measuring height and weight and signing the informed consent, participants completed a general warm-up consisting of 10 minutes of light jogging and dynamic stretching. They were then familiarized with the three starting styles that were to be used during the investigation and asked to perform five submaximal 5-m sprints progressing in intensity from 50% to 90% maximal effort with a self-selected starting style. All sprints were performed indoors on a rubberized surface and required participants to wear an athletic running shoe. Kraan et al. (9) stated that initiating forward movement with

TABLE 1. Coefficient of variation (%) based on sprint times for each starting style at each distance.

Starting style	0 m	2.5 m	5 m	0–2.5 m	2.5–5 m	0–5 m
Parallel	8.71	4.17	2.91	5.01	8.53	2.64
Split	6.24	3.51	2.26	5.02	4.81	2.20
False	7.20	3.92	2.94	4.08	3.38	2.79

TABLE 2. Mean (*SD*) sprint times for each starting style at each distance.

Starting style	0 m (s)	2.5 m (s)	5 m (s)	0–2.5 m (s)	2.5–5 m (s)	0–5 m (s)
Parallel	0.80 (0.11)	1.55 (0.10)†	1.99 (0.11)†	0.74 (0.07)†	0.44 (0.06)	1.19 (0.06)†
Split	0.69 (0.06)†	1.31 (0.07)†	1.74 (0.08)†	0.62 (0.06)*	0.43 (0.03)	1.05 (0.06)*
False	0.81 (0.07)	1.45 (0.08)†	1.89 (0.13)†	0.65 (0.05)*	0.44 (0.11)	1.08 (0.12)*

*Significantly different from parallel start ($p < 0.01$).
†Significantly different from both starts ($p < 0.01$).

a backward step is instinctive for up to 95% of individuals; therefore, to ensure that participants were adopting their natural backward step and to avoid any influence of the parallel start, the first sprinting style used for all participants was the false start. The order of the two remaining starting styles (parallel and split) was randomized for all participants. Each subject was required to perform a minimum of three 5-m maximal effort sprints for each starting style with the last two being recorded for analyses. Approximately 90 seconds' rest was given between each trial and 3 minutes' rest between each starting style. If the trial was not completed according to the descriptions outlined above or if the participant attempted to anticipate the starting buzzer, then an additional trial was completed after a subsequent 90 seconds of rest. All trials were initiated with a buzzer (Swift Performance Equipment) that also commenced the timing gates. This was used as a means of capturing the reaction and movement times before crossing the first timing gate.

Statistical Analyses

Means and standard deviations are used throughout as measures of centrality and spread of data. Within-subject reliability of the sprint times (0, 2.5, and 5 m) for each starting style was evaluated using coefficients of variation (CV). Pearson correlation coefficients were used to identify relationships among the different starts. A two-factor (distance × start) repeated-measures ANOVA with Holm-Sidak post hoc comparisons was used to determine significant differences among conditions. Statistical significance for all tests was set at an α level of 0.05. ANOVAs and Pearson correlations were analyzed with SigmaStat 3.1 (Systat Software Inc., Richmond, CA).

RESULTS

The inter-trial variability for each starting style is shown in Table 1. Greatest variation in the times (CV 6.24–8.71%) was observed from the beginning of the audio cue to the first light. Less variation was noted as the distance from the starting line increased and reaction time became less influential on total time.

No significant differences in time taken to the first timing gate were observed between the false and parallel starting styles, although both starts took significantly longer than the split start (see Table 2). At 2.5 and 5 m, there were significant differences among all starts, as initiating forward movement with a backward step was found to be quicker than stepping

TABLE 3. Pearson correlation matrix between starting styles and distances.

	S0	F0	P2.5	S2.5	F2.5	P5	S5	F5	M
P0	0.226	−0.077	0.748*	0.215	0.010	0.826*	0.221	0.393	−0.393
S0		0.077	0.309	0.665*	0.133	0.343	0.647*	0.406	0.136
F0			0.059	0.115	0.820*	0.152	0.208	0.398	0.089
P2.5				0.218	0.207	0.862*	0.289	0.342	−0.102
S2.5					0.258	0.254	0.931*	0.399	−0.010
F2.5						0.284	0.336	0.544	0.104
P5							0.357	0.468	−0.214
S5								0.499	0.095
F5									−0.223

M = mass of participants; P = parallel; S = split; F = false.
*Significant difference ($p < 0.01$).

forward (parallel was 6.4% slower at 2.5 m and 5.3% slower at 5 m compared with the false start).

When the movement time was removed (time to the first timing gate) and only the time between each successive gate was examined, the false start was not significantly different from the split start at any distance; however, the times were significantly less than for the parallel start for 0–2.5 and 0–5 m (parallel was 15.0% slower for 0–2.5 and 9.5% slower from 0–5). However, there were no significant differences among any of the starts in the time taken to sprint from 2.5 to 5 m (see Table 2).

Pearson correlations were used to identify the relationship among the various starts at the three distances. As can be observed from the correlation matrix (see Table 3), there were no significant correlations among any start regardless of whether movement time was included (see Table 3). The only significant correlations were found within the starting styles between distances.

Discussion

The use of a backward step to accelerate forward has been regarded as an inferior starting style because intuitively it seems counterproductive to an athlete's performance (6). However, this conjecture is based on the assumption that the time required to complete the backward step is greater than that to adjust the position of the center of mass and step forward. The results from the current investigation provide opposition for this notion as the false and parallel starts achieved near-identical times to the first timing gate (Table 2). In fact, when the distance to be covered was just 3 m (second timing gate), using a backward step reduced the sprint time by 100 ms or 6.0% (Tables 2 and 3). A 6% reduction in the time to cover a short distance may have a considerable impact on athletic performance when movement time is a critical factor.

When an athlete adopts a false starting style by repositioning their base of support, forward movement of the center of mass is either temporarily suspended or slowed until the horizontal impulse generated from the backward step is large enough to elicit forward movement. As a result, the total false start movement time recorded by the first timing gate is composed of reaction time, and positive (forward) and negative (backward) movement time, compared with just reaction time and positive movement time when the parallel start is initiated via a displacement of the center of mass. Therefore, if both starts require the same distance to be traveled to the first gate (50 cm) but do not result in significantly different movement times, as in the current study, then it can be inferred that the use of a backward step resulted in a subsequent increase in the horizontal velocity of the center of mass at the first timing gate (0 m). If the use of a backward step does increase the horizontal velocity of the center of mass at the first timing gate, further improvements to performance should be expected at the second timing gate. This is precisely what was observed; the false start was 90 ms faster ($p < 0.01$) between gates 1 and 2 (0–2.5 m) despite the near-identical times at gate 1 (see Table 2). However, it is assumed that the reaction times for both starts were similar, which may or may not be the case, but was outside the scope of this investigation and is a possible limitation.

The significant difference between the false and parallel starts was maintained at the 5-m mark (100 ms or 5.0%) (see Table 2), but the times between 2.5 and 5 m were not significantly different (Table 2). This would suggest that any mechanical advantage gained via a step backward is utilized before traveling 2.5 m, although any reduction in this first 2.5 m is maintained for the remainder of the sprint. Kraan et al. (9) reported that the use of a backward step allowed for the generation of greater force and power at push off, and the results from this study suggest that this additional force may be partly responsible for the superior sprint performance over 5 m. Further investigation into the kinetics and kinematics associated with the first few steps may provide additional insight into the mechanical advantages associated with a backward step.

The split start served as a control condition for the current study because it allowed each participant to displace his support area to a position behind their center of mass before the initiation of forward movement. This start allowed for a horizontal impulse to be generated immediately after the starting cue, without having to displace the center of mass or take a step backward, therefore reducing the movement time to the first gate (see Table 2). However, with the exception of a stoppage in play, athletes will rarely find themselves with an opportunity to adopt this starting posture (6), consequently reducing its practical significance. Furthermore, Kraan et al. (9) found the split start to be less effective than the false start in terms of generating horizontal force and power at push off, perhaps because of the absence of a SSC action. Although the split start was significantly faster than both other starts to each timing gate, the difference between it and the false start was a result of a reduction in movement time to reach the first gate (see Table 2). When the initial movement time was removed from the sprint performance over 5 m, only 30 ms separated the false from the split starting style ($p > 0.05$).

Surprisingly, there seems to be no relationship in sprinting performance among any of the three starting styles even over a short distance such as 5 m (see Table 3). These findings imply that each starting style is characterized by its own specific kinetic and kinematic demands (i.e., technique and strength/power characteristics). Therefore, if the false start is viewed as the optimal starting style for an athlete's respective sport, then the kinetics and kinematics of the backward step need to be analyzed and subsequently enhanced for sprint performance and thus for athletic performance to improve. Using the SSC has shown to improve performance compared with concentric-only movements (2–5,9); therefore, with proper training, the false start may have the potential to result in superior sprint performance to the split start over certain distances, although this contention requires additional investigation.

While comparing the first step kinetics associated with stepping backward or forward, Kraan et al. (9) found that 95%

of the sprint trials completed, independent of the starting style that the athlete was instructed to use, were performed with a backward step. This finding provides support for the argument that displacing the support area and taking a step backward is instinctive to most athletes, whereas a great deal of practice may be required to perfect a forward step. Similar results were seen during the present study, although the percentage of trials performed incorrectly was not recorded. Despite the fact that it may be instinctive, it would be interesting to conduct a longitudinal study that looked at the performance of a parallel start with sufficient practice. Would performance improve? Would movement time and the subsequent 2.5- and 5-m times remain inferior to the false start? Conversely, are the benefits associated with the false start attributable to the positioning of the support area behind the center of mass and the SSC?

Practical Applications

The results from this study failed to justify the elimination of a backward step to accelerate forward. In fact, they provide clear support for the use of this paradoxical movement to improve sprint performance over distances as short as 2.5 m. If an athlete is able to travel 50 cm just as quickly with a step backward but can also improve his horizontal velocity and therefore any subsequent sprint time, is there any practical application for using a parallel start? The results from the current investigation suggest that if the distance to be traveled in a straight line is greater than 0.5 m, there may not be any advantage to using a forward step; however, the degree of transference to performance over longer distances and different surfaces remains unclear.

The findings from this study may have been different had each participant been well trained with the parallel start, but it is possible that the superior performance is a result of the mechanical advantages associated with shifting the support area vs. the center of mass. With a parallel start, the center of mass must be repositioned in front of the feet before a horizontal force can be developed. This delay, in combination with the absence of a SSC action, may not be conducive to improving an athlete's acceleration over short distances, thus resulting in an increased movement time. If an athlete were able to stop play and set their position, then perhaps a split start could result in superior performance. If this is not the case and they are starting from a parallel stance variation, then the next best way to initiate forward movement is with a step in the opposite direction.

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