Adopting an External Focus of Attention Improves Sprinting Performance in Low-Skilled Sprinters

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Abstract

Porter, JM, Wu, WFW, Crossley, RM, Knopp, SW, and Campbell, OC. Adopting an external focus of attention improves sprinting performance in low-skilled sprinters. *J Strength Cond Res* 29(4): 947–953, 2015—For more than 10 years, researchers have investigated how the focusing of conscious attention influences motor skill execution. This line of investigation has consistently demonstrated that directing attention externally rather than internally improves motor skill learning and performance. The purpose of this study was to test the prediction that participants completing a 20-m sprint would run significantly faster when using an external focus of attention rather than an internal or no-focus of attention. Participants were college-aged volunteers ($N = 84$; 42 women, 42 men; mean age = 20.32, $SD = 1.73$ years) with no prior sprint training. This study used a counterbalanced within-participant design. Each participant completed 3 days of testing, with each day utilizing a different focus of attention (i.e. internal, external, or control). Running times were collected automatically using infrared timing gates. Data were analyzed using a 1-way repeated measures analysis of variance (ANOVA). The results of the ANOVA revealed a significant main effect for condition, $F\,(1, 83) = 6565.3$, $p \leq 0.001$. Follow-up analysis indicated that the trials completed in the external focus condition (mean = 3.75 seconds, $SD = 0.43$) were significantly faster than trials completed in the internal (mean = 3.87 seconds, $SD = 0.64$) and control conditions (mean = 3.87 seconds, $SD = 0.45$). The analysis also indicated that the control and internal conditions were not significantly different. The results of this study extend the findings of previous research and demonstrate sprinting performance can be improved by using an external focus of attention.

Key Words verbal cues, skill assessment, practice, instructions, directions

Introduction

Often within a sport-training environment, coaches use verbal instructions to provide movement instruction and feedback to optimize performance. Ideally, practitioners structure their verbal instructions in a manner that influence movements toward the successful completion of the action. Moreover, one of the many factors coaches must contemplate when delivering verbal instructions is how the information will influence the athlete's focus of attention. Within the motor learning and control literature, attentional focus is defined as directing one's attention to specific characteristics in a performance environment, or to action-preparation activities (7). This allocation of attention can be directed internally or externally. An internal (INT) focus of attention is when a performer attends to a specific body part or the movement of their body during the execution of a motor skill. In contrast, an external (EXT) focus of attention occurs when attentional resources are directed toward the effects the movements have on the environment (27). For example, a basketball instructor teaching a student how to dribble a ball may instruct the student to focus on pushing the ball down with even strokes of the wrist and hand. This form of instruction would elicit an INT focus of attention because the student is directed to attend to movements of the body (i.e. wrist and hand). In contrast, the coach could instruct the student to focus on dribbling so that the ball makes a consistent audible sound between dribbles. This form of instruction would elicit an EXT focus of attention because the focus is directed toward the effects of the movement on the environment (i.e. movement of the ball). On the surface, the 2 forms of instruction seem to be very similar, resulting in equal dribbling performance. However, more than 15 years of motor behavior research suggest that instructing the

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athlete to focus externally results in elevated performance compared with providing instruction to focus internally (23).

The constrained action hypothesis is often used to explain the benefits of adopting an EXT focus of attention (30). This hypothesis proposes that when an INT focus of attention is used, the motor control system is constrained, which interferes with automatic motor processes that regulate movement. However, focusing on the movement effect (EXT focus) allows the motor system to more naturally self-organize all the coordinated movements involved within an action in an unconstrained manner. This lack of interference not only results in more effective motor performance but also motor learning. Several studies have validated the predictions of this hypothesis. For example, in a study by Wulf et al. (30), participants balanced on a stabilometer, while probe reaction times (RTs) were taken to measure the cognitive demands required under external and internal attentional focus conditions. External focus participants demonstrated faster probe RTs compared with participants using an INT focus of attention. The authors suggested that the decrease in probe RTs indicated a higher level of automaticity, reduced interference, and lessened cognitive load while utilizing an EXT focus of attention. Studies have also investigated the constrained action hypothesis at the neuromuscular level. Through the use of electromyography (EMG), experiments conducted by Vance et al. (20) and Marchant et al. (9) demonstrated that providing EXT focus instructions elicited greater efficiency in the muscle fiber recruitment pattern compared with instructions designed to direct attention internally. Additionally, the results of a study by Makaruk et al. (8) suggest adopting an EXT focus of attention, rather than an INT or neutral focus, during 9 weeks of plyometrics training significantly improved kinetic and kinematic jumping measures. The authors (8) contend that an EXT focus of attention enhanced the effectiveness of the stretch-shortening cycle and movement coordination patterns. Consistent with the predictions of the constrained action hypothesis (30), results such as these, based on a motor programming framework, suggest directing attention externally may be less cognitively demanding; the reduction in cognitive demand frees attentional resources (6) allowing the central nervous system and effectors to better execute the specified motor program. On the other hand, authors using an ecological framework have suggested that an EXT focus of attention may allow the motor system to self-organize into a stable and preferred state of movement (1).

In addition to experiments that have directly tested the predictions of the constrained action hypothesis, numerous studies have demonstrated robust findings in favor of an EXT focus of attention (28). These benefits have been demonstrated using a variety of sport skills such as golf chipping (3,31), basketball free throw shooting (1), volleyball serving (29), soccer ball kicking (29), and soccer ball throw-in mechanics (24). Enhancements in dynamic balance have also been reported when using an EXT focus of attention (10). Patient populations have additionally benefited from adopting an EXT focus (12,26). A recent study also demonstrated that skilled distance runners improved oxygen consumption efficiency although using an EXT focus while running at a constant speed on a treadmill (18). Several studies have also demonstrated that eliciting an EXT focus improves vertical (25) and horizontal jumping ability (12,15,22).

Many of the aforementioned studies explored the manipulation of attentional focus using discrete tasks and/or skills requiring the successful manipulation of an object (e.g. swinging a golf club or controlling a stability platform). One area of motor performance that has received little consideration regarding the potential influence of attentional focus is the exploration of continuous skills requiring locomotion (17). Understanding how locomotor-based tasks, such as sprinting, are influenced by a performer's focus of attention is not only important to advance our theoretical understanding of this phenomenon; it is equally valuable for practitioners (i.e. coaches) who teach and assess locomotor-based skills and abilities. Additionally, continuous motor skills are operated with a closed loop form of motor control, whereas discrete skills are managed using an open loop control system (7). Because of this, discrete skills are preprogrammed, and continuous skills facilitate online processing allowing for behavioral modification. Because continuous skills are controlled online with a closed loop system, different demands for attention are required relative to discrete skills. Hence it is important to more directly investigate how altering a mover's focus of attention influences the performance of continuous skills. Thus far in the research, only 1 study has investigated the behavioral influence attentional focus has on locomotion. That study (14) investigated agility performance while directing attention externally, internally, and neutrally (i.e. control [CON] condition). In that study, participants completed the "agility L run." The results of that study (14) revealed that participants finished the agility L run course faster when adopting an EXT focus. Consistent with previous studies, the internal and CON conditions were not significantly different. The findings reported by Porter et al. (14) provide initial evidence that locomotor-based tasks may be affected by the performer's attentional orientation. However, what is not understood is how focus of attention impacts short-distance sprinting ability. Sprinting and agility are separate motor skills and are believed to be controlled and influenced by separate underlying abilities (19). Moreover, sprinting performance does not accurately predict agility performance and vise versa (19,21,32). Thus, one cannot assume changes in agility performance would also be observed in short-distance sprinting. Consequently, there is a need for both theoretical and practical reasons to directly assess how altering focus of attention may influence sprinting performance.

As discussed above, previous studies have demonstrated that adopting an EXT focus of attention results in a more effective muscle recruitment pattern when performing a biceps curl (9) or dart throw (20). Additionally, empirical evidence has also demonstrated improved movement coordination patterns, enhanced force production, and efficient use of the stretch-shortening cycle of the lower extremities (8) as a result of adopting an external relative to an INT focus of attention. Effective muscle fiber recruitment, an evolved coordination pattern, increase ground reaction forces, and efficient stretch-shortening cycles in the legs are all critical to effectively sprint, especially over a short distance (e.g. 20 m). Theoretically speaking, if these components of sprinting have benefited from the use of an EXT focus of attention, then it is expected that when these variables (i.e. muscle fiber recruitment, force production, stretch-shortening cycle, etc.) are executed during sprinting, a noticeable improvement in observable motor behavior (i.e. sprint time) would be detected when participants are directing their conscious attention to the result of the movement, rather than focusing on the movement itself. This prediction is consistent with the perspectives presented in the constrained action hypothesis (30). Specifically, with reduced cognitive demands as a result of adopting an EXT focus of attention, the motor control system is able to coordinate the actions of the periphery resulting in elevated performance.

The assessment of sprinting performance is not only important to advance our theoretical understanding but also important from a practical perspective. Assessing sprinting performance over a short distance is widely accepted as a valid and reliable measure of speed and athletic potential (2,11). Consequently, subtle changes in verbal instructions provided by a coach or sprint test administrator may directly alter the performer's focus of attention and, therefore, affect the performance outcome. Because the ability to outrun an opponent is a highly sought after physical ability in sport, it is important to determine if sprinting performance is influenced by simply altering one's focus of attention. Addressing these considerations is particularly important considering the findings of a study by Porter et al. (16). In that study, athletes competing at the USA Track and Field Outdoor National Championships were surveyed about the type of instructions and feedback their coaches provided during practice leading up to the national championship meet. The authors also inquired about how the athletes focused their attention during competition. Surprisingly, 84.6% of surveyed athletes indicated that their coaches provided verbal instructions that elicited an INT focus of attention during practice. The result of that study also revealed that 69% of surveyed athletes used an INT focus of attention during competition. Similarly, findings reported by Durham et al. (5) indicated that 95.5% of physiotherapists provided verbal feedback that encouraged an INT focus of attention. Findings like the ones reported in the Porter et al. (16), and Durham et al. (5) underscore the need to further test the generalizability of the attentional focus that affect in commonly used tasks. Doing so will improve the techniques used by practitioners, resulting in elevated motor performances.

The purpose of this study was to investigate the effect of changing a performer's focus of attention on short-distance sprinting performance. It was hypothesized that participants would demonstrate faster movement times when provided with verbal instructions designed to promote an EXT focus of attention compared with an INT focus of attention and CON condition. Based on the findings of previous studies, it was also hypothesized that the INT focus condition would not be significantly different than the CON condition.

Methods

Experimental Approach to the Problem

We used a within-subject experimental design to examine the potential short-distance sprint performance differences that resulted from changing the subjects' focus of attention. We chose to use a within-subject design in an attempt to control for potential between-subject variability. We chose to measure the total time it took participants to sprint 20 m on an indoor hardwood service. We examined sprinting performance in 3 different focus of attention conditions. One was a CON condition, which served as a baseline measure. In the CON condition, subjects were simply asked to perform the task to the best of their ability. Subjects also performed in an EXT focus condition. In the EXT condition, volunteers were asked to focus their attention on the result of the sprinting movement. Subjects also performed sprints while in an INT focusing condition in which they were asked to focus on their sprinting technique. The order of the experimental conditions was counterbalanced to control for possible order effects. To ensure that our untrained volunteers had plenty of time to recover, subjects only executed 1 condition per day over a 3-day period. The dependent variable (i.e. sprint times from each condition) was analyzed using a repeated measures analysis of variance (ANOVA). The reported values in the following sections represent means $\pm$ *SD*.

Subjects

A total of 84 undergraduate college students ($n = 42$ women, mean age = 20.17, $SD = 1.53$ years, mean height = 162.6, $SD = 10.5$ cm; mean weight = 59.87 kg, $SD = 10.92$ kg; and $n = 42$ men; mean age = 20.8, $SD = 1.85$ years; mean height = 179.83, $SD = 9.7$ cm; mean weight = 83.91, $SD = 13.15$ kg) were recruited to participate in the study. None of the subjects were former high school track and field athletes. Also, none of the participants were current or former collegiate athletes of any sport. All participants had no formal sprint mechanics training. We considered the sample of participants to be moderate to low-skilled sprinters. However, we did not consider sprinting to be a novel task. Presumably, all participants had sprinted before their involvement in the current experiment. All participants completed a medical history form and signed an informed consent before their participation in the present study. All forms and experimental methods were approved by the University's Institutional Review Board. Participants were naive to the purpose of the study.

Apparatus and Task

The task used in this study was a maximum effort of 20-m sprint. The sprinting activity was conducted on a hard wood surface in a basketball gymnasium located at the University. Wireless infrared timing gates (Brower Timing Systems, Draper, UT, USA) were used to record the total movement time it took each participant to run the 20-m distance. The first set of timing gates were aligned with the start line; the second set of timing gates were aligned with the finish line creating infrared beams that were parallel to the start and finish lines. All timing gates were mounted atop tripods at a height of 100 cm. The timing system began collecting movement time when the subject crossed the first infrared beam located at the start line and stopped when the participant crossed the second infrared beam located at the finish line. After completion of each trial, movement time was recorded from the timing system to a computer spreadsheet and saved for later analysis.

Procedures

Utilizing a counterbalanced within-subject design, all volunteers completed a total of 3 trials in each experimental condition (i.e. INT focus, EXT focus, CON) over a 3-day period (Monday, Wednesday, Friday). Specifically, participants completed 3 trials of 1 condition on Monday, then 3 trials of a second condition on Wednesday, followed by 3 trials of the third condition on Friday. Subjects completed their testing sessions at the same time each day. Experimental conditions were counterbalanced across days of the week to control for possible order effects. Additionally, subjects were asked to maintain a consistent routine in their daily activities (e.g. amount of sleep, hydration, diet, caffeine consumption, etc.) for the duration of the study. Subjects in the INT focus condition were provided the following instructions before each of the 3 trials: "While you are running the 20-m dash focus on driving 1 leg forward as powerfully as possible while moving your other leg and foot down and back as quickly as possible as you accelerate." This instructional statement was adopted from a popular track and field coaching textbook (4). The authors also consulted with a professional track and field sprinting coach to ensure these were common cues provided when cuing sprint mechanics. When subjects were in the EXT focus condition they were provided the following instructions: "While you are running the 20-meter dash focus on driving forward as powerfully as possible while clawing the floor with your shoe as quickly as possible as you accelerate." The EXT instructions were modeled after the INT instructions in an attempt to keep the 2 sets of instructions "mechanically" similar. When subjects were in the CON condition, they were instructed to "Please run the 20-meter dash as quickly as possible." The CON instructions were designed to be neutral and to not explicitly direct the performer's attention internally or externally.

All volunteers completed the same 5-minute dynamic warm-up before data collection on each of the 3 testing days. After participants finished their warm-up, they were provided the following instructions: "Today you will complete a total of 3 maximum effort 20-meter dash sprints. Prior to each trial you will be provided a set of instructions. Please listen carefully to the provided instructions." After, participants were asked if they had any questions, they were instructed to stand directly behind the start line; at that time, the prescribed instructions (i.e. INT, EXT, or CON) were read aloud to the participant. After the instructions were provided, participants were told they could begin running when they were ready. Specifically, participants were

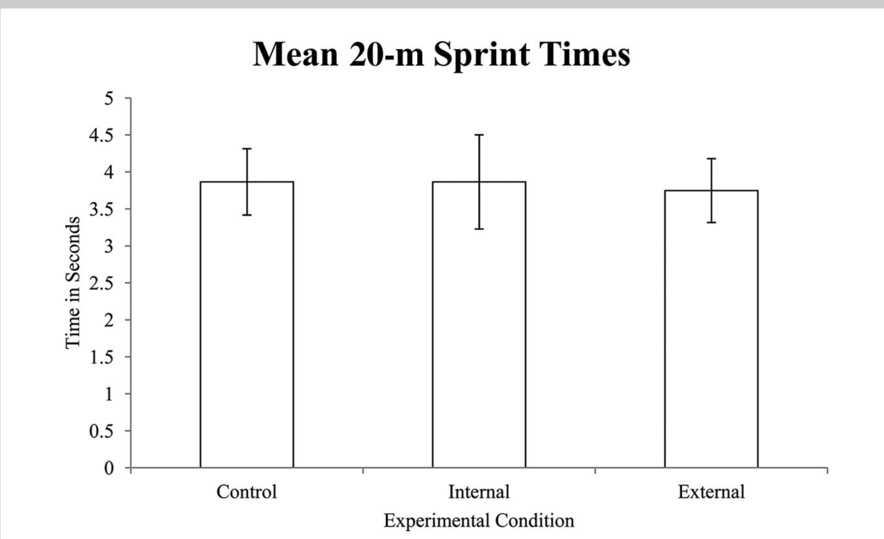

Figure 1. Mean 20-m sprint times for each of the 3 experimental conditions. The mean time for each condition is the mean of the 3 trials completed by participants within each condition. Error bars represent *SD*. The results of the ANOVA revealed a significant main effect for condition, $F(1, 83) = 6565.3$, $p \leq 0.001$, $\eta^2 = 0.988$. Multiple comparisons using least significant differences indicated that the external condition ($M = 3.75$ seconds, $SD = 0.43$) was significantly faster than the internal (INT) ($M = 3.87$ seconds, $SD = 0.64$; $p = 0.039$; ES = 0.22) and control (CON) conditions ($M = 3.87$ seconds, $SD = 0.45$; $p = 0.003$; ES = 0.27). The analysis also revealed that the INT and CON conditions were not significantly different.

not provided a "go or start" command, rather they were allowed to start running at their own discretion. The automatic timing system started collecting movement time when the participant crossed the start line and stopped collecting data when the participant crossed the finish line. All participants started the sprint from a "2-point" standing position. They were allowed to position their feet and legs in a comfortable staggered position. They were allowed to place their arms in a position of their choosing. In an attempt to avoid any confounding attention directing cues, no verbal instructions were provided to the volunteers about how they should stand or use their arms during the start or while they were sprinting. After the completion of each trial, participants walked back to the start line and sat for 1 minute. After the 1-minute rest period, participants were instructed to step back to the start line. At that time, the researcher reread the prescribed instructions (i.e. INT, EXT, or CON) to the subject. That exact process was repeated for each trial over the 3 days of testing. Only the experimenters and the participant were present in the gymnasium at the time of testing. At no time during the 3 days of testing were participants informed of their running times or provided any performance-related feedback.

Statistical Analyses

The Statistical Package for the Social Sciences version 16 was used for the data analysis. Participants' movement times were averaged within each condition, providing 1 time per participant per condition for the analysis. Movement time values were analyzed using a 1-way ANOVA with repeated measures. When significant differences were observed, a partial η^2 effect size (ES) statistic was calculated to determine the magnitude of all observed differences. Effect sizes were based on the criteria of $\eta^2 < 0.01$, small; $\eta^2 = 0.06$, moderate; and $\eta^2 > 0.14$, large.

Results

The results of the ANOVA revealed a significant main effect for condition, F (1, 83) = 6565.3, $p \leq 0.001$. Multiple comparisons using Least Significant Differences indicated that the EXT condition (mean = 3.75 seconds, $SD = 0.43$) was significantly faster than the INT (mean = 3.87 seconds, $SD = 0.64$; $p = 0.039$; $ES = 0.22$) and CON conditions (mean = 3.87 seconds, $SD = 0.45$; $p = 0.003$; $ES = 0.27$). The analysis also revealed that the INT and CON conditions were not significantly different. Mean run times across conditions are displayed in Figure 1.

Discussion

Previous research has demonstrated that directing attention externally improves whole body movement tasks such as the vertical jump (25), standing long jump (13,15,24), agility L run (14), and balance (30). The purpose of this study was to investigate if changing a person's focus of attention through the use of verbal instructions influenced sprinting performance. Based on the findings reported in previous research, we predicted that participants would run significantly faster following instructions that directed their attention externally rather than internally. We also predicted that directing attention externally would produce faster movement times compared with a CON condition with neutral instructions that did not explicitly direct attention internally or externally. The results of the analysis support the experimental hypotheses. Specifically, when participants completed trials utilizing the EXT instructions, they ran significantly faster compared with trials using the INT and CON instructions. Consistent with previous findings, participants' performances in the INT condition were not significantly different than trials completed in the CON condition. In fact, they were nearly identical (Figure 1).

Although the instructions used in the INT condition were adopted from a popular track and field coaching book, the findings of this study clearly demonstrate that subtle differences in verbal instructions that promote an EXT focus of attention enhance sprinting performance. This finding adds to a growing body of research suggesting that practitioners should be critical of the instructions they provide. Additionally, verbal instructions should be structured in a manner that directs the performer's conscious attention externally. This study makes a unique contribution to the existing body of literature by demonstrating the significant influence that verbal instructions can have on short-distance sprinting performance. In addition, this study demonstrates the generalizability of using an EXT focus of attention to enhance the performance of a locomotor skill such as sprinting.

The present findings provide partial support of the constrained action hypothesis. The constrained action hypothesis proposes that directing attention toward the movements of the body (i.e. INT focus) interferes with or "constrains" the motor control system. However, providing instructions that elicit an EXT focus facilitates an unconstrained motor system, consequently producing enhanced motor performances. According to the performance data (i.e. sprint times), the internal instructions used in this study (i.e. leg and foot action) did not have a negative impact on sprinting performance. This conclusion is supported by the similar performances observed between the CON and INT conditions. Conversely, it seems that the instructions provided to participants in the EXT condition had an enhancing effect on sprinting ability, as indicated by significantly faster sprint times relative to performances in the CON and INT condition.

A noteworthy observation in the present study is the similar movement times observed for trials completed in the INT and CON conditions. This finding is consistent with prior attentional focus research (12,14,31). A possible interpretation of this previous and current finding is that subjects in the CON condition chose to direct their attention internally, resulting in similar performances to the INT condition. However, verbal reports from a recent study propose a different conclusion when comparing the INT and CON conditions. In a study by Porter et al. (14), after subjects completed each trial of an agility test, they were asked what they focused on while performing the agility task. Although the subjects in the EXT condition reported focusing their attention externally 67% of the time and in the internal condition they reported focusing their attention internally 76% of the time, volunteers in the CON condition reported that 77% of the time they used neither an exclusive internal or exclusive EXT focus of attention strategy. It is possible that subjects in the present study followed a similar focus of attention strategy. Specifically, when subjects were completing their 20-m sprint trials in the CON condition, they likely did not focus their attention appropriately or in a consistent manner resulting in less than optimal performance (14). This finding indicates that coaches should provide frequent verbal instructions that explicitly direct attention to movement effects.

Previous research provides another possible explanation for the results of the present experiment. Several studies have demonstrated that adopting an EXT focus of attention produces more effective movement patterns through efficient muscle fiber recruitment (9,20,33) and a more effective stretch-shortening cycle (8). Although outcome measures were used for this study, the findings suggest that the faster movement times by the EXT condition may have been a result of efficient muscle fiber recruitment. Additional research using performance productions measures, such as EMG, is needed to test the underlying mechanisms that may be responsible for the reduced sprint times demonstrated by the EXT condition. Nonetheless, the present results show that the sprinting performance of moderate and low skilled sprinters can be immediately improved by directing attention to the result of the movement rather than the movement itself.

Sprinting speed is a common measure that is used in numerous athletic venues to evaluate both performance and athletic potential. Thus, it is advantageous for athletes to not only work on improving speed from a physiological and mechanical perspective but it is paramount to also work on the cognitive component of speed training. The results presented above clearly indicate that the benefits of focusing on the result of the movement extend to continuous power-based tasks such as sprinting. Athletes and coaches alike should be encouraged to test methods similar to the ones presented in the present study if they desire immediate improvements in sprint performance, especially in low-skilled sprinters. This further highlights the need for coaches to spend time planning what specific instructions and cues they provide to athletes. The large and growing body of literature strongly supports the conclusion that providing verbal instructions or feedback that encourages performers to focus their attention externally will elevate their motor performance. Also, the findings of this study further underscore the importance of using consistent instructions when administering motor skill tests. As demonstrated in the present study, a subtle change in verbal instructions can significantly alter motor skill performance.

Practical Applications

The findings reported in this study suggest that focusing on movement effects rather than aspects of the body significantly increase running speed when performing a short sprint. As practitioners design training environments, they should not only be concerned with volume and intensity of the training program but also should pay particular attention to the impact of verbal instructions on performance. The results of this study provide practitioners a simple strategy on how to formulate verbal cues or instructions when teaching sprint mechanics. When providing instructions, practitioners (coach, physical therapist, educator) should keep in mind the significant effect they can have on performance through their choice of words. Specifically, coaches should structure their verbal instructions to emphasize the effects or outcome of the movements rather than the movements themselves. In other words, wording of instructional statements should have a strong emphasis on the end result as opposed to narrowly focusing on instructions that cause the athlete to focus on specific movements or body parts. It is not only critical that coaches have knowledge in proper sprint techniques but also equally important that coaches are able to effectively cue deficiencies of movement in sprint mechanics. Coaches should be very reluctant to convey movement information that is directly based off of qualitative or quantitative movement analyses. Instead, coaches must translate biomechanical information, derived from analyses, in a way that optimizes the attentional focus of the athlete. Based on the results of this study, it appears an effective way to accomplish this goal is by cuing sprinters to focus on movement effects rather than specific body parts.

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