Attentional Focus and Cueing for Speed Development

Article *in* Strength and conditioning journal · December 2016

DOI: 10.1519/SSC.0000000000000266

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ABSTRACT

STRENGTH AND CONDITIONING PROFESSIONALS COMMONLY DEPEND ON EVIDENCE TO GUIDE "WHAT THEY COACH" (E.G., PROGRAMMING), BUT THE SAME CANNOT ALWAYS BE SAID FOR THEIR APPROACH TO "HOW THEY COACH" (E.G., INSTRUCTION). CONSEQUENTLY, PROFESSIONALS HAVE ADOPTED THE CONVENTIONAL VIEW THAT COACHING IS MORE ART THAN SCIENCE, DESPITE THE FACT THAT THERE ARE DECADES OF RESEARCH ELUCIDATING THE SCIENCE UNDERPINNING THIS SO-CALLED ART. IN LIGHT OF THIS GAP, THIS ARTICLE WILL DELVE INTO THIS UNDERPINNING SCIENCE AND PROVIDE AN EVIDENCE-BASED FRAMEWORK FOR INSTRUCTION AND CUEING THROUGH THE LENS OF LINEAR SPEED DEVELOPMENT.

INTRODUCTION

John Wooden is not only considered by most to be one of the best coaches of all time but also remembered for his love of teaching. Wooden's appreciation for teaching is best exemplified by his famous words, "you haven't taught until they have learned" (42). This quote suggests a distinction between teaching and learning, supposing that teaching does not always result in learning. As it turns out, Wooden's intuition and insights were quite accurate, as research has shown that the acute motor skill performance expressed in a practice context is not necessarily indicative of the retention and transfer (i.e., learning) of those motor skills in a future practice or sporting context (24,61). Consequently, it is important for strength and conditioning (SC) coaches to dissociate between performance and learning, as *performance* "refers to the temporary fluctuations in [motor skill] behavior that can be observed and measured during or immediately after the [skill] acquisition process," whereas *learning* "refers to the relatively permanent changes in [motor skill] behavior that support long-term retention and transfer" (61). Thus, coaches should be cautious not to assume learning has occurred because they observed an immediate change in motor skill performance; rather, coaches must be patient, waiting to see if the initial change in motor skill performance is retained during subsequent practices or within the context of competition.

Although learning is mediated by a number of factors, such as the differential use of blocked versus random practice schedules to promote skill learning (i.e., contextual interference) (50,53), one of the most misunderstood factors impacting motor skill learning is the influence of instruction and cueing on the attentional focus adopted by the athlete (23,55). Part of this misunderstanding comes from the commonly held belief that the act of coaching is an *art* rather than a *science*. For example, Stoszkowski and Collins (63) evaluated the preferred methods for acquiring knowledge from 320 coaches that spanned 26 different countries and 30 different sports. The results showed that 92.6% of coaches preferred informal learning environments, with 41.5% of coaches preferring peer discussion and 1.8% of coaches preferring to get their information from academic journals. It is disconcerting to consider that the highest level of evidence (i.e., research) ranks last on the preferred methods for coaches to acquire knowledge, with YouTube (2.9%), social networks (4.9%), and websites (9.1%) all achieving higher usage marks. Furthermore, 66% of coaches noted that pedagogy, which includes topics such as coaching methods, communication, and skill acquisition, was the last area where they had learned something that was useful to their coaching practice, whereas only 8.1% had noted learning something important from psychology, physiology, or biomechanics.

This evidence suggests that coaches are interested in the coaching methods that mediate motor skill learning; however, they are emphasizing the experience of other coaches rather than the

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KEY WORDS:
coaching; instruction; cueing; attentional focus; acceleration; sprinting

assimilation of scientific evidence and the systematic application of such evidence within their personal coaching practice. This presents a problem, because research has already suggested that coaches preferentially adopt a method of instruction and cueing that is not always optimal for motor skill learning (55). Thus, there is a misalignment between the type of information coaches' want (or find useful) and their preferred method for acquiring such information. Consequently, the instruction and cueing methods that are currently adopted by coaches to teach motor skills, for which peers are motivated to learn from one another, are not likely to optimize motor skill learning. For this reason, it is important that coaches understand the science of instruction and cueing, while being provided with an instructional framework that can be applied in a practical context with the explicit goal of promoting motor skill learning.

ATTENTIONAL FOCUS: INTERNAL FOCUS VERSUS EXTERNAL FOCUS

Just as Stoszkowski and Collins (63) reported that 66% of coaches had recently found information within the category of pedagogy to be most helpful in their current practice, there has been a recent increase in SC publications emphasizing the influence of attentional focus on skill learning as mediated by coaching instructions and cues (6,21,30,48,49,52,56). The role of attentional focus, or an athlete's focus of attention, has emerged as an important mediator of motor skill learning (70).

From a motor skill learning standpoint, *attentional focus* can be defined as the conscious effort of an individual to focus their attention through explicit thoughts in an effort to execute a motor skill with superior performance (6). From a coaching perspective, instructions and cues are used to focus an athlete's attention on the most important feature of the motor skill being learned before motor skill execution. Specifically, an athlete can be encouraged to adopt an *external focus* on the intended movement effect or outcome (e.g., "push the ground away" or "cut and change direction as fast as you can"), adopt an *internal focus* on body movements associated with the motor skill (e.g., "push off of the inside edge of your foot" or "rapidly extend your hip, knee and ankle") (70,72,76), or in the case of no instruction being provided, adopt what can otherwise be considered the athlete's *normal focus*, which is likely going to result in internally or externally directed thoughts (55). From a practical perspective, a coach teaching a defensive back in American football how to improve their backpedal speed, emphasizing increased leg frequency, could provide an external focus cue by encouraging the athlete to focus on "pushing off the ground as rapidly as they can" or they could provide an internal focus cue by encouraging the athlete to focus on "extending their knees as rapidly as they can." Although the essence of the 2 cues is similar (i.e., fast leg action), the external focus references "pushing off the ground" and the internal focus references "extending [the] knees." Furthermore, coaches may see this difference as trivial, with the likely belief being that a variety of factors (e.g., motor skill type, skill level of athlete, specific motor skill error) influence the differential use of internal versus external focus cues; however, the available evidence suggests that coaches would be more likely to encourage motor skill learning if they used instruction and cues that directed attention externally opposed to internally (70). Contrary to this evidence, it is common for coaches and physical therapists to preferentially use internally directed instruction and cues to teach motor skills. For example, Porter et al. (2010) (55) found that of the 13 track and field athletes questioned at the USA Track and Field Outdoor National Championship, 84.6% reported that their coaches use internal focus cues during practice, with 69% of those athletes reporting that they use internal focus cues during competition. Similar results were seen in a group of 8 physical therapists who were working with post-stroke patients on gait rehabilitation, with the results showing that the physical therapists were providing internally focused instruction 67% of the time. Based on the aforementioned studies, there is an apparent discontinuity between current practices and the best practices that should be used to encourage motor skill learning (61).

Wulf et al. (72) (experiment 1) were the first to evaluate the influence of attentional focus on practice performance and motor skill learning. The researchers found that instruction encouraging an external focus opposed to an internal focus of attention led to better performance and motor skill learning during a ski-simulator task in novice participants. Specifically, the internal focus group was "instructed to exert force on the outer *foot*" and the external focus group was "instructed to exert force on the outer *wheels*" while a control group received no additional instruction. The results showed that the external focus group was more effective than the internal focus group during practice (i.e., greater amplitude and frequency of movement). More importantly, the external focus group was significantly more effective than the internal focus and control groups during a delayed retention test (i.e., day 1–Practice; day 2–Practice; day 3–Retention Test) where no instruction was provided during the same ski-simulator task. This provides evidence that an external focus leads to superior skill learning compared with an internal focus and control condition within a novice population learning a dynamic balance task.

In a follow-up experiment, Wulf et al. (72) (experiment 2) evaluated the effects of instruction on balance in another group of novices. An internal focus group was asked to "keep their feet at the same height" while an external focus group was asked to "keep the red markers [on the balance platform] at the same height." The results showed no difference between groups during practice; however, the external focus group outperformed the internal focus group during a delayed retention test where no additional instruction was provided. Thus, the benefit of an external focus of attention was not observed until the delayed retention test. This is important, as coaches may observe that an internal cue is effective during the skill acquisition process; however, the mechanism by which an internal focus cue encourages an acute change in performance does not align with the mechanisms associated with long-term motor skill learning. Similar results have been reported elsewhere (20,74), supporting the supposition that coaches should assess learning separate from the context where the initial skill learning took place (i.e., future practice session or competition). There has since been extensive research confirming the various performance and learning benefits of an external focus of attention for balance and suprapostural tasks (8,37,60,72,78), neuromuscular expression of force and velocity (19,21,34,65), discrete sport skills with an implement (e.g., golf, tennis, and soccer) (73,75,77), discrete sport skills without an implement (e.g., vertical and horizontal jumping) (52,69,71,79), and continuous sport skills (e.g., swimming, running, sprinting, and agility) (22,51,58,62).

Building on the evidence noted above, the following sections will discuss the influence of attentional focus on sprint performance. Sprinting, which will be discussed in terms of acceleration and absolute speed, was selected for 3 primary reasons. First, an athlete's ability to accelerate has broad application and importance to a variety of sports (14,16,29). Second, although not as prevalent as acceleration, absolute speed (or maximal velocity) plays an important role within many team sports (e.g., soccer and rugby) (7,13) and also represents the most common cause of hamstring injuries, for which technique has been identified as one of the underpinning causes (2). Finally, there is an emerging body of evidence elucidating the biomechanical determinants of effective sprinting (9–11,40,57) and the role of attentional focus (22,54,56), which collectively provides the necessary insights required to build an evidence-based framework around instruction and cueing for sprinting.

ATTENTIONAL FOCUS: SPRINTING

Ille et al. (22) were the first to evaluate the differential effects of an internal focus and external focus on 10-m sprint performance in a group of expert and novice sprinters. Participants performed 10-m sprints from a block start under an external focus, internal focus, and a control condition. During the internal focus condition, the participants were asked to "push quickly on your legs and keep going as fast as possible while swinging both arms back and forth and raising rapidly your knees." During the external focus condition, the participants were asked to "get off the starting blocks as quickly as possible, head towards the finish line rapidly and cross it as soon as possible." The results showed that compared with an internal focus, the external focus condition resulted in faster total sprint times, faster reaction times, and faster running times (i.e., total sprint time minus reaction time and block clearance).

More recently, Porter et al. (56) evaluated 84 novices and 9 trained collegiate football players (i.e., intermediate skill level for sprinting) (54) in a 20-m and 20-yd sprint task under an external focus, internal focus, and a control condition. Both studies used similar cues, with the participants being told to focus on "running the 20 meter/yard dash with maximum effort" during the control condition, focus on "running the 20 meters/yards with maximum effort, [and] focus on gradually raising your body level. Also, focus on powerfully driving one leg forward while moving your other leg and foot down and back as quickly as possible" during the internal focus condition, and to focus on "running the 20 meters/yards with maximum effort, [and] focus on gradually raising up. Also, focus on powerfully driving forward while clawing the floor as quickly as possible" during the external focus condition. The results showed that novices were significantly faster over 20-m under the external focus condition compared with the internal focus and control conditions, with no difference between the internal focus and control condition (56). Conversely, Porter and Sims (2013) (54) found no difference between conditions for the 0 to 10-yd and 0 to 20-yd splits; however, the football players were significantly faster over the 10- to 20-yd split under the control condition compared with the internal focus and external focus conditions, which were not different from one another. Porter and Sims (2013) (54) concluded that whereas novices benefit from an external focus, trained athletes might benefit from adopting a normal focus of attention (i.e., control condition).

The research described above shows that both novices and experts benefit from adopting an external focus of attention over various sprint distances (22,56). Additionally, research has also shown that experts benefit from adopting simple external focus cues that relate to different phases of the 100-m sprint compared with their baseline or normal focus (i.e., control) (31). However, there is also evidence suggesting that those with an intermediate level of sprinting experience perform equally well across internal focus, external focus, and control conditions for certain sprint distances (i.e., 0–10 and 0–20 yd), while performing better under a control condition (i.e., normal focus) for others (i.e., 10–20 yd). Consequently, although more research is required to fully understand the influence of attentional focus on sprint performance and learning, when considered in the context of the available evidence (see Ref. 70 for a detailed review), it can still be recommended that coaches should encourage an external focus opposed to an internal focus of attention when instructing sprinting.

Finally, there are 2 relevant limitations within the studies noted above that should be considered in a practical context. First, all 3 studies (22,54,56) used cues that included more than 1 focus point. This creates a memory recall problem, because it would be difficult for the participants to focus on all cues simultaneously during such a high-intensity activity. Thus, it is advisable for coaches to limit the substance of their instructions or cues to 1 or 2 focus points, because this aligns with known limitations in short-term memory recall (38) and the vast majority of the current literature on attentional focus (70). Second, the studies noted above did not directly assess learning through the use of delayed retention and transfer tests, as this is a known limitation of using within-subject designs. Thus, the current evidence only provides insights concerning acute practice performance rather than long-term skill learning. Future studies, using a between-subject design, should not only assess practice performance but also assess sprint skill learning through the use of delayed retention and transfer tests. Moreover, longitudinal studies examining the differential impact of internal and external focus cues would likely provide the most practically relevant evidence for coaches.

In summary, although the evidence for using an external focus of attention to optimize sprint performance and learning is still emerging, when considered in terms of the extant literature (70), it can be recommended that coaches should instruct and cue in a way that encourages athletes to adopt an external focus. However, the recommendation to use instructions and cues that encourage an external focus is only a starting point, because there seems to be a series of factors that potentially mediate the effectiveness of a given external cue (68). Therefore, the next section will discuss the characteristics of an external cue that can be manipulated to ensure that the athlete's focus of attention is directed at the most relevant feature of the to-be-learned motor skill (45), while identifying the subcharacteristics within an instruction or cue that can be manipulated to ensure individualized effectiveness (35).

ATTENTIONAL FOCUS: CUE CHARACTERISTICS

Although the evidence presented above clearly shows the benefit of using instructions and cues that encourage an external focus opposed to an internal focus when teaching a motor skill, there is also evidence that is pointing to the mediating role of certain cue characteristics (e.g., distance; Ref. 37). Specifically, there are 3 attentional focus cue characteristics that likely influence the benefit of adopting an external focus of attention. Those characteristics include focus *distance*, focus *direction*, and the intent that is encouraged by the focus *description*. Generally speaking, the focus distance can be proximal or distal to a fixed point (e.g., proximal: "drive the barbell away from the bench"; distal: "drive the barbell toward the ceiling"), the focus direction can be toward or away from a fixed point (e.g., away: "sprint away from the start line as fast as you can"; toward: "sprint toward the finish line as fast as you can"), and the focus description can be created through the use of action verbs (e.g., "snap, spring, or bounce off the ground") or analogies (e.g., "drop into the cut like you are trying to sit under a low roof"). To provide an example, consider the following external focus cue intended to improve sprint speed:

Example: "Focus on driving the ground back as explosively as you can."

In analyzing the substance of this external focus cue, it is evident that it contains all 3 D's (i.e., distance, direction, and description) noted above. That is, both distance and direction are noted with the portion of the cue stating, "focus on driving the ground back." Specifically, the ground would be considered a *proximal* focus, while encouraging the individual to drive *away* from the ground. Similarly, the description of the focus intent is captured by the portion of the cue stating, "focus on driving … as explosively as you can." The *action verb* "explosively" is used to express the intent and intensity with which the sprint should be performed. Similarly, the *action verb* "driving" is used to promote a fast and forward action, as would be expected when accelerating onto a freeway, for example. To provide further context, consider another example:

Example: "Focus on exploding towards the cone as if your were chasing an opponent."

Again, it is evident that all 3 D's are present within this external focus cue. This time the portion of the cue stating "towards the cone" captures the distance and direction. Because the cone is far away (e.g., 10 m), the distance would be considered more *distal*, whereas the direction would be *toward*. Moreover, the description in this cue uses an *action verb* and a clarifying *analogy*. Specifically, "focus on exploding" calibrates intent and intensity, whereas "as if you were chasing an opponent" provides an analogous scenario where the motor skill being taught would normally be performed.

The following sections will provide further insights into the available evidence and practical recommendations for manipulating distance, direction, and description.

DISTANCE

The distance the external focus encourages has been shown to mediate the benefit of an external focus of attention. The influential role of distance was first observed when Wulf et al. (2000) (75) found that novice golfers benefited from adopting a proximal external focus (i.e., club) opposed to a distal external focus (i.e., ball trajectory). The impact of distance was later assessed by McNevin et al. (2003) (37), who found that balance was improved when novices either focused on keeping a set of markers that were inside (i.e., far-inside) or outside (i.e., far-outside) of their feet parallel (i.e., external foci) opposed to focusing internally (i.e., "keep feet parallel") or using a close external focus (i.e., "keep a set of markers in front of your feet parallel"). Focus distance has since been evaluated in dart throwing (1,36), putting (25,59), golf (5,44), rowing (43), horizontal jumping (48,49), a dynamic balance task (17), and playing the piano (15). Generally speaking, a distal external focus seems to be more beneficial than a proximal, especially as expertise increases (5) or if the requirement of the task is to produce maximal power (i.e., broad jump) (48); however, novices are more likely to benefit from a proximal external focus, especially for tasks involving an implement and accuracy (i.e., throwing, hitting, and striking) (77).

DIRECTION

The direction of focus encouraged by an external focus of attention has not been explicitly examined within the attentional focus research. However, a series of studies by Porter et al. (48,49) can be recontextualized to provide insights concerning the influence of focus direction. Specifically, in both studies, participants were asked to use a proximal external focus (i.e., "when you jump, focus on jumping as far past the start line as possible") and a distal external focus (i.e., "when you jump, focus on jumping as close to the cone as possible"). The results showed that the distal external focus resulted in the farthest jump distances, followed by a proximal external focus and then an internal focus. Although these results can be examined as proximal and distal, they can also be evaluated in terms of toward and away. More specifically, the proximal external focus references "jumping as far past the start line as possible," which can be considered an "away-focus" because the participant is encouraged to jump as far away from the start line as possible. Conversely, the distal external focus references "jumping as close to the cone as possible," which can be considered a "toward-focus" because the participant is encouraged to jump toward the cone. Thus, these results can be reconceptualized to suggest that a "toward" external focus resulted in superior performance compared with an "away" external focus. Considering the emphasis on jumping far, whether thought of as a distal external focus or a "toward" external focus, it makes sense that an external focus that made the distance goal more salient would result in superior performance compared with the alternatives (i.e., proximal external focus or "away" external focus).

DESCRIPTION

The description presented within an external focus cue can be considered the most important source of meaning, as it defines the spatiotemporal (i.e., space and time) aspects of the movement. For example, consider the action verbs *push* and *punch*. Although both words suggest impact between 2 persons, the word *push* would not be associated with the same level of intensity as the word *punch*. Specifically, *pushing* someone is associated with a longer and slower action than *punching* someone. Thus, if a SC coach wants an athlete to spend more time on the ground during a sprint, then they could suggest that the athlete "focus on pushing the ground away"; conversely, if that same coach wants the athlete to spend less time on the ground during the sprint, then they could suggest that the athlete "focus on punching the ground away." Although the fundamental movement encouraged by the 2 focus cues is the same, the manner with which the movement is performed (i.e., slower or faster) will likely be different.

Finally, although not explicitly defined as an external focus of attention, analogies can be considered a type of external focus, because they do not explicitly call attention to the body and associated movement process (i.e., internal focus). Moreover, analogies have been shown to improve skill learning to a greater degree than providing explicit instruction (26,27,46); however, this effect is likely mediated by culture (47), because culture influences the types of analogies that are familiar and relevant to the athlete. Thus, analogies should be culturally and generationally relevant, while drawing associations that help the learner understand goal-relevant features of the movement being taught. For example, when teaching a novice how to accelerate from a 2-point stance, a practitioner could use the following analogy:

Example: "Focus on driving off the start line like a jet taking off."

This analogy imparts 2 important goal-relevant features that are shared between a human accelerating and a jet taking off. First, this analogy suggests that an angled body position with a progressive rise is important, as a jet will initially have a low angle that progressively rises through takeoff. Second, this analogy also suggests that this movement should be done very fast, as anyone who has seen a jet takeoff can attest. Thus, the jet analogy and the movement being taught share specific spatiotemporal characteristics, which is why this analogy would work well for teaching acceleration. Conversely, had the analogy required the learner to "focus on driving off the start line like a helicopter taking off," there would have been a disparity between the spatiotemporal characteristics needed for effective acceleration and those suggested by the helicopter analogy. Therefore, analogies allow a coach to convey important information about goal-relevant features of a movement without needing to use overly complex or internally directed language.

In summary, the distance, direction, and description encouraged by an external focus of attention will have a direct impact on how a movement is performed. Although there are varying levels of evidence supporting the differential impact of the 3 D's on performance and learning, the theoretical rationale described above serves as a practical framework for practitioners looking to optimize the external focus cues they provide their athletes (Figure).

INSTRUCTIONAL FRAMEWORK

The evidence and practical insights presented above provide a clear framework that coaches can use to optimize their instruction and cueing. By directing an athlete's attention externally toward the movement outcome, opposed to internally toward the movement of the body, the coach ensures that attention is directed at the primary movement goal (e.g., jumping high) rather than a subservient process goal (e.g., extending the hip). However, if the information provided by the

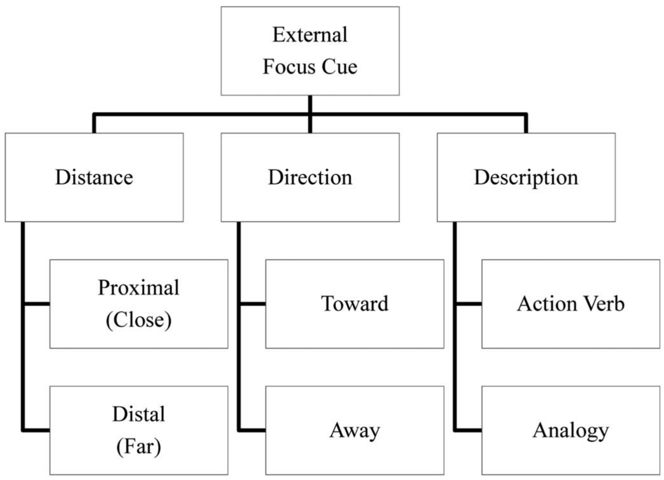

Figure. Focus cue characteristics: distance, direction and description. Reprinted with permission from IDEA Health & Fitness, Inc., www.ideafit.com.

coach, irrespective of whether it is external or internal, is not directed at task-relevant features of the motor skill, then the cue is not likely to be as effective (45). Thus, it is important for coaches to consider the kinematic and kinetic determinants of the movements they are teaching when selecting the most precise instruction or cue. For example, if while working with a rugby wing, a coach identified that the athlete was below positional norms for relative lower-body strength, relative power, and 10-m sprint speed, then the coach may decide to emphasize the development of strength qualities that are associated with the expression of sprint speed (3,28). Conversely, if an athlete is "strong enough," then it may be beneficial to emphasize sprint-specific work, as additional strength development may not support further changes to speed (12). In this scenario, it would be important to prioritize the common kinematic or technical errors, which if modified, would support improved sprint ability. For this reason, it is important that coaches have a clear understanding of the kinematic and kinetic determinants of the movements they are teaching. In line with this view, the following sections will provide an instructional framework for acceleration and absolute speed. Each instructional framework will emphasize the kinetic and kinematic determinants of the movement, while associating externally focused cue examples that can be modified in terms of distance, direction, and description.

INSTRUCTIONAL FRAMEWORK: ACCELERATION

Sprint acceleration, or the ability to rapidly increase velocity (m/s^2) over short to moderate distances (i.e., 5–10 m), is one of the most important speed qualities required in sport (e.g., Ref. 18). Until recently, the kinetic and kinematic determinants of acceleration were not well understood beyond the practical experience of coaches. Rabita et al. (57) produced the first overground sprinting study to examine the determinants of effective acceleration based on a population of elite and subelite sprinters. The results clearly showed that the elite sprinters could produce nearly 20% more horizontal force relative to body weight than the subelite sprinters (9.59 versus 7.74 N/kg, respectively), allowing the elite sprinters to leave the blocks 0.44 m/s faster than the subelite sprinters, which accounted for 80% of the between-group velocity differences for the 40-m sprint (8.16 versus 7.59 m/s, respectively) (9). From an attentional focus perspective, the goal is to get the athlete to "push back" with as much force as possible (39–41,57). Consequently, instructing or cueing technical attributes, or developing neuromuscular qualities, which encourage a coordination profile that optimizes horizontal force production, is desirable.

Although there is a scarcity of kinematic data on the optimization of the acceleration phase of sprinting, the fieldwork and research done by Mann provide a strong basis for understanding the technical qualities associated with elite acceleration and absolute speed as discussed in the next section. In his book, *The Mechanics of Sprinting and Hurdling*, Mann discusses the kinematics associated with what he refers to as critical positions. One such position for acceleration is toe-off or the position the body is in right before leaving the ground into flight. During the first step out of a start position, effective sprinters will achieve a low trunk angle relative to the ground (~48–53°), an extended back leg (i.e., "push leg"; ~0° @ hip; ~154–159° @ knee), and flexed front leg (i.e., "punch leg"; ~80–90° @ hip; ~≤90° @ knee). These positions will then rapidly reverse as the athlete transitions into their second step, with the back leg punching forward and the front leg pushing back. This transition is often called "piston-like leg action," because the legs move forward and back in straight lines with minimal cyclical action (i.e., up and down action as if cycling a bike), especially in the first 2–3 steps of acceleration from a static start (32). Note that these positions are targets rather than absolutes, as many team sport athletes will not be able to achieve the same positions as the elite sprinters for which these recommendations are based. Despite this, the norms described above will provide the coach with insights into where their athlete can improve, in a relative sense, to maximize their acceleration.

From an instruction and cueing standpoint, there are 4 general categories that emerge from the limited research available on acceleration. Generally, coaches label these 4 categories as *posture* or trunk position, *front-side leg action* or the punch leg, *backside leg action* or the push leg, and *arm action* (64). These 4 categories have become ubiquitous coaching references across

Table 1
Instructional framework for acceleration

Acceleration			Distance		Direction		Description		
Motor Skill Characteristic		**Internal Focus**	**External Focus (Close)**	**External Focus (Far)**	**External Focus (Away)**	**External Focus (Toward)**	**External Focus (Action Verb)**	**External Focus (Analogy 1)**	**External Focus (Analogy 2)**
Posture	Minimize trunk flexion, achieve spinal neutral, and project forward and upward at a low angle relative to the ground	"Focus on keeping a neutral spine while you sprint forward at a low body angle"	"Stay long & low as you drive the ground back as explosively as you can"	"Stay long & low as you explode toward the set of cones on the 10-meter line"	"Get long as you drive away from the start line as rapidly as possible"	"Get long as you drive toward the set of cones on the 10-meter line"	"Project low and get long as you explode off the start line"	"Project out from the start line as if the top of your head was a battering ram smashing through a door"	"From head to heel, imagine your body is a chain being pulled in both directions - snap the chain as you project out from the start line"
			Place pieces of athletic tape on each knee cap as reference point (4)						
Leg action: front side	Optimize hip, knee and ankle flexion at the point of toe-off, emphasizing a forwardly directed leg action	"Focus on flexing your hip, knee and ankle as you bring your leg forward"	"Accelerate the pieces of tape up & away from the ground as rapidly as you can"	"Accelerate the pieces of tape toward the top of the fence line in front of you as rapidly as you can"	"Drive the pieces of tape away from the start line as fast as you can"	"Drive the pieces of tape toward the top of the fence line as fast as you can"	"Repeatedly explode through the pieces of tape as fast as you can"	"Drive your knees forward as if you were repeatedly punching through sparing mitts"	"Drive your knees forward as if you were continuously shattering panes of glass"
Leg action: backside	Optimize hip, knee and ankle extension at the point of toe-off, emphasizing a backwardly directed leg action	"Focus on extending your hip, knee and ankle as you bring your leg backward"	"Push the ground back with as much force as possible"	"Push past the timing gates with as much speed as possible"	"Sprint away from the start line as fast as possible"	"Sprint toward the timing gates as fast as possible"	"Hammer the ground back as hard and fast as you can"	"Explode out and up like a cheetah is 2 steps behind you"	"Explode out and up like a jet taking off from an aircraft carrier"

(continued)

Table 1
(continued)

			Place pieces of tape on the front of the shoulder and the ulnar side of the wrist as reference points (4)						
Arms	Emphasize a reciprocating action whereby the arm moving forward is flexing at elbow and shoulder, while the arm moving backward is extending at the elbow and shoulder	"Focus on alternating your arms by flexing and extending at your elbow and shoulder"	"Continuously accelerate the pieces of tape away from one another as fast as possible"	"Continuously accelerate the pieces of tape on your wrist back at the wall as fast as possible"	"Drive the pieces of tape toward & away from one another as aggressively as possible"		"Throw the tape on your wrist past your pockets as fast as possible"	"Imagine your forearm is a door and your elbow is the hinge—open and close the door as fast as possible"	"Imagine that your arms are hammers and your shins are the nails—smash the hammer through the nails"

Critical Position: Toe-Off; Objective: Maximize Horizontal Force Production; General Instruction: "The goal is to sprint 10-meters as fast as you can."

Theoretical rationale for using tape (4).

acceleration and absolute speed (64); however, the evidence presented above provides general support for their importance, especially as the collective coordination profile can be optimized to encourage horizontal force production. Table 1 provides a detailed description of recommended external cues relative to the 4 identified categories.

INSTRUCTIONAL FRAMEWORK: ABSOLUTE SPEED

Absolute speed, or the maximal velocity (m/s) that can be achieved by an athlete, is an important athletic quality that is commonly expressed when an athlete is required to sprint beyond 20 m. Unlike acceleration, there is a larger body of evidence that provides insights into the kinetic and kinematic determinates of successful maximal velocity sprinting. Weyand et al. (2000) (67), in their seminal study, produced the first experiment to show that mass-specific vertical force production clearly differentiated fast and slow sprinting. Specifically, the results showed that faster sprinters (11.1 m/s) produced 1.26 times greater vertical force than their slower counterparts (6.2 m/s). Furthermore, these forces were generated with significantly shorter ground contacts in the fast versus slow sprinting. Thus, the collective data support the notion that creating a large force in a short period of time is critical to producing large top-speeds (66,67).

More recently, Clark and Weyand (2014) (11) added to the research described above showing that faster sprinters are not only producing greater forces than their slower counterparts but also they are doing so during the first half of the stance phase (2.65 $\pm$ 0.05 versus 2.21 $\pm$ 0.05 body weight, respectively), with no differences seen during the second half of the stance phase (1.71 $\pm$ 0.04 versus 1.73 $\pm$ 0.04 body weight, respectively). In describing the kinematic features that likely support a large mass-specific force during absolute speed, Clark and Weyand (2014) (11) note the

Table 2
Instructional framework for absolute speed

Absolute Speed			Distance		Direction		Description		
Motor Skill Characteristic		**Internal Focus**	**External Focus (Close)**	**External Focus (Far)**	**External Focus (Away)**	**External Focus (Toward)**	**External Focus (Action Verb)**	**External Focus (Analogy 1)**	**External Focus (Analogy 2)**
			Place a piece of athletic tape near the belly button or front of hips as a reference point (tape goes on clothes) (4)						
Posture	Minimize trunk flexion, achieve spinal neutral, and continuously rise until almost vertical relative to the ground	"Focus on keeping a neutral spine while you rise to a vertical body posture"	"Focus on getting tall and leading with the tape as you push away from the ground"	"Focus on getting tall and leading with the tape as you project up toward the sky"	"Explode away from the ground as you rise to a vertical sprint position"	"Explode toward the 40-meter line as you rise to a vertical sprint position"	"Spring off the ground in an effort to project up and forward with each step"	"Imagine that you are wearing a large belt buckle. Get long and lead with the belt buckle as you sprint"	"Imagine you are in a wind tunnel. Sprint with a slight lean and stay long as if supported by the wind"
			Place pieces of athletic tape on each knee cap and behind the heel of each shoe as reference points						
Leg action: front side	Optimize hip, knee and ankle flexion at the point of toe-off, emphasizing an upwardly directed leg action	"Focus on flexing your hip, knee and ankle as you bring your leg up & forward"	"Accelerate up and away from the ground by rapidly bringing the pieces of tape together"	"Accelerate up towards the sky by rapidly bring the pieces of tape together"	"Drive the pieces of tape away from the ground as fast as you can"	"Drive the pieces of tape vertically toward the sky as fast as you can"	"Smash the tape toward the sky with the intention to lift & fly"	"Imagine you are in shin high water. Sprint with the intention of stepping up and out of the water"	"Imagine the ground is hot and you are bare foot. Sprint with the intention of lifting off the ground as fast as you can"
Leg action: backside	Optimize hip, knee, and ankle extension at the point of toe-off, emphasizing a down and back leg action	"Focus on extending your hip, knee and ankle as you bring your leg down & back"	"Push off the ground as fast as possible"	"Push past the cones as fast as possible"	"Treat the ground like rubber—bounce off the ground as rapidly as possible"	"Treat the ground like rubber—bounce up toward the sky as rapidly as possible"	"Hammer the ground down & back as hard and fast as you can"	"Hit the ground as if to spin the earth backward"	"Repeatedly explode off the ground as if sprinting up a steep flight of stairs"

(continued)

Table 2 (continued)

			Place pieces of tape on the front of the shoulder and the ulnar side of the wrist as reference points (4)					
Arms	Emphasize a reciprocating action whereby the arm moving forward is flexing at the elbow and shoulder, while the arm moving backward is extending at the elbow and shoulder	"Focus on alternating your arms by flexing and extending at your elbow and shoulder"	"Continuously accelerate the pieces of tape away from one another as fast as possible"	"Continuously accelerate the pieces of tape on your wrist back at the wall as fast as possible"	"Drive the pieces of tape toward & away from one another as aggressively as possible"		"Throw the tape on your wrist past your pockets as fast as possible"	"Imagine your forearm is a door and your elbow is the hinge - open and close the door as fast as possible"	"Imagine that your arms are hammers and your shins are the nails - smash the hammer through the nails

Critical Position: Toe-Off; Objective: Maximize Vertical Force Production; General Instruction: "The goal is to sprint 40-m as fast as you can." Theoretical rationale for using tape (4).

following when referencing Mann (2011, p. 613) (32):

First, the knee elevation sprinters achieve late in the swing phase appears to contribute to early stance ground force application by allowing greater limb velocities to be achieved prior to foot-ground impact. Second, the erect stance-phase posture sprinters adopt likely contributes to the stiffness required to decelerate the limb and body relatively quickly after the instant of foot-ground impact.

Further support for the importance of knee elevation or hip flexion comes from Mann and Herman (1985) (33). Specifically, the researchers note the following when discussing kinematic factors differentiating gold, silver, and bronze medalist sprinters (p. 160):

The most consistent success factor identified in the sprint results of elite athletes is the action of the upper leg. Better sprinters end ground contact early and quickly begin leg recovery. This abbreviated leg extension is one major factor in decreasing the critical ground contact time. During the recovery phase, all 3 sprinters produced similar full extension, followed by excellent flexion (high knee) positions. This flexion result is critical in initiating the production of upper leg velocity into and during ground contact.

Thus, athletes who can effectively terminate the stance phase, allowing enough time to achieve an optimal high knee position, are able to generate greater forces, especially during the first half of the subsequent stance phase. Therefore, the ability to generate cues that encourage these positions and coordinative capacities will result in an improved ability to express absolute speed.

Mann has provided important technical recommendations for optimizing absolute speed. Specifically, the critical position or "golden position" that represents an optimized coordination profile is that of toe-off, which is the same phase of the sprint as discussed in the previous section (32). Mann describes this as the position where maximum upper-leg hip flexion (i.e., ~80°) is achieved, which should occur no later than 0.033 s after toe-off. This position is associated with a relatively vertical body position, an extended back leg (i.e., "push leg"; ~ 0–10° @ hip; ~150–155° @ knee) and a flexed front leg (i.e., "punch leg"; ~80–90° @ hip; ~ ≤90° @ knee).

Similar to the last section, coaches should instruct and cue *posture*, *front-side leg action*, *backside leg action*, and *arm action* to optimize the coordination profile associated with absolute speed (64). Table 2 provides a detailed description of recommended external cues relative to the 4 identified categories.

SUMMARY

In summary, to optimize motor skill performance and learning, it is necessary to use instruction and cues that encourage the athlete to adopt an external focus of attention. By adopting an external focus of attention, the athlete will perform better during the context of practice, while encouraging the retention and transfer of the practiced motor skill. To optimize the impact of an external focus cue, it will be important for coaches to consider 2 factors. First, it is necessary to identify the primary limitation associated with the movement skill being taught. If the primary limitation is coordinative in nature, then effective cueing is likely to make a distinct impact; however, if the problem lies within a lack of physical strength, or some other underpinning physical quality, then the effectiveness of the cue will be limited until the underpinning problem is resolved. Second, once the primary coordinative limitations have been identified and prioritized, then the coach will provide the athlete with an individualized external focus cue. By referencing the framework described earlier, the coach can manipulate distance, direction, and description until the most effective cue has been identified. This 2-step process provides coaches with a systematic approach to selecting the instruction or cue most likely to encourage desired coordinate changes. Moreover, this process allows the coach to evolve and modify language in accordance with the physical and psychological development of the athlete relative to the motor skill being learned.

As a final suggestion, this process should not intimidate coaches, especially if they are used to primarily giving athletes internal focus cues. Rather, coaches should look at this as a long-term transformation that is guided by daily noticing, implying that coaches should reflect during and after a training session and simply start to notice the language they use relative to the results they see. If a coach notices he or she is using an internal cue, then the suggestion would be to try an external cue on the subsequent rep(s). Over time, the coach's language will evolve and this will be met with a systematic improvement in their athlete's motor skill performance and learning.

Conflicts of Interest and Source of Funding: The author reports no conflicts of interest and no source of funding.

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