Human Movement Science 52 (2017) 84–95

Contents lists available at ScienceDirect

Human Movement Science

journal homepage: www.elsevier.com/locate/humov

Full Length Article

Experience level influences the effect of attentional focus on sprint performance

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ARTICLE INFO

Article history:
Received 2 September 2016
Revised 26 December 2016
Accepted 24 January 2017
Available online 6 February 2017

Keywords:
Focus of attention
Sprinting
Human performance
Kinetic analysis

ABSTRACT

Two experiments evaluated the influence of attentional focus on 10-meter sprint time and start kinetics in a group of collegiate soccer players and highly experienced sprinters. In Experiment 1, the collegiate soccer players were asked to perform 10-meter sprints under an external focus condition, an internal focus condition and a control condition. For the 10-meter sprint time, the results showed that both the external focus and control conditions resulted in significantly faster sprint times than the internal focus condition. There were no significant differences observed between the external focus and control conditions. There were also no significant differences observed across any of the conditions for a select set of kinetic variables. In Experiment 2, the highly experienced sprinters performed the same 10-meter sprint task using the same instructional conditions as in Experiment 1. For the 10-meter sprint time and kinetic variables, there were no significant differences observed across any of the conditions. These results provide new evidence that experience level mediates the influence of attentional focus on sprint performance.

1. Introduction

Attentional focus has emerged as an important mediator of performance and learning across a diversity of motor skills (for a review, see Wulf, 2013). Attentional focus is defined by the conscious intent of an individual to direct their attention towards specific features of the environment, or to the action-preparation process, in an effort to execute a motor skill with superior performance (Magill, 2011). Specifically, an individual can focus *internally* on their body movements (i.e., movement process) or *externally* on the effect their movements have on the environment (i.e., movement outcome) (Wulf, Hoss, & Prinz, 1998). For example, a coach instructing the vertical jump may provide an internal cue by telling an athlete to "focus on explosively extending your hips" or provide an external cue by telling an athlete to "focus on explosively pushing off the ground." While the instructions carry the same message (i.e., get off the ground 'explosively'), the internal cue calls attention to the body (i.e., hips) and the external cue calls attention to the effect on the environment (i.e., ground).

The need for coaches and clinical practitioners to optimize verbal instruction and cue selection has motivated numerous investigations into the effects of attentional focus on various motor tasks. The majority of studies evaluating the effects of attentional focus have found that an external focus of attention results in superior performance and learning compared to

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http://dx.doi.org/10.1016/j.humov.2017.01.012
0167-9457/

an internal focus (for reviews, see Marchant, 2011; Wulf, 2013). For example, Wulf et al. (1998) (experiment 1) found that instruction inducing an external focus of attention, rather than an internal focus of attention, led to better performance and learning on a ski-simulator task in novice participants. 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 explicit instruction. The results showed that the external focus group was significantly 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 – where no instruction was given, which provides evidence that an external focus leads to superior skill learning than an internal focus or no focus at all. There has since been extensive research confirming the performance and learning benefits of an external focus of attention for balance and supra-postural tasks (e.g., McNevin, Shea, & Wulf, 2003; Wulf, Weigelt, Poulter, & McNevin, 2003), vertical and horizontal jumping (e.g., Porter, Ostrowski, Nolan, & Wu, 2010; Wulf, Zachry, Granados, & Dufek, 2007), agility (e.g., Porter, Nolan, Ostrowski, & Wulf, 2010), sprinting (e.g., Ille, Selin, Do, & Thon, 2013; Porter, Wu, Crossley, & Knopp, 2015), swimming (e.g., Freudenheim, Wulf, Madureira, Pasetto, & Corrêa, 2010; Stoate & Wulf, 2011), and a diversity of sport specific skills (e.g., Al-Abood, Bennett, Hernandez, Ashford, & Davids, 2002; Wulf, McNevin, Fuchs, Ritter, & Toole, 2000).

The 'constrained action hypothesis' has been proposed as a theoretical explanation for the learning and performance advantage of adopting an external focus rather than an internal focus of attention (Wulf, McNevin, & Shea, 2001). Accordingly, Wulf et al. (2001) suggest that an internal focus "constrains the motor system by interfering with automatic motor control processes that would 'normally' regulate the movement;" conversely, an external focus allows the "motor system to more naturally self-organize, unconstrained by the interference caused by conscious control attempts" (p. 1144). Further, Wulf and Lewthwaite (2010) suppose that an internal focus of attention causes a "self-invoking trigger," which leads to overt control over movements that would otherwise be controlled automatically, causing a series of ongoing "microchoking" episodes. From a motor control perspective, Lohse, Jones, Healy, and Sherwood (2014) have provided empirical evidence for this, showing that individuals adopt different control strategies under an internal and external focus of attention (Lohse, Sherwood, & Healy, 2010). Specifically, Lohse and colleagues (Lohse et al., 2010, 2014) evaluated novices learning a dart-throwing task and found that an external focus of attention resulted in greater kinematic variability in the throwing arm, with a concomitant increase in accuracy. Conversely, an internal focus of attention resulted in reduced kinematic variability in the throwing arm, with a similar reduction in accuracy. The researchers suggest that adopting an external focus of attention leads to increased "functional variability" (Muller & Loosch, 1999), allowing the motor system to reduce variability in the target outcome (i.e., accuracy) by increasing movement variability in redundant bodily dimensions (e.g., joint motion), and therefore increase the number of coordinative solutions available to achieve the desired outcome.

Although research has highlighted the beneficial effects of adopting an external focus of attention (Wulf, 2013), the majority of studies have examined motor skill performance (e.g., balance control, golf shot accuracy, and jump height) without investigating the biomechanical factors underpinning performance changes (Lohse et al., 2010). The few studies that have examined the effects of attentional focus on the mechanical determinants of movement performance have primarily evaluated implement-based skills including juggling (Zentgraf & Munzert, 2009), rowing (Parr & Button, 2009), dart throwing (Lohse et al., 2010, 2014), and golf (An, Wulf, & Kim, 2013; Lawrence, Gottwald, Khan, & Kramer, 2012; Munzert, Maurer, & Reiser, 2014). However, there are limited and inconsistent findings surrounding the influence of attentional focus on the biomechanical factors that may underpin focus mediated performance differences in non-implement based skills (e.g., sprinting, jumping, and agility). For example, Wulf and Dufek (2009) found that physically active students generated significantly larger vertical impulse during a vertical jump when focusing externally opposed to internally. In agreeance with Wulf and Dufek (2009), Wu, Porter, and Brown (2012) and Ducharme, Wu, Lim, Porter, and Geraldo (2016) found that university students broad jumped significantly farther using an external focus condition compared to an internal focus condition, however, the differences observed in performance were not explained by differences in peak force (Ducharme et al., 2016; Wu et al., 2012) or impulse (Ducharme et al., 2016). More recently, Bezodis, North, and Razavet (2016) found that college aged team sport athletes sprinted over 10-meters significantly faster under a control condition (i.e., no explicit focus) compared to an internal focus condition and external focus condition, which were not different from one another. From a kinetics standpoint, the control condition generated less peak vertical force and vertical impulse compared to the other conditions, however, no other kinetic variables (e.g., average horizontal force) were shown to be different across the three conditions. Thus, building on the research noted above, it is of scientific and practical importance to gain further insight into the influence of attentional focus on biomechanical determinants of performance in non-implement based motor skills.

Among non-implement based motor skills, the ability to accelerate rapidly is of particular interest because of the broad application to a variety of sports (e.g., Di Salvo et al., 2010; Duthie, Pyne, Marsh, & Hooper, 2006; Lockie, Murphy, Schultz, Jeffriess, & Callaghan, 2013). Thus, expanding on the work of Bezodis et al. (2016), the first aim of this study was to evaluate the differential effects of various attentional focus instructions (i.e., internal focus, external focus and 'normal focus') on 10-meter sprint performance and a select set of kinetic variables. Specifically, while multiple studies have assessed the influence of attentional focus on sprint performance (Bezodis et al., 2016; Ille et al., 2013; Mallett & Hanrahan, 1997; Porter & Sims, 2013; Porter et al., 2015), and while Bezodis et al. (2016) also evaluated step kinetics & kinematics at 5-meters, no research has evaluated the role of start kinetics in explaining sprint performance differences influenced by various attentional foci. Based on the evidence showing the importance of mass-specific horizontal propulsive force during the start of a sprint (Clark & Weyand, 2015; Morin et al., 2012; Rabita et al., 2015), in addition to capturing 10-meter sprint times (s), the present