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Forward thinking: When a distal external focus makes you faster

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ABSTRACT

Studies have demonstrated a benefit to performance and learning of a distal relative to a proximal external focus of attention. That is, focusing on a movement effect that occurs at a greater distance from the body has been found to be more effective than concentrating on a movement effect closer to the body. The present study examined the distance effect in skilled kayakers performing an open, continuous skill. Participants ($n = 27$) performed a wild water racing sprint of 100 m on Class 2 water. Using a within-participants design, a distal external focus ("Focus on the finish") was compared to a proximal external focus ("Focus on the paddle") as well as to a control condition. The distal focus condition (30.63 s, $SD = 3.21$) resulted in significantly shorter sprint times than did the proximal (32.07 s, $SD = 3.27$) and the control (31.96 s, $SD = 3.58$) conditions ($ps < 0.001$). The effect size was large ($\eta_p^2 = 0.53$). There was no significant difference between the proximal and control condition ($p = 1.00$). The findings demonstrate the importance of adopting a distal, rather than proximal, external focus for skilled athletes performing open, continuous skills under time pressure.

1. Introduction

Over the past two decades, numerous studies have demonstrated a benefit to efficient and effective motor performance, skill retention and transfer as a result of an external versus an internal attentional focus (e.g., Wulf, Höß, & Prinz, 1998; for a review, see Wulf, 2013). Even though the difference between external and internal focus instructions has often been small, studies have yielded consistent and robust results demonstrating a significant advantage whilst using an external focus. Researchers produce an internal focus by asking participants to concentrate on body movements required for the skill (e.g., motion of arms in a golf shot), whereas in the external focus condition they are asked to concentrate on the intended movement effect (e.g., motion of the golf club; Wulf, Lauterbach, & Toole, 1999). To date, researchers have used a wide range of tasks to examine the effects of attentional focus on motor performance and learning. Advantages of an external compared with an internal focus have been shown for various measures of movement effectiveness (e.g., movement accuracy, consistency) and efficiency (e.g., force production, muscular activity, heart rate, oxygen consumption). This benefit to performance and learning has also been demonstrated for a wide variety of skills, including sport skills (e.g., soccer, volleyball, basketball, swimming, running, kayaking, gymnastics), musical skills (Duke, Cash, & Allen, 2011; Mornell & Wulf, 2018), or activities of daily living (e.g., Fasoli, Trombly, Tickle-Degnen, & Verfaellie, 2002). The external focus advantage is independent of the task, performer's skill level, age, or (dis)ability (for reviews, see Lohse, Wulf, & Lewthwaite, 2012;

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Marchant, 2011; Wulf, 2007a, 2007b, 2013; Wulf & Lewthwaite, 2010, 2016; Wulf & Prinz, 2001).

An external focus appears to have the dual advantage of directing attention to the task goal while at the same time reducing a detrimental self-focus (including an internal focus) or other distracting thoughts (Wulf & Lewthwaite, 2016). The result is greater automaticity in movement control, as indicated, for example, by an increased use of fast, reflexive movement adjustments (Wulf, McNevin, & Shea, 2001), more effective dual-task performance, and greater movement fluidity (e.g., Kal, van der Kamp, & Houdijk, 2013). In contrast, an internal focus facilitates access to the self (McKay, Wulf, Lewthwaite, & Nordin, 2015) and presumably results in "micro-choking" episodes (see Wulf & Lewthwaite, 2010), that is, widespread, inefficient activation of the muscular system, disruption of automaticity, and the use of more conscious control of movements.

One shortcoming of previous research is that the skills used in most attentional focus studies thus far have tended to be closed in nature, that is, performed in a stable or predictable environment (Schmidt, Lee, Winstein, Wulf, & Zelaznik, 2019). Open skills that are performed under environmental conditions that are constantly changing and often unpredictable (Schmidt et al., 2019, p. 25) have rarely been used in studies examining effects of different attentional foci. As Schmidt et al. (2019) pointed out, in those situations, it is not possible to effectively plan the whole action in advance. "Success in open skills is largely determined by the extent to which the individual is successful in adapting the planned motor behavior to the changing environment. Often this adaptation must be extremely rapid, and the effective responder must have many different actions ready to implement" (Schmidt et al., 2019, p. 25–26). Factors that contribute to changes in the environment may include other performers (e.g., teammates, opponents) or the natural environment itself (e.g., wind, water, weather). To our knowledge, only two studies have compared the effectiveness of different attentional foci on the learning of complex open skills and their performance in a competitive setting, namely, tennis performance under actual game conditions (Tsetseli, Zetou, Vernadakis, & Michalopoulou, 2016; Tsetseli, Zetou, Vernadakis, & Mountaki, 2018). These authors found that participants (8–9 year old children) demonstrated enhanced skill learning with an external focus relative to internal focus and control conditions, as well as superior game performance, although only with respect to certain elements of the game (i.e., decision making).

Given the dearth of studies that have involved open skills, and limited evidence for the effectiveness of an external focus for those skills, the main purpose of the present study was to further examine potential benefits of an external focus for the performance of an open, continuous skill – wild water kayak sprinting. This activity (sometimes known as white water kayak racing) was selected as it provided variation in the performance environment (openness), via moving water and river topography. This permitted the control needed to be able to make measured comparisons – an undertaking which would be much more challenging using a task in which variation was provided by other people or the weather, for example.

In addition, we wanted to further examine potentially different effects of distal versus proximal external foci. A number of studies have shown that a focus on a movement effect that occurs at a greater distance from the body – and is presumably more easily distinguishable from body movements – results in more effective performance and greater automaticity than does a focus on a more proximal movement effect (see Wulf, 2013). McNevin, Wulf, & Shea (2003) first demonstrated that increasing the distance of the external focus from the body led to greater learning benefits. Participants who were asked to concentrate on markers on a balance platform that were farther away from their feet (distal external focus) demonstrated more effective balance learning than did participants who were asked to concentrate on markers right in front of their feet (proximal external focus), or the feet themselves (internal focus). The "distance" effect has been replicated in several other studies using tasks such as golf putting (e.g., Kearney, 2015) or chip shots (Bell & Hardy, 2009), dart throwing (McKay & Wulf, 2012), standing long jump (Marchant, Griffiths, Partridge, Belsley, & Porter, 2018; Porter, Anton, & Wu, 2012), or music performance (Duke et al., 2011).

In the present study, we asked whether a distal focus would enhance wild water racing performance in experienced kayakers, relative to a proximal focus on the paddle. We also included a control condition in which the kayakers were free to adopt their own attentional focus. If the familiarity of the attentional focus plays a significant role (Maurer & Munzert, 2013), foci that skilled performers typically adopt might yield more effective outcomes than other, instructed foci. However, any effects of familiarity typically seem to be outweighed by (instructed) external foci (e.g., Mornell & Wulf, 2018; Wulf & Su, 2007). Therefore, and based on previous findings related to the distance effect, we hypothesized that a distal external focus would result in the fastest sprint times. All participants performed 100 m sprints under three conditions (distal focus, proximal focus, control conditions), with condition order counterbalanced across participants to control for possible effects of practice, fatigue, etc. Subsequent to each trial, manipulation checks were conducted that included questions about participants' visual and attentional focus during the just-completed trial.

2. Method

2.1. Participants

A sample size of 26 participants was estimated via a power analysis using G*Power 3.1, with an estimated η_p^2 value of 0.08, an α value of 0.05, and a power value of 0.90. Twenty-seven experienced river kayakers took part in the study. Their age range was 14 to 58 years, with a mean age of 41.3 years ($SD = 13.1$). Six of the participants were female. All participants were competent to paddle on Class 2 white water or harder and were currently active paddlers. They had an average of 18.0 years ($SD = 11.5$) of experience. Their standard of paddling on white water was Class 3.0 (range: 2–5) on a white water scale of 1(simple) - 5(extreme). Written informed consent was obtained from all participants in advance of taking part. The study complied with the university's research ethics and integrity requirements.

3. Apparatus and task

The task entailed sprinting 100 m downriver in a wild water racing kayak (Perception Wavehopper, adjustable for fit) (see Fig. 1). Wild water racing boats are relatively long and narrow (4.5 × 0.6 m) with a rounded hull profile; the dimensions of the craft used complied with competition regulations. The experiment was conducted on a class 2 section of the River Kent in Kendal, UK, in an easily accessible area free from disturbance. A schematic of the course is shown in Fig. 2. All participants used the same paddle (SEL carbon wing) and spray deck (Reed Chillcheater). They were asked to wear a helmet and clothing suitable for a boat-based sprinting task and were provided with a buoyancy aid (personal flotation device). A transit aligned with a high-speed video camera (Panasonic HDC TM 900) was used for accurate timing (see Fig. 2). The camera was set to a frame rate of 25/s (0.04 s per frame).

4. Procedure

Participants were tested individually. After a warm-up period of about 15 min to get acquainted with the boat and venue, they performed one familiarisation trial. They were asked to sprint down the identified 100 m course as fast as possible. No additional instructions were provided. Subsequently, participants performed the same task under the three different conditions (proximal external focus, distal external focus, control). In all cases the instructions were provided immediately prior to the sprint once the participants were established and prepared at the start. The order of conditions was counterbalanced across participants (i.e., proximal-distal-control, distal-control-proximal, control-proximal-distal). In all trials, participants were asked to look at the same fixed visual point (a tree beyond the finish directly aligned with the river and thus in their natural sight line). They were also asked to sprint from the fixed start point to a well-defined point immediately beyond the transit to ensure they passed this timing point at full speed. Before each trial, the task goal of sprinting down the course as fast as possible was reiterated. In the control condition, no further instructions were given. In the proximal focus condition, participants were instructed to concentrate on the paddle ("Think only about the paddle. Use it as well as you can to sprint fast."). In the distal focus condition, they were asked to focus on the finish ("Think only about the finish. Imagine arriving as fast as you can."). A check was made to ensure the goal of the task, instructions, and the importance of adhering to them, were clear.

At the start point, the rear of the kayak was lightly held until the participant indicated that they were ready to go. Following each trial, participants were assisted from the boat and seated on the bank. As manipulation checks, they were asked after the trials in the distal and proximal focus conditions what percentage of time they had concentrated on the finish or paddle, respectively. After the control trial, they were asked what they had focused their attention on. In addition, participants were asked after each trial what percentage of time that had looked at the visual target point (tree). The boat was then carried back to the start. The break between trials was approximately 10 min.

5. Data analysis

Sprint times were analysed in a repeated-measures ANOVA. Bonferroni adjustments were made for all post hoc tests. Mauchly's test demonstrated sphericity had not been violated (χ^2 (2) = 2.75, $p > 0.05$). Partial eta squared (η_p^2) effect sizes are reported when appropriate, with magnitudes classified as trivial (0.009), small (0.010–0.059), medium (0.060–0.139), or large (0.140 and greater) (Cohen, 1992). Participants' reports of attentional focus in the control condition were classified as distal external focus (e.g., "line," "tree," "finish"), proximal external focus (e.g., "blade," "boat"), internal focus (e.g., "arm speed", "body rotation", "legs"), or other

Fig. 1. Participant sprinting down the course.

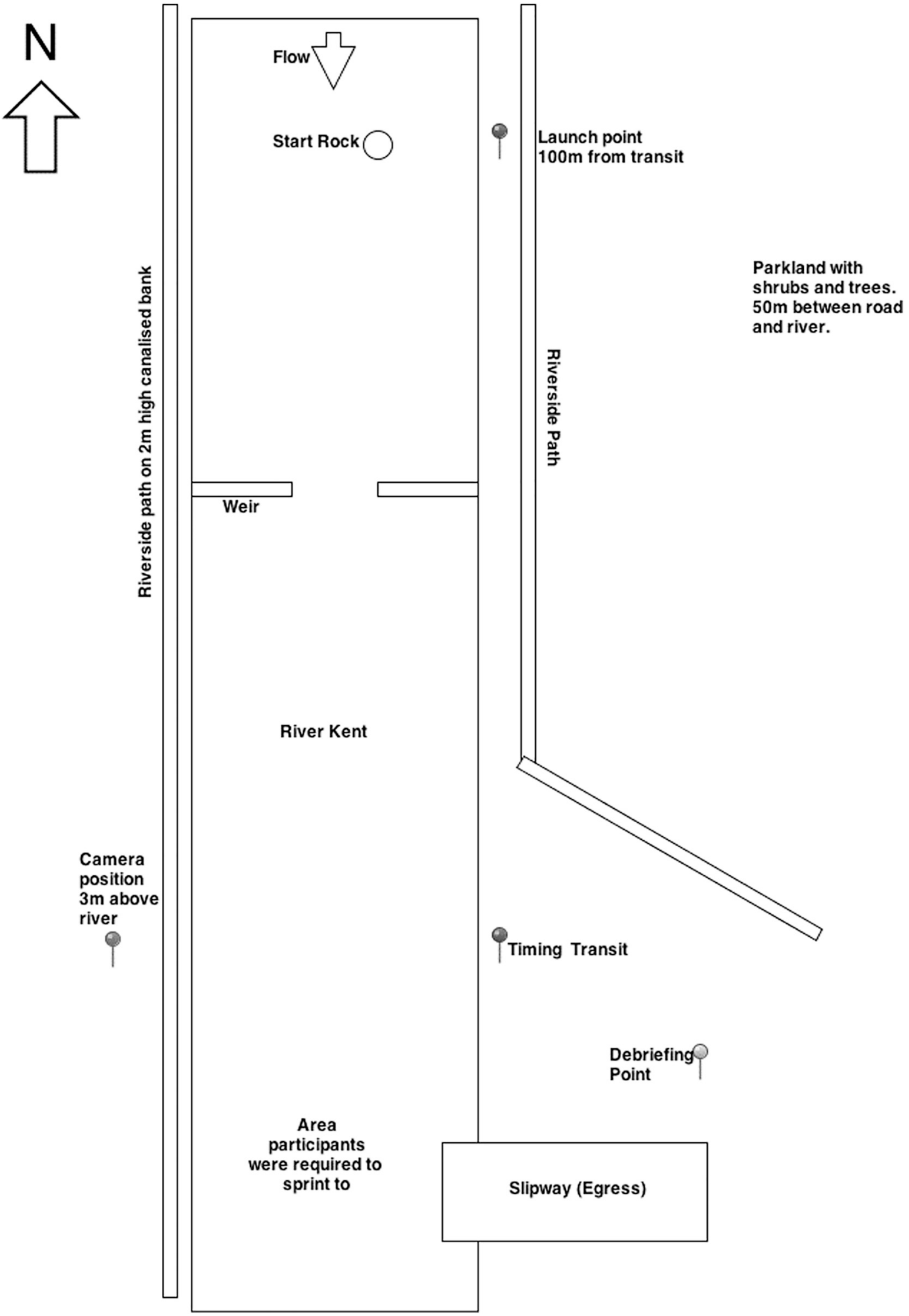

Fig. 2. Venue organisation. 100 m between start point and timing transit.

focus (e.g., “more commitment,” “tactical decisions,” “felt more upright”).

6. Results

6.1. Sprint times

Average sprint times for each condition can be seen in Fig. 3. The distal focus condition (30.63 s, $SD = 3.21$) resulted in the fastest times. The proximal focus (32.07 s, $SD = 3.27$) and control (31.96 s, $SD = 3.58$) yielded similar times. The effect of condition was significant, $F(2, 52) = 28.85$, $p < 0.001$, $\eta_p^2 = 0.53$. Post-hoc-tests indicated that times in the distal focus condition were significantly faster than those in both the proximal focus and control conditions, $ps < 0.001$. There was no difference between the proximal focus and control conditions ($p = 1.00$). In the distal focus condition, participants completed the 100 m course, on average, 4.5 m – or one boat length – ahead of the other two conditions.

7. Manipulation checks

7.1. Visual focus

Participants maintained their visual focus on the target point (tree) behind the finish for most of the duration of each trial. Specifically, in the control condition, they reported looking at the target 98.7% of the time, in the proximal focus 98.4%, and in the distal focus condition 96.2% of the time.

7.2. Attentional focus

In the two conditions in which participants were instructed to use distal or proximal external foci, the majority indicated that they had used those foci most of the time on the respective trials (distal focus: 97.1%; proximal focus: 98.4%). In the control condition, the reported foci were mixed. The most commonly reported focus was a distal external focus (13 participants or 48.1%). Two participants (7.4%) reported using a proximal external focus, while six participants each (22.2%) indicated using an internal or other focus.

8. Discussion

The findings of the present study showed that skilled kayakers performed a 100 m wild water racing sprint more effectively when they were asked to adopt a distal external focus compared with a more proximal focus or no instructed focus (control condition). That is, when the same kayakers focused their attention on the finish, the resulting sprint times were about 4.3% faster than when they focused on the paddles or adopted their own foci. Given that vision was directed at the same point (tree), these differences in performance were clearly a function of participants' attentional focus. The present findings are in line with those of previous studies in which skilled performers benefited from distal relative to proximal foci, albeit on short-duration, discrete tasks under stable environmental conditions (closed skills) such as a standing long jump (Porter et al., 2012) or hitting golf balls (Bell & Hardy, 2009), or serial tasks such as playing a sequence of alternating notes on a piano (Duke et al., 2011). In the present study, participants performed a long-duration (about 30 s) continuous, open skill under changing environmental conditions. Thus, the present results demonstrate the generalizability of the attentional focus effect, and specifically the “distance” effect, to variable and unpredictable situations.

Why was the distal focus more effective than a proximal focus? McNevin et al. (2003); see also Shea & Wulf, (1999) argued that movement effects that occur in close proximity to the body are less easily distinguishable from the body movements that produced the effect than are more distal effects. However, aside from the spatial distance to the body, adopting a more distal focus on the overall task goal might also trigger the whole action necessary to achieve the desired movement outcome (Wulf, 2007b). Thus, a distal focus might

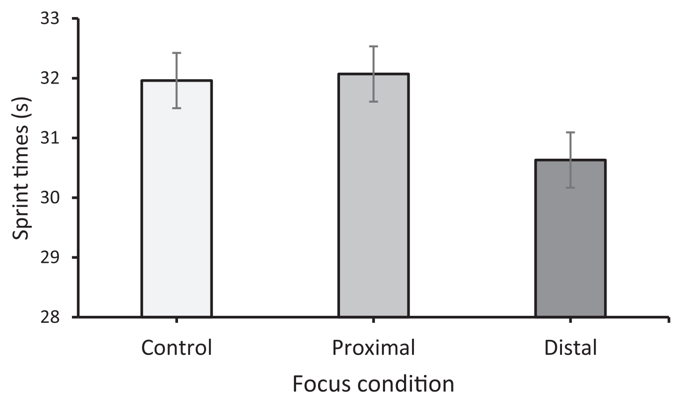

Fig. 3. Average sprint times for each experimental condition. Error bars represent standard errors.

be particularly advantageous for experienced performers who have the capability to produce skilled actions automatically. For experienced kayakers, such as those in the present study, paddling has become largely automatic, and a concentration on the paddles likely disrupted the fluidity of their motion and/or perhaps provided a distraction from the task goal, namely, sprinting as fast as possible. In contrast, the instruction to focus on the finish line presumably facilitated automatic control processes and enhanced their overall speed and task performance. External foci, and in particular distal external foci, have been shown to result in faster movement adjustments than more proximal or internal foci (McNevin, Shea, & Wulf, 2003). Navigating a kayak through white water necessitates rapid adjustments as well as quick decision making (e.g., Tsetseli et al., 2016) – capabilities that are facilitated by the automatic control processes and spare attentional capacity associated with an external focus (Kal et al., 2013; Wulf et al., 2001).

An interesting question is whether novice kayakers would benefit more from a proximal external focus, or whether the demands of the water environment, and the requirement for constant motion are better served by a distal focus. Wulf and Prinz (2001) first suggested that the optimal attentional focus might depend on the level of expertise. This may be the case particularly when the skill involves a specific technique (e.g., paddle strokes) that subserves the achievement of the overall movement outcome (e.g., sprinting fast). That is, while focusing on the finish line was beneficial for experienced kayakers, for a novice kayaker, might focusing on the motion of the paddles result in more effective performance? A recent study with novice and experienced volleyball players provides evidence for the notion that the optimal focus is a function of expertise (Singh & Wulf, 2020). In that study, high-skilled players continuously passed a volleyball more accurately to a target on the wall with a distal focus on the target, whereas novices' accuracy was enhanced by a movement-form related, proximal external focus on their "platform" (an imagined flat surface between both wrists and elbows). Thus, for novices in kayaking who are still learning or fine-tuning a specific technique, a more proximal external focus on a task sub-goal might be more advantageous. Further studies are needed to examine the interaction of external focus distance and skill level.

Wulf and Lewthwaite (2016) described the effect of the connections between the intended movement effect, or task goal, and neuromuscular action as fluid goal-action coupling. The coupling of performers' goals to their movement actions is reflected in increased functional connectivity of task-related neural motor networks (e.g., Di & Biswal, 2015) that is typically seen in expert performers (e.g., Bernardi, Ricciardi, Sani, Gaglianese, Papasogli, Ceccarelli, …Pietrini, 2013; Milton, Solodkin, Hluštík, & Small, 2007). Efficient goal-action coupling is facilitated by maintaining an external focus on the task goal while at the same time reducing a detrimental internal or self-related focus, as well as other distractions. An external focus – and presumably especially a distal focus – clarifies neuromuscular coordination by suppressing unnecessary neural activity (Kuhn, Keller, Lauber, & Taube, 2018; Kuhn, Keller, Ruffieux, & Taube, 2017) and muscular co-contractions (e.g., Lohse, Sherwood, & Healy, 2011; Vance, Wulf, Töllner, McNevin, & Mercer, 2004). In fact, McNevin et al. (2003) found that a distal relative to a proximal external focus led to greater movement automaticity, as demonstrated by increased high-frequency, small-amplitude movement adjustments (mean power frequency or MPF) on a balance task. While the proximal focus resulted in somewhat higher MPFs than an internal focus of attention, a distal focus led to clearly superior performance and enhanced automaticity relative to both. In addition to facilitating automaticity, by producing more successful performance and ease of movement, the distal focus may have contributed to enhanced performance expectancies (e.g., Pascua, Wulf, & Lewthwaite, 2015) and goal-action coupling through a confidence pathway (see Wulf & Lewthwaite, 2016). The proximal focus on the paddles in the present study likely resulted in inferior performance compared with the distal focus on the finish for similar reasons, namely, less-than-optimal coupling of goals and actions, or brain and muscle activation patterns.

The distal focus condition resulted in superior performance relative to both the proximal focus and control conditions, while there was no difference between the latter two. One might have expected the instructed external, albeit proximal, focus to produce more effective results than the control condition as previous findings indicate that participants' foci tended to be internal (e.g., Pascua et al., 2015) or a mixture of internal and external (e.g., Christina & Alpenfels, 2014; Mornell & Wulf, 2018) when no focus direction was given. Alternatively, given participants' level of experience and presumably the familiarity with the foci they adopted in the control condition (Maurer & Munzert, 2013), one might have expected to see more effective performance in the control condition compared with the proximal focus condition. Yet, even experienced performers often tend to adopt a less-than-optimal focus unless they are given instructions that promote a (distal) external focus (e.g., Mornell & Wulf, 2018). Our participants reported using a mixture of attentional foci during the control trial: While almost half of the participants' post-trial comments related to a distal external focus, 44% of the comments indicated an internal or other focus. Thus, the favorable effects of some foci versus detrimental influences of other foci may have led to the significantly slower sprint times under control conditions.

Finally, it is interesting to note that, while a distal external focus can be coincident with the task goal, specifically asking performers to focus their attention on that task goal seems to benefit performance. In the present study, the task goal (sprinting down the course as fast as possible) and distal external focus instruction (focusing on the finish line) were similar, albeit not completely congruous. In previous studies, instructions to focus on the target when the task goal was to hit a target (e.g., Pascua et al., 2015), or to focus on the produced sound in tasks involving speech production (Lisman & Sadagopan, 2013) or making music (Mornell & Wulf, 2018), also resulted in benefits to performance or learning. Thus, it appears that, purposely directing attention to the intended movement effect, or task goal, is critical for optimal performance. Without a clear (distal) external focus, performance suffers because the performer's concentration appears to become somewhat "sporadic," as evidenced by participants' reports of their attentional focus under control conditions (see also Porter, Nolan, Ostrowski, & Wulf, 2010).

Our findings highlight the importance of maintaining a distal external focus, perhaps particularly under changing environmental conditions. The fluidity with which movement goals are translated into action when the performer adopts a (distal) external focus (Wulf & Lewthwaite, 2016) was reflected here in significantly faster wild water sprint times relative to other attentional foci. Rapid adjustments and fast decision making are also required for other continuous skills that are performed under changing environmental conditions, including downhill and mogul skiing, race car driving, and mountain biking. The present findings have important implications for coaching in these and other, comparable, open skill sports and activities. While coaches or performers may frequently consider it necessary to direct attention to the implement, and/or body movements, it is a distal "external focus [that] propel[s] performers' cognitive and motor systems in productive 'forward' directions" (Wulf & Lewthwaite, 2016, p. 1382).

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