THE EFFECTS OF ATTENTIONAL FOCUS INSTRUCTIONS ON THE PERFORMANCE OF A PERSISTENT FORM-BASED SKILL IN GYMNASTICS

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Abstract:

External relative to internal focus instructions have been shown to be more effective for enhancing optimal performance across various motor tasks that do not rely on movement quality or movement form. The aim of this study was to examine the effects of an external versus an internal focus of attention on the motor performance of a gymnastic skill that requires static strength and movement form. Participants with previous experience in aerobic gymnastics were asked to perform an L-support task for 4 seconds in three attentional focus conditions: internal focus, external focus, and control, with the order counter-balanced across focus conditions. Two pieces of yellow tape (2×9 cm) were attached to the gymnasts' feet on the inner side of the navicular bones. Two pieces of red tape (2×9 cm) were wrapped around the distal phalanx of the big toes of the right and left foot. All participants performed four trials in the external focus (focus on keeping red tape below the yellow tape), internal focus (focus on pointing your toes), and control (no-focus) conditions. The results showed that execution faults were smaller in the external focus condition compared to the internal focus and control conditions. No difference was found between the internal focus and control condition. The findings of this study indicate that the external focus is more beneficial than the internal focus and no-focus control condition for enhancing the performance of a static gymnastic skill that requires static strength and movement form.

Keywords: *focus of attention, movement form, motor performance, gymnastics*

Introduction

Effective and efficient verbal communication between the coach and athlete is crucial for optimising motor performance. In this regard, coaches aim to provide purposeful and appropriate verbal instructions with respect to movement techniques, which subsequently could enhance the performance and learning of a new motor skill. These verbal instructions have the potential to direct the attentional focus of performers to the important and relevant aspects of the motor task, either internally or externally (Wulf, 2007). An external focus is defined as the performer's attentional focus on movement effects or movement goals, such as elements outside the body, implements, surfaces, a target, and/or the trajectory of an object or the task goal. In contrast, an internal focus reflects a performer's attentional focus on body movements such as arms, hands, feet, or toes. Ample research has adequately shown that an external focus is more beneficial than an internal focus across various motor tasks (Chua, Jimenez-Diaz, Lewthwaite, Kim, & Wulf, 2021; Wulf, 2013). Yet, little research has been conducted on motor skills that require a combination of dynamic or static strength and movement form (Abdollahipour, Wulf, Psotta, & Palomo Nieto, 2015; Guss-West & Wulf, 2016; Lawrence, Gottwald, Hardy, & Khan, 2011). Therefore, the aim of the current research was to examine the effectiveness of attentional focus instructions on

the motor performance of a gymnastic motor skill that requires static strength and movement form.

Recent meta-analyses and reviews have reported the consistent superiority of an external relative to an internal focus of attention across various outcome measures, motor tasks, ages, (dis)ability ranges, and expertise levels (Chua, et al., 2021; Simpson, Ellison, Carnegie, & Marchant, 2021). Largely, the outcome measures utilised in these studies have relied upon outcome measures such as performance accuracy, movement time, stability/deviations in balance, distance, or amount of force production. For instance, studies have shown the advantages of an external relative to an internal focus in performance accuracy in golf putting task, dart-throwing task, two-handed catching of tennis balls, and playing the piano (Abdollahipour & Psotta, 2017; An, Wulf, & Kim, 2013; Duke, Cash, & Allen, 2011; Lohse, Sherwood, & Healy, 2010; Marchant, Clough, & Crawshaw, 2007), movement time such as riding a pedalo or swimming (Freudenheim, Wulf, Madureira, Pasetto, & Corrêa, 2010; Stoate & Wulf, 2011; Totsika & Wulf, 2003), force production such as pressing barbell (Marchant, Greig, Bullough, & Hitchen, 2011), distance such as vertical jump-and-reach task, standing long-jump task (Porter, Ostrowski, Nolan, & Wu, 2010; Wulf, Dufek, Lozano, & Pettigrew, 2010), or stability/deviations in balance on a stabilometer, ski-simulator, or a rubber disk task (Wulf, Höß, & Prinz, 1998; Wulf, Mercer, McNevin, & Guadagnoli, 2004; Wulf, Shea, & Park, 2001; Wulf, Weigelt, Poulter, & McNevin, 2003). As posited by the constrained-action hypothesis, a possible explanation for the advantages of an external focus is that an external focus promotes an automatic mode of motor control, whereas an internal focus degrades movement automaticity. More recent explanations propose that an external focus promotes goal-action coupling, which consequently enhances performance outcomes (Abdollahipour, Palomo Nieto, Psotta, & Wulf, 2017; Abdollahipour, Land, Valtr, Banátová, & Janura, 2023; Wulf & Lewthwaite, 2016). As such, an external focus is shown to be more effective than an internal focus in various motor tasks and contexts with respect to outcome measures such as performance accuracy, movement time, stability in balance, or force production.

Nonetheless, only a few studies have been carried out on attentional focus effects whereby the quality of movement form is of primary consideration (Abdollahipour, et al., 2015; Guss-West & Wulf, 2016; Lawrence, et al., 2011). Moreover, the gymnastic skills examined have been dynamic in nature. Initially, Lawrence et al. (2011) did not find any benefits for an external focus ("focus on the movement pathway and on exerting an even pressure on the support surface") relative to an internal focus ("focus on exerting an equal force on their feet, keeping their arms out straight, level with their shoulders") when comparing movement form during the performance of a complex series of gymnastic routines (e.g., starting position, a lunge, an arabesque, a full turn, and a finish position). However, these instructions were confounded or irrelevant to particular aspects of the routines. Indeed, attentional focus instructions did not adequately apply to all the movements the participants were required to do (e.g., a full turn). Next, Guss-West and Wulf (2016), using a survey analysis, reported that professional ballet dancers use more external focus cues, including metaphors and images such as "stretching like a star in all directions", "climbing up a corkscrew" or "jumping over a lake" when performing elements like an arabesque, pirouette, or a grand jeté, respectively. Likewise, Abdollahipour et al. (2015) also examined a gymnastic element requiring temporary movement form. Having attached a tape marker to the chest, gymnasts were asked to perform a jump and ½ half-turn task. While airborne, participants were instructed to focus on the direction in which "the tape marker" (external focus) or "your hands" (internal focus) are pointing after the half-turn. The findings suggested superior movement form and greater jump height in the external focus as compared to the internal focus or no-focus conditions. While current evidence points to the benefits of external focus for gymnastic elements that require dynamic strength, there is a clear need to advance research for examining the influence of attentional focus on motor performance or learning of motor skills that require static strength and movement form.

Therefore, the goal of the current research was to examine the effects of an internal versus an external focus of attention on motor performance in a task that requires static strength and movement form in gymnastics. We used simple and straightforward instructions by directing attention to a clear external focus cue (e.g., tape) or internal focus cue (e.g., toes) to avoid possible confounds or confusion for the gymnasts (cf., Lawrence, et al., 2011). Specifically, the current study examined the effects of attentional focus on the motor performance of an L-support gymnastic element, which is an isometric strength task and requires not only balance and strength but also movement form. We hypothesised that an external focus would be more effective (i.e., lower execution deductions) than an internal focus or control condition for enhancing movement form.

Methods

Participants

Twelve female gymnasts aged 9 to 22 years (*M*age = 14.70 ± 4.98 years), participated in the

present study. All participants were experienced healthy aerobic gymnasts, with an average training experience of $M = 9.58 \pm 4.77$ years. They were recruited from an aerobic gymnastics club in Prague, Czech Republic. As previous research on the effectiveness of attentional focus on movement form in gymnastics has produced results with a large effect size (Abdollahipour, et al., 2015), we also assumed a large effect size when performing power analysis. As such, a power analysis with G*Power 3.1 indicated that 12 participants would be sufficient to identify significant differences between attentional focus conditions in a within-participants design with a power $(1-\beta)$ of .80, a large effect size f of .4 ($\eta p^2 = .14$), the number of measurements = 3, correlation among repeated measures = .50, nonsphericity correction $\varepsilon = 1$, and an α level of .05 (Faul, Erdfelder, Lang, & Buchner, 2007). Informed consent was collected from all participants or their legal delegates before data collection. Their current training programme consisted of 3-5 sessions of 2-3 hours per week. Most participants had experience competing at the Czech national level. Participants were not aware of the particular objective of the study.

Task and apparatus

The task was to hold the position of L-support, an aerobic gymnastic element, on a mini portable parallel bar. The element's beginning position is sitting with legs near one another, and hands put along the side of the body near the hips. The two arms uphold the body with just the hands in contact with the smaller portable parallel bar. Hips are flexed, and legs should be held parallel to the floor throughout the task (see Figure 1). Participants were barefoot. The skill required not only isometric strength of the hip flexors, *musculus rectus femoris*, *abdominals*, and *obliques* but also balance and high precision (alignment, feet, toes, and back position), as any imperfection is taken into account as a deduction (see Table 1). The height of the mini portable parallel bar was 25 cm. The width of the parallel bar was 22 cm, and its length was 35 cm.

The experiment was conducted in a quiet room with dimensions of 4×5 m^2. All trials were recorded by two video cameras that were mounted onto tripods. One camera was set up on the diagonal front side of the participants and the second one on the left side of the mini portable parallel bar, both at a 1-meter distance. The purpose of the recordings was to help the two gymnastic international level specialists to check the execution scores of particular trials in case there was more than 0.1 difference between the two raters. Two pieces of yellow tape (2×9 cm) were attached to the gymnasts' feet on the inner side of the navicular bones. Two pieces of red tape (2×9 cm) were wrapped around the distal phalanx of the big toes of the right and left foot (see Figure 2). The tape was attached to the participants in all conditions but only served as the attentional cue in the external focus condition.

Figure 1. Schematic L-support motor task.

Figure 2. External cues represented by red and yellow tapes.

Procedure

The participants were asked to be barefoot at the beginning of the experiment as coloured tape was applied to their feet. Next, they were instructed to look at one picture representing the L-letter shape and an L-support technical representation (see Figure 3) provided by the Fédération Internationale de Gymnastique (FIG, 2009). A verbal summary of the task was given by the experimenter as the

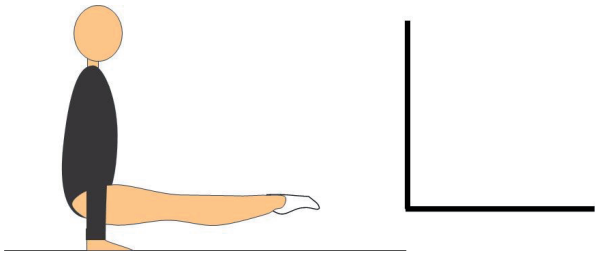

Figure 3. L-letter shape and L-support technical representation.

Table 1. General and specific execution points from the Fédération Internationale de Gymnastique code of points for aerobic gymnastics (FIG, 2009)

Execution faults	Judging criteria	Small	Medium	Large	Unacceptable
		0.1	0.2	0.3	0.5
Incorrect body alignment	Upper body position, arms and shoulders placement and neck relative to the spine	1 part	2 parts	3 parts	4 parts or more
Incorrect body form	L-shape body form, back and legs position with hips flexed at 90°	1 part	2 parts	3 parts	4 parts or more
Legs not parallel to the floor	Positioning of the legs parallel to the floor throughout the task	10°	20°	30°	40°
Legs/ feet bent	Positioning of the feet relative to the knees and hip joint	< 5 cm	5-10 cm	10-15 cm	> 15 cm
Legs/ feet apart	Feet have to be together throughout the task	< 5 cm	5-10 cm	10-15 cm	> 15 cm

participant was viewing the pictures. The verbal description included the L-position with the legs held above the floor, and the back was straight and aligned with the head upright. This information was identically presented to all participants. Participants were familiar with the task as they were experienced gymnasts.

After receiving the instructions, participants completed a practice trial. Subsequently, all gymnasts performed four trials in each of the external focus (EF), internal focus (IF), and control (Con) conditions in a counterbalanced order. The requirement was to hold the L-support for four seconds. Rest intervals of 20 seconds were provided between trials and 3 minutes between focus conditions. During the 20-second break, participants were given relevant instructions, depending on which condition was coming next. In the external focus conditions, participants were asked to "focus on keeping the red tape below yellow the tape", which helped the athletes to straighten their feet/ toes without focusing on them. In the internal condition, participants were instructed to "focus on pointing their toes", which is a typical instruction in gymnastic training for straightening the feet/ toes. No focus instructions were given in the control condition.

After completing four trials in each attentional focus setting, a manipulation check was used. Participants were asked at the end of every 4 trials: "What did you focus on?". The participants were asked to indicate, on a scale from 1 (not at all) to 10 (very much), "How much did you focus on…?". At the end of all 12 trials under the 3 focus conditions, the participants were asked to indicate the level of task difficulty on a scale from 1 (not at all) to 10 (very much). No input on their results was explained to the participants. At the end of the experiment, the investigators thanked the gymnasts for participating in this study.

Statistical analysis

Dependent variables

The dependent variable was represented by the participants' motor performance, indicated by the average execution scores on movement form in each attentional focus condition. Each rater assessed each L-support execution according to general and specific execution points indicated in the FIG (2009) for aerobic gymnastics (see Table 1). Principally, deductions were added for uncontrolled feet, legs/feet bent or apart, incorrect body alignment, rounded back position, and legs not parallel to the floor (see Table 1). The judges' scores for each trial were promoted as a measure of movement form. The judges then compared their performance execution error scores and found a compromise where there was an inconsistency. For each mistake, execution deductions were listed as follows: small error = 0.1, medium error = 0.2, major error = 0.3, and/or unacceptable error = 0.5 (see Table 1).

Data analysis

L-support execution scores were averaged across 4 trials and analysed using a one-way analysis of variance with repeated measures on the attentional focus conditions: (EF, IF, Con). The assumptions of normality were tested using the Shapiro-Wilk test. The data were normally distributed for all attentional focus conditions ($p>.05$). Mauchly's test was used to test the assumption of sphericity ($\chi^2(2) = 4.340$, $p=.114$). The Bonferroni test and adjustments were used in all *post-hoc* comparisons. Estimates of effect size were calculated using two measures. First, partial eta squared (ηp^2) was utilised where $\eta p^2 = .01$, .06, and .14 were estimated for a small, moderate, or large effect, respectively (Lakens, 2013). Cohen's *d* was employed as a measure of the difference between focus conditions in within-subject designs that also considers the correlation between the two means (Morris &

DeShon, 2002). The evaluation of Cohen's *d* corresponded to low (*d* = 0.2), medium (*d* = 0.5), and large (*d* = 0.8) effects (Cohen, 1998).

Inter-rater reliability in assessing the movement execution scores between two judges was determined using intra-class correlation (ICC) analysis based on a two-way mixed-effects, absolute agreement parameters (Shrout & Fleiss, 1979). The coefficient values of <.50, .50-.74, .75-.90, and >.90 were indicating poor, moderate, good, and excellent correlation, respectively (Portney & Watkins, 1993). A non-parametric Friedman test was used to compare the intensity of foci among the attentional focus conditions. The Kendall's *W* values were used for reporting the effect sizes of Friedman test ranging from 0 (indicating no relationship) to 1 (a perfect relationship). The level of significance was set at α=.05 for all statistical tests. Data analysis was provided with IBM SPSS Statistics (Version 21 for Windows, IBM, Armonk, NY, USA).

Table 2. Participants' responses to the questions in %, "What did you focus on?" in per cent, and "How much did you focus on it?" (Likert scale from 1 to 10) in different attentional focus conditions

	Control		Internal focus		External focus	
	"What did you focus on?"	"How much …?	"What did you focus on?"	"How much …?	"What did you focus on?"	"How much …?
Reported external foci						
Red tape below yellow tape	-	-	-	-	50.00	8.50
Red tapes being together	-	-	-	-	8.33	8.00
Red tapes	-	-	-	-	8.33	9.00
Tapes together	-	-	-	-	8.33	7.00
Tapes together and red below yellow tape	-	-	-	-	8.33	8.00
On holding L-shape/L-support	16.67	7.50	-	-	-	-
Total	16.67	-	-	-	83.33	-
Average	-	7.50	-	-	-	8.10
Reported internal foci						
Feet together and pointing toes	8.33	10.00	25.00	8.33	-	-
Pointing tips of toes	8.33	9.00	16.67	8.50	-	-
Tips of toes	-	-	25.00	9.00	8.33	3.00
Keep the legs together and keep them in the air	-	-	8.33	9.00	-	-
Straight body	-	-	8.33	4.00	-	-
Straight legs and body	8.33	9.00	-	-	-	-
Legs and back	-	-	8.33	10.00	8.33	10.00
Feet together	8.33	9.00	-	-	-	-
Feet	-	-	8.33	8.00	-	-
On lifted legs	8.33	8.00	-	-	-	-
Rise legs a bit up	8.33	5.00	-	-	-	-
Contracting abdominal	8.33	10.00	-	-	-	-
Straight back and pointing tips of toes	8.33	9.00	-	-	-	-
Straight legs	8.33	8.00	-	-	-	-
Total	75.00	-	100	-	16.67	-
Average	-	8.56	-	8.12	-	6.50
Other foci						
Not to sit on the bar	8.33	9.00	-	-	-	-
Pass	-	-	-	-	-	-
Nothing	-	-	-	-	-	-
Total	8.33	-	-	-	-	-
Average	-	9.00	-	-	-	-

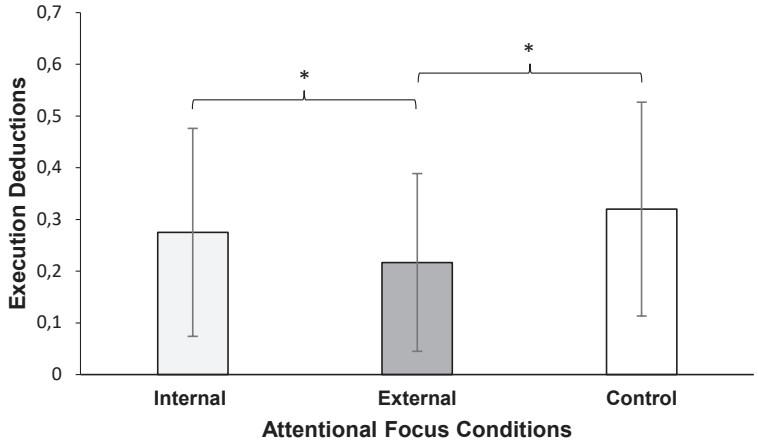

Figure 4. Mean execution scores for movement form in attentional focus conditions.

Results

Manipulation check

Participants' responses to the questions in the manipulation check indicated that the gymnasts adhered to the external and internal focus instructions to a great extent (see Table 2). Although some participants reported using other foci, most of those cues were external or internal in the external focus versus internal focus conditions, respectively. In the control condition, a relatively large proportion of cues were internal in nature. The ratings on the "intensity" of foci "How much did you focus on…?" were relatively high, with an average rating of 8.3 ± 1.66 for the internal focus, 8.0 ± 1.90 for the external focus, and 8.4 ± 1.50 for the control conditions (see Table 2). There was no significant difference among different focus conditions in intensity of foci, $\chi^2(2) = 0.619$, p=.734, Kendall's $W = .026$. Participants reported the level of task difficulty as medium, with an average rating score of 4.66 ± 2.09 out of 10.

Inter-rater reliability

The average measure ICC for execution scores in all trials was r=.905, 95% *CI* (.807, .931), p<.001, indicating excellent inter-rater reliability between the two judges.

Movement form

Figure 4 shows the mean execution scores for movement form across trials under the different attentional focus conditions. The results revealed that the main effect of attentional focus condition, $F(2, 20) = 14.76$, p<.001, $\eta p^2 = 0.57$, was significant. Bonferroni *post-hoc* test showed that the execution scores for L-support in the EF ($M = 0.21 \pm 0.17$) were significantly better than in the IF ($M = 0.27 \pm 0.20$, p=.002 $d = 1.27$) and control ($M = 0.32 \pm 0.20$, p=.002, $d = 0.96$) conditions. No significant differences were observed between the IF and control condition (p=.196, $d = 0.43$).

Discussion and conclusion

The findings of this study highlight the advantage of an external focus over an internal focus and no-focus instructions condition in a static-strength gymnastic motor skill that emphasises movement form. These findings are consistent with previous studies, which have shown that gymnasts benefited from the external focus compared to the internal focus of attention in temporary form-based elements such as jump and ½ turn in gymnastics (Abdollahipour, et al., 2015). Also, the current finding is in line with previous studies that have shown the advantages of the external over the internal focus of attention in the motor tasks that do not have a clear focus cue, such as swimming (Stoate & Wulf, 2011). Overall, the findings support the notion that the immediate beneficial effects of external focus instructions on corrections of movement forms could be expanded to those motor tasks that require static strength in gymnastics.

The absence of effects for an external relative to an internal focus instruction in the study by Lawrence et al. (2011) might be related to the complexity of the task (e.g., five-part gymnastic floor routine) and the content of instructions (Abdollahipour, et al., 2015). For instance, external focus instructions related to "focusing on the movement pathway and on exerting an even pressure on the support surface". On the other hand, the internal focus instructions were related to "focusing on exerting an equal force on their feet, keeping their arms out straight, level with their shoulders" (Lawrence, et al., 2011, p. 434). Essentially, to compare the effectiveness of attentional focus instructions on motor performance, it has been recommended that the differences in the content of instructions should only be one or two words (Abdollahipour, et al., 2015; Wulf, 2013). Also, the content of attentional focus instructions, in essence, should be relevant to the task goal. When external attentional focus instructions are vague, long, and irrelevant to many aspects of the motor

task, the effect may not manifest (Abdollahipour, et al., 2015; Lawrence, et al., 2011). Our findings follow existing evidence that has shown only 1- or 2-word differences in attentional focus instructions (e.g., the marker versus hands) was enough to trigger the effect, as demonstrated in prior studies (Abdol lahipour, et al., 2015).

Also, the findings of the current study indicated that while there was no difference in performance outcome between the internal and control conditions (when no instruction was given), the external focus of attention was better than the control condition. This finding is identical to the finding of a previous study on a jumping gymnastic element (Abdollahipour, et al., 2015), as movement form was enhanced in the external focus compared to the control condition. The results of the post-interview questionnaire showed that the majority of participants in the control condition (when no particular focus instruction was given) tended to focus on their body movements (Land, Tenenbaum, Ward, & Marquardt, 2013; Pascua, Wulf, & Lewthwaite, 2015; Porter, et al., 2010). That is, the participant's thinking process in the control condition is to some extent identical to the internal focus condition, specifically in the movement form-based elements (Abdollahipour, et al., 2015). Therefore, it could be suggested that when no focus instructions are given, participants have a natural tendency to focus internally on movement technique. This may be especially true for motor tasks in which the quality of the movement is the outcome of interest.

From a mechanistic standpoint, directing attentional focus at body-related movements or execution techniques induces the internal focus of attention that produces excessive self-concentration and may disrupt the automaticity of movement control, which transmits noise to the motor system, leading to blockage of optimal motor skills execution (McKay, Wulf, Lewthwaite, & Nordin, 2015; Wulf, et al., 2001). The external focus of attention, on the other hand, promotes more automatic methods of motor control by reducing conscious attentional demands and promoting goal-action coupling (Abdollahipour, et al., 2017, 2023; Wulf & Lewthwaite, 2016). More specifically, an external focus promotes functional connectivity among task-relevant motor networks that is typically observed in expert performers and, presumably, more permanent neuroanatomic changes (structural connectivity) that underlie the translation of goals into actions (Singh, Shih, Kal, Bennett, & Wulf, 2022; Wulf & Lewthwaite, 2016).

Apart from the traditional mechanistic account of the benefits of the external focus, an alternative interpretation may be found in the role that external focus plays in reducing fatigue experienced during static strength-based tasks. Research has shown that the external focus is more beneficial than the internal focus as rates of perceived exertion increase (Lohse & Sherwood, 2011). This could be due to greater movement efficiency and neuromuscular coordination associated with the external relative to the internal focus. Indeed, numerous studies have demonstrated reduced EMG activity, heart rate, oxygen consumption, cortical activity, or corticospinal modulation (see EMG meta-analysis by Chua, et al., 2021). Therefore, the enhanced efficiency of the motor system with the external focus likely facilitated the performance of the L-support task and enabled participants to maintain their movement form. In contrast, the internal focus of attention would promote focus on bodily movements, thus leading to greater awareness of fatigue, leading to more performance errors and reduced effort. However, future research with this or similar tasks should include some of the measures mentioned above in a larger sample.

Practical application

The current findings have practical applications for coaches and trainers who teach motor skills that require movement form but do not have a clear focus cue. That is, for correcting movement patterns and improving techniques in form-based motor skills such as gymnastics, ballet, or synchronised swimming, a set of external focus cues (e.g., tape), may be an efficient way to improve movement quality (Abdollahipour et al., 2015; Guss-West & Wulf, 2016). As such, trainers of motor skills or sports that do not involve an implement or do not have a clear focus cue are advised to create task-relevant and effective external focus cues, which are in the direction of the movement goal.

Limitations and future directions

Although our findings showed immediate benefits of the external relative to the internal focus instruction on motor performance, it would be interesting to examine the effectiveness of attentional focus instructions on form-based motor skills in long-term motor learning tests (e.g., retention and transfer). In addition, it would be worthwhile to examine if the benefits associated with promoting external focus of attention using an external cue or metaphors or mental images on movement goal are still valid during retention or transfer tests.

The results of the current study showed that the external relative to the internal focus instructions enhanced motor performance of a static strength motor skill that requires movement form. That is, with having fewer execution faults, external focus instructions promoted immediate motor performance of a gymnastic element (i.e., L-support) that requires high precision and static hold. Overall, an external relative to an internal focus could also be beneficial for motor tasks that do not use a clear external focus cue and are evaluated based on the quality of the movement (Abdollahipour, et al., 2015).

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Conflict of interest

The authors report no conflict of interest.