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Mind over body: Creating an external focus for sport skills

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ABSTRACT

In a recent study examining the efficacy of different external foci (Singh and Wulf [2020]. The distance effect and level of expertise: Is the optimal external focus different for low-skilled and high-skilled performers? *Human Movement Science*, 73. https://doi.org/10.1016/j.humov.2020.102663), an external focus instruction referred to parts of the body (arms). Specifically, the image of a "platform" was used to describe the area between the wrists and elbows when passing a volleyball. The present study followed up on that study by addressing the question whether a focus on an image that represents a body part (platform) would be more effective than a focus on the body parts (arms) themselves (i.e. internal focus). In a within-participant design, novice volleyball players continuously passed a volleyball to a target on the wall. Participants completed eight 45-s trials under each of the external ("focus on your platform") and internal focus ("focus on your arms") conditions, performed in a counterbalanced order. The results showed that the total score (i.e. sum of scores over 45 s) was significantly higher when participants focused on the platform rather than their arms. Thus, invoking an image of an external object that "replaces" a body part can serve to promote an external focus that results in immediate performance advantages compared with an internal focus on the same body part. The findings suggest that instructors within a range of applied settings can creatively use such images to facilitate the performance of motor skills.

KEYWORDS

Attentional focus; volleyball; coaching

Highlights

- The image of an object ("platform") is used to promote an external focus in volleyball.
- Novice volleyball players pass a ball to a target with a focus on the platform versus arms.
- Passing accuracy is superior with an external (platform) relative to an internal focus (arms).
- Using the image of an object to "replace" a body part can promote an external focus of attention.

Introduction

An important component in the process of learning or teaching motor skills is the performer's focus of attention. Originally defined by Wulf, Höß, and Prinz (1998), an internal focus of attention refers to a concentration on body movements, whereas an external focus refers to a concentration on the intended effect of the movement (e.g. motion of golf club, spin of a ball, force exerted against an object). In one of the initial studies comparing the effectiveness of an external versus internal focus, instructions to focus on keeping markers (external focus) on a balance platform horizontal resulted in more effective learning than did instructions to focus on keeping the feet (internal focus), placed behind the markers, horizontal (Wulf et al., 1998, Experiment 2). Since then, numerous studies have replicated the beneficial effects of adopting an external relative to an internal focus of attention (for reviews, see Lohse, Wulf, & Lewthwaite, 2012; Wulf, 2007, 2013; Wulf & Lewthwaite, 2010, 2016; Wulf & Prinz, 2001). Across a wide range of tasks and different performer characteristics (e.g. skill level, age, health status), an external focus has consistently been found to facilitate both immediate performance and longer-term learning (Chua, Jimenez-Diaz, Lewthwaite, Kim, & Wulf, 2021).

When performers were given instructions or feedback that promoted an external focus, findings have shown that movement accuracy increased (e.g. Bell & Hardy, 2009; Lohse, Jones, Healy, & Sherwood, 2014), balance was more effective (Kim, Jimenez-Diaz, & Chen, 2017), and movement form was enhanced (e.g. Abdollahipour, Wulf, Psotta, & Nieto, 2015; An, Wulf, & Kim, 2013). Also, movements are typically performed more efficiently with an external focus, as evidenced by reduced

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oxygen consumption for a given task (e.g. Schücker, Hagemann, Strauß, & Völker, 2009), reduced muscular activity (e.g. Lohse, Sherwood, & Healy, 2011; Vance, Wulf, Töllner, McNevin, & Mercer, 2004), greater movement fluidity (e.g. Kal, van der Kamp, & Houdijk, 2013), or greater sustainability of activities such as weight lifting (e.g. Marchant, Greig, Bullough, & Hitchen, 2011; Nadzalan, Lee, & Mohamad, 2015).

To explain the differential effects of external versus internal foci on movement coordination, the constrained action hypothesis (Wulf, McNevin, & Shea, 2001) was initially developed. According to this hypothesis, an external focus facilitates performance by promoting automatic control processes, whereas an internal focus induces a more conscious type of control, constraining the neuromotor system and disrupting the usage of fast and reflex-based control mechanisms. More recently, Wulf and Lewthwaite (2016) described an external focus as a contributor to goal-action coupling, whereby functional and structural neural connections between the performer's intended movement goal and neuromuscular activation are strengthened. An external focus is also assumed to reduce self-referential processing or activation of a self-invoking trigger associated with an internal focus (McKay, Wulf, Lewthwaite, & Nordin, 2015; Wulf & Lewthwaite, 2010). Increased confidence resulting from effective performance with an external focus may result in additional performance and learning benefits (Wulf & Lewthwaite, 2016).

While there is copious experimental evidence that adopting an external focus leads to superior performance and learning compared with the use of an internal focus, there is also evidence that some external foci are more effective than others. Focusing on a movement effect that is farther away from the body (i.e. distal focus) has been shown to be more effective than focusing on an effect that is closer to the body (i.e. proximal focus). McNevin, Shea, and Wulf (2003) first demonstrated that increasing the distance of the external focus increased the learning advantage. Concentrating on markers on a balance platform that were farther away from the feet resulted in more effective balance learning than did concentrating on markers closer to the feet, or the feet themselves (internal focus). The so-called distance effect has been replicated in other studies using tasks such as golf putting (Kearney, 2015), pitching golf balls (Bell & Hardy, 2009), dart throwing (McKay & Wulf, 2012), jumping (Porter, Anton, & Wu, 2012), and landing (Raisbeck & Yamada, 2019). However, even though more distal foci have been found to be more effective than proximal foci in comparison with internal foci, proximal external foci are still more effective than internal foci (e.g. Abdollahipour et al., 2015; Lawrence, Virian, Oliver, & Gottwald, 2020; Totsika & Wulf, 2003; Wulf et al., 1998). For example, Abdollahipour et al. (2015) found that gymnasts produced superior movement form when asked to focus on a tape marker attached to their chest compared with an internal focus (hands crossing in front of chest).

Another factor that needs to be considered in the context of the "distance" of the external focus is the performer's skill level. Wulf and Prinz (2001) first suggested that experienced performers might benefit from adopting a distal focus, which might facilitate the production of the movement pattern necessary to achieve the desired outcome; however, novices who are still trying to learn the basic coordination might benefit more from a proximal focus, particularly if it is more technique-related than a distal focus (see also Wulf, 2007). Indirect evidence for this idea has been provided by separate studies demonstrating that novice participants learning to pitch golf balls benefited from a focus on the club motion relative to the ball trajectory and target (Wulf, McNevin, Fuchs, Ritter, & Toole, 2000, Experiment 2), whereas the opposite was the case for advanced golfers (Bell & Hardy, 2009). A recent study by Singh and Wulf (2020) provided the first direct evidence for the notion that the optimal external focus distance might depend on the performer's level of expertise. Moreover, these authors chose a task that did not involve the use of an implement such as a club, racquet, or bat to which attention could be directed in a proximal focus condition. Rather, an image was used to refer to body movements. Specifically, in Singh and Wulf's (2020) study, volleyball players who were asked to continuously pass a volleyball to a target on the wall were instructed to concentrate either on their "platform" (proximal external focus) or the bullseye (i.e. target on the wall that participants were aiming at) (distal external focus). The "platform" was used to describe the area between both wrists and elbows that the ball hits off of. Their results showed that the high-skilled group performed more effectively with the bullseye focus relative to the platform focus. In contrast, the low-skilled group demonstrated superior performance with the platform focus compared with the bullseye focus. Thus, for low-skilled performers, using an image (platform) that represented parts of the body (arms) resulted in enhanced performance compared with a more distal focus.

Images have previously been used to induce an external focus of attention. For instance, Wulf, Lauterbach, and Toole (1999) referred to the golf club motion as a pendulum (see also Wulf, 2007).[1] Yet, Singh and Wulf's (2020) proximal external focus instruction did not refer to an implement but rather the body. This is similar to a study by Lohse and Sherwood (2011) who showed that muscular endurance on a static wall-sit task was greater when participants focused on an imaginary line (external) as compared to their thighs (internal). This raises the interesting question whether complex task performance can be enhanced by a focus on an image that represents a body part (platform) rather than a focus on the body parts (arms) themselves (i.e. internal focus). If this were the case, it would have important implications for practical settings. It would allow instructors to use such images when teaching novices new movement patterns without referring to the body per se and thus avoiding the negative sequalae associated with an internal focus. The present study was therefore designed to address this question. We used the same task as Singh and Wulf (2020) and, in a within-participant design, asked novice participants to focus on either their arms (internal focus) or their platform (external focus). We hypothesized that they would perform more effectively with a focus on the platform relative to a focus on their arms.

Methods

Participants

Based on a factorial design with one within-participant factor (focus) and one between-participant factor (order of conditions), an estimated effect size of $\eta_p^2 = .22$ (Klostermann, Kredel, & Hossner, 2014; Lohse, Sherwood, & Healy, 2010; Zachry, Wulf, Mercer, & Bezodis, 2005), an α-level set at .05, and a power value of 95%, a sample size of 14 participants was estimated via a power analysis using G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007). Fourteen university students (7 females, 7 males) aged 18–40 years ($M = 22.8$, $SD = 3.88$) participated in the study. Each participant had less than 4 years of playing experience and was considered a novice volleyball player who had a basic understanding of the volleyball passing technique. No collegiate or former collegiate volleyball players participated. On average, participants had 2.85 years of recreational playing experience. Participants were naïve as to the purpose of the study. Also, participants had either not taken a motor control and learning class or, if they were enrolled in that class, they had not yet been taught about the effects of attentional focus. The study was approved by the university's institutional review board. Each participant provided their informed consent before beginning the experiment.

Apparatus and task

Participants were asked to pass a volleyball (Molten Flistatec V5M5000-3N) continuously towards a target on the wall 1.5 m in front of them (see Figure 1). The target consisted of a bullseye, 15 cm in diameter and located 1.4 m above the floor. Four points were awarded each time the ball hit the bullseye, which was surrounded by concentric circles. The first circle had a diameter of 45 cm. Three additional circles had diameters of 60, 90, and 120 cm. Three, two, and one points, respectively, were given for balls hitting the progressively larger circles.

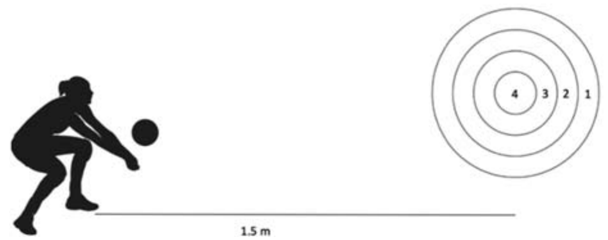

Figure 1. Schematic of the apparatus and task.

Procedure

Participants performed a total of 16 45-second trials with the goal of maximizing the number of points scored in the allotted time. Eight trials were performed in the internal focus and eight trials in the external focus condition. The order of conditions was counterbalanced among participants, with half of the participants completing the internal focus condition first and the external focus condition second, and vice versa. At the beginning of the experiment, a demonstration was provided by the experimenter, a former professional volleyball player. Each participant performed a dynamic stretch on their own prior to performing a practice trial. In the internal focus condition, participants were instructed to "concentrate on your arms", while in the external focus condition they were instructed to "concentrate on your platform". The experimenter gave focus reminders at the beginning of each trial. The timer started when the performer self-tossed the ball towards the target. If the ball hit the ground during a trial, participants were asked to self-toss again and continue the task. A 15-second break was provided after each trial, and a 2-minute break was given after the first eight trials. To record the points scored, a video recorder was used that was mounted on a tripod and facing the target. The reliability of the performance assessment was determined by having two raters independently review the video recordings offline. One of the two raters assessed 20% of the trials and was blind to the experimental condition under which the trials were performed.

Dependent variables and data analysis

Inter-rater reliability in scoring performance was determined using intraclass correlation (ICC) analysis based on a two-way random-effects, absolute-agreement, single-rating model with two raters (Shrout & Fleiss, 1979). Similarly, we evaluated intra-rater reliability, with the same (primary) rater scoring 20% of the trials again after an interval of several weeks. Coefficient values of <.50, .50–.74, .75–.90, and >.90, respectively, indicate poor, moderate, good, and excellent correlation (Portney & Watkins, 1993). The total score (i.e. sum of points), the number of passes (wall hits), and the average accuracy score (i.e. points per pass) were determined for each 45-s trial. Each of these measures was averaged across all eight trials in each focus condition. Data were analyzed in a 2 (focus: internal, external) × 2 (order: internal-external, external-internal) analysis of variance (ANOVA) with repeated measures on the first factor. Partial eta squared (η_p^2) was used to determine effect size. For all analyses, the alpha level was set to a value of .05.

Results

Reliability of scoring

Inter-rater reliability was excellent, with an ICC (2, 1) for randomly selected trials (20% of all trials) of $r = .998$, 95% CI [.997, .998], $p < .001$. Also, intra-rater reliability was high with an ICC (2, 1) value of $r = .999$, 95% CI [.998, .999], $p < .001$.

Total score

The external focus on the platform ($M = 125.1$, $SD = 34.5$) resulted in higher scores compared to the internal focus on the arms ($M = 112.7$, $SD = 34.5$) (see Figure 2). The difference between focus conditions was significant, F (1, 12) = 6.62, $p = .024$, $\eta_p^2 = .36$. The main effect of order, F (1, 12) < 1, and the interaction of focus and order, F (1, 12) = 3.13, $p = .10$, were not significant.

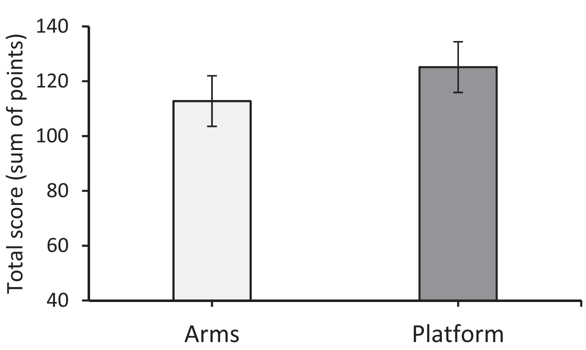

Figure 2. Total score in the internal (arms) and external (platform) focus conditions. Error bars represent standard errors.

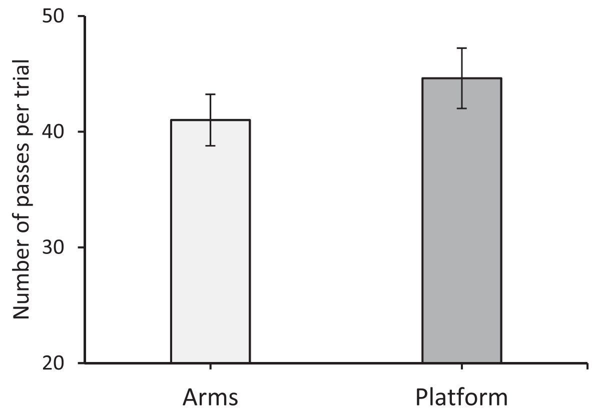

Figure 3. Number of passes in the internal (arms) and external (platform) focus conditions. Error bars represent standard errors.

Number of passes

The average number of passes completed per trial are shown in Figure 3. In the external focus condition participants performed more passes ($M = 44.6$, $SD = 9.8$) than they did in the internal focus condition ($M = 41.0$, $SD = 8.3$). The focus effect was significant, F (1, 12) = 5.88, $p = .032$, $\eta_p^2 = .33$. There was no effect of order, F (1, 12) = 1.12, $p = .310$, $\eta_p^2 = .09$, or interaction of focus and order, F (1, 12) = 3.22, $p = .098$, $\eta_p^2 = .211$.

Accuracy scores

Average accuracy scores were similar in the external ($M = 2.8$, $SD = .036$) and internal focus ($M = 2.7$, $SD = .032$) conditions (see Figure 4). The difference between focus conditions was not significant, F (1,12) = 1.30, $p = .277$, $\eta_p^2 = 098$. The main effect of order, F (1, 12) < 1, and the interaction of focus and order, F (1, 12) < 1, were not significant either.

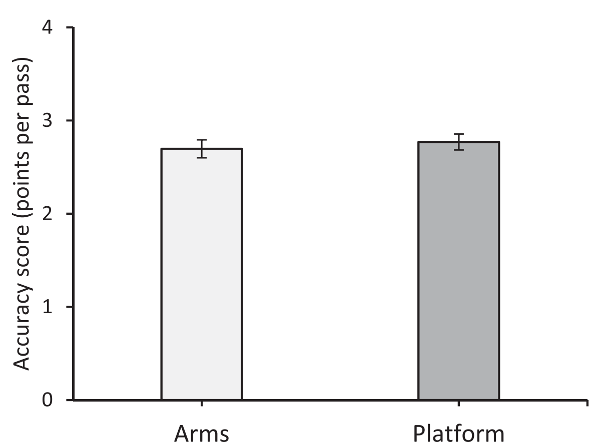

Figure 4. Average accuracy scores in the internal (arms) and external (platform) focus conditions. Error bars represent standard errors.

Discussion

In the present study, we asked whether thinking of a body part as an object, thereby adopting an external focus, would result in more effective motor performance than thinking of the body part itself (internal focus). When asked to concentrate on the platform, the novice volleyball players in our study achieved higher total scores than when they were instructed to concentrate on their arms. More specifically, scores were about 10% higher with a focus on the platform relative to the arms. This result confirmed our hypothesis. It showed that a focus on movement coordination can be relatively effective provided the performer replaces the image of, or concentration on, a body part with that of an external object.

The total score for each 45-s trial was a function of both the number of passes and the accuracy with which the target was hit. Therefore, we also analyzed each of those components of performance. In the external focus condition, participants passed the ball at a significantly higher rate, about once per second (44.6 times during a 45-s trial), than they did in the internal focus condition (41.0 times). There was no difference between conditions in terms of passing accuracy. Thus, the number of passes had a greater influence on overall performance than did the accuracy of the passes. Given that the average accuracy scores were already relatively high, namely, 2.7 (internal focus) and 2.8 (external focus) out of possible 4 points, there was limited room for improvement with regard to accuracy. It is therefore perhaps not surprising that the number of passes had a greater influence on the performance differences between conditions. The increase in the speed of passes when the focus was on the platform, relative to the arms, seems to reflect an enhanced efficiency and fluidity of movements with an external focus (Kal et al., 2013). Neuromuscular efficiency, including reduction of muscular co-contractions (e.g. Marchant, Greig, & Scott, 2009; Vance et al., 2004), has generally been found with an external compared to an internal focus. These findings in the peripheral nervous system are in line with observed increases in intracortical inhibition (i.e. excitability of inhibitory circuits; Kuhn, Keller, Ruffieux, & Taube, 2017) and surround inhibitions (i.e. motor evoked potential in adjacent muscles shaping neural drive during voluntary movement; Kuhn, Keller, Lauber, & Taube, 2018) in the motor cortex when an external focus is adopted. Those findings are also consistent with the notion of an external focus as an important contributor to efficient goal-action coupling (Wulf & Lewthwaite, 2016).

In contrast, the adoption of an internal focus is assumed to result in disruptions to goal-action coupling due to more conscious constraint of the motor system in attempting to control movement processes (Wulf et al., 2001). In addition, an external focus presumably prevents, or at least reduces, accessibility to detrimental self-referential processing or the activation of a self-invoking trigger that is associated with references to one's own body (McKay et al., 2015; Wulf & Lewthwaite, 2010; Yin, Sui, Chiu, Chen, & Egner, 2019). In many previous studies, external versus internal focus effects occurred as the result of as little as one- or two-word differences in the instructions (e.g. Wulf et al., 1998, "focus on your feet" [internal] versus "focus on the markers" [external]; Wulf & Su, 2007, "focus on the swing of your arms" [internal] versus "focus on the swing of the club" [external]). References to the body are assumed to facilitate access to the neural representation of the *self* and result in "micro-choking" episodes (for a discussion, see Wulf & Lewthwaite, 2010).

While in the majority of studies examining the effectiveness of external versus internal foci, attention was directed to actual objects (e.g. implements, markers, targets) in external focus conditions, the present study shows that even replacing thoughts about body parts with an image of an object can be sufficient to promote an external focus, with immediate benefits for performance. In previous studies, images were also invoked to induce an external focus (e.g. Lohse & Sherwood, 2011; Wulf, Chiviacowsky, Schiller, & Ávila, 2010; Wulf, McConnel, Gärtner, & Schwarz, 2002). However, in the latter two studies, instructions to think of the leg as a pendulum (when kicking a soccer ball) (Wulf et al., 2002) or producing a C (at the beginning of a soccer throw-in) (Wulf et al., 2010) were included in a list of several statements designed to induce an external focus. Therefore, it is unclear whether those statements in and of themselves were effective. Lohse and Sherwood's (2011) findings, however, were relatively similar to the present findings, even though their task and measurement were quite different. These authors used a static wall-sit task and measured the time participants were able to maintain that position while focusing on keeping their thighs (internal focus) or imaginary lines between markers on their knees and hips parallel to the floor (external focus). Time to failure was longer and the level of perceived exertion was lower when the same participants adopted an external rather than internal focus. Thus, those findings demonstrated greater muscular efficiency in a static force production task when the thighs were thought of as lines. In the present study, movement fluency or speed was enhanced in a whole-body, dynamic, and continuous aiming task when the arms were thought of as a platform. The findings provide converging evidence that invoking an image of an external object that "replaces" a body part can serve to promote an external focus that results in performance advantages compared with an internal focus on the same body part.

These findings have interesting implications for applied settings. They suggest that coaches, or athletes themselves, can create images to facilitate motor coordination for effective performance (see also Wulf, 2007). In fact, many coaches and performers have already discovered the benefits associated with such images. For example, former U.S. champion and figure skating coach, Garrett Lucash (personal communication, July 19, 2020), frequently uses cues and phrases to invoke images, including "elevator up to the top floor" (to prompt skaters to keep their hips up, especially as they bend their knees), "grow taller as if you are a tree", or "balance an egg on your head" (intended for skaters to keep the head level, and neck and torso extended upwards). Images may be particularly relevant for form-based sports that don't involve implements, such as gymnastics, ballroom dance, or ballet, but are certainly not limited to them. In a survey of professional ballet dancers (Guss-West & Wulf, 2016), many dancers reported using external foci when performing certain routines, such as "elevating myself like a balloon" (5th position), "stretching like a star in all directions" (arabesque), "gliding through air" (grand jeté), or "climbing up a corkscrew" (pirouette en dehors). Ballet instructors have also seen the benefits of using such images in their teaching practice (Guss-West, 2021). The present findings provide experimental evidence for the effectiveness of external foci that make use of images of bodily movements or postures, while at the same time reducing a focus on the body. They give instructors and performers another set of tools they can use creatively in the process of teaching or learning motor skills.

Note

1. In another line of research, images or analogies have been used in an attempt to enhance learning and, in particular, performance under pressure (e.g. Liao & Masters, 2001; Masters, Poolton, Maxwell, & Raab, 2008; Schücker, Hagemann, & Strauß, 2013). In these studies, the effectiveness of instructions involving analogies – such as "move the bat as if it is traveling up the side of a mountain" (Masters et al., 2008) or moving a golf club like a pendulum (Schücker et al., 2013) – has typically been compared to *sets* of explicit, detailed technique-related instructions. Thus, there is a possible confounding influence of the amount of information provided to different groups of learners. In the present study, the instructions differed in only one word ("concentrate on your arms" versus "concentrate on your platform") to promote an internal versus external focus, respectively.

Disclosure statement

No potential conflict of interest was reported by the authors.

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