

Article

External Focus enhanced Vertical Jump: Skilled Volleyball Players vs Novices Compared

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Abstract: An external focus is defined as directing one's attention to objects and the environment. Conversely, an internal focus is defined as directing one's attention to the movements themselves. According to the constrained action hypothesis, an external focus could enhance sports performance in tasks such as golf putting, basketball free throw, jumping, and sprinting. However, few studies have examined whether the effect of an external focus on jump performance differs between experts and novice participants. This study aimed to clarify whether the influence of an external focus during jump differs between expert volleyball players and novice participants. Forty participants were recruited. We tested expert volleyball players ($n = 20$, $\text{Mage} \pm \text{SD} = 20.2 \pm 0.9$ years) who were members of a college volleyball club, and novice participants for volleyball ($n = 20$, $\text{Mage} \pm \text{SD} = 20.9 \pm 1.1$). The Yardstick Jump Testing System (Swift Performance) was used to record maximal vertical jump-and-reach height. Each participant performed three trials under two conditions (internal focus vs external focus). The jump-and-reach height (cm), flight time (ms) and attention score were subjected to a mixed repeated-measures analysis of variance (ANOVA), including the factors of "group" (experts/novice) and "condition" (external focus/internal focus). The average jump-and-reach heights for experts under the external and internal focus conditions were 44.6 cm ($\text{SD}=5.1$) and 42.8 cm ($\text{SD}=4.9$), respectively. For novices, the average heights were 42.5 cm ($\text{SD}=5.2$) and 41.4 cm ($\text{SD}=4.6$), respectively. Jump-and-reach height was significantly higher in the external focus condition than in the internal focus condition ($F(1, 38) = 29.66$, $p = .01$, $\eta^2p = .44$). We did not find a difference in flight time between conditions. An external focus may facilitate effective whole-body movement, i.e., coordination between the upper and lower body during a jump. Overall, the external focus enhanced jump performance compared to the internal focus regardless of sports expertise.

Keywords: attentional focus; external focus; internal focus; constrained action hypothesis.

1. Introduction

Over the past two decades, a substantial body of research has examined the impact of attentional focus on sports performance (Chua et al., 2021; Makaruk et al., 2020; Stoate & Wulf, 2011; Wulf, 2013; Wulf et al., 1998; Wulf et al., 2002). Two types of attentional focus have been proposed to

explain performance differences in sports. Specifically, an external focus involves directing attention toward a target object or the environment (e.g., equipment or surroundings) rather than the movements themselves. Conversely, an internal focus entails directing attention toward the execution of the movements, disregarding



the target and environment. This typically involves focusing on movement execution details such as the positioning of individual body parts or the kinesthetic sensations associated with the movements. Although the effects of external and internal focus of attention on sports performance have been widely investigated, research comparing expert and novice performance in this context remains still inconclusive (Couvillion & Fairbrother, 2018; Makaruk et al., 2020; Porter et al., 2010; Guss-West & Wulf, 2016; Zhuravleva & Aiken, 2023).

Previous studies have demonstrated that external focus can enhance jump performance (Abdollahipour et al., 2016; Gokeler et al., 2015; Keller et al., 2015; Makaruk et al., 2020; Noroozi et al., 2024; Porter et al., 2012; Wu et al., 2012; Wulf & Dufek, 2009; Wulf et al., 2007; Wulf et al., 2010; Zhuravleva et al., 2024). For instance, Wulf et al. (2007) reported superior jump performance and a higher center of mass during jumps under an external focus condition compared to an internal focus condition. Similarly, participants receiving verbal instructions emphasizing external focus achieved greater standing jump heights (Porter et al., 2012). Additionally, the efficacy of external focus has been observed in the rehabilitation of patients following anterior cruciate ligament (ACL) reconstruction (Gokeler et al., 2015). These findings collectively suggest that an external focus enhances performance in explosive movements, including both vertical (Abdollahipour et al., 2016; Gokeler et al., 2015; Wulf & Dufek, 2009; Wulf et al., 2007; 2010) and standing long jumps (Coker, 2016; Porter et al., 2012; Noroozi et al., 2024; Wu et al., 2012; Westphal & Porter, 2013).

According to the constrained action hypothesis (Wulf et al., 2001), instructions promoting an internal focus may lead to conscious interference with automated movements, impeding efficient execution. An external focus has been shown to reduce electromyography (EMG) activity such as biceps curls (Vance et al., 2005) and basketball free throws (Zachry et al., 2005). Reduced EMG activity suggests increased movement efficiency, as an external focus may facilitate better muscle and joint coordination rather than merely increasing maximum muscle strength (Vance et al., 2005; Zachry et al., 2005). Skilled athletes have internalized sports skills and techniques, rendering them automatic. Therefore, from a biomechanical perspective, an external focus might facilitate the effective recruitment of muscle fibers and improve coordination between agonist and antagonist muscles (Wulf et al., 2010; Vance et al., 2004; Zachry et al., 2005).

The automated movements of skilled athletes are expected to exhibit more refined patterns compared to those of unskilled individuals. However, regarding the impact of attentional focus on sports performance across different expertise levels, findings remain inconsistent (Beilock & Gonso, 2008; Castaneda, & Gray, 2007; Chen et al., 2021; Couvillion & Fairbrother, 2018; Ille et al., 2013; Porter et al., 2010; Guss-West & Wulf, 2016; Schorer et al., 2012; Singh & Wulf 2020; Zhuravleva & Aiken, 2023). Several studies reported beneficial effects of external focus for experts across a range of tasks, including sprinting (Ille et al., 2013; Porter & Sims, 2013), speed jump roping (Couvillion & Fairbrother, 2018), and swimming (Stoate & Wulf, 2011). Conversely, other studies, such

as Couvillion and Fairbrother (2018), found no significant effects of an external focus on performance in novice participants. A meta-analysis by Makaruk et al. (2020) highlighted that few studies have directly compared skilled athletes and unskilled individuals, underscoring the need for further investigation.

Recently, some studies have demonstrated the potential efficacy of internal focus. Herrebrøden (2023) suggested that an internal focus can facilitate motor learning and sports performance in certain contexts. For example, novice participants performed a gymnastics floor routine better in an internal focus condition than in an external focus condition (Lawrence et al., 2011). Similarly, Gottwald et al. (2020) investigated the effect of attentional focus on a computerized aiming task and suggested that an internal focus was effective in proprioceptive task. Furthermore, internal focus might improve sports performance for non-experts (Neumann et al., 2020; Perkins-Ceccato et al., 2003). Thus, it is likely that the effectiveness of an internal focus varies depending on the task and skill level.

This study aimed to elucidate whether the impact of external focus during jumping differs between expert volleyball players and novice participants. We compared jump-and-reach heights under external and internal focus conditions. We hypothesize that jump-and-reach height will be greater under the external focus condition than the internal focus condition, regardless of expertise, in accordance with the constrained action hypothesis (Wulf et al., 2001). Additionally, we anticipated an interaction between volleyball expertise and the effect of attentional focus; specifically, the

disruptive effect of internal focus may be more pronounced in skilled volleyball players than in novices, as skilled players rely on advanced and automated movements that are more susceptible to conscious interference.

2. Materials and Methods

Participants - A prior-hoc power analysis was conducted using G*Power 3.1 to determine the sample size (Faul et al., 2007). To examine the main effect between groups, the estimation was based on an F-test effect size of 0.4, power of 0.8, alpha level of 0.05 (Cohen, 1992), two between-subjects factors (experts/novice), and two within-subjects (external focus/internal focus). A sample size of participants was obtained 40. Forty participants were recruited. As presented in Table 1, we tested expert volleyball players who were members of a college volleyball club and novice participants for volleyball. Volleyball players had Mage $\pm$ SD = 11.1 $\pm$ 2.4 years of experience playing volleyball. Participants had normal or corrected-to-normal vision. All participants gave written informed consent prior to the experiments. This study was approved by the Local Ethics Committee (2020-03).

Table 1. Descriptive for each group

	N	Age	SD	experience
Expert	20	20.2	0.9	11.1 $\pm$ 2.4 years
Novice	20	20.9	11.	

Procedure - The Yardstick Jump Testing System, Vertec Tester (Swift Performance) was used to record maximal vertical jump-and-reach height. The experiment was conducted on an outdoor athletic field. Tester consisted of plastic rugs

(each with a spacing of 10 cm). The Vertec Tester was positioned to the participant's right or left side. Prior to the experiment participants practiced the jump for one or two trials without any instruction.

The first author conducted the experiment with each participant individually. Each participant performed three trials under two conditions. In the external focus condition, participants were asked to pay close attention to the rungs of the Vertec, and to execute a vertical jump with maximal effort ("Please focus your attention on the Vertec Tester board and jump with maximal effort"). In the internal focus condition, participants were asked to pay close attention to their foot sensations and the exertion of force in their legs, to refrain from visually targeting the rungs of the Vertec prior to jumping, and to execute a vertical jump with maximal effort ("Please focus your attention on your foot sensations and the exertion of force in their legs, to refrain from visually targeting the rungs of the Vertec prior to jumping, and jump with maximal effort"). The order of the two conditions was counterbalanced across participants. We calculated the average of three trials as the average jump-and-reach height. We used the highest recorded value among the three trials as maximum jump-and-reach height. To measure flight time, the jump was recorded by a video camera with a sampling rate of 1/300 s (CASIO, EXILIM PRO EX-F1). Measures of flight time were calculated using Kinovea (version 0.9.3). The reliability of this software has been established in previous research (Puig-Diví et al., 2019). Flight time was the total time from when the toes left the ground before the jump until the feet touched the ground again.

Using Kinovea, the researcher counted the number of frames from when the toes left the ground before the jump until the feet touched the ground again. The endpoints of segments were determined by the researchers. The flight time was then calculated by multiplying the total number of frames during the jump by 1/300 s (Maruo, 2024). We used the Likert scale to measure attention score how much attention participants were able to pay under each condition, consistent with a method used in a previous study (e.g., Abdollahipour et al., 2017; Langner et al., 2023). Participants were asked to indicate on a 5-point rating scale (1 = not at all; 5 = very strong).

Statistical Analysis - The jump-and-reach height (cm), flight time and attention score were subjected to a mixed repeated-measures analysis of variance (ANOVA), including the factors "group" (experts/novice) and "condition" (external focus/internal focus). The degrees of freedom of all F-ratios were adjusted using the Greenhouse-Geisser procedure. The original degrees of freedom are reported with the epsilon value where required. Bonferroni correction was applied to post-hoc comparisons. All statistical analyses were conducted using JAPS (0.15.0.0).

3.Results

Table 2 shows average jump-and-reach height for each group. Shapiro-Wilk test for the external focus condition was not significant ($p = .41$), nor was it significant for the internal focus condition ($p = .49$). Levene's test for the external focus condition was not significant ($p = .82$), nor was it significant for the internal focus condition ($p = .83$). A mixed ANOVA revealed that jump-and-reach

height was significantly higher in external focus condition than in internal condition ($F(1, 38) = 29.66, p < .001, \eta^2p = .44$). The jump-and-reach height did not differ between groups ($F(1, 38) = 1.25, p = .27, \eta^2p = .03$). The interaction between condition and group was not significant ($F(1, 38) = 2.00, p = .17, \eta^2p = .05$).

Table 2 also shows maximum jump-and-reach height for each group. Shapiro-Wilk test for the external focus condition was not significant ($p = .44$), nor was it significant for the internal focus condition ($p = .70$). Levene's test for the external focus condition was not significant ($p = .55$), nor was it significant for the internal focus condition ($p = .52$). A mixed ANOVA revealed that jump-and-reach height was significantly higher in external focus condition than in internal condition ($F(1, 38) = 19.36, p < .001, \eta^2p = .34$). The jump-and-reach height did not differ between groups ($F(1, 38) = .98, p = .33, \eta^2p = .03$). The interaction between condition and group was not significant ($F(1, 38) = 2.15, p = .15, \eta^2p = .05$).

The average flight time for experts in external focus condition and in internal focus condition were 516 ms ($SD = 34.9$), and 515 ms ($SD = 35.8$), respectively. The average flight time for novice in external focus condition and in internal focus condition were 526 ms ($SD = 38.3$), and 529 ms ($SD = 38.6$), respectively. Shapiro-Wilk test for the external focus condition was significant ($p = .05$), and not significant for the internal focus condition ($p = .19$). Levene's test for the external focus condition was not significant ($p = .67$), nor was it significant for the internal focus condition ($p = .89$). The average flight time did not differ between conditions ($F(1, 38) = .32, p = .57, \eta^2p = .01$). The average flight

time did not differ between groups ($F(1, 38) = 1.12, p = .30, \eta^2p = .03$). The interaction between condition and group was not significant ($F(1, 38) = 1.00, p = .32, \eta^2p = .03$).

The maximum flight time for experts in external focus condition and in internal focus condition were 521 ms ($SD = 34.0$), and 522 ms ($SD = 36.7$), respectively. The maximum flight time for novice in external focus condition and in internal focus condition were 537 ms ($SD = 36.2$), and 537 ms ($SD = 39.6$), respectively. Shapiro-Wilk test for the external focus condition was significant ($p = .03$), and not significant for the internal focus condition ($p = .22$). Levene's test for the external focus condition was not significant ($p = .57$), nor was it significant for the internal focus condition ($p = .86$). The maximum flight time did not differ between conditions ($F(1, 38) = .12, p = .73, \eta^2p = .01$). The maximum flight time did not differ between groups ($F(1, 38) = 1.83, p = .18, \eta^2p = .05$). The interaction between condition and group was not significant ($F(1, 38) = 0.01, p = .97, \eta^2p = .01$).

Table 3 shows attention score for each group. Shapiro-Wilk test was significant for both the external focus condition ($p < .001$), and the internal focus condition ($p < .001$). Levene's test for the external focus condition was significant ($p = .02$), and not significant for the internal focus condition ($p = .78$). The attention score was significantly higher in external focus condition than in internal condition ($F(1, 38) = 30.78, p < .001, \eta^2p = .45$). The attention score did not differ between groups ($F(1, 38) = .30, p = .59, \eta^2p = .01$). The interaction between condition and group was not significant ($F(1, 38) = 3.42, p = .07, \eta^2p = .08$).

Table 2. Jump-and-reach height for each group in both conditions (EF: external focus, IF: internal focus).

		N	95% Confidence Interval Mean			SD	Minimum	Maximum
	group		Mean	Upper	Lower			
EF average	expert	20	44.6	47.0	42.3	5.1	32.7	55.3
EF average	novice	20	42.5	44.9	40.1	5.2	34.7	55.7
IF average	expert	20	42.8	45.0	40.5	4.9	29.0	54.7
IF average	novice	20	41.4	43.6	39.3	4.6	34.7	53.0
EF maximum	expert	20	46.1	48.6	43.6	5.3	34.0	56.0
EF maximum	novice	20	44.1	46.4	41.7	5.0	36.0	57.0
IF maximum	expert	20	44.0	46.2	41.8	4.7	33.0	56.0
IF maximum	novice	20	43.0	45.3	40.7	4.9	35.0	54.0

Table 3. Attention score for each group in both conditions (EF: external focus, IF: internal focus).

		N	Mean	95% Confidence Interval Mean		SD	Minimum	Maximum
group				Upper	Lower			
EF	expert	20	4.5	4.8	4.2	0.6	3.0	5.0
EF	novice	20	4.3	4.7	3.9	0.9	3.0	5.0
IF	expert	20	3.3	3.7	2.9	0.8	2.0	5.0
IF	novice	20	3.7	4.1	3.3	0.8	2.0	5.0

4. Discussion

This study aimed to clarify whether the impact of external and internal focus during jumping differs between expert volleyball players and novice participants. The jump-and-reach height and the attention score were significantly higher in the external focus condition than in the internal focus condition. Our findings are consistent with previous studies (Abdollahipour et al., 2016; Gokeler et al., 2015; Keller et al., 2015; Makaruk et al., 2020; Noroozi et al., 2024; Porter et al., 2012; Wu et al., 2012; Wulf & Dufek, 2009; Wulf et al., 2007; 2010; Zhuravleva et al., 2024) in corroborating the constrained action hypothesis (Wulf et al., 2001). Notably, the absence of an interaction between volleyball expertise and attentional focus suggests that directing attention to the rungs of the Vertec scale can enhance jump performance regardless of an individual's sports expertise. These findings extend previous knowledge by suggesting that an external focus augments vertical jump performance regardless of sports expertise. Previous studies have consistently demonstrated that an external focus can enhance performance in both vertical jumps (Abdollahipour et al., 2016; Gokeler et al., 2015; Wulf & Dufek, 2009; Wulf et al., 2007; 2010) and standing long jumps (Coker, 2016; Porter et al., 2012; Noroozi et al., 2024; Wu et al., 2012; Westphal & Porter, 2013).

Considering the flight time results, it may not be accurate to conclude that external focus solely enhanced explosive movements. We did not find a difference in flight time between the conditions, suggesting that there was no difference in leg muscle strength exertion. This indicates that the external focus effect on jump-and-reach height is not

attributable solely to leg muscle strength but rather to improvements in whole-body movement coordination, particularly in the efficient transmission of force from the legs to achieve a higher touch. Previous studies have supported the notion that external focus can facilitate the effective recruitment of muscle fibers within a muscle and the coordination between agonist and antagonist muscles (Vance et al., 2004; Wulf et al., 2007; Zachry et al., 2005). Wulf et al. (2001) assumed that internal focus can disrupt skilled behavior and automation of movement. Our findings suggest that an external focus facilitates effective whole-body movement coordination, specifically between the upper and lower body during a jump.

It is also important to note that no interaction was observed between volleyball expertise and attentional focus. This aligns with findings in golf putting tasks, where shot accuracy was higher in the external focus condition regardless of expertise (Chen et al., 2021; Wulf & Su, 2007). We hypothesized that the impact of internal focus might be larger in novice participants than in expert volleyball players because internal focus can improve sports performance for non-experts (Neumann et al., 2020; Perkins-Ceccato et al., 2003). One possible reason for this is the attentional differences between experts and novices. Our Likert scale assessment of subjective attention revealed that experts tended to exhibit higher attention scores in the external focus condition compared to the internal focus condition. This suggests that experts may find it challenging to direct their attention to specific movements due to the automatization of their skills and techniques. Our results emphasize the significance of

attention quality and movement coordination in sports performance, even in the absence of an interaction in jump performance.

This study demonstrated the effect of external focus on vertical jump performance in both experts and novice participants. In contrast to previous research suggesting that external focus does not enhance sports performance in novice participants (Couvillion & Fairbrother, 2018; Schorer et al., 2012), our findings indicate a positive effect for novice participants. Systematic reviews and meta-analyses have highlighted the scarcity of research directly comparing skilled and unskilled individuals (Makaruk et al., 2020). Makaruk et al. (2020) evaluated forty-seven previous studies examining the effects of attention on jump performance and suggested the beneficial effects of an external focus. However, the differential effects of this attentional focus across varying levels of expertise remain underexplored. Our findings suggest that directing attention externally before jumping can enhance performance, regardless of the participant's skill level.

This study has some limitations. First, we examined only female college students. Future research could include a more diverse sample, such as male students and highly trained athletes, to enhance the generalizability of the findings. Second, the present study only examined the jump-height and flight time using the Yardstick Jump Testing System and video recording. To improve the reliability and validity of the measures, future studies should consider using more precise motion capture systems.

5. Practical Applications

Our findings, along with those of previous studies, support the beneficial effects of external focus on performance. However, coaches often give advice that encourages athletes to focus on their internal sensations. Given that several studies have reported the benefits of internal focus (Gottwald et al., 2020; Lawrence et al., 2011; Neumann et al., 2020; Perkins-Cecato et al., 2003), further research is necessary to elucidate the impact of internal focus on performance across different skill levels. No significant differences in jump height were found between groups. Although participants varied in their years of volleyball experience, there were no differences in leg strength between the groups. To further investigate the effects of attentional focus, it is necessary to include groups with varying levels of athletic experience, including those with less sports experience.

6. Conclusion

This study aimed to clarify whether the influence of external and internal focus during jumping differs between expert volleyball players and novice participants. The results suggest that external focus enhances jump performance when compared to internal focus, regardless of sports expertise. Furthermore, the flight time during the jump did not differ between conditions. Although this study was limited to a sample of female college students, the present findings suggest that an external focus facilitates effective whole-body movement. Future studies should examine the relationship between sports expertise (expert vs novice) and the effect of attentional

focus (external focus vs internal focus) on other movement types and sports events.

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Conflicts of Interest: No potential conflict of interest was reported by the authors.

Data availability statement: The datasets generated for this study are available on request to the corresponding author.

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