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EFFECTS OF INCREASING THE DISTANCE OF AN EXTERNAL FOCUS OF ATTENTION ON VERTICAL JUMP

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I have the the suggested revision. Please let me know if there is anything I need to change, thanks!

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by

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Submitted in Partial Fulfillment of the Requirements for the
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TITLE: EFFECTS OF INCREASING THE DISTANCE OF AN EXTERNAL FOCUS OF ATTENTION ON VERTICAL JUMP

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Several previous studies have demonstrated the benefits of distancing an external focus resulting in improved performance in a variety of skills. The objective of this study was to investigate whether increasing the distance of an external focus of attention relative to the body improved the performance of the counter-movement vertical jump in recreationally active individuals. It was hypothesized that jumps performed by recreationally active individuals under the external focus conditions would outperform performance completed in the control condition. Moreover, it was also predicted that jump height would systematically increase as the participants focus of attention was directed at an increasing distance. Using a within-participant design, college aged student (n = 38) completed two counter-movement vertical jumps on a Vertec^{TM} within five conditions. Data were analyzed using a repeated measures analysis of variance (ANOVA). Results showed that jump heights in the control and upper far conditions were significantly higher than trials completed in the lower near condition. No significant differences were found between the upper near and unreachable conditions. The findings of this study suggest there are limited benefits for extending the distance of an external focus of attention in the vertical jump.

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CHAPTER 1

INTRODUCTION

The vertical jump has become a regularly used assessment among sport coaches to evaluate motor ability and athletic potential, and is sometimes used as a predictor of athletic success (Brodt, Wagner, & Heath, 2008). For example, vertical jumps have been heavily used to predict athletic success in volleyball (Thissen-Milder, & Mayhew, 1991), as well as in football by the National Football League (NFL) (Garstecki, Latin, & Cuppett, 2004; Sawyer, Ostarello, & Suess, 2002). With such importance placed on the vertical jump, coaches should become knowledgeable about the instructional strategies they can use to help athletes achieve optimal performance. Coaches have the ability to help athletes improve their performance of a variety of motor skills based on the content of the instructions they provide, specifically if they use verbal instructions that direct athletes' focus of attention in a particular manner (Porter, Wu, & Partridge, 2010).

Past studies have shown that where an individual focuses his or her attention during the execution of a motor skill influences both the performance and learning of the practiced task (McNevin, Shea, & Wulf, 2003; Wulf, Lauterbach, & Toole, 1999; Wulf, Zachry, & Granados, 2007). In particular, if a performer's attention is directed to the movement effect (i.e., external focus), rather than the movement itself (i.e., internal focus), the performer will likely produce a more accurate and efficient movement (Porter, Anton, & Wu, 2012).

For example, instructing a golfer to focus externally on the swing of the club, compared with the swing of his or her arms (i.e., internal focus), has been demonstrated to enhance the accuracy of a variety of golf shots (Wulf et al., 1999; Wulf & Su, 1997). Researchers have also found attentional focus benefits for balance tasks (Totsika & Wulf, 2003; Wulf, Höβ, & Prinz, 1998),

muscular endurance (Marchant, Greig, & Bullough, 2011), and performance on physical fitness tests (Bredin, Dickson, & Warburton, 2013). These same benefits have been observed in sport specific motor skills as well. Such as, by shifting focus of attention, researchers have demonstrated increased swimming speeds in intermediate swimmers (Freudenheim, Wulf, & Madureira, 2010), along with better accuracy in soccer ball placement (Wulf, McConnel, & Gätner, 2002) and volleyball serving (Wulf, McConnel, & Gätner, 2002).

A possible reason for the advantages of focusing on the effects of one's movements, instead of on the movements themselves, is an explanation proposed by McNevin, Shea, and Wulf (2000) called the "constrained action hypothesis." According to this hypothesis, trying to consciously control one's movements by directing attention internally constrains the motor system by interfering with automatic motor control processes that would "normally" regulate the behavior. Instead, focusing on the movement effect (i.e., externally) presumably allows the motor system to more naturally self-organize, unconstrained by the interference cause by conscious control attempts – resulting in more effective performance and learning (Wulf, McNevin, & Shea, 2001).

Wulf et al. (2001) tested their hypothesis with the use of a stabilometer. The task was to remain in balance – keeping the platform in a horizontal position – for as long as possible during 90-second trials. Participants were either told to focus their attention internally on their feet or externally on markers that were attached to the platform. In addition to balancing, participants were also asked to perform a secondary task. Participants used a hand-held button that was connected to a computer that recorded reaction time. The computer produced a tone and the participants' task was to extinguish the stimulus as fast as possible by pressing the hand-held button. Wulf et al. (2001) found that those in the external focus condition performed better on the

balance task in comparison to the internal focus condition. The researchers also found that participants had a faster reaction time when they were in the external condition. The authors attributed the better balance performance associated with external focus of attention to the participants' reducing their active intervention into control processes governing balance, which is why they were able to perform better on the reaction time task (Wulf et al., 2001). Overall, the external focus of attention condition resulted in better balance performance, increased speed of responding to the secondary task, and decreased attention demands relative to the internal focus of attention condition (Wulf et al., 2001), validating the predictions of the constrained action hypothesis.

A study by Wulf, Dufek, and Lozano (2010) analyzed the electromyography (EMG) activity of the leg and vertical jump height when low-skilled participants adopted an internal and external focus of attention. Compared to the internal focus condition, the external focus resulted in lower EMG activity while at the same time resulting in a significantly higher vertical jump. Wulf et al. (2010) found that the lower EMG activity allowed for optimal coordination within the muscle, resulting in a more efficient movement, which produced a greater jump height. The results of that study also demonstrated that directing attention towards the desired outcome (i.e., external) resulted in neuromuscular activation patterns that were similar to those seen in more experienced performers, who, presumably, tend to adopt an external focus, instead of focusing internally (Wulf, 2008; Wulf et al., 2010). It appears that consciously intervening in these control processes – as participants under internal focus conditions apparently do – results in a "freezing" or "constraining" of the degrees of freedom, less fluid interactions between control mechanisms, and less automatic movement execution which all culminate in depressed motor behavior (Totsika & Wulf, 2003; Wulf et al., 2001).

Based on the predictions of the constrained action hypothesis, McNevin et al. (2003) predicted that when an external focus of attention is close to the body, a mover would be more likely to interfere with the autonomous control processes, than if the external focus was placed farther away. McNevin et al. (2003) tested this hypothesis by using a dynamic balancing task on a stabilometer. Balance was measured from participants' root-mean-square-error (RMSE) and mean power frequency (MPF) while utilizing an internal or one of three external foci of attention that differed in respect to distance and direction relative to the participant (McNevin et al., 2003). The goal of the four conditions was to keep the stabilometer platform horizontal. The results of the McNevin et al. (2003) study revealed that the external far conditions had significantly better balance than those in the external near and internal conditions. These results suggest that the benefits of an external focus of attention can be amplified by increasing the distance of the focus from the person's body. Porter, Anton, and Wu (2012) extended the findings of McNevin et al. (2003) by testing the "distance-effect" hypothesis using a discrete power based task, the standing long jump. Porter et al. (2012) tested participants in three conditions: baseline, external focus near, and external focus far. They found that low-skilled participants jumped significantly farther while in the external far condition compared to when they were in the internal or external near conditions. The results of the Porter et al. (2012) study demonstrated that the benefits of increasing the distance of an external focus of attention were not limited to continuous balance tasks, such as the one used by McNevin et al. (2003).

The distance-effect can help both novice and skilled athletes, as demonstrated in the study done by Porter, Anton, Wikoff, and Ostrowski (2013). Porter et al. (2013) re-tested the hypothesis of Porter et al. (2012) but this time used male athletes that were members of a Division I sport team at a university in the United States. The results of that study were

consistent with previous findings reported in the literature; the jumps completed under the external far condition were significantly farther than that of the other test groups (i.e., control, internal, external near) (Porter et al., 2012).

The purpose of the present study was to investigate whether increasing the distance of an external focus of attention relative to the body would improve the performance of the counter-movement vertical jump in recreationally active individuals. It was hypothesized that jumps performed by recreationally active individuals under the external focus conditions would outperform performance completed in the control condition. Moreover, it was predicted that jump height would systematically increase as the participants focus of attention was directed at an increasing distances from the individual.

The distance effect has been investigated using the standing long jump (Porter et al, 2012; Porter et al, 2013; Westphal & Porter, 2013); however, studies have yet to address the distance effect using the vertical jump. The majority of the distance effect research has been conducted using college-aged individuals that were low-skilled or highly-skilled (Porter et al, 2012; Porter et al, 2013; Westphal & Porter, 2013); this study will add to that body of knowledge by being delimited to recreationally active individuals (i.e., moderately skilled) within a college-aged population. This study will uniquely contribute to the existing focus of attention distance effect literature by being the first to use the vertical jump to do so. In the world of strength and conditioning, or even coaching, motor behavior research is often overlooked (Porter et al., 2010). This study will hopefully provide a practical way to implement more efficient, research-tested methods of instruction to enhance coaching practices. Considering many coaches and sport organizations use the vertical jump to assess athletic performance and training effectiveness (Brodt, Wagner, & Heath, 2008), such findings could be invaluable for practitioners.

CHAPTER 2

METHOD

Participants

Approval was gained from the Human Subject Committee before contact was made with any potential participants for this study. During the recruitment process, participants were asked if they have participated, or currently participant, in collegiate athletics. If they were a former or a current college athlete, the participant was not used in the present study. The participants were not aware of the specific study purpose. Prior to their involvement in the experiment, all participants signed an inform consent. Participants were 38 recreationally active adults (n = 24 men and n = 14 women; M age = 22.39 years, SD = 4.62). All participants were considered recreationally active individuals. This means they had received no formal training or learning of the vertical jump with a Vertec™, had regularly participated in some form of exercise at least three times a week (e.g., aerobics, weight training, swimming, biking, etc.) for the past six months, but had not competed in these activities on a collegiate or professional level.

Apparatus and Task

A Vertec™ measurement device was used to record vertical jump-and-reach height. The Vertec™ consists of a series of horizontal plastic rungs incrementally spaced by 1.27 cm (i.e., 0.5 inches) at increasing vertical heights, which participants reached for during maximum counter-movement jumps. The participants were asked to stand with their dominant hand closest to the Vertec™. From a standing position, the participant reached with their dominant hand, along the spine of the measurement device. The height of the device was then adjusted so that the lowest rung was 30.48 cm (i.e., 12 inches) from the extended fingertips of the participant.

Procedures

The study used a within-participant design. All research sessions were held in a controlled laboratory environment. The only people present for the session were the participant and experimenter. The same experimenter conducted all testing sessions. After the completion of the necessary paperwork, the Vertec™ was adjusted to the appropriate height using the previously described method. The participants were then given a 5-minute warm-up by briskly walking in a climate-controlled building. After the completion of the warm-up, the participant sat to rest, observed a demonstration of the counter-movement vertical jump given by the researcher, and received general instructions about the testing protocol. They were told they would be given a series of instructions of things to focus on while they were jumping. All participants were instructed that their goal was to jump as high as possible on each attempt while following the prescribed instructions. They were also told that they should be as honest as possible on a survey after each jump attempt. The survey asked the participant "On the previous trial, what did you focus on?" They were able to practice two sub-maximal jumps to familiarize themselves with the equipment prior to testing.

After the initial 1-minute seated rest, the participant was asked to stand under the Vertec™. Once in the correct position, they were read aloud one of the below four prescribed instructions. Participants performed two jumps under each of the conditions with a 1-minute rest between each jump. All instructions were read in a counterbalanced order to control for possible order effects. All participants completed two trials in each experimental condition in a counterbalanced order for a total of eight trials.

The instruction used for the control (CON) condition was, "Jump to the best of your ability." When participants were in the lower near (LN) condition, they were given the

instructions, “When you jump, focus on your shoes leaving the ground.” Instructions for the upper near (UN) condition were “When you jump, focus on the rung you want to touch.” When participants were in the upper far (UF) condition, they were instructed, “When you jump, reach for the pink tape.” The pink tape was attached to the highest rung of the Vertec^{TM}, located 76.2-cm (i.e., 30 inches) from the participants’ standing reach. This rung was positioned slighted out during this condition to allow for better visibility. Finally, the unreachable (UNR) instructions were “When you jump, focus on jumping up and reaching the ceiling.” The ceiling of the test facility was 3.66 m tall (i.e., 12-ft).

Statistical Analyses

The two jumps completed in each of the five conditions were used for each participant, resulting in 10 jumps per participant. The Statistical Package for the Social Sciences (SPSS, version 16; IBM, Armonk, NY, USA) was used for the statistical analysis. The criterion for significance was set using an alpha level of $p \leq 0.05$. A repeated measures analysis of variance (ANOVA) was used to assess the differences between the five experiment conditions. Partial Eta squared (η^2) effect sizes (ES) were calculated to determine the magnitude of observed significant differences. The average jumping heights for each condition are reported below (see Table 1) with their ± standard deviation. The upper and lower 95% confidence intervals (CI) associated with average jumping heights for each condition are also reported below in Table 1.

CHAPTER 3

RESULTS

Results of the ANOVA indicated a significant main effect for condition, $F(2.983, 205.819) = 2.501$, $p < 0.05$, $ES = 0.035$. Significant differences were found between the CON, LN, and UF conditions. Specifically, the CON (53.848 cm) and UF (53.921 cm) conditions resulted in greater jump heights, in comparison to the LN (52.85 cm) condition. No significant difference was found between the CON and UF conditions. No significant differences were found between any other conditions. The questionnaires taken after each trial revealed moderate to strong adherence rates to the instructions given across the experimental conditions. The respective adherence rates for the various conditions were as follows: LN (71%), UN (84%), UF (84%), and UNR (63%).

Table 1

Means, standard deviations, and 95% confidence intervals of all five conditions.

Condition	Mean	Std. Deviation	95% Confidence Interval	
			Lower Bound	Upper Bound
Control (CON)	53.848	± 9.308	51.628	56.068
Lower Near (LN)	52.850	± 9. 599	50.561	55.139
Upper Near (UN)	53.576	± 9.138	51.397	55.755
Upper Far (UF)	53.921	± 9.062	51.760	56.081
Unreachable (UNR)	53.775	± 8.930	51.646	55.906

CHAPTER 4

DISCUSSION

The purpose of the current study was to investigate whether increasing the distance of an external focus of attention relative to the body improved the performance of the counter-movement vertical jump in recreationally active individuals. It was predicted that the external focus conditions would result in better jumping performance relative to trials completed in the control condition. In addition, it was hypothesized that performance would increase as the distance between the external focus and the participant increased.

Based on the results of this study, the hypotheses were only partially supported. The UF condition resulted in increased jump heights in comparison to the LN condition. This is consistent with findings in previous studies (McNevin et al., 2003; Porter et al., 2012), which reported that when an external focus is placed further away, it results in better performance. However, this effect was not observed in the other conditions in the present study. None of the other conditions were found to be significantly different, even though participants were instructed to direct their attention at progressively greater distances. Westphal and Porter (2013) found results similar to this when testing the distance effect in the standing long jump. The researchers found that instructing participants to jump towards a cone that was placed in front of them at a distance of 3-m resulted in further jumps than their baseline; but placing the focus further away at 5-m did not result in better performance in comparison to the 3-m focus. In that study, they reported that there appears to be a limit to the beneficial effects of incrementally increasing the distance of an external focus. The results of the present study suggest that the limited distance-effect benefit observed in the long jump (Westphal & Porter, 2013) also exist in the vertical jump.

Westphal and Porter (2013) attributed the lack of difference to the low-skill level of the individuals tested. Past literature suggests that, depending on a participant's level of experience, some external directing cues may not be as effective as other external cues (Wulf, McNevin, Fuchs, Ritter, & Toole, 2000). Similar results were found by Perkins-Ceccato, Passmore, and Lee (2003), where low-skilled golfers received more benefit from instructions directing their attention to their golf swing, and high-skill golfers found more benefit from instructions directed attention further away towards the target. This could explain the lack of difference between the three upper (i.e., focusing above their head) focus conditions in the present study. Considering the skill level of the participants tested in the current study, it is possible that the three foci of attention used in the three upper conditions were not different enough to have a meaningful effect on jumping performance.

Another possible explanation for the lack of difference between the UNR condition and others is the lack of adherence. According to the results of the questionnaire, participants only adhered 63% of the time when instructed to reach for the ceiling. The lack of consistency in focus during this condition may be a reason it did not have better results than the other conditions as predicted. It is not clear why the adherence rate of the UNR condition was lower than the other conditions. It is conceivable that participants had a difficult time processing the instructions to reach for an unachievable goal (i.e., reaching the ceiling). It is also possible that since the goal was not achievable, that participants simply ignored the instructions and chose to direct their attention elsewhere. Additional research is needed to test these possibilities.

A noticeable difference between the current study and existing research (Marchant et al., 2011; Porter et al., 2013;Wulf & Dufek, 2009; Wulf et al., 2010) is that none of the conditions resulted in better performances in comparison to the CON condition. However, there was one

condition that resulted in inferior performances. Specifically, when participants were asked to focus on their shoes leaving the ground, they performed worse in comparison to the CON condition. This result was not expected, especially considering the LN condition had the second lowest adherence rate (71%). This suggests that having a person focus underneath them when it comes to the vertical jump is less than optimal. It also suggests that, when given a choice as was the case in the CON condition, recreationally active individuals may be choosing a more optimal strategy of focusing on something above them since the CON condition results in jump heights comparable to the other upper external conditions.

Although this study adds to the existing body of research by being the first to look at the distance effect in the vertical jump, it does have limitations. First, the present study used recreationally active individuals, which may not have been experienced enough to elicit the differences between the UN, UF, and UNR conditions. This study should be replicated using non-recreationally active or highly skilled jumpers to test if increasing the distance of an external focus has effects on vertical jump performance within those skill levels.

A second limitation of this study is the minimal practice time experienced by the participants. The participants had no previous training on a Vertec^{TM} and were only allowed two familiarization jumps prior to the beginning of the testing session. It is possible that with more practice, the results of this study may have differed. In addition to the low number of practice attempts, a third limitation of this experiment was that motor learning was not measured. Research has shown that when learning a task, groups instructed using different cues did not initially perform differently during practice trials, but did performed differently during later retention test (McNevin et al., 2003; Shea & Wulf, 1999; Wulf et al., 2001). Since the participants were not skilled and had minimal practice, the full benefits of the different cues may

not have had time to manifest. Future studies should perform retention tests in order to see which cues results in better learning of the vertical jump test.

The results of this study do have meaningful implications to the world of coaching. Considering the vertical jump is used as an assessor of athleticism in many sports (Brodt et al., 2008; Garstecki et al., 2004; Sawyer et al., 2002; Thissen-Milder, & Mayhew, 1991), both recreationally and on a professional level. This study found that instructing someone to focus on something above him or her is just as effective as giving general instructions to jump high. In all cases, coaches should avoid instructing their athletes to focus on the ground or their shoes; this is going to be detrimental to jumping performance.

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Effects of increasing the distance of an external focus of attention on vertical jump

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