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Evidence of non-compliance with instructions in attentional focus research

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Abstract: An external focus of attention has been associated with superior learning compared to internal focus or no focus conditions. Despite considerable support for an external focus advantage, a few issues still need investigation (Wulf, 2007). The present study examined the effects of focus instructions on the performance and learning of the standing discus throw and determined the extent of adherence to focus instructions by obtaining post-experimental verbal reports from participants. Twenty-four male college students were randomly assigned to external, internal and control focus conditions. They were given basic instruction on the throwing technique and presented a video model of the correct form. Focus instructions dealt with "trailing the movement with the discus" (external), "leading the movement with the hip" (internal), or "doing your best" (control). Four blocks of ten throws were performed in acquisition and one block of ten throws was performed in a 24hr retention test. The last two throws of each block were videotaped and measured for later analyses. The results indicated no differences between conditions on form or distance scores. However, the interviews indicated that participants in the internal and external focus groups used a combination of internal and external focus cues during acquisition and retention. These findings corroborate those of Maxwell and Masters (2002) and Poolton, Maxwell, Master, and Raab (2006) that showed learners used internal and external attentional focus cues interchangeably. Future research should examine the extent of adherence to focus instructions and the effects of task demands and/or learner preferences on focus instructions.

Key Words: Motor learning, attention, movement form, throwing.

Introduction

One important function of skill instruction is to direct learners' attention to relevant cues (Schmidt & Wrisberg, 2008; Wrisberg, 2007). In the past 10 years research results have generally suggested a learning advantage of an external focus of attention over that of an internal focus or no focus (see Wulf, 2007 for a review). An external focus is defined as one that directs learners' attention toward cues in the environment (e.g., a golfer focusing on the club movement) while an internal focus is one that directs attention toward internal mechanisms (e.g., a golfer focusing on keeping his/her arms straight during the back swing) (Wulf, 2007; Zachry, Wulf, Mercer, & Bezodis, 2005). Previous research has demonstrated that an external focus improves performance outcomes, produces more efficient movements, promotes better postural stability, and enhances the rate of skill acquisition to a greater extent than does an internal focus (Wulf, 2007). Conversely, an internal focus of attention has largely been shown to be ineffective (Wulf, 2007).

The advantages of an external focus have been well documented in research examining the learning of sports tasks. In one of the first studies of this kind (Wulf, Lauterbach, & Toole, 1999) the effect of focus instructions on performance accuracy of the pitch shot in golf was examined. The task required participants to pitch a golf ball a distance of 15 m to a circular target. Both external and internal focus groups received the same basic instructions regarding stance, the correct grip, and posture, and differed only with respect to the focus they were told to use. The external focus group was instructed to focus on the club movement (i.e., pendulum motion of the club) while the internal focus group was told to focus on the mechanics of arm movements (i.e., arm straight, right arm bent, etc.). The results revealed that the external focus group produced significantly higher shot accuracy (i.e., the ball landing closer to the center of the

target) than the internal focus group during both the practice phase and on a retention test administered 24 hr later. Subsequent studies have demonstrated similar advantages of external focus instructions during the learning of other sport skills, such as the basketball free throw shot (Zachry et al., 2005); the volleyball serve (Wulf, McConnel, Gärtner, & Schwarz, 2002; experiment 1); the tennis ground stroke (Wulf, McNevin, Fuchs, Ritter, & Toole, 2000; experiment 1); and a soccer kick (Wulf, Wächter, & Wortman, 2003).

One possible explanation for superior performance and retention when adopting an external focus is the constrained action hypothesis. According to this view learners who focus externally experience an unconscious and automatic processing of the required movements (for a more detailed discussion see Wulf, 2007), resulting in efficient movement production and the achievement of desired performance outcomes (Wulf, McNevin, & Shea, 2001). On the other hand, focusing on internal mechanisms is presumed to constrain the motor system, induce additional "system noise," and degrade performance (Vance, Wulf, Töllner, McNevin, & Mercer, 2004; Wulf, 2007; Zachry et al., 2005).

Despite considerable evidence supporting the advantages of an external focus during task practice two potential limitations of previous research suggest generalizations of this advantage to all forms of skill learning may be premature. First, previous researchers have primarily used outcome scores (e.g., the spatial accuracy of a golf ball hit to a target) to evaluate the effectiveness of focus instructions on the performance and learning of motor tasks (Poolton, Maxwell, Masters, & Raab 2006; Wrisberg, 2007; Wulf, 2007; Wulf et al., 1999; Wulf & Su, 2007). To date, no research has examined the effects of instructed focus on the quality of learners' movements. Thus, it is possible that the relative merits of an external focus may be limited to improvements in movement outcome rather than the quality of the actions producing the result. An emphasis on movement quality would presumably be important in the learning of tasks requiring precise movement form for effective performance such as figure skating, gymnastics, field events in track, and springboard diving (Wrisberg, 2007).

A second potential limitation of previous attentional focus research has been the implicit assumption that participants adhered to their respective focus instructions. The results of two recent studies examining the relative merits of an internal and external focus during the learning of a golf-putting task (Poolton et al., 2006) and a dynamic balance task (Maxwell & Masters, 2002) suggest this assumption may be a tenuous one. Verbal reports (Poolton et al., 2006) and post-experimental checks of participants' adherence to focus instructions (Maxwell & Masters, 2002) obtained in these studies revealed a worrisome degree of non-compliance during the acquisition phase.

The purpose of the present study was to further address these two potential limitations in previous attentional focus research by examining the effects of focus instructions on the performance and learning of a task (i.e., the standing discus throw) for which the quality of the movement is important to a successful outcome (i.e., maximum landing distance) and by obtaining post-experimental verbal reports to determine the extent to which participants adhered to their respective focus instructions.

Methods

Participants

Twenty-four male university students (M = 21.8 yr, SD = 3.7) volunteered to participate in the study. After obtaining approval from the Institutional Review Board students were recruited from undergraduate and graduate physical activity classes and an introductory psychology class. The principal criteria for participation were that individuals had no previous experience with the discus throw and no current or prior shoulder injuries.

Task and apparatus

The learning task was the standing discus throw (Babbitt, 2002). According to the USA Track and Field handbook, proper execution of this task consists of the following sequence: stand sideways to the throwing area holding the discus in the preferred hand, bend the knees, swing the discus as far back behind the body as possible, pivot toward the throwing area on the preferred foot while rotating the hips and shoulders, and rapidly release the discus with a clockwise spin at approximately 30 degree angle (Babitt, 2002). The handbook also indicates that the orbit of the discus in the thrower's hand prior to release follow a high-low-high pattern. To assist participants in achieving this orbit and a 30 degree release angle, a rope was placed five feet in front of the throwing area at a height of six feet. To capture the mechanics of participants' movement pattern selected trials were video recorded using a camcorder situated a distance of 10 ft from and perpendicular to the

dominant side of the participant. A skill checklist developed from the handbook (Babbitt, 2002) was used to evaluate the quality of participants' throwing movements. The checklist included 17 actions that characterized effective skill execution during the phases of initial position, arm swing, leg movement and discus release.

Procedures

Following the completion of informed consent papers, participants received basic instructions regarding posture and execution of the movement pattern for the standing discus throw, watched an expert model performing the action, and practiced the fundamental movement pattern five times while holding the discus but not releasing it. Basic instruction included the appropriate grip for holding the discus, correct initial body position with feet shoulder width apart, backward and forward rotation of the trunk and shoulders, arm swing, and release of the discus with a clockwise rotation over the index finger at a 30 degree angle. Providing identical instructions ensured that participants in all conditions received the same amount of information about the task. Thus, groups only differed with respect to attentional focus directions.

Participants were randomly assigned to one of three focus instruction conditions. The external focus condition (EXT) was told to focus on letting the discus trail the movement during forward rotation. The internal focus condition (INT) was instructed to focus on leading the movement with the opposite (i.e., front) hip during forward rotation. The control condition (CON) was told to do their best. After receiving their respective focus instructions participants observed the expert model a second time.

The study was comprised of an acquisition phase and a retention phase that took place over two days. On day one participants completed the acquisition phase, which consisted of four blocks of 10 trials with no additional feedback from the experimenters. Prior to each block participants were reminded of their focus instructions and told to throw the discus over the rope. They also received a focus reminder along with the instruction to "throw the discus as far as possible" prior to the 9th and 10th trial of each block. The landing point of the discus on those two trials was marked and the distances measured and recorded following the 10th throw. In addition, participants' throwing form was video recorded for subsequent analysis.

On day two participants took part in the retention phase, which occurred approximately 24 hrs following the acquisition phase and consisted of a brief warm-up followed by a final block of 10 throws. No reminders of focus were provided prior to or during this phase. However, on the 9th and 10th trial participants were again instructed to throw the discus as far as possible and their throwing distance and form were recorded. Following the retention phase participants in the INT and EXT conditions were asked to respond to two questions to determine the extent to which they adhered to their respective focus instructions. Specifically, they were asked to rate on a scale from one to four (a) the extent to which they followed the instructions they were given ("not at all" to "always") and (b) how effective they felt the instructions were ("not at all" to "highly"), In addition, any participant that did not give a rating of "4" to the first question was asked to describe what other types of focus he used.

Results

Throwing distance for the 9th and 10th throws for each participant on each block were measured to the nearest centimeter and the mean of the two scores was calculated for analysis purposes. Two expert discus throwers evaluated participants' video recorded form using the checklist. The order of the trials was randomized and the raters had no knowledge of any participants' focus condition. A high level of inter-rater reliability was achieved for all trials (r = .85) so the two ratings were averaged for subsequent analysis.

For acquisition, separate 3 (Conditions) x 4 (Blocks) ANOVAs with repeated measures on the second factor were used to evaluate distance and form scores. For retention, separate one-way ANOVAs were used to evaluate distance and form scores. Post-experimental ratings of adherence to and perceived effectiveness of the instructed focus were evaluated by tabulating the frequencies of each rating category for the INT and EXT conditions. Qualitative analysis of participants' open-ended comments was also conducted.

Throwing Distance

Figure 1 depicts the throwing distance on the last two trials of each acquisition block and the retention block. Generally, distance appeared to increase over blocks for the EXT and CON conditions with the former achieving the highest score by the last block of acquisition trials and during the retention block. The acquisition performance of INT participants appeared to

improve over the first three blocks but then level off and remained lower than that of the other conditions during retention. For acquisition, Mauchly's test indicated that the assumption of sphericity had not been violated (chi-square = 10.531, p = .062). The subsequent ANOVA revealed a significant main effect for block, F (3, 63) = 4.23, p = .001, but no significant main effect for condition, F (2, 21) = .10, p = .907. The Condition x Block interaction also failed significance, F (6, 63) = 2.13, p = .062. The post-hoc analysis of the block effect indicated a significant difference in throwing distance only between blocks 2 and 4, p = .021. For retention, the ANOVA indicated no significant difference between conditions, F (2, 23) = .52, p = .601.

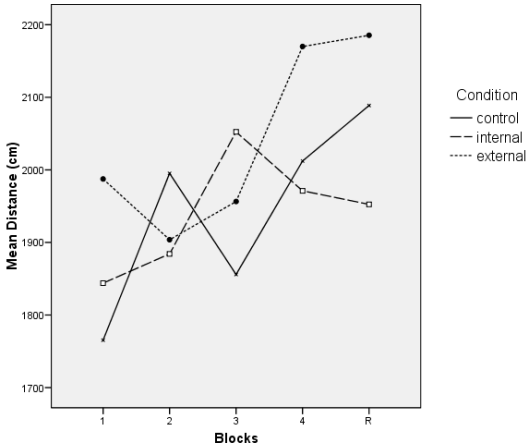

Figure 1: Mean distance thrown for all conditions across acquisition and retention phases.

Movement Form

There was little change in participants' form over the acquisition and retention phases of the experiment. Mean judges' ratings ranged from 7.5 to 9.0 for all three conditions. For acquisition, Mauchly's test indicated that the assumption of sphericity had been violated (chi-square = 16.834, p=.005) so degrees of freedom were corrected using the Greenhouse-Geisser estimate of sphericity (epsilon = 0.69) (Vincent, 1999). The subsequent ANOVA revealed no significant effects for block, F (3, 63) = 1.39, p = .261, condition, F(2,21) = .11, p = .897, or the Condition x Block interaction, F (6, 63) = .44, p = .785. For retention, the ANOVA indicated no significant difference between conditions, F (2, 23) = .06, p = .944.

Post-Experimental Ratings

For the internal condition three participants indicated that they followed their focus instructions "all of the time," three said they did so "mostly," and two reported they followed instructions "somewhat." No external condition participants reported following their focus instructions "all of the time" while seven indicated they did so "mostly" and one "somewhat." Comparable numbers of participants in the two conditions perceived their instructed focus to be either highly effective (internal = 5; external = 4) or moderately effective (internal = 3; external = 3). One EXT participant rated the focus as mildly effective.

Post-Experimental Comments

Inspection of these comments suggested that most participants devoted at least some attention to the focus opposite the one they were instructed to use. For example, INT participants who did not follow their instructed focus all of the time said they occasionally focused on: "the discus rolling off my fingers;" "rolling the discus in the right motion;" "my grip and throwing (the discus) over the rope;" and "grasping and having the feel of the discus." Self-reports of EXT participants indicated that at times they focused on: "the angle of the arms;" "balancing and transferring the weight"; "foot placement and making sure that the arm angle was correct;" "leading with the legs and trunk;" and "moving weight from the back to the front."

Discussion

The present study represented an initial attempt to evaluate the effects of attentional focus instructions on the development of a complex movement pattern as well as on improvements in movement outcomes. The majority of previous investigators have used outcome measures to assess instructional focus effects on the performance and learning of motor tasks (Poolton et al., 2006; Wulf, 2007: Wulf et al., 1999). The results of these studies have largely supported a learning advantage for participants given external focus instructions (Wulf, 2007). For example, external focus instructions have improved learners' performance during either acquisition or retention tests on sport tasks such as golf pitching (Wulf et al. 1999, Wulf & Su, 2007), volleyball serving (Wulf, et al. 2002; experiment 1), and the tennis ground stroke (Wulf et al. 2000; experiment 1). However, since only a few previous studies have included manipulation checks to determine participants' adherence to focus instructions (Maxwell & Masters, 2002; Poolton et al., 2006), a secondary purpose of the

current study was to obtain post-experimental ratings of adherence along with open-ended comments concerning any deviations from the instructed focus.

The most important findings of this study were obtained from the post-experimental manipulation checks. Both the ratings of adherence and additional comments of participants in the INT and EXT conditions indicated a lack of full adherence to their respective instructed focus during the acquisition phase. These comments suggest that the majority of participants in both conditions used some combination of external and internal focus cues to complete the task. The findings are consistent with the results of previous studies that employed manipulation checks to determine the degree of adherence to instructed focus during the learning of a golf putting task (Poolton et al., 2006) and a dynamic balancing task (Maxwell & Masters, 2002). In both of these studies learners indicated that they used both internal (i.e., focusing on body movements) and external (i.e., focusing on movement outcomes) focus cues while executing the tasks regardless of the focus they were instructed to use. Taken together, this research suggests that instructing learners to use a particular attentional focus does not guarantee that they will do so.

In addition to determining participants' adherence to their respective instructional focus, another aim of this investigation was to determine the effects of attentional focus on the learning and movement form of a complex movement pattern. While the outcome scores of EXT participants appeared to be better than those of participants in the other conditions by the end of acquisition and during the retention phase, the analyses produced no significant conditions effect for either outcome scores (i.e., distance thrown) or form ratings. The only significant effect was obtained for blocks during acquisition, with post hoc analysis indicating that distance thrown was significantly greater on block 4 than on block 2. It should be noted that these findings do not negate previous research indicating an advantage for learners adopting an external focus of attention (Wulf et al. 1999; Wulf & Su 2007 experiment 1; Wulf et al. 2000; experiment 1; Zachary et al. 2005) since the majority of participants in both the INT and EXT conditions did not completely adhere to their instructional focus. It is possible that the lack of significant findings may have been due to that fact that both the INT and EXT conditions used similar multi-focus cues to complete the task. If participants completely adhered to their instructed focus, the advantages of an external focus of attention may have emerged.

It is also possible that the lack of significant focus effects may have been due to the complex nature of the learning task. The standing discus throw requires a high level of multi-limb coordination that may require more than 40 acquisition trials for measurable improvements in form to be manifested. It is also possible that the additional instruction to "throw as far as possible" on the last two trials of each block, which were the ones used to assess focus effects on distance and form, may have altered participants' perception of task requirements and influenced their performance.

In summary, then, it remains unclear as to how attentional focus instructions affect the learning of tasks for which the development of a complex movement pattern is necessary for the production of effective outcomes. Moreover, it appears that focus manipulations may not always achieve the desired effect (i.e., full adherence), at least during early learning. Therefore, further research is needed that (a) examines focus effects on tasks emphasizing a functional connection between movement quality and desired outcome (e.g., springboard diving), (b) provides adequate practice for improvements in movement outcomes and movement form to occur, and (c) includes manipulation checks to determine how and when participants are focusing their attention.

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