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An External Focus of Attention Enhances Golf Shot Accuracy in Beginners and Experts

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Numerous studies have shown that one factor influencing motor skill learning is the learner's focus of attention induced by instructions or feedback. Specifically, instructions that induce an external focus of attention, whereby attention is directed to the movement effect on the environment (e.g., implement), can enhance learning. Such instructions have been shown to be more effective than those that induce an internal focus by directing attention to the movements themselves (see Wulf, 2001). For example, Wulf, Lauterbach, and Toole (1999) had participants without golf experience practice pitch shots. Whereas one group of participants was instructed to focus on the pendulum-like motion of the golf club (external focus), another group was instructed to focus on their arm movements (internal focus). The results showed that the external focus group was considerably more accurate in their shots than the internal focus group. Other studies have shown advantages of adopting an external focus for learning a ski simulator task (Wulf, Höß, & Prinz, 1998, Experiment 1), basketball shooting (Al-Abood, Bennett, Hernandez, Ashford, & Davids, 2002; Zachry, Wulf, Mercer, & Bezodis, 2005), volleyball serves and soccer passes (Wulf, McConnel, Gärtner, & Schwarz, 2002), as well as various balance tasks (e.g., Totsika & Wulf, 2003; Wulf et al., 1998, Experiment 2; Wulf & McNevin, 2003). Benefits of an external focus have also been found for daily life activities in persons who had a cerebrovascular accident (Fasoli, Trombly, Tickle-Degnen, & Verfaellie, 2002) and balance in individuals with Parkinson's disease (Landers, Wulf, Wallmann, & Guadagnoli, 2005).

The benefits of adopting an external focus of attention have been explained with the constrained action hypothesis (e.g., McNevin, Shea, & Wulf, 2003; Wulf, McNevin, & Shea, 2001). According to this view, individuals who direct their attention to their movements (internal focus) while performing a motor skill control their actions in a relatively conscious manner. This, in turn, tends to constrain the motor system and disrupt automatic control processes. In contrast, focusing on the movement effect, or adopting an external focus, has been shown to promote use of automatic processes. For example, Wulf et al. (2001) found reduced probe reaction times (RTs) for participants adopting an external focus while practicing a balance task (stabilometer), compared to those adopting an internal focus. Faster probe RTs are generally assumed to indicate reduced attentional demands, or a greater degree of automaticity. Furthermore, the frequency of movement adjustments was higher under external relative to internal focus conditions, again indicating a more automatic, reflex-type mode of control (see also McNevin et al., 2003).

While most studies examining attentional focus effects on motor performance and learning compared internal and external focus conditions, only a few included control conditions without attentional focus instructions (e.g., Landers et al., 2005; Wulf et al., 1998, Experiment 1; Wulf & McNevin, 2003; Wulf, Weigelt, Poulter, & McNevin, 2003). In those studies, internal focus and control conditions resulted in similar performances, whereas an external focus produced superior performance or learn-

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ing. This suggests an external focus enhances motor performance, whereas an internal focus neither enhances nor degrades performance compared to no attentional focus instructions (control condition). However, all previous studies that included control conditions used balance tasks, and performers' attention was directed to the overall the task goal (i.e., focus on reducing movements of the balance platform or feet, respectively). An interesting question is, therefore, whether a similar pattern of results would be found for tasks that require whole-body movements and the control of multiple degrees of freedom, with the appropriate timing and force production. This is the case for many sport skills, for instance, in which the performer's attention is often directed to a critical aspect of the task (e.g., the swinging motion in golf). Therefore, we asked how effective external and internal focus conditions, relative to a control condition without instructions, would be for learning a sport skill. For example, would internal focus instructions—even if they directed individuals' attention to a relevant aspect of the task—be ineffective, or would they provide a learning advantage, at least compared to a control condition? We used a golf task, similar to the study by Wulf et al. (1999), but included a control condition to examine this issue. Another purpose of the present study was to examine the generalizability of the attentional focus effects to expert performers, as only few studies have looked at this population. Therefore, in a second experiment, we compared the effectiveness of internal focus, external focus, and control conditions for expert golfers.

Experiment 1

The purpose of the first experiment was to examine the relative effectiveness of an external and internal focus, compared to a control condition, for learning a complex sport skill. Similar to the study by Wulf and colleagues (1999), participants without experience in golf practiced pitch shots with either external or internal focus instructions. In that study, the external focus condition produced more effective learning. The question addressed in the present experiment was how their performances would compare to that of a control group without attentional focus instructions.

Method

Participants

Thirty undergraduate students, all right-handed and with no or little prior experience playing golf participated in this experiment. They were not aware of our specific study purpose. All participants provided informed consent prior to data collection.

Apparatus, Task, and Procedure

The apparatus, task, and procedure were similar to those used by Wulf et al. (1999). The experiment was conducted outdoors on a lawn surface. The participants' task was to hit golf balls with a 9 iron into a circular target with a 50-cm radius. Participants hit the balls from an artificial turf mat (1.2 x 1.5 m), with a center 15 m from the target. Four concentric circles with radii of 1.5, 2.5, 3.5, and 4.5 m, respectively, were drawn around the target to determine the accuracy of the shots. The experimenter recorded where the ball landed. Five points were awarded for balls hitting the target. Four, 3, 2, or 1 points were recorded for balls landing in one of the other zones, respectively. Zero points were given for balls landing outside the largest circle.

Participants were randomly assigned to one of three groups: control, internal focus, and external focus. Before the practice phase, the experimenter described and demonstrated the basic technique of the pitch shot to each participant. All participants received the same instructions regarding grip, stance, and posture. The subsequent instructions differed for the three groups, however. The instructions for the internal focus participants were directed at the swinging motion of their *arms*. The attentional focus of the external focus participants was directed toward the pendulum-like motion of the *club*. Participants in the control condition received *no attentional focus* instructions. All participants performed 60 practice trials. Before each set of 10 trials, the experimenter reminded the external and internal focus participants to maintain their respective focus. One day later, participants performed a retention test consisting of 10 trials. They received no instructions or reminders on Day 2.

Results

The total scores on each 10-trial block for the three groups are shown in Figure 1. As can be seen, all groups increased their scores across practice blocks. The main effect of blocks was significant, $F(5, 135) = 11.21$, $p < .001$. Although the external focus group tended to demonstrate greater accuracy compared to the two other groups, the main effect of group was not significant, $F(2, 27) < 1$. Also, the Group x Block interaction was not significant, $F(10, 135) < 1$.

On the retention test, there was a clear advantage for the external focus group. This group had higher scores than both other groups, which showed basically identical performances. The main effect of group was

significant, with $F(2, 27) = 5.38$, $p = .011$. Post hoc LSD (least significant difference) tests indicated the external focus group had significantly higher accuracy scores than the internal focus and control groups ($p < .05$).

Discussion

The findings replicated the learning benefits of instructions inducing an external relative to an internal focus found in several previous studies (for a review, see Wulf, 2007). External focus participants were clearly superior to internal focus participants in retention. The important question in the present study was how the control group would perform relative to the external and internal focus groups. The results showed the control group demonstrated almost identical performance to the internal focus group in both practice and retention, with both groups being less accurate than the external focus group. These results replicate the findings of other studies that included control conditions (e.g., Landers et al., 2005; Wulf et al., 1998, Experiment 1; Wulf & McNevin, 2003; Wulf et al., 2003, Experiment 2). In contrast to those studies, though, the present experiment was the first to use a skill that required coordinating multiple degrees of freedom, including appropriate time and force parameterization. Also, performers' attention was directed to only one aspect of the task (swinging motion of the club vs. arms, respectively), as opposed to the task goal (i.e., remaining in balance by focusing on the platform or feet, respectively). It is interesting to observe such a consistency in the effects of external versus internal foci and control conditions, despite the differences between tasks and the specific instructions given to participants. These findings provide converging evidence that adopting an external focus of attention *enhances* learning, whereas an internal focus is essentially ineffective (i.e., no more effective than control conditions without instructions).

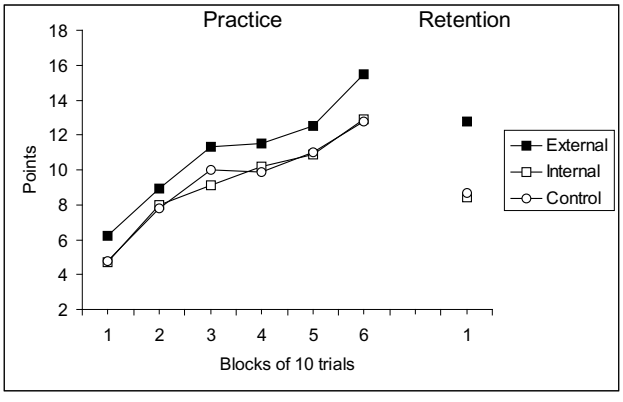

Figure 1. Accuracy scores for the external focus, internal focus, and control groups during practice and retention in Experiment 1 (Novices).

The advantages of an external focus have been attributed to the fact that it promotes a more automatic type of movement control than focusing on the body movements (e.g., Wulf et al., 2001). Consequently, one would not necessarily expect to see advantages of an external focus if the skill is already controlled automatically. That is, if a skill has become automatic through extensive practice, instructing the performer to focus on the movement outcome, or effect, might not provide an additional benefit compared to "normal" (control) conditions. Therefore, in Experiment 2, we wanted to examine the effects of instructions to adopt an external focus, relative to control and internal focus conditions, in expert golfers.

Experiment 2

In one of the few studies comparing internal and external focus conditions in performers with different levels of expertise, Wulf et al. (2002, Experiment 1) used participants with no experience (novices) or some experience (advanced performers) in volleyball. The task required participants to practice the "tennis" serve. Both groups of performers equally benefited from feedback inducing an external focus rather than an internal focus. Similarly, in their Experiment 2, individuals with soccer experience showed improved learning (lofted soccer pass) when provided with feedback that induced an external focus. However, although the advanced performers' skill level in the Wulf et al. (2002) experiments was clearly higher than the novices, their overall performance level was still in the medium range. In contrast, a study by Perkins-Ceccato, Passmore, and Lee (2003) examined attentional focus effects in highly skilled golfers with an average handicap of 4. Their performances were compared to low-skilled golfers, with an average handicap of 26, under external focus (i.e., focus on hitting the ball as close to a target as possible) and internal focus conditions (i.e., focus on movement form). Perkins-Ceccato et al. (2003) found that highly skilled golfers performed more effectively with external focus instructions, whereas the less skilled golfers benefited more from internal focus instructions. However, in their study different types of information were given under external and internal focus conditions, thus creating a confound between information content and attentional focus. Arguably, focusing on the movement technique would be expected to be more important for novices than experts (see also Wulf, McNevin, Fuchs, Ritter, & Toole, 2000), whereas focusing on the outcome can be assumed to be a more natural focus for expert

performers (e.g., Vallacher & Wegner, 1987). Also, the Perkins-Ceccato et al. (2003) study did not include a control condition. Thus, the question remains whether the effectiveness of different attentional focus instructions varies with higher levels of expertise. The present experiment, therefore, sought to determine how the same attentional focus instructions as those in Experiment 1 would affect expert golfers' performance.

Method

Participants

Six expert golfers (all men) participated in this experiment. With the exception of 1 participant, all were members of University of Nevada–Las Vegas golf team. The average handicap was 1.3 (5 participants had 0 handicaps, 1 had a handicap of 8). All gave their informed consent prior to data collection.

Apparatus, Task, and Procedure

The apparatus and task were similar to those used in Experiment 1, with a few exceptions. Participants hit the balls with their own clubs. Furthermore, because of the participants' higher skill level and expected greater shot accuracy, the target (located at a distance of 15 m) was smaller, with a 25-cm radius. Also, the four concentric circles around the target were smaller, with radii of 50, 75, 100, and 125 cm, respectively. The scoring system was the same as that used in Experiment 1, however. All participants performed under control (C), internal focus (I), and external focus (E) conditions. The order of conditions was counterbalanced: Participants 1 and 4 performed in the order CIE, Participants 2 and 5 performed in the order IEC, and Participants 3 and 6 performed in the order ECI. As in Experiment 1, participants were instructed to focus on their arm motion (internal focus), club motion (external focus), or what they normally focused on (control). Participants performed 20 trials under each condition.

Results

Average accuracy scores under control and internal focus conditions were 1.38 (SD = 0.29) and 1.29 (SD = 0.28), respectively. In contrast, external focus instructions resulted in clearly higher scores, with an average of 1.93 (SD = 0.24). The effect of attentional focus was significant, $F(2, 10) = 9.66$, $p = .005$. Post hoc LSD tests indicated the differences between the external focus, control, and internal focus conditions were significant ($p < .05$). The latter two conditions did not differ from each other.

Discussion

Expert golfers' performance benefited from instructions that induced an external focus. Directing their attention to the club motion was not only more effective than directing attention to their arm movements it was also more effective than no attentional focus instructions (control condition). Given the participants' high skill level, one might have expected to see their best performance under the control condition (i.e., when they were free to focus on what they usually focused on). This was based on the assumption that their performance was already at a near optimal level, and that directing their attention to something on which they didn't typically focus would disrupt their performance (e.g., Vallacher & Wegner, 1987). Alternatively, one might have expected similar performances under control and external focus conditions. Because an external focus is assumed to promote movement automaticity (e.g., Wulf et al. 2001) and participants' movement control could be assumed to be relatively automatic already, no additional advantages of external focus instructions were anticipated. However, the pattern of results was different: external focus instructions resulted in superior performance compared to internal focus or control conditions, which produced comparable performances.

The present findings suggest the advantages of focusing on the movement effect are generalizable to a wide range of skill levels. They demonstrate that inducing an external focus can apparently enhance the performance of individuals who are considered experts, such as the golfers in the present study. Given that high-level performance is generally difficult to improve, it is remarkable that the external focus instructions achieved a significant improvement. How can the performance benefit produced by the external focus instructions be explained, given that movement execution is presumably already automatic in experts? It is conceivable the different types of foci induced subtle but important differences at the neuromuscular level. Studies have shown that an external focus reduces EMG activity compared to an internal focus (Marchant, Greig, Scott, & Clough, 2006; Vance Wulf, Töllner, McNevin, & Mercer, 2004; Zachry et al., 2005). Zachry and colleagues (2005) argued that greater EMG activity might add "noise" to the motor system, which constrains the system and hampers fine movement control—and, as a consequence, makes the outcome less reliable. Furthermore, Marchant and colleagues (2006) recently showed an external focus also reduces EMG activity compared to control conditions. They used a biceps curl task (similar to Vance et al., 2004) and found instructing participants to focus on the bar movement (external focus) produced less EMG activity

than instructing them to focus on their arms (internal focus) or no focus (control), with no difference between the latter two conditions. Given that biceps curls would probably not be considered a difficult or complex motor skill—but rather one performed relatively automatically—it might seem surprising that performance could be improved (i.e., in terms of movement efficiency) through an external focus. A similar effect might be responsible for the external focus advantages seen in our expert golfers. Giving them a specific external focus might have served to reduce unnecessary muscular activity (or noise), with the result that enhance movement accuracy.

The present experiment used a within-participant design and examined the immediate effects of attentional focus on performance. Thus, the effects cannot be interpreted as long-term changes and *may* be only temporary. While the external focus benefits might still have functional use for expert golfers, a fruitful endeavor for future research would be to use learning paradigms—with different groups, more extended practice periods, and retention or transfer tests—to determine long-term effects of training in expert performers with different attentional foci.

General Discussion

Two main findings resulted from the present study. First, directing learners' attention to the movement effect (external focus) can enhance learning complex, real-life skills. In contrast, wording instructions in a way that directs individuals' attention to coordinating their movements (internal focus), while not detrimental, is ineffective. In the present experiments, as in other studies (Landers et al., 2005; Wulf et al., 1998, Experiment 1; Wulf & McNevin, 2003; Wulf et al., 2003, Experiment 2), internal focus instructions provided no advantage compared to not giving instructions at all. Second, the benefits of adopting an external focus generalize to high skill levels. Similar to beginners, the performance of semiprofessional golfers also benefited if their attention was directed externally.

In the present study, the external focus condition involved instructions that directed participants' attention to the golf club motion. While this is one effect of participants' movements on the "environment," there are, of course, other effects on which their attention could have been directed. For example, the trajectory of the ball, the landing point of the ball, and the final position of the ball all represent effects the performer's movements have on the environment. Which of these should a performer focus on to optimize performance? Directing attention to the club was effective for both beginners and experts in the present study. Nevertheless, it seems reasonable to assume that the optimal focus varies with the skill level. In general, with continued practice, longer and longer strings of an action are assumed to be controlled and represented as a unit (or motor program; e.g., Park & Shea, 2005; Pedotti, Crenna, Deat, Frigo, & Massion, 1989). As a consequence, "control over the act moves towards higher levels of representation as the lower level features of the action become coordinated and thus capable of discharge without conscious monitoring" (Vallacher, 1993, p. 455). That is, as an action becomes more automated, it is assumed to be monitored at progressively higher levels (e.g., Vallacher, 1993; Vallacher & Wegner, 1987). Such a hierarchy of goals might be to "hole the golf ball," "give the ball a backspin," and "hit the ball with an open club face." For example, giving the ball a backspin would be a relatively high-level goal, while the steps required to achieve it would be represented at a lower hierarchy level. Thus, a performer can focus on movement effects at different hierarchical levels, and that focus would also be expected to change with practice or experience. While beginners typically focus on lower level effects that are a direct consequence of their limb movements—or even on controlling their body movements (internal focus)—skilled performers tend to focus on higher level effects of their actions (see also Wulf & Prinz, 2001). Because of their extensive experience, focusing on those effects presumably triggers the muscular activities necessary to achieve the effect. In fact, directing the attention of highly skilled performers to a lower level effect might disrupt the automatic control processes they normally use.

In general, it seems reasonable to suggest actions should always be controlled at the highest possible level. This way, the performer takes advantage of available motor programs, which control the action effectively and efficiently. Of course, for novices who have not yet developed the necessary motor programs, it might not be feasible to focus on high-level effects. For example, for beginning golfers, focusing on a "direct" effect of their movements, such as the golf club motion, has been shown to be more effective than focusing on a less direct effect, such as the ball trajectory (Wulf et al., 2000, Experiment 2). Directing attention to a lower level effect, such as the club movement, might be more effective, because this effect is more directly related to the body movements and can be associated more easily with the motor commands that produced the club motion (Wulf & Prinz, 2001). In contrast, directing the attention of an expert golfer to the club motion—while being effective, as seen in Experiment 2—might not be optimal. Perhaps directing their attention to the ball trajectory or target (Perkins-Ceccato et al., 2003) might have been even more effective, as it represents a higher

level goal. At any rate, the optimal focus of attention as a function of skill level might be a fruitful direction for future research.

Interestingly, although one might expect individuals would spontaneously adopt the optimal focus of attention, this does not seem to be the case. As several studies, including the present experiments, have shown, when participants do not receive attentional focus instruction (control condition), their performance is typically similar to that seen under internal focus conditions and less effective than under external focus conditions (Landers et al., 2005; Wulf et al., 1998, Experiment 1; Wulf & McNevin, 2003; Wulf et al., 2003). This suggests individuals tend to choose a lower-than-necessary level of control. One reason for this might be that individuals (especially adults) are inclined to be relatively cautious when confronted with novel and complex motor tasks. The problem is that this does not result in optimal performance but rather degrades performance and learning. External focus instructions offset this tendency and promote the use of higher level control processes. That is, when encouraged to focus on the movement effect, participants use the automatic control processes they have available, resulting in more effective performance.

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