

Influence of Attentional Focus on Learning a Swing Path Change

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The learning and retention of a swing path change (movement form performance) of a six iron (Study 1) and a driver (Study 2) as a function of attentional focus was studied to determine if the facilitating effect of external focus of attention on movement outcome performance also held for movement form performance. Study 1 findings revealed that the instructor-selected external cue group learned and retained more of an inside-out swing path with a six iron than either the instructor-selected internal cue group or participant-selected cue group. Study 2 results showed that both the instructor-selected external cue and participant-selected cue groups learned and retained more of an inside-out swing path with a driver than the instructor-selected internal cue group. These findings provide two lines of evidence that reveal the benefit of using an instructor-selected, external focus of attention cue when teaching experienced players to learn to change (improve) their swing path.

Keywords: attentional focus, external focus, internal focus, golf learning, swing path

There is ample evidence (e.g., Al-Abood, Bennett, Hernandez, Ashford, & Davids, 2002; McNevin, Shea, & Wulf, 2003; Wulf, Lauterbach, & Toole, 1999; Wulf, McNevin, & Shea, 2001; Wulf, Mercer, McNevin, & Guadagnoli, 2004; see Wulf, 2007a, 2007b for a review; Wulf, McConnel, Gärtner, & Schwartz, 2002; Totsika & Wulf, 2003; Southard, 2011; McNevin, Weir & Quinn, 2013) revealing that an instructor-selected external focus of attention (performer's attention is focused on the effects of his/her body movement) facilitates the improvement of movement outcome performance (e.g., accuracy of a golf shot) more than an instructor-selected internal focus of attention (performer's attention is focused on his/her body movement

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itself) for both inexperienced (novice) and experienced (skilled) performers (Bell & Hardy, 2009; Wulf & Su, 2007). Whether this facilitating effect also holds for improving movement form (e.g., golf swing) is still a matter of some uncertainty because only a few studies have addressed it and the findings that exist do not clearly support it. One of these studies (Wulf et al., 2002) found the facilitating effect for the movement form of a volleyball serve to hold during acquisition practice for advanced players and external feedback groups, but that effect was not retained. This finding suggests that improvements in movement form produced by an external focus of attention in acquisition practice may be a function of skill level, but may be temporary. Another study (Southard, 2011) found that increasing velocity was most effective for improving the throwing form of novices and retaining that improvement, with an external focus of attention more effective than an internal focus. A third study (Lawrence, Gottwald, Hardy, & Khan, 2011) investigated the learning, retention and transfer of the movement form of a novel gymnastics routine, but failed to find any evidence in support of either an external or internal facilitating effect. Taken together, the findings emanating from two of these three studies provide at least enough evidence (albeit minimal) in support of the facilitating effect of an external focus of attention on movement form to warrant further investigation, which was the target of the present research. More specifically, the purpose of the present research was to extend the research of the previous three studies by investigating the extent to which the facilitating effect of external focus of attention on movement outcome performance also holds for movement form performance.

The action-effect principle (Prinz, 1997) and the constrained action hypothesis (CAH; Wulf et al., 2001; Wulf, Shea, & Park, 2001) have been advanced to explain the facilitating effect of an external focus of attention on movement outcome performance. The action-effect principle maintains that body movements are planned and controlled in relation to their effects (outcomes). And, CAH proposes that focusing attention on movement effects (external focus) rather than the body movements that produce the effects (internal focus) provides congruence between movement planning and control, and the desired effects. Congruence optimizes the efficiency of centrally planning and controlling the many degrees of freedom in performing the movements (Wulf, Hüb & Prinz, 1998). It allows for the usual noncognitive, automated processes to plan and control the movements, which results in movement coordination proceeding “naturally” in relation to the desired effect (Wulf, 2007a, 2007b). Conversely, focusing attention on the body movements that produce the desired effect diminishes this efficiency because the congruence of movement planning and control in relation to the desired movement effect is reduced. More specifically, attending to the certain aspects of body movements often leads to cognitively intervening with control processes that disrupt or interfere with the “natural” or usual automated control processes involved in planning and controlling movements in relation to their effects. As a result, movement coordination is prevented from proceeding “naturally” in relation to the desired movement effects, which negatively affects the movement-effect performance. Based on the action-effect principle and CAH explanation, it seems reasonable to expect that the facilitating effect of an external focus of attention on movement effect performance would also hold for movement form performance if the latter was, in fact, either a movement effect (e.g., form of a dive, gymnastic or ice skating skill) or a much higher priority than the movement effect (e.g., pay most of your attention to improving the form

of your golf swing and very little to the shot outcome). Since movement form and movement effect are the same or nearly the same, the congruence between movement planning and control, and the desired effect would be maximum or a little less, which would allow for the usual noncognitive, automated processes to plan and control the movements. As a result, movement coordination would proceed “naturally” in relation to the desired effect because movement form and movement effect are the same or nearly the same.

It is common, when teaching students (beginners or experienced) at the outset of learning to improve the movement form of their golf swing, to verbally instruct them to focus their attention completely on the specifics of the movement pattern during practice swings (without hitting balls). In this context, movement form of the swing itself would be considered the movement effect. For instance, verbally instructing students to focus their attention on movement specifics (e.g., drop your right arm to your right side on the downswing) during each practice swing would be an internal focus while directing them to focus on the movement of the clubhead (e.g., swing the clubhead on an inside-out path to contact the ball) would be an external focus. However, since the ultimate purpose of improving the movement form of a golf swing is to produce more effective golf shots, the improved form needs to be practiced and learned while hitting a ball to a target, which is the context of the present research. Typically, the practice routine that accompanies or follows a lesson involves one or more practice swings followed by an actual swing in which a ball is hit to a target. Moreover, when using a routine like this, it is common for teachers to verbally instruct students to focus all or most of their attention on their movement form and little or none on hitting the ball to the target (movement effects). This practice context and routine, and direct verbal manipulation attentional focus approach was used in both studies of the present research to investigate the extent to which the facilitating effect of an external focus of attention found for movement effect performance also holds for movement form performance when the latter was, in fact, a much higher priority than the movement effect (e.g., focus on improving the form of your golf swing and don't worry about the shot outcome).

Both studies in the present research used experienced golfers for two reasons. One reason was to extend the previous work of Wulf et al. (2002) who found evidence for the facilitating effect of external focus on movement form with experienced volleyball performers in acquisition, but not in retention. And other reason was that the problem of learning to change a well-learned swing is pervasive for experienced golfers who always seem to be striving and struggling to learn to improve the form of their swing, especially the swing path, to improve their shots. And, any research, including the attentional focus studies of the present research that attempts to reveal useful information about more effective conditions for learning to change well-learned movements and the retention of that learning is justified. The present research also studied the movement form of two somewhat different swings produced by hitting balls to a target with two different types of golf clubs to be certain that any attentional focus effects found were not swing specific. A six iron swing in which the ball was hit off an artificial turf mat was investigated in the first study and a driver swing in which the ball was hit off a tee was examined in the second study. Thus, present research studied the learning and retention of the golf swing path change (movement form performance) of a six iron (Study 1) and a driver (Study 2) as a function of experienced golfers' attentional focus.

Study 1¹

Method

Participants and Dependent Measures. A total of 45 adult male, experienced golfers (mean age = 65 years; $SD = 7.79$) with an average handicap of 18.34 ($SD = 5.09$) volunteered to participate. All golfers swung the club right-handed. Each golfer received a \$25 gift certificate for participating in the study.

Swing path was the dependent measure of movement form and it was calculated from swing video recordings using a JVC Digital and JC Video system. The swing path measure on each swing was the difference between the participant's set-up angle position and his downswing angle at waist height. A line was drawn up the shaft of the club at address to determine the set-up angle. The downswing angle was determined when the clubhead reached waist height. Swing path also was considered the main dependent measure of movement effect because participants were verbally instructed to focus their attention on improving their swing path and to not worry about or focus their attention on the quality of the clubface contact with the ball or where the ball went in relation to the target (shot outcome). Thus, movement form and movement effect were nearly one and the same.

A shot-outcome measure that was of special interest in this study was carry distance of the ball because it has been shown to be increased with improved swing path (e.g., Alpenfels, Christina & Anderson, 2004) when other factors (e.g., clubhead speed, vertical launch angle) known to affect it remain essentially the same. Carry distance and the other major factors of which it can be a function were measured by a Flight Scope launch monitor and analyzed in relation to carry distance and attentional focus. These factors included smash factor (ball speed divided by clubhead speed), clubhead speed, ball speed, and vertical launch angle.

Each dependent measure for each participant on the pretest, posttest, and retention test was the average of the three measures taken on each test. Poorly struck and missed shots were excluded and repeated. Only shots that were judged by the participant and tester to be representative of his typical six-iron shots were measured and recorded.

Study Design and Procedures. A 3×3 (Groups \times Tests) design was used in which focus of attention Groups were external, internal and control, and Tests were pretest, posttest and retention test. Participants were randomly assigned to the three, focus of attention groups with the restriction that there be 15 golfers per group and that the groups be balanced in terms of handicap. Participants in the external group were verbally instructed to focus their attention on a teacher-determined external cue while those in the internal group were told to focus their attention on a teacher-determined internal cue. Golfers in the participant-selected cue group were verbally instructed to select their own cue on which to focus their attention.

Before the pretest, participants in each group were asked to identify the cue(s) on which they focus their attention to help them effectively perform their swing. Next, each participant warmed-up by stretching the way he ordinarily did before hitting balls and then by taking eight practice swings with his own six iron without hitting a ball. After warm-up, a pretest was given in which three, six-iron shots were measured by a launch monitor and recorded by the video system. Following the pretest, each participant was asked to identify the cue(s) on which he focused his

attention to help him perform each of the three swings. Next, a 15-minute lesson was given showing (via video) and explaining each student's current swing path in relation to the desirable swing path based on his three pretest swings hitting six-iron shots. Specifically, the participant's swing path was compared with a more desirable swing path, and the path change (correction) that needed to be learned was clearly pointed out verbally and visually. At this point, any questions or points of clarification regarding contents of the lesson were addressed. The lesson was provided by a qualified PGA Master Professional Instructor who has over 25 years' experience and is one of *Golf Magazine's* Top 100 Teachers.

Next, an alignment rod was placed on the target line for participants in all three groups during instruction and the practice session to serve as an aid in helping them properly line up to the target and also learn to swing on an inside-out path relative to the target-line alignment rod. Depending on the experimental group to which each participant was randomly assigned, he was verbally instructed to use a (a) teacher-selected external attention cue, (b) teacher-selected internal attention cue, or (c) self-selected attention cue. The external cue group was verbally instructed to swing the clubhead parallel to a swing-path alignment rod that was positioned on an inside-out path from 8:00 o'clock to 2:00 o'clock relative to the target-line alignment rod, which was at 12:00 o'clock. The internal cue group was verbally instructed to bring their right elbow to their right side on the first part of the downswing to help them learn to swing on an inside-out path relative to the target-line alignment rod. The participant-selected cue group not given a cue, which allowed them to select and use whatever cue they preferred (self-selected cue) to learn to swing on an inside-out path relative to the target-line alignment rod. Next, each participant took three practice swings, which were video recorded, trying to use the cue to which he was randomly assigned while the teacher provided participants in each group with instructional feedback to ensure that they were correctly using the cue to which they were assigned to learn to change his swing path. Any remaining questions or points of clarification about the using the cue to which they were assigned were addressed at this time.

A structured practice session began immediately after the lesson. It involved each participant taking a practice swing with his own six iron followed by an actual swing in which he hit a ball the target trying to apply the attention cue to which he was assigned and taught in the lesson. This practice swing-actual swing cycle was repeated a total of 36 times resulting in 36 practice swings and 36 actual swings. A three-minute rest break was given after the 12th shot and the 24th shot. The practice swing was made anyway (i.e., slow motion, half speed, in parts, etc.) each golfer preferred with the provision that it must help him specifically focus his attention on applying the cue to which he was assigned and taught in the lesson. No instructional feedback was provided during the practice session.

The posttest, which was the same as the pretest excluding the warm-up, was administered within three minutes after the last practice session shot. A retention test, which was the same as the pretest and posttest, was administered about 24 hours after the posttest. The warm-up procedures for the retention test were the same as those used for the pretest. Immediately after the posttest and the retention test, each participant was asked to identify the cue(s) on which he focused his attention to help him effectively perform his swing. Alignment rods were present during the lesson and practice session, but not during the pretest, posttest and retention test.

Results and Discussion

Cues on Which Participants Reported Focusing. Eighty percent or 36 of the 45 participants reported focusing on one or more internal cues to help them perform what they thought was an effective swing path at the outset of the study (before and after the pretest). This finding indicates that the majority of the participants relied more on internal than external cues before the study began. Following the posttest and retention test, 100% of the 15 participants in the instructor-selected external cue group reported focusing their attention on swinging the clubhead inside-out along an imaginary alignment rod to hit the ball, while 100% of the 15 participants in the instructor-selected internal cue group reported focusing on dropping their right elbow to their right side on the downswing. Indeed, these are the two cues on which the participants in each group were verbally instructed to attend in this study. About 53% or 8 of the 15 golfers in the participant-selected cue group reported using the same cue that was used by the external group while the other 47% or 7 participants reported using the cue that was used by the internal group. Thus, about half of the participants in the participant-selected cue group relied on an external cue and the others on an internal cue.

Swing Path. Thirty percent of all of the shots taken on the pretest, posttest and retention test for each group had to be repeated because they were poorly struck shots that were not measurable and/or judged not to be representative of each participant's typical six-iron shots. For the swing path measure to be valid, set-up angle had to be unaffected by the attention cues manipulated in this study and hence, remain essentially the same from pretest to posttest to retention test. Conversely, downswing angle had to be free to vary as a function of these attention cues. If this was the case, swing path, as measured by the difference between set-up and downswing angles, would reflect any influence the attention cues had on it. To determine if this was indeed the case, a 3×3 (Groups \times Tests) ANOVA with repeated measures on the second factor revealed that set-up angle remained the same for each group from pretest to posttest to retention test, and that there were no appreciable, set-up angle differences or interaction among groups ($p > .05$).

Table 1 presents the actual swing path means (in degrees) along with their standard deviations and the swing path means that were adjusted by the pretest (covariate) along with their standard deviations on each test for each group. Positive means indicate that the downswing angle was above the set-up angle reflecting more of an outside-in swing path relative to the target line, whereas negative means indicate that the downswing angle was below the setup angle reflecting more of an inside-out swing path. Positive and negative means approaching zero indicate that the downswing angle was close to the set-up angle revealing more of an inside-out swing relative to the target line. Inspection of the actual means revealed that the downswing angle of all three groups was above their set-up angle on the pretest reflecting more of an outside-in swing, but that it was reduced on the posttest following instruction and practice with the external group improving the most. All three groups retained much of their improvement from the posttest to the retention test with the instructor-selected internal cue and participant-selected cue groups showing a slight improvement on the retention test. Examination of the standard deviations reveals that participants' swing path in each group varied considerably about their pretest group mean. To adjust for the pretest swing-path differences

Table 1 Swing Path Means and Standard Deviations on the Three Tests for the Three Groups

Groups	Actual Means			Adjusted Means Based on Pretest	
	Pretest	Posttest	Retention Test	Post	Retention Test
Internal					
<i>M</i>	10.49	6.74	5.82	5.73	4.93
<i>SD</i>	10.83	10.29	9.26	4.73	4.87
Participant					
<i>M</i>	7.37	3.05	1.75	4.34	2.90
<i>SD</i>	10.83	7.88	8.05	4.74	4.88
External					
<i>M</i>	9.49	- 0.61	- 0.87	0.88	1.12
<i>SD</i>	8.97	7.44	6.73	4.72	4.86

Note: Means are in degrees. Positive means indicate that the downswing angle was above the set-up angle reflecting more of an outside-in swing path relative to the target line whereas negative means indicate that the downswing angle was below the setup angle reflecting more of an inside-out swing path. Positive and negative means approaching zero indicate that the downswing angle was approaching the set-up angle.

among participants within and between groups at the outset of the study, each participant's average pretest swing-path measure was used as a covariate in a 3×2 (Groups \times Tests) ANCOVA to determine the effects of the attention cues on the posttest and retention test swing-path data.

Adjusted swing path means and standard deviations of the three groups over the posttest and retention test are shown in Table 1. Inspection of the adjusted means reveals a pattern similar to that displayed by the actual means on the posttest and retention test. Swing path performance between posttest and retention test (Tests) was not significant, $F(1, 41) = .01$, $p = .91$, $\eta_p^2 = .00$, nor was the Groups \times Tests interaction, $F(2, 41) = .21$, $p = .82$, $\eta_p^2 = .01$. This indicates that in spite of the differences observed in the adjusted means from posttest to retention test for each of the three groups, they were due to chance and hence, essentially the same. Thus, the swing path performance achieved by each of the groups on the posttest following instruction and practice was retained on the retention test.

The Groups effect was significant, $F(2, 41) = 9.83$, $p < .01$, $\eta_p^2 = .32$. The Bonferroni post hoc test at the .01 level revealed that the external cue group ($M = 1.00$, $SD = 5.96$) significantly learned and retained more of an inside-out average swing path than the internal cue group ($M = 5.33$, $SD = 8.22$, $p < .01$) and the participant-selected cue group ($M = 3.62$, $SD = 5.79$, $p < .01$). Interestingly, the participant-selected cue group had more of an inside-out swing path than the internal cue group, but that difference was not significant ($p = .77$). Taken together, these findings indicate that an instructor-selected external attention cue was more effective than an instructor-selected internal attention cue and a participant-selected attention cue in learning to improve swing path of a six iron.

Carry Distance. Each participant's average pretest carry distance was used as a covariate in a 3×2 (Groups \times Tests) ANCOVA to determine the effects of the attention cues on the posttest and retention test carry distance performance. Carry distance performance between posttest and retention test (Tests) was not significant, $F(1, 41) = .73, p = .40, \eta_p^2 = .02$, nor was the Groups \times Tests interaction, $F(2, 41) = 1.46, p = .24, \eta_p^2 = .07$. This indicates that the average carry distance of the ball from posttest to retention test for each of the three groups was essentially the same, which means that the carry distance performance achieved on the posttest following instruction and practice was retained on the retention test.

The Groups effect was significant, $F(2, 41) = 5.28, p < .01, \eta_p^2 = .21$. The Bonferroni post hoc test revealed that the external cue group ($M = 124.44, SD = 11.31$) learned and retained significantly ($p = .008$) more average carry distance than the participant-selected cue group ($M = 113.53, SD = 11.34$). As expected, this carry distance effect reflected the swing path effect, which suggests that the different swing paths of the two groups contributed, at least in part, to their respective carry distances. Specifically, it is possible that the better swing path of the external cue group enabled them to produce a faster ball speed, which resulted in more carry distance than the participant-selected cue group because they were more efficient at translating clubhead speed into ball speed. If this was the case, then differences in swing paths would reflect differences in ball speed provided that there was no difference between groups in clubhead speed, which was the case ($p > .05$). The significant Groups effect for ball speed, $F(2, 41) = 4.80, p = .013, \eta_p^2 = .13$, and the Bonferroni post hoc test revealed that ball speed was appreciably ($p = .024$) faster for the external cue group ($M = 94.75$ mph) than it was for the participant-selected cue group ($M = 90.56$ mph) and essentially the same as the internal cue group ($M = 95.20$ mph). This ball speed finding is also consistent with the smash factor means, which measure the golfers' ability to translate clubhead speed into ball speed. Smash factor for the external cue group ($M = 1.30$) was more efficient (better) than it was for the participant-selected cue group ($M = 1.26$). These ball speed and smash factor findings suggest that the better swing path of the external cue group enabled them to produce a faster ball speed, which resulted in more carry distance than the participant-selected cue group because they were more efficient at translating clubhead speed into ball speed. Usually, being more efficient means making better contact with the ball, that is, impact position of the ball on the clubface that is more centered.

A similar relationship between swing path and carry distance also was found for the external and internal cue groups. The external cue group did have more carry distance than the internal cue group ($M = 120.37, SD = 11.32$) which was expected, but this effect was not significant ($p > .05$) while it was for swing path. This nonsignificant effect was unexpected because the swing path for the external cue group was considerably more inside-out (better) than it was for the internal cue group, which should have produced a substantial difference in carry distance between the two groups. Further, it is unclear why the carry distance for the internal cue group was longer than it was for the participant-selected cue group when the swing path for the internal cue group was less inside-out (worse) than the participant-selected cue group. It seems counterintuitive to think that the centeredness of impact of the ball on the clubface was better for the internal cue group than it was for the participant-selected cue group when the latter group had a better swing path,

but the ball speed, smash factor and clubhead speed data suggest that it was. The significant Groups effect for ball speed, $F(2, 41) = 4.80$, $p = .013$, $\eta_p^2 = .13$, and the Bonferroni post hoc test revealed that ball speed was significantly ($p = .024$) faster for the internal cue group ($M = 95.20$ mph) than it was for the participant-selected cue group ($M = 90.56$ mph) and essentially the same as the external cue group ($M = 94.75$ mph). Smash factor was better for the internal cue group ($M = 1.29$) than it was for the participant-selected cue group ($M = 1.27$), but not quite as good as for the external cue group ($M = 1.31$). There were no significant ($p > .05$) differences in clubhead speed (in mph) for the three groups (internal $M = 72.99$; participant-selected $M = 72.19$; external $M = 73.36$) or in vertical launch angle (in degrees) for the three groups (internal $M = 20.26$; participant-selected $M = 18.70$; external $M = 20.17$). These results indicate that in spite of having a worse swing path than the participant-selected cue group, the internal cue group was better at translating clubhead speed into ball speed to produce more carry distance. This finding demonstrates that swing path was not the sole determiner of the extent to which the ball is impacted on the center of the clubface. Other factors such how the clubhead is released at impact to square-up the clubface with the ball in relation to the target and the timing of that release relative to the swing path are also important, and may have been involved to produce this unexpected carry distance finding. In spite of the longer than expected carry distance generated by the internal cue group, all of the other findings clearly indicated that the instructor-selected external attention cue was more effective than a participant-selected attention cue on increasing the ball's average carry distance using a six iron.

Study 2²

The findings of Study 1 are based on a practice session in which no instructional feedback was provided. It is possible that the swing path and carry distance effects, especially the unexpected carry distance effects, would have been different if participants had instructional feedback during the practice session. In addition, it is also possible that differences between six iron and driver swings could differentially influence one's ability to learn to change well-learned swing path as a function of attentional focus. A driver swing is a longer and more forceful swing that also generates more clubhead speed than a six iron swing. In addition, hitting a ball off of an artificial-turf mat with an iron is somewhat different than hitting a ball of a tee with a driver. Thus, the purpose of Study 2 was to determine the extent to which the swing path findings and the expected and unexpected carry distance effects of Study 1 also hold for a driver swing when instructional feedback is provided during the practice session.

Method

Participants and Dependent Measures. A total of 39 adult male, experienced golfers (mean age = 64 years; $SD = 15$) with an average handicap of 18 ($SD = 4.11$) volunteered to participate. None of them participated in Study 1. All golfers swung the club right-handed. Each golfer received a \$25 gift certificate for participating in the study. The dependent measures and the procedures used to obtain them were the same as in the first study.

Study Design and Procedures. The design was the same as in Study 1 except that participants were randomly assigned to each group with the restriction that there were 13 rather than 15 golfers per group. The same instructor that gave the lesson in Study 1 was used in Study 2. The procedures were the same as in Study 1 with the following exceptions. Warm-up involved taking four practice swings with his own driver instead of eight practice swings with his own six iron. A structured practice session began immediately after the lesson as in Study 1, but the session was slightly different in that follow-up instructional feedback with video review was provided after the 12th and 24th shot in place of a three-minute rest break. The follow-up instructional feedback emphasized the same swing path fundamentals that were taught to them in the opening 15-minute lesson. The pretest, posttest, and retention test were the same as in Study 1.

Results and Discussion

Cues on Which Participants Reported Focusing. About 70% or 27 of the 39 participants reported focusing on one or more internal cues to help them perform what they thought was an effective swing path at the outset of the study (before and after the pretest). This finding indicates that the majority of the participants relied more on internal than external cues at the outset of the study. Following the posttest and retention test, 100% of the 13 participants in the external cue group reported focusing their attention on swinging the clubhead inside-out along an imaginary alignment rod to hit the ball, while 100% of the 13 participants in the internal cue group reported focusing on dropping their right elbow to their right side on the downswing. Indeed, these are the two cues to which the participants in each group were verbally instructed to attend in this study. About 62% or 8 of the 13 participants in the participant-selected cue group reported using the same cue that was used by the external group while approximately 39% or 5 participants reported using the cue that was used by the internal group. Thus, more of the golfers in the participant-selected cue group relied on an external cue.

Swing Path. For both swing path and carry distance measures, 30% of all of the shots taken on the pretest, posttest and retention test for each group had to be repeated because they were poorly struck shots that were not measurable and/or judged not to be representative of each participant's driver shots. Swing path was measured as it was in Study 1. To determine if set-up angle remained essentially the same from pretest to posttest to retention test, a 3×3 (Groups \times Tests) ANOVA with repeated measures on the second factor revealed that set-up angle remained essentially the same for each group from pretest to posttest to retention test, and that there were no appreciable, set-up angle differences or interaction among groups ($p > .05$).

Table 2 presents the actual swing path means (in degrees) for each group on each test along with their standard deviations and the swing path means that were adjusted by the pretest (covariate) along with their standard deviations. Positive means indicate that the downswing angle was above the set-up angle reflecting more of an outside-in swing path relative to the target line, whereas negative means indicate that the downswing angle was below the setup angle reflecting more of an inside-out swing path. Positive and negative means approaching zero indicate that the downswing angle was close to the set-up angle revealing more of an inside-out

Table 2 *Swing Path Means and Standard Deviations on the Three Tests for the Three Groups*

Groups	Actual Means			Adjusted Means Based on Pretest	
	Pretest	Posttest	Retention Test	Post	Retention Test
Internal					
<i>M</i>	12.86	5.66	6.47	4.47	5.26
<i>SD</i>	12.61	7.28	7.97	3.46	3.68
Participant					
<i>M</i>	7.72	0.68	-0.32	2.08	1.10
<i>SD</i>	7.02	4.88	4.42	3.47	3.69
External					
<i>M</i>	10.89	0.18	0.35	- 0.03	0.14
<i>SD</i>	8.97	5.55	5.63	3.43	3.64

Note: Means are in degrees. Positive means indicate that the downswing angle was above the set-up angle reflecting more of an outside-in swing path relative to the target line whereas negative means indicate that the downswing angle was below the setup angle reflecting more of an inside-out swing path. Positive and negative means approaching zero indicate that the downswing angle was approaching the set-up angle.

swing path relative to the target line. Inspection of the actual means revealed that the downswing angle of all three groups was above their set-up angle on the pretest reflecting more of an outside-in swing path, but that it was reduced on the posttest following instruction and practice with the external group improving the most. All three groups retained much of their improvement from the posttest to the retention test. Examination of the pretest standard deviations reveals that participants' swing path in each group varied considerably about their pretest group mean. To adjust for the pretest swing-path differences among participants within and between groups at the outset of the study, each participant's average pretest swing-path measure was used as a covariate in a 3×2 (Groups \times Tests) ANCOVA to determine the effects of the attention cues on the posttest and retention test swing-path data.

Adjusted swing path means and standard deviations of the three groups over the posttest and retention test are shown in Table 2. Inspection of the adjusted means reveals a pattern similar to that displayed by the actual means on the posttest and retention test. Swing path performance between posttest and retention test (Tests) was not significant, $F(1, 35) = .01, p = .91, \eta_p^2 = .00$, nor was the Groups \times Tests interaction, $F(2, 35) = .69, p = .51, \eta_p^2 = .01$. This indicates that in spite of the differences observed in the adjusted means from posttest to retention test for each of the three groups, they were essentially the same. Thus, the swing path performance achieved by each of the groups on the posttest following instruction and practice was retained on the retention test.

The Groups effect was significant, $F(2, 35) = 8.68, p < .01, \eta_p^2 = .33$. The Bonferroni post hoc test revealed that both the external cue group ($M = 0.06, SD =$

2.98, $p < .001$) and participant-selected cue group ($M = 1.59$, $SD = 2.77$, $p < .029$) significantly learned and retained more of an inside-out average swing path than the internal cue group ($M = 4.86$, $SD = 3.02$). Although, the external cue group had more of an inside-out swing path than the participant-selected cue group, that difference was not significant ($p = .61$). The participant-selected cue group having a similar swing path to the external group and an appreciably better swing path than the internal group was not found in Study 1 in which the swing path of the external group was better than the other two groups with no appreciable difference between the internal and participant-selected cue groups. One possible explanation for this finding could be rooted in the fact that the percentage of golfers who reported relying on an external cue in Study 1 (53%) was less than it was in Study 2 (62%). It is possible that the higher percentage of golfers in the participant-selected cue group who reported relying on the external cue in Study 2 essentially made this group more like the external than the internal group, which would explain the similarity of the swing path findings for these two groups. However, further research is needed before the validity of this explanation can be ascertained. Taken together, these findings clearly indicate that both the instructor-selected external attention cue and participant-selected attention cue were more effective than the instructor-selected internal attention cue in learning to improve swing path of a driver.

Carry Distance. Each participant's average pretest carry distance was used as a covariate in a 3×2 (Groups \times Tests) ANCOVA to determine the effects of the attention cues on the posttest and retention test carry distance performance. Carry distance performance between posttest and retention test (Tests) was not significant, $F(1, 35) = .21$, $p = .65$, $\eta_p^2 = .006$, nor was the Groups \times Tests interaction, $F(2, 35) = 0.56$, $p = .95$, $\eta_p^2 = .003$. This indicates that the average carry distance of the ball from posttest to retention test for each of the three groups was essentially the same, which means that the carry distance performance achieved on the posttest following instruction and practice was retained on the retention test.

The Groups effect was marginally significant, $F(2, 35) = 2.67$, $p = .08$, $\eta_p^2 = .13$. The Bonferroni post hoc test revealed that the external group ($M = 179.33$, $SD = 16.42$) produced significantly ($p = .027$) more average carry distance than the internal cue group ($M = 164.53$, $SD = 15.51$). It is likely that the better swing path of the external cue group, as compared with the internal cue group, was an important contributor to the external group's longer carry distance because the smash factor for the external group ($M = 1.391$) was better than it was for the internal group ($M = 1.358$), which resulted in a faster ball speed for the external group ($M = 119.46$ mph) than the internal group ($M = 116.56$ mph). There were no significant ($p > .05$) differences in clubhead speed (in mph) for the three groups (internal $M = 85.49$; participant-selected $M = 86.35$; external $M = 86.09$) or in vertical launch angle (in degrees) for the three groups (internal $M = 14.01$; participant-selected $M = 14.32$; external $M = 16.72$). The external cue group also had more carry distance than the participant-selected cue group ($M = 170.83$, $SD = 15.79$), but that difference was not significant ($p = .20$); nor was the difference between the participant-selected and internal cue groups ($p = .30$). Taken together, these results indicate that the instructor-selected external attention cue was more effective than the instructor-selected internal cue on increasing the ball's carry distance with a driver.

General Discussion

The findings of Study 1 and 2 extended the previous research on movement form (Wulf et al., 2002; Lawrence et al., 2011; Southard, 2011) by revealing that the facilitating effect of external focus of attention on movement outcome performance also holds for movement form performance. The results of Study 1 revealed that the instructor-selected external cue group learned and retained more of an inside-out swing path with a six iron than either the instructor-selected internal cue group or participant-selected cue group. Study 2 results showed that both the instructor-selected external cue group and participant-selected cue group (62% selected the external cue) learned and retained more of an inside-out swing path with a driver than the instructor selected internal cue group. Study 2 results also revealed that letting experienced players select their own cue on which to focus their attention was as or more effective than an instructor-selected internal cue when teaching experienced players to learn to change their driver swing form. It is likely that the latter finding was the result of 62% of the players in the participant-selected group choosing an external cue, which made that group more like the external group and less like the internal group. Taken together, the findings of both studies provide two lines of evidence that clearly support the advantage of using an instructor-selected, external focus of attention cue when teaching experienced players to learn to change (improve) the swing form of a six iron and driver. And lastly, the results of both studies indicated that teaching experienced players to focus their attention on an instructor-selected internal cue was least effective in helping them to learn to change (improve) their swing form within the scope of one lesson and practice session.

The swing path findings of the present research were consistent with the prediction of action-effect and CAH explanations. As predicted, the facilitating effect of an external focus of attention on movement effect performance holds for movement form performance when the latter is, in fact, either a movement effect (e.g., form of a dive, gymnastic or ice skating skill) or a much higher priority than the movement effect (e.g., pay most of your attention to improving the form of your golf swing and very little to the shot outcome). Since movement form and movement effect were nearly the same in the present two studies, the congruence between movement planning and control, and the desired effect were maximum or a little less, which allowed for the usual noncognitive, automated processes to plan and control the swing path movements. As a result, movement coordination proceeded quite “naturally” in relation to the desired effect because movement form and movement effect were nearly the same.

A secondary interest of the present research was the carry distance of the ball, which can be increased with improvements in swing path when other factors (e.g., clubhead speed, vertical launch angle) remain essentially the same. Study 1 revealed that the instructor-selected external cue group, which had more of an inside-out (better) swing path than the participant-selected cue group, produced significantly more average carry distance of the ball with a six iron than the participant-selected cue group. And, Study 2 showed that the instructor-selected external cue group, which had more of an inside-out (better) swing path than the instructor-selected internal cue group, generated appreciably more carry distance of the ball with a driver than the instructor-selected internal cue group. These findings were expected

and reflect the influence of the swing path (movement form) improvements on the carry distance of the ball (movement effect). The ball speed and smash factor data suggest that the better swing path of the instructor-selected external cue group enabled them to generate more carry distance than the participant-selected cue group because they were more efficient at translating clubhead speed into ball speed. This efficiency usually means making better contact with the ball, that is, impact position of the ball on the clubface that is more centered.

Essentially, the pattern of carry distances for the three groups reflected the pattern of swing paths for the six iron and driver with one exception. The six iron swing path for the instructor-selected internal cue group was the more outside-in (worse) than the participant-selected cue group, but unexpectedly had more carry distance than the latter group. It is unclear why the carry distance for the internal cue group was longer than it was for the participant-selected cue group when the swing path for the internal cue group was less inside-out (worse) than the participant-selected cue group. It seems counterintuitive to think that the centeredness of impact of the ball on the clubface was better for the internal cue group than it was for the participant-selected cue group when the latter group had a better swing path, but the ball speed, smash factor and clubhead speed data suggest that it was. The internal cue group had a ball speed that was appreciably faster than the participant-selected cue group, but essentially the same as the external cue group. Moreover, smash factor, which is a measure of the ability to translate clubhead speed into ball speed, was more efficient for the internal cue group than it was for the participant-selected cue group, but not quite as efficient as the external cue group. And, clubhead speed as well as vertical launch angle was essentially the same for the three groups. These results indicate that, in spite of having a worse swing path than the participant-selected cue group, the internal cue group was better at translating clubhead speed into ball speed to produce more carry distance. This finding demonstrates that swing path was not the sole determiner of the extent to which the ball is impacted on the center of the clubface. Other factors such as how the clubhead is released at impact to square-up the clubface with the ball in relation to the target and the timing of that release relative to the swing path are also important, and may have been involved in producing this unexpected carry distance finding. In spite of the longer than expected carry distance generated by the internal group, all of the other findings clearly indicated that the instructor-selected external attention cue was more effective than a participant-selected attention cue on increasing the ball's average carry distance using a six iron.

Notes

1. Support for Study 1 was provided by a research contract from Education Department of the PGA of America.
2. Support for Study 2 was provided by a research contract from *Golf Magazine*. Some of the data from Study 2 were previously presented in a 2013 *Golf Magazine* article (volume 55, pages 92–95) titled “The Ultimate Slice Fix!”.

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