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ARTICLE

Evaluation of Near Versus Far Target Visual Focus Strategies With Breaking Putts

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The purpose of this study was to compare near-target (NT) and far-target (FT) visual focus strategies during the stroke on breaking putts. The ball was considered the NT and the FT was the point along the target line closest to the hole. Over three testing session, 28 golfers completed an equal number of putts for each combination of three independent variables: Method (NT, FT), Putt Length (6, 10, 14 ft), and Break (toe-to-heel, heel-to-toe) for a total of 144 putts. The FT method was associated with a significantly higher make percentage (40%) in comparison with the NT (37%), (p = .047). There was also a significant Method x Break interaction (p = .041); the FT method was relatively more effective for heel-to-toe breaking putts (41%) than the NT method (36%). These findings suggest that a FT visual strategy could be effective for golfers on breaking putts inside 14 ft.

Keywords: golf, putting, visual focus, technique, slope

Putting is an important skill in the game of golf. Each week on the PGA Tour, those in contention tend to be the best ball strikers; however, the eventual winner is usually the best putter, on that week, out of the best ball strikers (Broadie, 2016). Putting success depends on the ability to read the green to determine an *intended* initial direction to start the ball's motion as well as an *intended* speed along that initial direction. While the initial spin imparted to the ball can have an influence on the ball's path to the hole, previous research suggests this influence is secondary (Cochran & Stobbs, 1968; Werner & Greig, 2000) and it is not likely a ball launch characteristic that is intentionally manipulated by the golfer. The physical point of the putter face that contacts the ball (impact spot) as well as the path, face angle, and speed at that point are the four primary factors, under the control of the golfer, that determine the *actual* initial speed and direction of the ball (MacKenzie & Evans, 2010). Face angle, path, and impact spot primarily determine the initial ball launch direction, while the fourth factor, putter face speed at the impact spot, primarily determines the launch speed of the ball (MacKenzie, Foley, & Adamczyk, 2011). Starting the ball on the intended line could be considered a separate

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skill from starting the ball with the intended speed. As such, the specific method of practice, or putting technique employed, could differentially influence these sub skills. In particular, the visual focus strategy employed by the golfer, during the putting stroke, might have contrasting influences on these sub skills.

Two general visual focus strategies *during the stroke* have been investigated over the past 50 years and can be classified based on whether the golfer visually focuses at the ball (near target) or where they intend to project the ball (far target) (MacKenzie, Foley, & Adamczyk, 2011). While near target putting dominates in golf, far target methods have been used in professional tournaments by Major champions Johnny Miller, Vijay Singh, Louis Oosthuizen, and Jordan Speith. Visually focusing on the far target during the stroke may result in a golfer directing their focus of attention on the effect of their movements (external focus), such as concentrating on rolling the ball into the hole. The majority of research suggests that maintaining an external focus of attention results in improved success across a variety of skills including golf (Perkins-Ceccato, Passmore, & Lee, 2003; Poolton, Maxwell, Masters, & Raab, 2006; Wulf, Lauterbach, & Toole, 1999; Wulf & Prinz, 2001; Wulf, Mcconnel, Gärtner, & Schwarz, 2002; Wulf, Tollner, & Shea, 2007). Vickers (1992), while researching gaze control in near target-oriented putting, concluded that visually focusing on the ball for an extended period of time, *during the stroke*, resulted in improved accuracy. While not reported in the study, it would seem likely that this improved accuracy was the result of improvements in face angle, path, and/or impact spot—as opposed to improvements in speed control. Previous research does suggest that focusing on the ball should result in a higher quality of impact (Abrams, Meyer, & Kornblum, 1990). Alternatively, with respect to speed control, visually focusing on the far target allows the performer to better estimate the correct amount of impulse to apply to the ball (Vickers, 1996; Williams, Singer, & Frehlich, 2002). Focusing on the far target during the stroke would prevent the probable decay of the distance cue when gaze is shifted to the ball before the initiation of the stroke in near target putting (Laabs, 1973). MacKenzie et al. (2011) investigated the contrasting influences of near target and far target strategies of visual focus on the four aforementioned factors that primarily determine the launch of the ball. In comparing the two visual focus strategies in putting, MacKenzie et al. (2011) found no statistical differences in the variability of the face angle, path, or impact spot, which suggests that the consistency of these variables were not meaningfully influenced by visually focusing on the far target. MacKenzie et al., (2011) did find that practicing with a far target visual strategy improved speed control with the putter.

To date, there have been seven studies which have explicitly compared near target and far target visual focus strategies during the putting stroke (Aksamit & Husak, 1983; Alpenfels, Christina, & Heath, 2008; Bowen, 1968; Cockerill, 1979; Gonzalez, Kegel, Ishikura, & Lee, 2012; Gott & McGown, 1988; MacKenzie, Foley, & Adamczyk, 2011). Only Gonzalez et al. (2012) provided findings that suggested a performance benefit with a near target visual focus strategy. However, it should be noted that there were only 12 participants with minimal golf experience (average of 1 year) and they did not putt to an actual hole. In contrast, Alpenfels et al. (2008) have been the only researchers to demonstrate that a far target strategy resulted in improved performance. They had 40 experienced golfers putt to actual holes on a nominally flat green with no noticeable break and determined that lag putts from between 28 and 38 ft in length finished significantly closer to the hole when participants looked at the hole during the stroke. Bowen (1968) was the only researcher to manipulate the break of the test putts in a systematic manner; however, he used nongolfers and each participant was tested using only one of the two visual strategies. The fact that Bowen used breaking putts is important since it has been suggested that a far target strategy may prove more beneficial on breaking putts in comparison with straight putts (MacKenzie, Foley, & Adamczyk, 2011). MacKenzie et al. (2011) put forth this hypothesis based on the premises that (1) a far target strategy may be associated with better speed control and (2) breaking putts are more sensitive to variability in speed. Although Bowen (1968) used breaking putts, an important limitation was that he did not distinguish between looking at the center of the hole on straight putts versus looking at an extension of the target line on breaking putts. According to MacKenzie et al. (2011), the far target should be a point on a line that extends out from the intended initial launch direction of the ball—the target line. On a breaking putt, looking at the center of the hole will likely have a different influence on putting mechanics in comparison with looking down the target line.

Therefore, the purpose of this study was to compare near and far target visual focus strategies during the execution of the putting stroke on breaking putts in which the far target was defined as the point along the target line that was closest to the center of the hole. It was hypothesized that a far target visual focus strategy would be associated with higher putting success since previous research suggests that this technique provides golfers with more timely information for imparting the intended initial speed to the ball without negatively impacting the intended ball launch direction.

Methods

Participants

Twenty-eight experienced golfers (age: 48.1 ± 16.3 years, handicap: 12.5 ± 6.2, 4 left-handed, 3 females), who were playing golf on a regular basis at the time of testing, volunteered to participate. The study was approved by the University's Research Ethics Board, and testing procedures, risks, and time required were fully explained to each participant before they provided an informed consent.

Apparatus

All putting activity took place on a 6.5 m long × 2.5 m wide indoor putting green (Pro Putt Systems, Huntersville, NC, USA) with an average stimp of 10.5 feet and a constant slope of 1° (1.75%) directly across the width of the green (Figure 1). It should be noted that the average slope near the hole at PGA Tour events is 1.1° (Broadie, 2014). All participants executed putts using their own putter. Two central holes on the putting green were used for testing while four corner holes were used for practice and warm-up (Figure 1). Twenty-four putt-starting locations were marked on the green indicating putts from 6 ft (1.83 m), 10 ft (3.05 m) and 14 ft (4.27 m) to each test hole. Putts 1–12 were matched with putts 13–24 so that both sets consisted of an equal number of putts from each distance, while also ensuring

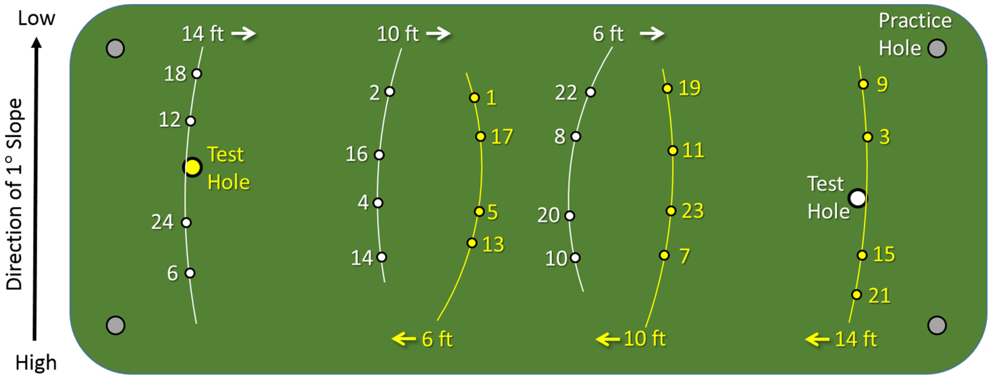

Figure 1 Indoor putting green set-up with a constant slope of 1° directly across the width of the green. Each of the 24 different putt starting locations are labeled. Two central holes were used for testing, while four corner holes were used for practice and warm-up.

the same number of putts breaking from left-to-right and from right-to-left from each distance. All putts were executed using the same set of three Titleist ProV1 golf balls (Acushnet Company, Fairhaven, MA, USA).

Study Design

The study design consisted of four sessions; an information/practice session followed by three testing days. On the first test day, odd-numbered participants (e.g., 1, 3, 5) putted using only the NT strategy, while even-numbered participants (e.g., 2, 4, 6) employed the FT strategy. On the second test day, each participant only used the visual technique they did not use on the first test day. Half of the odd-numbered participants completed putts 1–12 on the first test day and putts 13–24 on the second test day, while the other half of the odd-numbered participants did the reverse (Figure 1). The same balancing method was applied to the even-numbered participants. On the third and final test day, participants putted using both visual focus techniques on all 24 unique putts.

Procedures

At the initiation of the information/practice session, participants were informed about the relationship between the speed of the ball as it approaches the hole, and the probability of the ball being captured. The trade-off between maximizing the capture size of the hole, while at the same time maintaining sufficient ball speed to minimize random deflection due to green irregularities was explained. It was also explained that there will be variability associated with a golfer's speed control. As such, the 'intended' roll out distance should be sufficiently past the hole (if it were smoothly covered) to account for the fact that approximately half of all putts will fall short of this objective. Using methods similar to MacKenzie and Evans (2010) and Pelz & Frank (2000) it was determined that, for the various test putts used in this study, the optimal ball speed at the hole would have resulted in enough speed to carry the ball between 30 and 45 cm past a smoothly covered hole. As such, participants were instructed to hit all practice and test putts with this general objective 'speed' in mind.

During the information/practice session, participants were instructed on how to execute putts while using the FT visual focus strategy. Participants were instructed to change nothing about their normal putting method (green reading, posture, ball position, etc.,) until just before the initiation of the back stroke. Immediately before the back stroke, participants were instructed to slowly rotate their head (using only movement at the neck) for a final time so that visual focus was drawn down the target line and onto the FT. Once visual focus was confidently set on the FT, participants were instructed to keep their gaze fixed while executing their putting stroke. The FT in the study was defined as the point along the intended target line that was nearest to the center of the hole (Figure 2). Since the intended target line is based on the judgment of the golfer, the FT varies from participant to participant. Participants were instructed to think about starting the ball directly at the FT, while keeping in mind the speed they wanted to impart to the ball. While it was not an inclusion criteria, it should be noted that at the initiation of study all participants employed a NT visual focus strategy during their own golf games.

Following the FT technique instruction, participants made six attempts on each of eight unique practice putts. Putt distances ranged from 1 m to 6 m and included a variety of breaks. The first attempt on each unique putt was executed with the NT visual focus strategy and was followed by five attempts (from the same starting location to the same hole) using the FT visual focus strategy. Overall, 48 practice putts were taken (8 NT, 40 FT). This served to familiarize the participants with the testing environment and help them become accustomed to the FT visual focus strategy.

At the start of each testing day, all participants performed the same series of eight warm-up putts of varying distance and break using the visual strategy that would be required for that day's testing. On the third test day, the number of warm-up putts was doubled and an equal number were taken using each visual strategy.

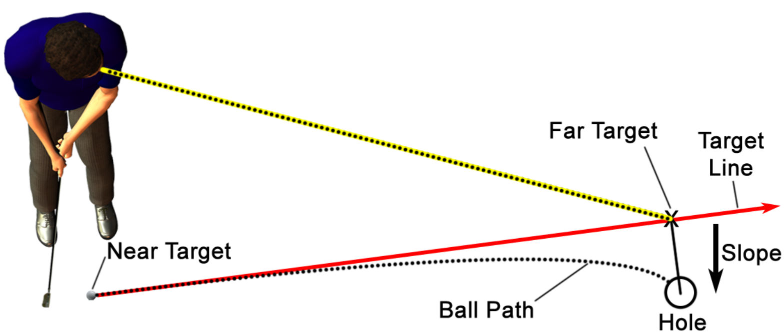

Figure 2 The far target was defined as the point on the target line that was closest to the center of the hole. The target line is coincident with the intended horizontal launch direction of the ball. While using the far target technique, participants visually focused on the far target during the stroke. This is an example of a heel-to-toe breaking putt (left-to-right) for this right-handed golfer.

On each of the first two testing days, participants completed their assigned set of 12 putts (either putts 1–12 or 13–24) in sequential order, four times, for a total of 48 putts. The third test day was similar to the others in that there were four rounds consisting of 12 putts each. In the first round (putts 1–12) and last round (putts 13–24), participants putted using the visual focus method used on their first test day. Rounds two (putts 1–12) and three (putts 13–24) were executed using the opposing visual focus technique. After every round of putts (12 putts/round, 4 rounds/day, 3 test days) the participants were notified on their success rate in an attempt to keep motivation at a constant and appropriate level. Over three test days, each participant executed a total of 144 putts (72 with each method).

The researcher retrieved the ball after each attempt and was responsible for placing a ball at the next numbered location. The researcher oriented the ball such that no logos or text were visible from the participant's view point while addressing the ball. Each putt attempt was recorded in terms of success (was the ball captured) and miss distance. Miss distance was defined as the minimum distance between the ball and center of the hole at any point along the ball's path. For example, if the ball's velocity vector bisected the hole as it entered, then a miss distance of 0 cm would be recorded, while a typical lip-out would be given a miss distance of 5 cm. A miss on the 'low' side of the hole was assigned a negative value. The validity of this method was tested by comparing miss distance estimates to those simultaneously measured using an 8-camera optical motion capture system (Raptor E, Motion Analysis Corporation, Santa Rosa, CA, USA), which tracked the center of a reflective golf ball relative to the center of the hole. A reasonably high intraclass correlation coefficient (r =. 92) was calculated on a sample of 96 test putts (48 on each of two separate days).

Statistical Analysis

Putting success (number of captured putts) was entered into a 2 × 3 x 2 (Method x Length x Break) analysis of variance (ANOVA) with repeated measures for all three independent variables. Miss distance data were processed to represent absolute error, constant error, and variable error. Each version of miss distance was entered into a 2 × 3 x 2 (Method x Length x Break) ANOVA with repeated measures for all three independent variables. To evaluate the effect of 'practice' across the three test days as well within each day (independent of Method), each dependent variable was entered into a 3 × 4 (Day x Round) ANOVA. If the assumption of sphericity was not met for any of the repeated measures, as determined using Mauchly's Test, then Greenhouse-Giesser corrections were applied. When significant values were determined, one-way ANOVAs and Bonferroni post hoc tests, with adjustments to control for Type I error, were used to determine where significant differences existed between conditions. Effect sizes were estimated using partial eta squared (η_p^2). Statistical significance was set at $\alpha \leq .05$ for all tests. Statistical analyses were performed using SPSS V22.0 for Windows (IBM Co., New York, NY, USA).

Results

On average, the FT method was associated with a significantly higher number of successful putts (40%) in comparison with the NT method (37%), ($F(1, 27) = 3.96$, $p = .047$, $\eta_p^2 = .11$) (Figure 3). Significant differences in terms of number of successful putts, in favor of the FT method, existed at the 10 ft putt length (39% vs 34%) (Figure 3). The main effect for Length, in terms of number of successful putts, was also significant ($F(2, 54) = 120, p < .001, \eta_p^2 = .82$). The main effect for Break, in terms of number of successful putts, was not significant ($F(1, 27) = .048, P = .83, \eta_p^2 < .001$). In terms of number of successful putts, there was a significant Method x Break interaction ($F(1, 27) = 4.31, p = .041, \eta_p^2 = .13$) (Figure 4). The FT method was relatively more effective for heel-to-toe breaking putts (41%) than the NT method (36%) in comparison with the difference for toe-to-heel breaking putts (FT: 39%, NT: 38%). For a golfer putting right-handed, a heel-to-toe breaking putt would break from left to right (Figure 2). When the putting success data were entered into a Day x Round ANOVA, there was a significant linear effect for

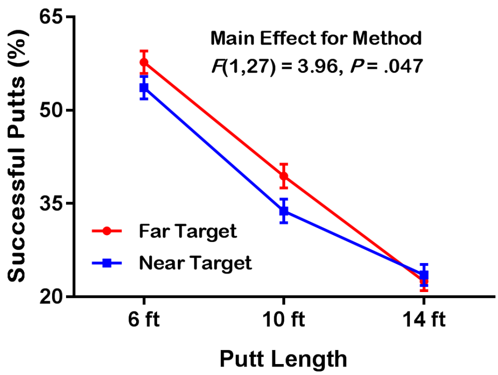

Figure 3 Percentage of putting attempts that were successfully captured by the hole at each of the three putt lengths and for each visual focus strategy. These are average values across all participants. Error bars represent 95% within-subject confidence intervals.

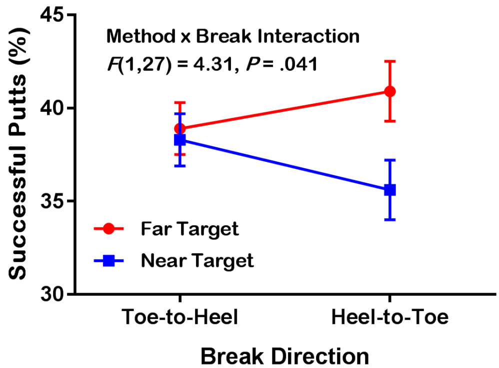

Figure 4 Percentage of putting attempts that were successfully captured by the hole for each break direction and for each visual focus strategy. These are average values across all participants. Error bars represent 95% within-subject confidence intervals.

Round ($F(1, 27) = 8.41$, $p = .004$, $\eta_p^2 = .204$), but there was no effect for Day and no Day x Round interaction. The putting success data across rounds are presented as percentage of putts missed to enable a clearer comparison with the miss distance data (Figure 5A and 5B).

On average, the FT method was associated with a significantly lower absolute miss distance (5.2 cm) in comparison with the NT method (6.1 cm), ($F(1, 27) = 11.2$, $p = .002$, $\eta_p^2 = .294$) (Figure 6). Statistically significant differences in terms of absolute miss distance, in favor of the FT method, existed at the 10 ft (5.2 vs 6.1 cm) and 14 ft (7.0 vs 8.5 cm) putt lengths. When the absolute miss distance data

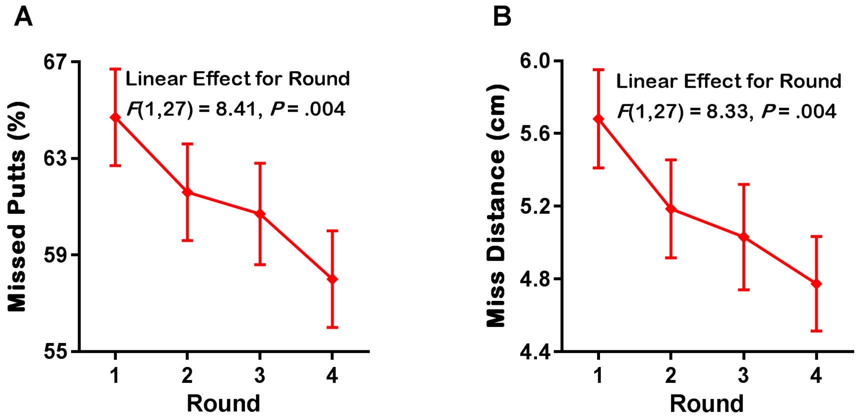

Figure 5 **(A)** Percentage of putting attempts that were *not* captured by the hole during each round of 12 putts. These are average values across all participants and days. **(B)** Average absolute miss distance during each round of 12 putts. These are average values across all putts, participants, and days. Error bars represent 95% within-subject confidence intervals.

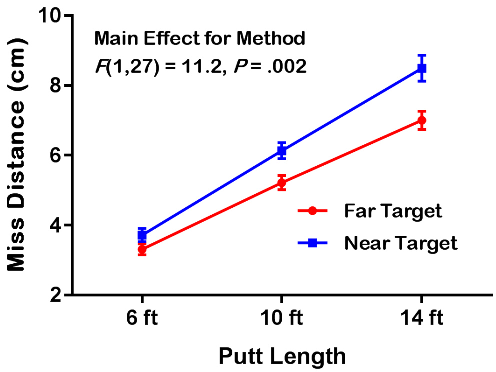

Figure 6 Average absolute miss distance at each of the three putt lengths and for each visual focus strategy. These are average values across all participants. Error bars represent 95% within-subject confidence intervals.

were entered into a Day x Round ANOVA, there was a significant linear effect for Round ($F(1, 27) = 8.33$, $p = .004$, $\eta_p^2 = .202$), but there was no effect for Day and no Day x Round interaction (Figure 5B). There were no significant differences found for the constant error version of miss distance, while the variable error version of miss distance followed the same trend as absolute error. For example, the FT method was associated with a significantly lower variable error miss distance (6.4 cm) in comparison with the NT method (7.4 cm), ($F(1, 27) = 6.1$, $p = .02$, $\eta_p^2 = .184$).

Discussion

The purpose of this study was to compare NT and FT visual focus strategies during the execution of the putting stroke on moderately breaking putts. The only other study to investigate these strategies with breaking putts had participants visually focus on the hole, regardless of the intended initial ball launch direction (Bowen, 1968). MacKenzie et al. (2011) argued that the far target should be a point on the target line, which will *not* bisect the hole on breaking putts. In this study, participants were instructed to visually focus on the point along the target line that was closest to the center of the hole while using the FT method. It was hypothesized that a FT visual focus strategy would be associated with higher putting success since previous research suggests that this technique may provide golfers with more timely information for imparting the intended initial speed to the ball coupled with the idea that breaking putts are more sensitive to errors in initial speed for a given starting direction.

As hypothesized, participants holed significantly more putts, averaged across all putt lengths and breaks, while employing the FT method (Figure 3). This result was primarily due to a 5% difference, in favor of the FT method, from the 10 ft putt length. This inference was supported by the findings for miss distance; on average, participants came closer to projecting the ball 'into' the center of the hole while using the FT method (Figure 6). As would be expected, miss distance increased for both visual strategies as putt length increased. A limitation of the current study was that kinematic data were not collected on either the putter or ball around the time of impact, as such, it is not possible to determine which mechanical variables were responsible for the FT method yielding better results. Previous research, upon which the current study's hypothesis was established, would suggest that the FT method gave participants an advantage in launching the ball with the intended speed. However, it is challenging to use speed control as the only explanation for FT success when considering the significant Method x Break interaction (Figure 4). The FT method was associated with an increased success rate for both break directions in comparison with the NT method. However, considering only the FT method, more heel-to-toe breaking putts were holed in comparison with toe-to-heel breaking putts, while the opposite was true when considering only the NT method (Figure 4). This may indicate that the two methods had a systematic difference in ball launch direction. For example, a scenario in which the FT method was associated with a more leftward launch direction (for a right-handed golfer), coupled with the notion that amateur golfers tend to under-read the amount of break (Pelz & Frank, 2000) could explain the Method x Break interaction. To be explicit, starting the ball left of the *intended* target line, on a left-to-right breaking putt, is advantageous if the break was underestimated. Perhaps the simplest explanation is that the act of rotating the head to look at the far target resulted in the participants starting their putts slightly more to the left (for right-handed golfers) while using the FT method. Future studies could investigate this conjecture by tracking putter and ball kinematics on breaking putts while comparing NT and FT visual focus strategies.

The dichotomous nature of measuring whether a putting attempt was successfully captured by the hole, or not, can have important implications for the interaction between the length of putt chosen for testing and the number of trials required to achieve the necessary statistical power. Consider the extreme examples of a 1 ft and a 100 ft test putt. Since virtually every 1 ft putt would be successful and every 100 ft putt unsuccessful, an unwieldy number of trials would be required to differentiate between levels of an independent variable expected to have an influence on putting performance. This effect, to a lesser extent, may have been present in this study and could explain why a significant difference between methods, in terms of make percentage, was only found at the 10 ft putt length. While possible, it seems unlikely that the method of visual focus would have a unique effect on 10 ft putts that's not present (or present to a lesser extent) on 6 ft and 14 ft putts. It is more probable that there wasn't enough trials taken at the 6 ft and 14 ft distances to have a statistically significant influence on the percentage of holed putts.

Recording miss distance was an attempt to quantify putting performance with an improved level of resolution relative to make percentage. In most previous studies, the ball's finish position relative to the hole has been used as a measure of performance (Alpenfels, Christina, & Heath, 2008; Bowen, 1968; Gonzalez, Kegel, Ishikura, & Lee, 2012). This is a reasonable measure with 'lag' putting for which the primary goal is to avoid three-putting. However, in this study, the objective was to maximize the number of 'one-putts'; therefore, ball finish position would be a relatively poor indicator of putting performance. For example, considering a putt from 10 ft, neither an attempt that stops 10 cm short of the hole, nor one that finishes 10 cm hole-high to the right, would be considered better than an attempt that lips-out and finishes 30 cm past the hole. While miss distance was favored over final resting position as a dependent measure in this study, there are limitations to using miss distance as a measure of putting performance. For example, a putt that lips out at a very high speed and finishes 100 cm past the hole would be given a better score than a putt which misses the edge by 2 cm and stops a 30 cm past the hole. However, given the type of putts in this study, this scenario occurred less frequently relative to the scenarios that contraindicated final resting location. Arguably, it's also more challenging to accurately measure miss distance in comparison with final resting location. The fact that miss distance was subjectively estimated while the ball was still moving (for most attempts) is an important limitation to point out. However, there are a few indicators which strongly suggest that miss distance, as used in this study, was sufficiently valid and reliable. Primarily, the subjective reporting of miss distance was found to have a relatively high intraclass correlation ($r = .92$) with miss distance as measured by a motion capture system, which indicates sufficient validity. Miss distance also closely corresponded to the putting percentage measure, which is perhaps most clear when considering the linear effect for round (Figure 5). As miss distance decreased from Round 1 to Round 4, there was a paralleled increase in the number of putts captured by the hole. It should also be pointed out that there would be no reason to suspect a systematic bias in the reporting of miss distance toward a particular level of any independent variable. The fact that miss distance revealed significant differences suggests that the random error in reporting miss distance was sufficiently low. Regardless, in future studies, it would be advantageous to track the motion of the ball around the hole with a motion capture system as a better method to discern putting ability.

Conclusion

This study has addressed important issues in the previous comparisons of NT and FT visual strategies of focus during the putting stroke. In particular, breaking putts were used and the far target was explicitly defined as a point along the target line. Experienced golfers, who normally putt using a NT strategy, were found to putt significantly better—both in terms of make percentage and miss distance—while employing a FT visual focus strategy on moderately sloped putts inside 14 ft. Future studies should investigate performance differences at the individual golfer level to determine factors that may predispose golfers to putting better with one of the visual focus strategies. Research should also focus on breaking putts on outdoor greens from distances beyond 14 ft and should considering securing additional FT practice time for participants before testing.

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