Quiet Eye Training and the Focus of Visual Attention in Golf Putting

by

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ABSTRACT

Previous research has shown that training visual attention can improve golf putting performance. A technique called the Quiet Eye focuses on increasing a player's length of fixation between the ball and the hole. When putting, the final fixation is made on the ball before executing the stroke leaving players to rely on their memory of the hole's distance and location. The present study aimed to test the effectiveness of Quiet Eye training for final fixation on the hole. Twelve Arizona State University (ASU) students with minimal golf experience putted while wearing eye tracking glasses under the following conditions: from three feet with final fixation on the ball, from six feet with final fixation on the ball, from three feet with final fixation on the hole and from six feet with final fixation on the hole. Participant's performance was measured before training, following quiet eye training, and under simulated pressure conditions. Putting performance was not significantly affected by final fixation for all conditions. The number of total putts made was significantly greater when putting from three feet for all conditions. Future research should test the effects of this training with expert golfers whose processes are more automatic compared to novices and can afford to look at the hole while putting.

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INTRODUCTION

Golf is one of the few sports where players do not focus on their target while making a stroke. In fact, this is common in most sports that require the use of equipment such as racquets and bats, like tennis, hockey, and baseball. Unlike these sports, in golf the ball is stationary when a player hits it. With putting, even though the distance between the ball and the hole is very short, players still look down at the ball as they hit it. This is true of even the best players in the world. What differentiates an amateur golfer from a professional, other than the amount of time spent practicing, is a technique called the quiet eye effect (Vickers, 2009).

The quiet eye effect refers to gaze behavior involving steady fixation on a target during and after an aiming task (Vickers, 2009). This effect is seen in many expert athletes and helps them to maintain focus to calculate and produce a smooth movement. It also helps them pay attention to specific things at the right time, ultimately leading to better accuracy. Amateur golfers who train in the quiet eye technique have been shown to improve faster than those taught with traditional coaching techniques that have golfers focus more on technical skills and biomechanics (Vine, 2017). However, in a sport like basketball, players do not focus on the ball as they shoot, rather, their focus is solely on the rim.

How might a golfer's putting be affected if they focused on their target, the cup? Studying these gaze behaviors and how they differ between sports could shed light on how the quiet eye technique works, even when otherwise implemented. This current study aims to answer the question: While golf involves looking between the target and

the ball, would training in the quiet-eye technique improve putting performance at different distances for golfers who look at the hole versus those who look at the ball?

LITERATURE REVIEW

Vickers (2009) discusses the quiet-eye effect as a possible link between perception and action, particularly in high performing athletes of different sports. In particular, this work demonstrated that training in the quiet eye technique increases free throw accuracy by as 22%. In a similar study by Oudejans, Van de Langenberg, and Hutter (2002) the vision of basketball players was manipulated with different shooting styles to see their effect on the number of baskets made. Players were tested in different viewing conditions. In the obscured viewing condition, a player had a clear view of the basket until the ball crossed his line of sight as he shot. This condition was labeled "early vision" since players could only see their target at the beginning of their shot. The other condition labeled "late vision" had player's line of sight to the basket obscured by the ball during the beginning of the shot but then allowed for a clear view of the rim as the player completed the follow through. The results of the study demonstrated that players in the late vision condition performed just as well as players that had completely unobscured vision while players in the early vision condition had severely impaired performance. These results indicate the importance of maintaining visual control of the target in aiming tasks such as shooting a basketball. This could have implications for putting, since the target in golf is not focused on through execution of the stroke.

A similar study done earlier by Vickers (1996) studied how basketball players controlled their gaze when aiming at a far target. This study was similar to that conducted

by Oudejans et al. (2002), in that participant gazes were controlled in the moments before their vision was obscured. This was shown to be critical in adequately assessing the distance and location of the target (Vickers, 1996). In addition, some participants exhibited visual suppression achieved by means of blinking as their hands and the ball entered their visual field. It is possible that players do this to suppress the interference of the ball and to maintain the memory of their target. This suggests aiming at the target for as long as possible right before shooting is more beneficial because it allows the player to receive more information about the location of their target for a longer period of time.

Unlike making basketball free throws, golf putting traditionally requires players to look at the target and then focus on the ball before putting. This requires golfers to rely on their memory of the location and the distance to the hole. In a study conducted by Laabs (1973), retention of lever position was tested by measuring recall of its distance and location. Participants were assigned to groups of differing delays, twelve seconds and immediate reproduction. Using a lever-positioning apparatus, participants were presented with a starting configuration and asked to reproduce it to the best of their ability. Delays between when participants saw the configuration and when they were asked to reproduce it were facilitated with a light that turned on and off for the appropriate time (immediate or 12-sec.) The results indicated that participants actually used separate memory functions, relying on different cues, for location and distance information. More importantly, it was found that location cues were better retained but distance cues are more likely to decay within a few seconds.

Applied to golf, the general location and direction of the hole relative to the player would be better retained but the judgement of exactly how far away the hole was

from the golfer would rapidly decay. If distance decays faster than location, it might be beneficial to commit the location of the ball to memory and actively receive information about the distance of the hole by looking directly at it before putting. Considering that many golfers, especially amateurs, take very long to make a stroke after they have looked at the hole, putting while looking directly at the hole would eliminate the decay of memory of the distance to the hole. In addition, it will also shift focus of the attention away from the body.

Motor learning can be improved by having players focus their attention on the effects of their movements of their body rather than their body producing an effect. McNevin et al. (2003) looked at the distance of an external focus of attention and its effect on performance and learning. Three groups of participants were instructed to balance on a stabilometer while focusing on markers placed at furthering distances from the participants. The results indicated that the far groups' performance was better than that of the close focus group. In addition, the far group's retention of the learning was more effective than that of the close group. These results show that focusing on more distant stimuli not only enhanced learning but also allowed participants to employ more natural control mechanisms. In golf putting, utilizing the hole as an external point of focus may be beneficial. This technique may be especially useful for improving learning and performance on longer putts. One critique this method faces is the increase in variability of the putter face. If a golfer does not have their club in their field of view while putting, it is possible that contact between the ball and putter may be negatively affected.

However, a study by Mackenzie (2011) demonstrated that this was not the case. In their study participants were split into two groups using different gaze techniques, looking at the hole and looking at the ball. Participants also putted from a distance of 1.22 meters and 4 meters. They then completed practice sessions over the course of four weeks, with a total of 100 putts for each condition. The results showed a significant improvement in the number of putts made after practice, regardless of group. More importantly, the results also showed that participants who focused on the hole while putting demonstrated significantly less variability in putter head speed. Making proper contact with the ball is important in starting the ball on the correct path (Mackenzie, 2011). According to a study by Pelz and Frank (2000), putter head speed is four times more important than the right line. In addition, focusing on the hole while putting did not significantly impact the quality of the contact between the putter and the ball. This implies that focusing on the hole while putting may help to improve consistency in putter head speed for both near and far putts. These effects still need to be assessed under pressure conditions.

You may have witnessed a golfer on television miss a putt that was surprisingly close to the hole and wondered why this happens. Performance degradation, commonly known as choking, occurs in expert golfers and especially in novice golfers in high pressure situations. Some attentional theories describe how automatic processes like short putts suddenly require more focus than usual and take the golfer's attention away from something like a small break in the putt, causing them to miss (Vine, 2017). A study by Vine (2011) looked at training in the quiet eye technique and its effects on putting performance under pressure conditions. These effects were then tested in real competitive

putting. In their study, participants were assigned to a control group or a quiet eye training group. After following the training protocol, or no training depending on the group, their putting performance as well as their gaze behaviors were measured. Following training, participants completed a trial in a high pressure setting. Analysis of the results demonstrated a significant lower level of performance error for the group that received quiet eye training as well as longer quiet eye periods. Under the pressure conditions, the control group displayed much shorter quiet eye durations and displayed significantly higher performance error. These results indicate that quiet eye training can successfully improve performance, especially under pressure conditions.

Since the quiet eye technique helps maintain visual control of the target in aiming tasks, has been shown to improve performance (Oudejans et al., 2002; Vickers, 1996) and putting requires similar visual attention for aiming, it was hypothesized that training in the quiet eye for golfers that look at the hole would increase performance. Not only does training in the quiet eye technique improve performance under pressure (Vine, 2011), but having an external focus of attention (the hole in golf) also improves learning (McNevin, et al., 2003). Based on this, the current study predicted that when the quiet eye technique is implemented to have golfers focus on the hole, it will positively impact their putting performance more so than looking at the ball while putting.

METHODS

Participants. 12 students (ages 18-65 years) with no previous formal golf instruction were recruited from Arizona State University's subject pool to participate in the study. Participants had normal or corrected vision to ensure that differences in

eyesight will not affect results. Those with prescription glasses only participated if they wore contacts since eye tracking glasses that were used during the study could not be worn at the same time as the participant's glasses.

Procedure. This study used a 2x3 mixed factorial design with conditions (pre-test, post-test, and pressure) as within-subjects factors and point of aim as a between-subjects factor. Data was collected before any formal instruction was given in the baseline condition as well as after instruction was given in the training condition. In addition, putting performance was also measured during a pressure manipulation phase that was completed after the testing collection phase. Before the pre-test, participants familiarized themselves with the green by taking 5 practice putts from 3 feet and 6 feet. Participant's performance was measured for 10 putts (without training) to establish a baseline. All participants were then trained in the Quiet Eye (QE) technique prior to treatment implementation. This involved instructing participants to fixate specifically between the back of the ball and the hole with the final fixation being made on either the ball or the hole depending on what the participant was assigned (outlined in Appendix A). Participants applied this training in 10 more putts before receving feedback. Video of gaze behavior was compared to an elite prototype that demonstrated a precise QE effect. Differences in the gaze control between the participant and the prototype were reviewed in an effort to improve their use and understanding of the specific gaze behaviors of the QE. Participants then performed an additional 10 putts, implementing what they had learned. Once training was complete, participants were randomly assigned to either the group that had a final fixation on the ball or on the hole before putting. For each condition participants performed a total of 20 putts; 10 putts from 3 feet and 10 putts

from 6 feet. The order in which the different distances were attempted were counterbalanced. All participants then performed 10 more putts in a simulated pressure condition. Gaze behavior and putting performances were measured throughout each data collection phase as well as during the pressure condition. Putting error was measured as the resting distance from the hole in cm for each individual putt.

Materials. Participants performed putts to a standard golf hole on an artificial putting green from birdieball (length = 8 ft, width = 4 ft, height = 0.5 in). Gaze behavior was be measured using eye tracking Tobii Pro Glasses 2, utilizing corneal reflection and dark pupil tracking to calculate a point of gaze at 50 Hz. Eye movements were tracked in real time and analyzed offline with Tobii Pro Lab analysis software. Measuring gaze behavior is a determining factor in ensuring proper use of QE (Vickers, 2009).

Measures. Putting performance was measured in terms of the percentage of the total putts made. A measure of the error was defined as the distance from the hole, in cm, for missed putts. These measures are consistent with those used in previous golf research (Wilson and Pearcey, 2009). The effects of putting under pressure were measured by assessing performance outcome after informing participants that the individual who makes the most putts will win a cash prize. In addition, participants were also informed that they were being recorded and that their putting performance will be shared and used as an example in a future class lecture. These techniques have been used to test the effects of high levels of anxiety in similar studies (Wilson et al., 2009; Vine and Wilson, 2010). The QE period was defined as the last fixation made to the target prior to beginning the stroke with the putter (initial movement of the putter into the backswing). This fixation was reviewed to ensure a minimum duration of 120 ms. Anxiety was

measured using the Mental Readiness Form 3 (see Appendix B), an 11-point Likert scale that measures cognitive anxiety (calm-worried), somatic anxiety (relaxed-tense), and self-confidence (confident-scared) (Krane, 1994).

RESULTS

A three-way mixed ANOVA was run to understand the effects of putting conditions, distance, and final attentional fixation on the number of putts successfully made. Initial analyses revealed that the data were normally distributed and there was no significant heterogeneity of variance. There were no outliers in the data, as assessed by inspection of a boxplot. The number of putts made was normally distributed, as assessed by Shapiro-wilk's test ($p>.05$). Putting under pressure from 3ft was not normally distributed for either groups, ball fixation $p=.004$, hole fixation $p=.022$. There was homogeneity of variances, as assessed by Levene's test for equality of variances ($p>.05$). For the pressure from 3ft condition, the assumption of homogeneity was violated when based on the mean but not when based on the median ($p = .145$). Mauchly's test of sphericity indicated that the assumption of sphericity was met $\chi^2(2) = .011$, $p = .994$. There was no statistically significant three-way interaction between conditions, distance, and final eye fixation, $F(2,20) = .213$, $p = .810$, partial eta-squared (ηp^2) = 0.021. There were no statistically significant main effects for conditions $F(2,20) = .263$, $p = .771$ but not surprisingly, there was a main effect of distance $F(1,10) = 86.733$, $p = .000$. The number of total putts made was significantly greater when participants putted from three feet in all conditions.

To test the proximal versus distal focus of attention effect two independent samples t-tests were run. Ball and hole fixation served as far versus close attention at 3

feet and 6 feet. The independent samples t-test performed on the data revealed that the mean error distance for putting from 3 feet while looking at the ball (close focus of attention) was not statistically significant from the mean error distance for putting from 3 feet while looking at the hole (far focus of attention) $t(4) = -.993$, $p = .377$. The same result was found for mean error distances for putts made from 6 feet when looking at the ball versus the hole $t(4) = -1.010$, $p = .370$. A paired-samples t-test was used to determine whether there was a statistically significant mean difference between the error distance for hole fixation at 3ft versus hole fixation at 6 ft as close and far focuses of attention respectively. No significant difference in mean error distance was found between putts made while looking at the hole from 3 feet versus 6 feet $t(2) = .477$, $p = .681$.

Table 1

Descriptive Statistics for Condition

Fixation	n	μ	σ
Ball Fixation 3ft	6	36.3	6.29
Ball Fixation 6 ft	6	42.3	3.66
Pressure Ball Fixation 3ft	6	21.59	20.98
Pressure Ball Fixation 6 ft	6	40.3	2.16
Hole Fixation 3ft	6	47.5	11.01
Hole Fixation 6ft	6	44	3.47
Pressure Hole Fixation 3ft	6	41.7	18.81
Pressure Hole Fixation 6ft	6	43	2.76

Note: Number of participants, mean distance from hole (cm), and standard deviation

Table 1

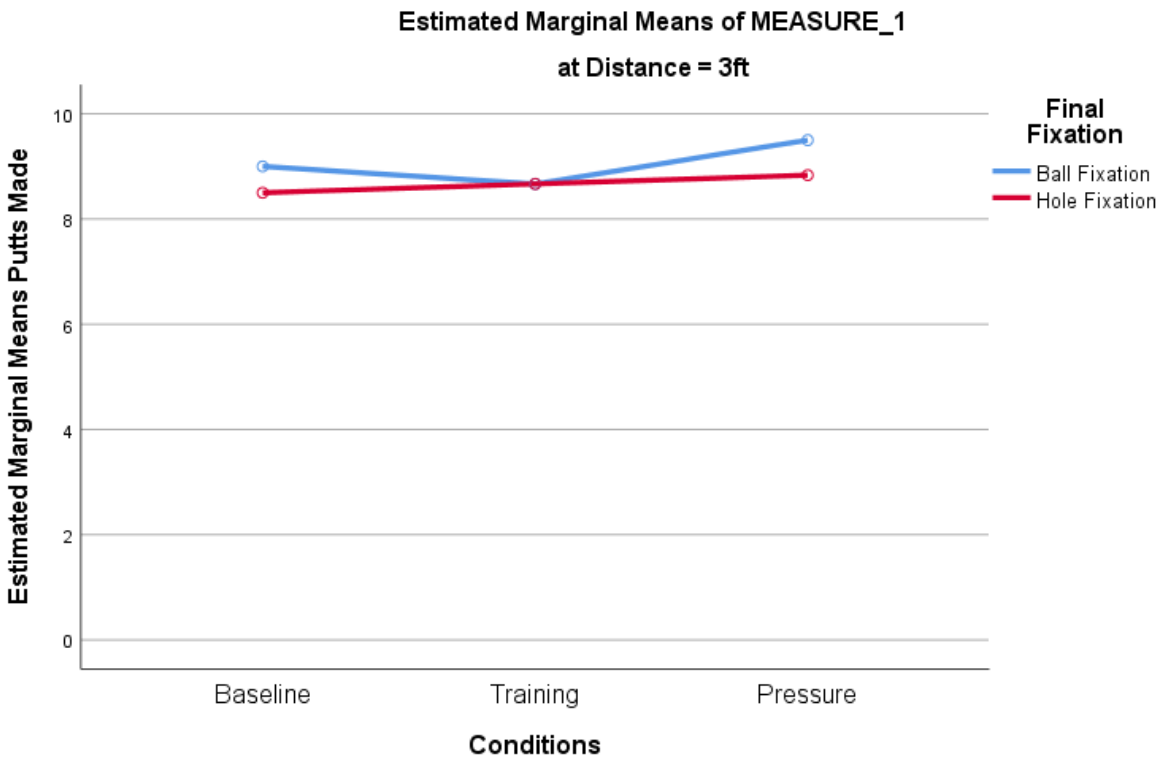

Figure 1: Mean number of putts made from 3 feet for all different conditions.

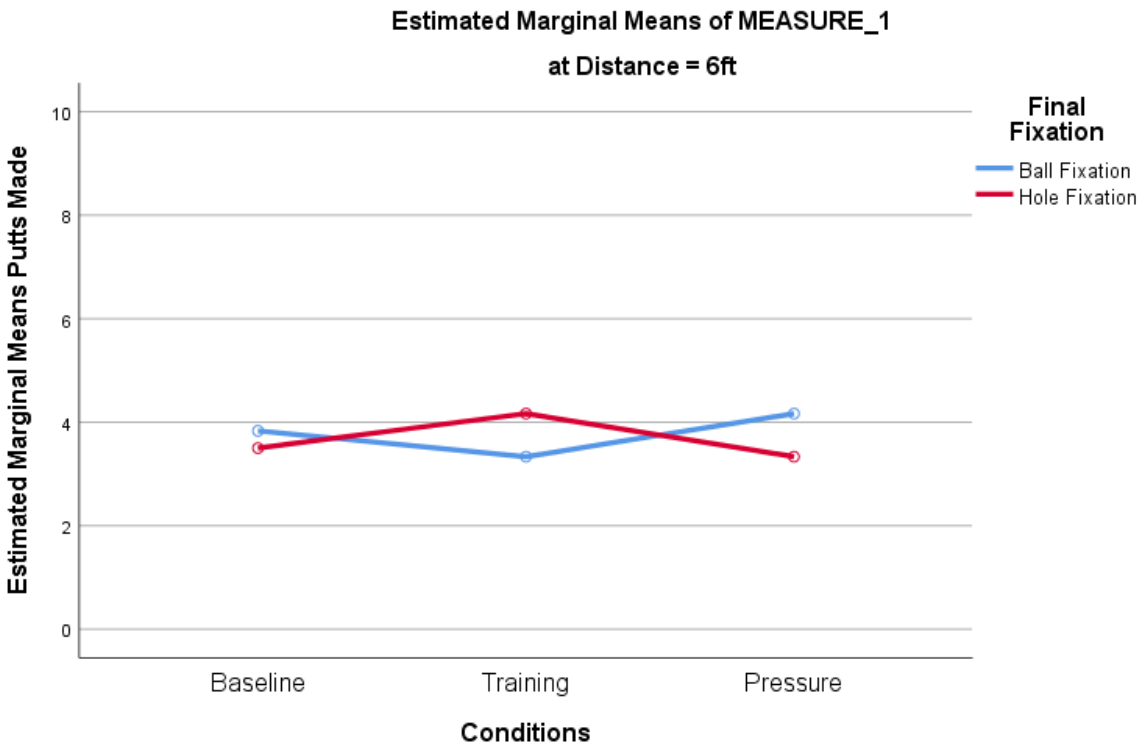

Figure 2: Mean number of putts made from 6 feet for all conditions

DISCUSSION

The results did not support the hypothesis that training in the quiet eye for golfers that look at the hole would increase performance. Putting while looking at the hole did not provide any statistically significant advantage. The difference in putting error for close versus far focuses of attention was not significantly different. These results do not support the findings from the study conducted by McNevin et al. (2003) that looked at the distance of an external focus of attention and its effect on performance and learning. They found that participants who focused on the far point of attention performed better than those who focused on the close point.

Participants in the present study had a lower mean number of putts made when looking at the ball compared to looking at the hole after training from 6 feet (Figure 2). This seems to contradict results from a study by (Beilock 2002) that looked at differences in performance for skill-focused attention and environmentally-focused attention. While subjects executed putts, they were required to attend to either the angle of the putter at the point of contact (skill-focus) or sounds that played through loud speakers (environmental-focus). The results showed that focusing attention on the angle of the club head improved performance but focusing on the sounds resulted in worse performance for novices. It is unclear why participants performed slightly better with an environmental focus. In the present study, looking at the hole while putting would be considered an environmental focus of attention. Although looking at the ball while putting is not exactly skill-focused, participants can still see the ball as it leaves the putter as well as the angle of the clubhead when it makes contact with the ball.

The main finding from Vine (2017) that amateur golfers who trained in the quiet eye technique showed improved performance was not entirely supported. Performance did not improve from pre-test to post-test for golfers with final fixation on the ball but did improve slightly for golfers with final fixation on the hole when putting from 6 feet after training (Figure 2). These results reversed under pressure conditions. Participants with final fixation on the ball performed slightly better than participants with final fixation on the hole (Figure 2). This finding contradicts what would be predicted by the Explicit Monitoring Theory by Baumeister & Steinhilber (1984) that states that attention is turned inwards under pressure conditions. Since the club is in view when final fixation is on the ball, it would be expected for participants to have worried more about their movements. Participants with final fixation on the hole would have an external point of focus and less chance to turn their attention inwards to things like their hands or club movement. Findings from Vine (2010) that quiet eye training improves performance under pressure were supported only by golfers with final fixation on the ball. Participants performance slightly improved when putting from both 3 feet (Figure 1) and 6 feet (Figure 2) for golfers that focused on the ball.

LIMITATIONS

This study is not without limitations. The duration of the training protocol was significantly shorter than those conducted in similar studies that lasted four weeks (Mackenzie, 2011). It is possible that 20 total putts for training is not adequate for novices. Training in the quiet eye technique has been done with as little as 20 putts (Vine, 2011) in between 10 rounds of competitive golf, but with experts not novices. The study

conducted by Vine (2010) used 320 acquisition phase putts and 120 test phase putts with only 14 novice golfers. Having a small number of participants should have been compensated with an increase number of putts for each subject.

The measures for the differences in mean for error, measured as the resting distance in cm from the hole, were also limiting. The artificial putting green from birdieball came fixed with a backstop located 40 cm from the center of the back of the cup. This might have inhibited participants from properly judging the strength applied to putts that missed, making it difficult to adjust accordingly for subsequent attempts.

Another note to mention is the pre-test scores, particularly for putts attempted from 6 feet, were particularly high. Nearly half of the participants (5 of 12) made at least 50 percent of putts for their baseline, with 3 of those 5 making 60 percent. This may have caused a ceiling effect, considering that only four of the twelve participants scored higher than baseline after receiving training.

CONCLUSIONS

This study sought to investigate the extent to which training in the quiet-eye technique would improve putting performance at different distances for golfers who fixated on the hole versus those who fixated on the ball. It was predicted that looking at the hole while putting after quiet eye training would improve putting results more than traditional quiet eye training. Focusing on the hole did not provide a significant advantage compared to looking at the ball and did not entirely support previous research involving focus of attention and pressure.

Future directions for research include studying the effects of similar training for expert golfers. Highly skilled golfers stand to benefit the most from training using an external focus of attention and actually perform worse with skill-focused methods (Beilock, 2002). The findings by McNevin et. al (2003) regarding the distance of the focus of attention, and its effect on performance, could be tested for aiming related tasks that require the use of sports equipment. Golf, along with sports like billiards and bowling are unique in the sense that there are no moving parts when it comes to the target. The focus of attention and its role in the quiet eye effect should continue to be researched to further understand when and how it should be applied.

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APPENDIX A

QUIET EYE PROTOCOL

1. Assume your stance and align the club so the gaze is on the back of the ball.

2. After setting up over the ball, fix your gaze on the hole. Fixations toward the hole should be made no more than 3 times.

3. The final fixation should be a QE on the back of the ball. The onset of the QE should occur before the stroke begins and last for 2 to 3 seconds.

4. No gaze should be directed to the clubhead during the backswing or foreswing.

5. The QE should remain on the ball/hole for 200 to 300 ms after the club contacts the ball.

APPENDIX B

MENTAL READINESS FORM 3

My thoughts are:

/ 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 11 /

CALM WORRIED

My body feels:

/ 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 11 /

RELAXED TENSE

I am feeling:

/ 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 11 /

CONFIDENT SCARED

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