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Research Notes

Quiet eye training alleviates the yips in golf putting: a research proposal

JOAN N. VICKERS[1]

[1] Faculty of Kinesiology, University of Calgary, Calgary, Canada.

Correspondence to: Joan N. Vickers. Faculty of Kinesiology, University of Calgary, Canada.
ORCID: https://orcid.org/0000-0003-1988-1701
email: vickers@ucalgary.ca
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ABBREVIATIONS

AB	Pseudonym of a professional golfer
EEG	Electroencephalogram
ms	Milliseconds
QE	Quiet eye
QET	Quiet eye training
YIPS	The occurrence of involuntary movements during the execution of a fine motor skill

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ABSTRACT
A research proposal is presented based on a unique quiet eye training (QET) program developed for a golfer who suffered from the YIPS. After receiving the QET program she overcame the YIPS and continued to perform on the LPGA tour. While positive results with one golfer is encouraging, a larger study is proposed involving YIPS sufferers in two groups, a QET group that received the program described herein, and a Control group undergoing traditional YIPS motor training. Both QE and electroencephalogram (EEG) data will be collected, with the goal to determine if the QET group established a neural network that differed from that of the Control group that contributed to a return of putting accuracy.

KEYWORDS: Eye movements | Sport | Expertise | Vision | Anxiety

INTRODUCTION

The YIPS got its name from Tommy Armour, a professional golfer who in 1927 found he could not perform the fine movements needed to putt accurately. The YIPS is "defined as the occurrence of involuntary movements during the execution of a fine motor skill and it is a common phenomenon, with a reported prevalence of 28 – 48%" of elite golfers (p. 1) [1]. Smith, Adler [2] define the YIPS as "a psycho-neuromuscular impediment affecting the execution of the putting stroke in golf" (p. 426). Watanabe, Yoshioka [3] further define the disorder as lying on a continuum with focal dystonia at one end (neurological) and choking under pressure at the other (psychological choking). The cause of the YIPS is unknown, but the symptoms have been widely documented. For example, in a meta-analysis by Clark et al (2015) [4] of 1429 studies, the YIPS occurred in sports as diverse as golf, shooting, darts, table tennis, cricket, cricket, bowling, baseball, archery, gymnastics. The YIPS tends to afflict older elite athletes who are no longer able to perform well learned skills where fine motor control is critical. The symptoms include heightened muscle activation, an inability to initiate well learned movements, anxiety, obsessive thoughts about technique, erratic eye movements and loss of focus. Of these the lack of visual focus which prevents the golfer from reading the green appropriately during the aiming of the putt, and an inability to maintain a long duration quiet eye (QE) during the stroke is emphasized.

A research proposal is presented based on a quiet eye training (QET) program developed for a professional golfer AB (a pseudonym) who in her 13th LPGA season

suffered from the psychological form of the YIPS. After a QE training program of about four months, AB overcame the YIPS in her 14th season and experienced her 2nd best year financially on the LPGA tour [5]. She was 15th in putting average in the league, improving from 1.86 putts per hole to 1.79. She is currently participating in LPGA events. AB ascribed her success as her mind being so busy on quiet eye (QE) she had no time, or no other space to think of other things.

While positive results with one golfer are encouraging, a larger study is proposed involving two groups of golfers who are suffering from the YIPS, a QET group that receives the QE training program described herein, and a Control group that undergoes traditional technical motor training. Two goals are pursued, to present a unique QET program designed for YIPS that improves accuracy, and provide electroencephalogram (EEG) evidence that the QET program leads to changes in neural activation that is unique for the QET group compared to the Control group.

What is the QE and QET?

The first QE study was published 25 years ago [6] and the first QET studies shortly thereafter [7,8]. The QE is the final fixation or pursuit tracking gaze that begins before the onset of a critical phase of the movement [9,10]. The QE is maintained on a specific location or object in the task environment within 3° of visual angle (or less) for a minimum of 100 milliseconds (ms). Studies in golf putting show the QE is the final fixation that is located on the back of the ball before the onset of the backswing within 1° of visual angle for more than 100 ms [9,11,12]. The QE offset occurs when the gaze deviates off the ball and underlying green by more than 1° for more 100 ms. The QE duration of highly skilled golfers is 2.0 - 3.0 s compared to 1.0 - 1.5 s for lower skilled golfers, with longer putts having a longer QE. Meta-analyses [13,14] confirm that a long duration QE is a significant characteristic of high levels of expertise and accuracy in golf putting and many other skills. Moreover, once the QE of expert golfers is known, those undergoing QET develop a longer QE duration and a significant increases in accuracy compared to those who are technically trained [12,15].

A QET program for the YIPS in Golf

AB revealed she had trouble focusing and no longer trusted the visual information she was using as she set up and performed short putts, while she had no problem on longer putts. One characteristics of the YIPS is that it occurs primarily during short putts, when both near and far target information is available, and rarely during longer putts where it is impossible to see the target peripherally. AB explained she used brief eye movements on numerous targets - the hole the ball, the club, the green and experienced a state of confusion where she could not decide which was best as the stroke was performed - to rely on near vision on the ball and/or club, or far vision on the target, or a combination of both locations.

The steps used to implement a QET program have been explained elsewhere so they will be briefly described here [7,9,16]. The first step is to record the QE of the trainee using a mobile eye tracker synchronized to an external camera that records the putting movements. Second, using a video of an expert golf prototype derived from research the optimal QE location, QE onset, QE critical movement, QE offset and QE duration is taught. Third, video feedback is provided the trainee of their own QE compared frame by frame

with that of the expert. Fourth, QET continues until all five QE characteristics (QE location, QE onset, QE critical movement, QE offset, QE duration) have been mastered under a variety of practice and play conditions.

The goal of QET is to shift attention away from trying to control specific muscle groups during the stroke to a QE focus that uses a sequence of eye movements not reported before in QET studies. Golfers who suffer from the YIPS are overinvested in their physical/ biomechanical technique and often fail to read the green properly and develop an aiming strategy that is effective [17]. As a consequence during QET there is limited emphasis on the physical, technical aspects of putting and instead emphasis on visual and cognitive skills needed to successfully aim for accuracy. Two phases of the putt were emphasized - an aiming phase and a QE phase. During the aiming phase the golfer assumes their stance and places the putter face as close to the back of the ball as possible. Fixations are used on the green to determine a specific target location where the ball will be aimed. Two targets exist in putting, a location on the hole on straight putts, and on sloping greens a location where the ball is expected to roll toward the hole. Through a process of pattern recognition and decision making an aim line is established between the target location, the back of the ball and the middle of putter face. Most putters have a line inscribed on the centre of the putter and golfers often mark a centre line on the ball. This aiming process establishes the location, direction, and distance to the target. The QE phase begins about a second before the backswing and begins once the line between the centre of the putter, the centre back of the ball and target has been refined and committed to memory. During the stroke the QE is held stable on the back of the ball during the backswing, foreswing, contact, and on the green under the ball as the club follows through toward the intended target, resulting in a total QE period of two to three seconds. This means the only thing the golfer focuses on as the stroke is performed is perfecting the contact between the centre club face and the centre back of the ball. The stroke is therefore performed with cognitive information pertinent to aiming accuracy held in memory. Studies that have assessed both the QE and club movement show that misses occur when golfers have a shorter QE duration, resulting in poor club-ball contact, while those with a longer duration QE exhibit stable acceleration and increased accuracy [12].

QE and EEG of The QET and Control Groups

At the outset alleviating two YIPS characteristics was proposed. The first was to re-direct the attention of the QET group away from thoughts about physical technique to a QET routine that establishes a precise aim line to the target that takes into account meaningful aiming conditions on the green. A secondary goal is to determine if the QET group establishes a neural network that differs from that of the Control group. Biological neural networks were first described by Hebb [18] as occurring “when an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A's efficiency, as one of the cells firing B, is increased’ (p. 62). Shat (p. 64) caught the essence of this neural event in the famous rhyme: “what fires together, wires together” [19].

The past ten years has resulted in studies seeking to determine how specific areas of the brain lead to increased accuracy in aiming sports [20,21,22]. Of importance in the current proposal is a novel study by Chueh, Lu [23] in which four neural networks (Fθ, FCα, SMR, T3a) were investigated during successful (61%) and unsuccessful putts (39%) performed

by highly skilled right handed golfers. Sixty putts were performed three meters distant from a regulation hole. Instead of reporting results from individual electrodes, clusters of electrodes were combined known to have specific cognitive and/or motor processing functions. Fθ frontal theta included activation of F3, Fz, and F4 and measured attentional focus to achieve a specific motor goal. FCα included recordings from FC3, FCz, and FC4 and measured activation from the supplementary motor area associated with motor planning and organization of voluntary action. SMR recorded from the motor cortex C3, Cz, and C4 and is associated with a quieting of the motor cortex during well learned actions. T3a (also labelled T7) was a single electrode recording from left temporal cortex involved in the inhibition of distracting thoughts and emotions. The results showed that successful putting was not explained by the activation of one of the networks alone, or one of the electrodes. Instead, successful putts occurred when both frontal theta Fθ and left temporal T3a were activated, along with the co-activation of SMR and FCα, indicating cognitive skills reflective of refined attention allocation and effective motor processing. Unsuccessful putts occurred when there was simultaneous activation of all four networks at once. They concluded that "multiple neural processes regarding attention processing measured on a cortical scale modulate putting performance. That is, attentional processes of superior performances can be equated as a "refinement of attentional state" associated with psychomotor efficiency when there are decreasing intrusive attentional processes (T3α) accompanied by a heightened focus (Fθ) on the task at hand. In this manner, skilled golfers achieve elevated efficiency by allocating synergistic neural resources towards essential attentional processes (i.e., increased focus and engagement on the task-specific elements in concert with lowered verbal-analytic activity) to achieve a successful cognitive-motor performance".

Cheuh et al did not report the motor phases of the putt, nor did they report the eyes movements or QE of the golfers, however Xu et al [24] assessed the QE and EEG of golfers during QE pre, which was three seconds before the onset of backswing and therefore similar to the aiming phase, and QE post which was three seconds after contact and similar to the QE phase. One hundred putts were performed at a distance of two meters by right handed university students to a regulation hole during hits (24.86%) when the ball went in the hole and misses (44.64%) which were more than 20 cm from the hole. EEG was recorded from Fz (prefrontal cortex), Cz (premotor cortex), and Pz (parietal cortex). The QE was measured using electro-oculography (EOG) which provided the duration of QE pre, QE post and QE total (QE pre plus QE post). Hits were associated with a longer QE pre, QE post, and QE total compared to misses. Cortical activation was greater in Fz, Cz and Pz during hits than misses. They also found greater activation in Fz than in Pz during hits than misses. They conclude that "greater attention was allocated to the visuomotor components in successful than unsuccessful putts during the QE periods and the parameters of movement were efficiently programmed and fine-tuned, resulting in more effective physiological responses and movement kinematics" (p. 7). Regrettably given a limitation of EOG technology no information was available indicating what the golfers were fixating during QE pre and QE post, however we can hypothesize that during the aiming phase an aim line was established which included fixations toward a specific target location, the middle back of the ball and the middle of the club, then during the stroke the QE was fixated the back of the ball while the location of the target, the middle of the club and aim line were held in memory. This may account for the elevated activation in

Fz, relative to Cz and Pz during hits versus misses found by Xu et al.

To my knowledge no QE/EEG studies exist that includes YIPS sufferers. Given results by Cheuh et al and Xu et al, it is expected that during the pretest both the QET and Control group will exhibit an absence of co-activation of Fθ and T3a, and FCa and SMR during the aiming phase and instead fire all four networks exhibiting a lack of focus and cognitive decision making critical in aiming. After training, the QET group will differ significantly from the Control group by creating an aiming line as described in the QET program followed by a stable QE as the stroke is performed. Co-activation of Fθ and T3a, and FCa and SMR will occur as described by Cheuh et al, while the Control group will perform as in the pre-test.

In summary, the QET program leads golfers to make all the decisions needed to perform the stroke during the aiming phase, and during the stroke the sole purpose of the QE is to perfect contact between the centre of the putter face and the centre back of the ball followed by the QE dwelling on the underlying green for a half second. Only after this should the golfer look up to see where the ball has gone. The QET golfers possess task and context specific aiming information that is meaningful resulting in a stroking action taken with purpose and confidence and increased accuracy, while golfers in the Control group will experience a dissociation between the cognitive processes that occur during the aim phase and attempt to perform the putt blindly under conditions of uncertainty and an inability to initiate the stroke with the specific aiming information needed to perform accurately.

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