THE EFFECTS OF INSTRUCTIONAL SELF-TALK ON QUIET EYE DURATION AND GOLF PUTTING PERFORMANCE.

Yonatan Sarig

Master's Thesis in Sports and Exercise Psychology

March 2017

Faculty of Sport and Health Sciences

University of Jyväskylä

ACKNOWLEDGEMNTS

I would like to express my appreciation to Dr. Gershon Tenenbaum for inviting me to use the facilities and equipment of Florida State University and for his guidance throughout the writing process of this thesis. Without his valuable guidance and resources he made available to me, this work would not have been completed.

I am also indebted to Dr. Antonis Hatzigeorgiadis of the University of Thessaly for his advice and guidance in devising the methodology of the experiment conducted in this thesis work.

Finally, I would like to thank the staff of the Sports Psychology department of the University of Jyvaskyla, Especially Prof. Taru Lintunen and Dr. Montse Ruiz for the valuable assistance and encouragement in writing the thesis.

TABLE OF CONTENTS

ABSTRACT

Thesis in Sports and Exercise Psychology, Yonatan Sarig, 2017. The Effects of Instructional Self-Talk on Quiet Eye Duration and Performance. Faculty of Sports and Health Science. University of Jyväskylä. Master’s thesis, 63p.

While the literature on the effects of self-talk is comprehensive, a somewhat under-investigated subject is the underlying mechanisms of self-talk (Theodorakis, Hatzigeorgiadis & Chroni, 2008). As of late, the trend has been shifted towards researching what are the motivational and attentional constructs that are at the base of self-talk. Potentially, one such attentional construct is the quiet eye; the final gaze fixation on a target before the execution of task-oriented movement (Vickers. 1996). Since the duration of the quiet eye is found to be associated with better performance, and interventions aimed at prolonging the quiet eye are always sought after, the aim of this study was to investigate whether instructional self-talk can prolong the quiet eye duration and thus, improve performance.

Thirty participants (*M* = 24.37, *SD* = 4.99) that were novices in golf putting were recruited for the study. The participants took part in a golf putting trial, while half of them underwent a short-term instructional self-talk training using dart throwing. The quiet eye duration was measured using a SensoMotoric Instruments (SMI) eye tracker while performance was measured using the index of putting proficiency (Smith & Holmes, 2004). Results from a repeated measures ANOVA test indicated that instructional self-talk had a positive effect on quiet eye duration, with participants in the self-talk group showing longer post quiet eye durations. In addition, instructional self-talk led to better performance, with participants in the self-talk group scoring higher in the index of putting proficiency post intervention. However, Pearson product-moment correlation yielded no significant correlation between quiet eye duration and performance. Based on these findings it is possible to assume that the quiet eye period is an attentional underlying mechanism of self-talk and that instructional self-talk can be used as a tool in quiet eye training. Therefore, instructional self-talk might be considered as a potential tool in quiet eye training. Future research will need to determine if it will be applicable for sports other than golf.

Keywords: Instructional self-talk, Quiet eye, Golf putting, Dart throwing.

1 INTRODUCTION

Self-talk is considered a fundamental mental skill in sports and exercise psychology alongside with imagery, goal settings, relaxation techniques etc. (Burton & Raedeke, 2008). Indeed, it is not surprising that self-talk has attracted many researchers and practitioners in the field as can be seen by the vast research and numerous interventions the scientific literature has to offer (Hatzigeorgiadis et al., 2011). Self-talk is looked at through the scope of several dimensions; whether positive and negative self-talk (e.g. Dagrou, Gauvin, Halliwell, 1992) or motivational and instructional self-talk (e.g Theodorakis, Weinberg, Natsis, Douma & Kazakas, 2000). The literature in recent years has focused on instructional and motivational self-talk, and a matching hypothesis, pairing instructional self-talk with novel tasks and fine motor movement and motivational self-talk with learned tasks and gross motor movement, has been theorized and tested to an extent (Hatzigeorgiadis et al., 2011).

Surprisingly enough, while the effects of self-talk are wildly investigated, research about the underlying mechanisms of self-talk has been somewhat scarce. Even though, a growing trend of research is investigating the attentional and motivational mechanisms at the base of self-talk. The attentional research up to this date mainly focused on none sport tasks or indirect measurements (Galanis, Hatzigeorgiadis, Zourbanos, Papaioannou & Theodorakis, 2016). Direct measurements of attentional concepts associated with sports performance like the quiet eye period have yet to be tested in the context of self-talk.

Given the importance of quiet eye period, the final fixation on a target before the execution of a goal-oriented movement, on sports performance (Vickers, 1996), training interventions aimed at prolonging quiet eye duration are being widely used among athletes. Looking at the nature of quiet eye and self-talk, it can be hypothesized that the usage of self-talk might contribute to the duration of the quiet eye period. If an athlete tells himself to focus on the target before executing a movement, it could help the athlete focus his or her attention and avoid distractions, thus prolonging the quiet eye period and performing better.

2 LITERATURE REVIEW

2.1 Self-talk

Self-talk is considered a fundamental tool in cognitive-behavioral therapy. When it comes to changing the individual's cognitions and behaviors within cognitive-behavioral framework, it seems that self-instructional training, or self-talk, is very effective (Meichenbaum, 1977). Self-talk can be widely described as statements addressed to oneself, which influence attentional and appraisal processes, thus regulating behavior (Meichenbaum, 1977). Therefore, self-talk is described in the literature as a self-management tool (Rokke & Rehm, 2001). Indeed, self-talk has been found useful in acquiring new skills and enhancing performance in different contexts such as educational (Kamann & Wong, 1993), emotion and behavior regulation (Callicot & Park, 2003), and coping with pain (Sanders, shepherd, Cleghorn &Woolford, 1994), distress (Zastowny, Kirschenbaum & Meng, 1986) and psychological disorders (Kendall, 2006; Treadwell & Kendall, 1996).

Given the nature and apparent benefits of self-talk, the construct has attracted the attention of the sports community, and thus, many self-talk interventions can be found in sports and exercise literature (Hatzigeorgiadis et al., 2011). Self-Talk in sports context is defined as the use of explicit, verbal cues to evoke appropriate responses with the aim of facilitating learning and enhancing performance (Theodorakis et al., 2000). Indeed, Self-talk interventions have been implemented on a variety of motor tasks ranging from fine motor movement (Van Raatle, Brewer, Lewis, Linder, Wildman & Kozimor, 1995) to gross motor movement (Hamilton, Scott & MacDougall, 2007), and on different kinds of sports such as handball (Zourbanos, Hatzigeorgiadis, Bardas & Theodorakis, 2013), basketball (Perkos, Theodorakis & Chroni, 2002), water polo (Hatzigeorgiadis, Theodorakis & Zourbanos, 2004) and golf (Kornspan, Overby & Lerner, 2004).

2.2 Positive and negative self-talk

The early literature focused on the positive and negative dimensions of self-talk. Van Raatle et al (1995) used a dart throwing paradigm to test the effects of positive and negative self-talk on performance. To elicit the different dimensions of self-talk, participants in the positive and negative groups were asked to say "you can do it" and "you cannot do it" respectively, while participants in the control group were not asked to use self-talk statements. The results indicate that participants which used positive self-talk were significantly more accurate in the dart throwing trial than both the control and the negative self-talk groups. Yet, when asked about future dart throwing performance, the negative self-talk group showed higher expectations to perform better in the future. The results suggest that positive self-talk has greater impact on performance compared to negative self-talk, yet, negative self-talk can serve as a motivator.

An interesting finding regarding the aforementioned results came from another research investigating the effects of positive and negative self-talk on performance (Dagrou et al., 1992). The same dart throwing paradigm was used and the participants were asked to use positive or negative phrases before each throw. The following investigation was divided into 5 blocks of 10 throws, and angular errors of each throw were measured as an indication of performance, thus comparison of errors between blocks could indicate improvement. It was found that, as before, positive self-talk led to better performance, and in addition the angular errors of the positive self-talk group were decreased significantly faster than the errors of the control group. Moreover, the angular errors of the negative self-talk group did not significantly decreased between blocks. This suggests that although negative self-talk might be a motivator for future performance, it does not lead to an improvement in performance if used continuously while performing.

Indeed, a study using self-report questionnaires investigated the correlations between positive and negative self-talk and affect (Hardy, Hall & Alexander, 2001). The 90 high-school athletes that participated in the research reported the affect they feel before and during competitions and their use of positive and negative self-talk. Investigating the associations between affect and self-talk revealed a positive correlation between self-talk and affect, hence, negative self-talk was associated with negative affect while positive self-talk was associated with positive affect. In addition, negative self-talk was perceived as demotivating while positive self-talk was viewed as motivation. Yet, it should be stated that some of the participants associated negative self-talk with positive affect and motivation.

2.1.1 Instructional and motivational self-talk

It can be seen than in general, positive self-talk is associated with better performance and positive affect, but one should keep in mind that to some individuals negative self-talk can be beneficial as a motivator. With the evidence of the aforementioned and other research provided about positive and negative self-talk, different dimensions were established and became prevalent in the literature; instructional and motivational self-talk. Motivational Self-talk includes cues aiming at creating a positive effect, building confidence and goad the athlete, while instructional Self-talk uses cues meant to focus and direct attention, and provide instruction regarding techniques and skills (Hatzigeorgiadis et al., 2011). Given the different nature of the aforementioned self-talk dimensions, it is hypothesized that motivational and instructional cues will have different effects on performance. Specifically, the matching hypothesis suggests motivational Self-talk usage to be more efficient while performing learned power and endurance tasks which require gross motor movement, whilst instructional Self-talk is hypothesized to have greater effect on novel tasks which require fine motor movement (Theodorakis et al., 2000).

There is ample evidence in the literature when it comes to the benefits of instructional self-talk. Perkos, Theodorakis and Chroni (2002) implemented an instructional self-talk intervention in a local basketball academy. The participants were children novice to the game of basketball. The children underwent a 12 weeks instructional self-talk training which was embedded in their basketball practice. The self-talk training aimed at improving dribbling, passing and shooting skills, and the children were instructed to use instructional self-talk cues before performing each of the skills mentioned (e.g. “Fingers, target” for passing). During the 12 weeks period, the children performed tests 6 times to measure their skill acquisition. Compared to a control group that underwent the same training without the self-talk component, the experimental group showed significantly better improvement in both dribbling and passing. The finding that shooting performance did not differ could be attribute to the fact that the participants reported less usage of self-talk while shooting than while performing the other skills. These results give credit to the assumption that instructional self-talk improves skill acquisition when it comes to novel and fine motor movement tasks. Another research that strengthens this notion was performed using elementary school children as participants in a football shooting task. The participants underwent baseline measures, followed by a 2 days training, in which instructional self-talk was incorporated for the experimental group, and a final assessment. Same as before, participants in the experimental group showed better performance, and in fact, a relatively large effect size was recorded (d= 1.20), indicating the effectiveness of self-talk among young children, even though the intervention relatively was short (Zourbanos, Hatzigeorgiadis, Bardas & Theodorakis, 2012).

When it comes to comparing between instructional and motivational self-talk, an early study (Theodorakis, Weinberg & Kazakas, 2000) examined the effects of both domains on different tasks, specifically soccer skills test, badminton service test, a sit up test and a knee extension test. In all tests, the motivational group was instructed to say "I can" while performing and the instructional self-talk group was instructed to say a phrase concerning the technical nature of the task (e.g. "I see the target"; "Breath out") while a control group was not instructed to use cues. Results show that instructional self-talk significantly improved performance in both the soccer and the badminton tasks. In the sit up task, no significant difference was find between the three groups and in the knee extension test both self-talk groups performed significantly better than the control group. It can be seen that, in concurrence with the matching hypothesis, instructional self-talk was effective in the two fine motor tasks. Although, when it comes to the endurance task, the sit ups, self-talk did not have an effect, and furthermore, the power task determined that instructional and motivational self-talk did not differ. Hence, the dual hypothesis was partially supported.

Zourbanos, Hatzigeorgiadis, Bardas and Theodorakis (2013) conducted yet another study that partially supports the matching hypothesis. The study investigated the effects of both self-talk dimensions on a novel vs a learned task. The procedure used in this investigation was a handball overarm throw technique using dominant arm as the learned condition and nonodominant arm as the novel condition. The instructional self-talk group used the cue "ball-target" while the motivational self-talk group used the cue "I can". Data analysis revealed that when it comes to learned tasks, both self-talk dimensions did not differ, but while performing a novel task, instructional self-talk was more effective. This further supports the role of instructional self-talk in the matching hypothesis, yet fails to show the unique contribution of motivational self-talk while performing learned tasks.

On the other hand, the study of Zourbanos, Hatzigeorgiadis, Bardas and Theodorakis (2004) found a significant effect to motivational self-talk. The study used two water polo tasks to measure the effects of instructional and motivational self-talk. The first task was to throw the ball into a target which is considered a precision task, while the second task was to throw the ball to distance, a power task. Using the same self-talk interventions as mentioned in the previous study, the researchers discovered that motivational self-talk significantly improved the power task while both self-talk groups did not show significant differences in the precision task. This shows that when it comes tasks that involve gross motor movement, motivational self-talk might be more efficient than instructional self-talk. Contrary to previously mentioned research, in this study instructional self-talk was not found to be more effective when it comes to precision, fine motor movement task. It might be due to the nature of the task at hand, since in water polo the swimmer is not allowed to touch the bottom of the pool so he or she uses endurance that might impair the execution of fine motor movement.

Interestingly enough, swimmers that received self-talk training over the course of eight weeks seemed to relay more on motivational self-talk rather than instructional self-talk. In the following study, swimmers underwent a self-talk intervention in between two competitions to investigate whether embedding self-talk in their training regime will have a positive impact on their performance. During the self-talk training, participants were taught, and practiced both motivational and instructional self-talk, and by the end of the intervention they were asked to come up with their own self-talk cues that will be used during practice and competition. The vast majority of the swimmers chose to use motivational self-talk during the competition while three participants chose mixed cues of motivational and instructional self-talk, and only one participant used solely instructional self-talk. The self-talk users has shown better results in the competition compared to the baseline competition and compared to a control group. These results give some evidence to the notion that motivational talk might be useful while engaging in endurance performance, although one must keep in mind that motivational and instructional self-talk could not be compared given the nature of the investigation (Hatzigeorgiadis, Galanis, Zourbanos & Theodorakis, 2014).

In order to test the unique benefits of instructional and motivational self-talk, and to validate the matching hypothesis, Hatzigeorgiadis et al., (2011) performed a meta-analysis of a total of 32 studies in the field. The meta-analysis yielded that self-talk is more effective for tasks involving fine, rather than gross movement, and novel, rather than learned tasks. In addition, Instructional self-talk was found more effective when it comes to fine tasks while motivational self-talk showed no significant benefits in any given task. Therefore, the matching hypothesis was partially accepted, showing that instructional self-talk is beneficial while performing fine, novel tasks, while motivational self-talk did not show effectiveness when it comes to gross, learned tasks.

In addition to fine and novel tasks, the meta-analysis revealed other moderators that effect the effectiveness of self-talk interventions. Studies that used training interventions have yielded greater effect sizes than studies that used short term interventions. Meaning that the longer the self-talk training program was implemented, the more effective it was. Yet, it is important to note, that studies that used short interventions also yielded meaningful effect sizes, showing that self-talk might have immediate impact on performance as well. Also, interventions that gave the participants the choice of creating their own self-talk cues, and whether to use them overtly or covertly were more effective than interventions that failed to do so. In other words, giving the participants the liberty to choose what they will say to themselves and rather to say it in their minds or out loud is recommended (Hatzigeorgiadis et al., 2011).

2.4 Underlying mechanisms of self-talk

While an ample amount of research has been conducted in regards of the effects of self-talk on performance, investigating the possible underlying mechanisms of self-talk is still somewhat overlooked. Theodorakis, Hatzigeorgiadis and Chroni (2008) suggested five mechanisms that might be at the basis of self-talk; enhancing attentional focus, increasing confidence, regulating effort, controlling cognitive and emotional reactions, and triggering automatic responses. Hardy, Oliver and Todd (2009) categorized the possible underlying mechanisms of self-talk into two dimensions: a cognitive dimension referring to aspects such as information processing, attentional control and concentration, and a motivational dimension which includes self-efficacy, persistence and regulation of affective states.

2.5 Motivational underlying mechanisms

Although the subject has not yet been adequately explored, the current literature provide us with some direct and indirect evidence regarding the underlying mechanisms of self-talk. When it comes to motivational aspects of self-talk, a study investigated the effects of self-talk on self-efficacy among young tennis players. After an initial skill and self-efficacy assessment, using self-report questionnaires, the players went through three sessions of motivational self-talk training which included introduction, practice and building a self-talk program. Results indicate that not only the players trained in self-talk usage outperformed a subsequent control group, they also showed a more significant increase in self-efficacy (Hatzigeorgiadis, Zourbanos, Goltsios & Theodorakis, 2008).

In a similar manner, Zetou Vernadaki, Bebetsos and Makraki (2012) showed the same trend of self-efficacy and performance improvement using an instructional self-talk intervention on a volleyball service skill among young volleyball players. When comparing instructional and motivational self-talk and their effects on different softball tasks, Chang et al (2014) has shown that when it comes to accuracy tasks, instructional and motivational self-talk did not differ, yet when it comes to power tasks, motivational self-talk yielded better performance. Interestingly, the same patterns could be shown when it came to self-efficacy. While performing the accuracy tasks, motivational and instructional self-talk caused the same increase in self-efficacy, yet while performing the power task, participants using motivational self-talk reported higher levels of self-efficacy. These findings indicate that self-talk might improve performance by increasing self-efficacy, thus letting the athlete believe he can perform better.

Another potential motivational mechanism underlying self-talk might be anxiety regulation. Young tennis players, undergoing a motivational self-talk training, were measured for anxiety and self-confidence levels using a self-report questionnaire. After the baseline measurements and the self-talk training, participants were evaluated again for their return performance. Anxiety was induced by telling the players that only those who will show the most improvement will receive awards. As before, participants in the experimental group performed better, and in addition reported higher levels of self-confidence and lower levels of cognitive anxiety. Therefore, the results provide preliminary evidence of self-talk as a regulating tool for anxiety in competitive situations (Hatzigeorgiadis, Zourbanos, Mpoumpaki, & Theodorakis, 2009).

In addition to regulating anxiety, self-talk is believed to regulate effort, or in other words, increase persistence while performing endurance tasks. A study examining the effect of motivational self-talk on cycling endurance performance has shown that the self-talk group cycled for a longer amount of time while reporting lower amount of exhaustion during the task. Physiological variables that objectively measure exhaustion, such as facial electromyogram, heart rate and lactate concentration did not differ between the self-talk group and the control group during the test, meaning that participants were exposed to the same amount of exhaustion but the self-talk group perceived the test as last exhausting (Blanchfield, de Morree, Staiano & Marcora, 2014). Other experiment that used a cycling protocol revealed that the self-talk group exhibited greater power output and oxygen consumption, further showing that self-talk enhances persistence in endurance tasks (Hatzigeorgiadis, Bartura, Argyropoulos, Ziurbanos & Flouris, 2016).

2.6 Attentional underlying mechanisms

When it comes to attentional underlying mechanisms, a series of experiments tested the effects of Self-talk in three neuropsychological domains; the intensity, selectivity and spatial attention, using a Vienna Test System (Galanis et al., 2016). All three sets of experiments followed the same protocol which consisted of baseline measurements, followed by a 5 days of attention training using self-talk and a final assessment.

In the first set of experiments, the alertness; the ability to control and maintain arousal, and vigilance; the ability to direct attention to one stimulus for a long time, were tested using a combination of visual and audio tests, thus giving indication of the attentional intensity. The second set of experiments explored the attentional selectivity by testing the ability to ignore irrelevant stimuli (whether visual, audio or combination of both), and by testing the ability to respond to two or more simultaneously. The third set of experiments tested spatial attention by measuring the ability to focus attention in space using central cues, peripheral cues and neglect. Participants in the experimental groups of all experimental sets, who were using Self-talk were found to perform better in all three domains, which translated into faster reaction times, the ability to focus attention on target for a longer amount of time and ignore irrelevant stimuli (Galanis et al., 2016).

Self-talk may also help athletes to avoid distractions, whether internal or external. When it comes to internal distraction, the distracting stimuli comes from within (e.g thoughts), Hatzigeorgiadis et al., (2004) aforementioned water polo experiment has shown that both instructional and motivational self-talk reduced the occurrence of interfering thoughts, regardless of task characteristics (power vs precision). When it comes to external distractions, or stimuli that originate in the environment, two recent experiments provide important preliminary data. In a field experiment, basketball female players were tested on free throw shooting, and in a lab experiment, students were asked to play a video game. Both experiments used sudden, loud sounds to create distractions. Both studies show the same results, participants in the self-talk group avoided the distractions more effectively, thus performed better (Charachousi, Tsetsila, Tsimeas, Galanis & Hatzigeorgiadis, 2014; Galanis, Hatzigeorgiadis, Sarampalis & Sanchez, 2016).

Yet another attentional construct has been recently investigated in regard to self-talk. Mental effort is described as the amount of mental energy one has to draw in order to meet attentional demands for task processing (Kahneman, 1973). Galanis et al (2016) explored the impact of self-talk using eye-tracker to measure pupil dilation. The research design used computerized fine motor tasks under different conditions that involved distractors. The self-talk group had significantly lower pupil dilation then controls, suggesting that self-talk made them use less mental effort while performing the task.

While the aforementioned studies examining the attentional underlying mechanisms provide an important preliminary evidence of the neuropsychological basis of Self-talk, most of the research done to this point was either using none sports related tasks (e.g. the Vienna Test System) or using indirect measurements (self-report questionnaires). To this point, to the best knowledge of the writer, no investigation has been conducted measuring a direct neuropsychological measurement while performing a sports related task. Therefore, investigating the quiet eye period as an underlying mechanism of Self-talk can be beneficial for better understanding the works of Self-talk.

2.7 Quiet eye

The quiet eye period is the final fixation on a target before the initiation of a critical movement (Vickers, 1996). In order to perform accurate goal-directed movements, the motor system often relies on visual information. To perform movements as precisely as we can, we gather information from our environment using our eyes and, presumably, the more accurate and timely the information, the more accurate our movement will be (Land, 2009). Therefore, the quiet eye period is a crucial phase of information gathering, involving a top down attention, which might determine the quality of our movement. To reinforce that statement, a growing body of research investigating quiet eye has shown again and again that the longer the quiet eye duration, the better the execution of goal-directed movements (Mann, Williams, Ward & Janelle, 2007). In other words, the longer the gaze is focused on the target, the better the movement to manipulate the target will be performed.

Given the importance of the quiet eye period in executing quality movements, it is not surprising that this cognitive concept has attracted the attention of sports and exercise science. The importance of peak performing is imperative in sports, and most sports involve fixation on targets, whether stationary (e.g. Shooting, throwing darts, bowling etc.) or dynamic (e.g. football, basketball, hockey etc.). Indeed, sports and exercise research has been focusing more and more on quiet eye in recent years (Vickers, 2007). The quiet eye is offering a way to improve performance by focusing on the target for a longer duration right before the execution of the movement (Vickers, 2007). For that reason, it seems that the main trend of research has been the application of quiet eye training to improve performance (Vine, Moore & Wilson, 2014; Vine & Wilson, 2010).

2.8 Quiet eye antecedents

With that in mind, it seems that the field of the antecedents of quiet eye, or what is affecting the quiet eye period, has somewhat been overshadowed by the quiet eye training research. Therefore, it is imperative to try and identify the different aspects that might improve or disrupt the quiet eye period, regardless of quiet eye training. The notion of longer gaze fixation that results in better performance is appealing, yet there is a need to see what possible variables underline this seemingly straightforward interaction.

As mentioned, quiet eye is a part of information processing (Mann et al, 2007). Therefore, it will be risky to assume that longer quiet eye will lead to better performance without taking into account the amount of information being processed. To address this issue, a couple of trials using overhand throwing onto a target paradigm were conducted in which quiet eye period was manipulated by controlling the gazing and executing movement times of the participants (Klostermann, Krendel & Hossner, 2013).

The results of the first trial as shown that indeed, longer quiet eye period resulted in greater performance than shorter quiet eye periods. However, the second trial introduced the amount of information being processed as a mediating variable. In this trial, the target either appeared on the top of the wall, resulting in 100% predictability or, in the second condition, the target appeared to the left or right, resulting in 50% chance predictability. By this manipulation, information processing was controlled, as well as quiet eye period using the same method as the first trial. The results of the second trial revealed that longer quiet eye periods lead to better performance only when there is high information processing (high predictability), while quiet eye duration as no effect on performance in low information processing situations (Klostermann et al., 2013).

Given that the quiet eye period may affect performance in high information processing situations, it is imperative to explore what variables contribute to the length of quiet eye and the predictability from the information gathered during that period. To that effect, Causer, Bennet, Holmes, Janelle and Williams (2010) had performed an experiment measuring quiet eye durations in shotgun shooting. They recruited 24 elite shotgun shooters and 24 sub-elite shotgun shooters and measured their quiet eye duration in three shooting disciplines: Skeet; in which two targets are released simultaneously from positions known to the shooter, Trap; in which one target is released from a concealed trench, and Double Trap; in which two targets are being released from concealed trenches. The quiet eye was measured by the time the shooters' gaze was fixated on the moving target before shooting the shotgun.

The results show that, as expected, longer gaze fixations on target led to better performance, hence larger chance of hitting the target. This result falls in with aforementioned findings that indicated that quiet eye period is associated with better performance (Land, 2009). In addition, the research has found that elite shooters had longer quiet eye periods (and therefore, better performance) than sub-elite shooters. This shows that expertise, or mastery, has an effect on quiet eye period. Meaning, the more seasoned an athlete is, the longer his gaze fixation on target will be. An additional interesting finding is that elite shooters had slower and more stable gun displacement than their sub-elite counterparts. It might show that the experienced shooters were "using" their longer quiet eye period to calculate the trajectory and movement of both targets and bullets from the visual data they were receiving and their past experience, therefore, they were able to predict the target's movement. That reinforces the argument that in quiet eye period, top down attention is involved (Mann et al., 2007).

Yet another study has shown the importance of mastery on quiet eye period (Mann, Coombs, Mousseau & Janell, 2011). In this study, 10 expert and near-expert golfers performed 90 putting trials in which their quiet eye period was measured, as well as their cortical activity, or readiness potential (Bereitchaftspotential). The readiness potential is a negative cortical activation that indicates the preparatory period preceding task execution and is being measured by evoked-related potential (Jahanshahi & Hallett, 2003). As before, longer quiet eye periods were associated with better performance and a significant correlation between mastery and quiet eye was evident. Hence, Expert golfers showed significantly longer quiet eye periods than near-expert golfers, resulting in better performance of putting. In addition, Experts have shown more cortical negativity from near-experts before the execution of the putting movement. This evidence is supportive of the notion that experts have relatively more attention allocation to the visuomotor components of the task, and that they are probably retrieving information relative to the task from their memory (Mann et al., 2011)

Most importantly, quiet eye and readiness potential were closely associated. This strengthens Vickers' (1996) theory that quiet eye is a period of visual orientation and visuomotor preparation that affect the magnitude and latency of readiness potential. The correlation might help understand what the neuronal pathways underlying quiet eye are so this phenomenon could be understood in more depth.

To show how mastery is associated with longer quiet eye period in a setting different than sports, Vickers and Lewinski (2012) conducted a research among police officers. In this study, 11 policemen that belongs to the Emergency Response Team, which are considered experts because of their past experience, and 13 rookie policemen were introduced to a potentially lethal scenario in which they needed to use their handgun. In this scenario, a scripted argument between a man and a receptionist took place in the policeman's present. During the argument the man becomes agitated and violent. At the end of the scenario the man is pulling out a gun or a cellphone out of his pocket, in which time the policeman needs to make a choice whether to use his handgun or not, hence executing or inhabiting his behavior. Throughout the final stage of the scenario, the officer's gaze fixations were recorded and analyzed.

The results indicate that veteran officers (experts) were more effective at shooting accuracy, shooting speed and decision making (whether to shoot or not). In fact, the experts have shown only 18.2% of decision errors compared to the 61.5% decision errors of the rookies. The rookies and experts did not differ in time of drawing and firing their weapon, meaning that the experts had quicker reaction time and more anticipation of what's about to unfold. When exploring the gaze fixations of rookies and expert it is evidence that experts fixated their gaze on places where concealed weapons might be hidden while rookies fixated their gaze on non-weapon locations. Therefore, the expert quiet eye period on the weapon was longer and they could react faster and identify whether there is a threat or not (Vickers and Lewinski, 2012). This study differs from the previous ones by the fact that it introduces a very dynamic research environment in which the participant needs to be focused on several locations and he needs to make the correct decision in a limited amount of time with partial information. The main addition of this study, is that it shows that experts can focus their gaze on the target even in stressful situations, while their less trained counterparts are in a state of panic and can't focus on the target at hand.

Therefore, there is a base to believe that stress and anxiety might be antecedents that influence the quiet eye period. A research that tested the effect of anxiety on the quiet eye period indirectly used policemen shooting behavior as well (Nieuwenhuys & Oudejans, 2010). Seven police officers took part in the experiment. The officers were presented with low anxiety and high anxiety conditions that were counter balanced between them. In the low anxiety condition the policemen needed to shoot at a mannequin. The high anxiety condition involved shooting a live opponent who occasionally shot back using paintball cartridges. An anxiety questioner was administered after each of the conditions as manipulation check. Under high anxiety conditions, the policemen shooting accuracy significantly decreased by about 20%. While analyzing the response time of the policemen it was found that under high anxiety they tended to act faster, which might account to their lack of accuracy. Also, they reacted to the threat by disorienting and changing location in order to avoid the threat, which led to them facing away from the opponent. They also blinked significantly more under the high anxiety condition (Nieuwenhuys & Oudejans, 2010).

Although quiet eye was not directly measured in this study, it is safe to say that quiet eye period was shorter in the high anxiety trial because of the policemen behaviors. Facing away from the opponent to keep yourself safe and blinking more will lead to shorter gaze fixation times on the assailant. Therefore, as the researchers concluded, shorter quiet eye times might partially explain the results. Although the two aforementioned studies are not sport related per se, their results are relevant and applicable to sports. Many types of sports, if not all, involve internal or external pressure which will elevate the levels of stress and might lead to anxiety (Baumeister & Showers, 1986). Therefore, studies about quiet eye in stressful settings can be relevant to sports.

When it comes to sports, while anxiety levels are not as high as in life threating situations, there is ample evidence that it may still deteriorate performance. This phenomenon is usually referred to as “chocking” (Baumeister & Showers, 1986). To study the effect of chocking on quiet eye, Vine, Lee and Moore (2013) conducted a trial using a putting procedure. In this trial, 50 expert golfers took part in a putting session. After a familiarization phase, the golfers filled in an anxiety questioner to serve as a baseline measure. Then, they were asked to participate in a “shootout” putting task. A “shootout” means that the participant needs to hold as many balls as he can without missing and is considered a reliable and valid task to manipulate pressure among golfers under the assumption that with every successful putt, more pressure will be added to succeed in the next putt (Pelz, 2000).

The results revealed that the golfers experienced higher anxiety during the “shootout” phase than the baseline phase. In addition, the quiet eye period was significantly shorter on the last putt (the missed out) than on the previous putts (successful putts). Therefore, the researchers concluded that a state of anxiety is a factor that can shorten the quiet eye period and thus decrease performance. Increase state anxiety will draw attentional resources from the task at hand, which in turn lead to shorter quiet eye period and lesser performance (Vine et al., 2013).

The aforementioned articles provide evidence that stressful situations can evoke anxiety which will lead to shorter quiet eye period and low performance (Nieuwenhuys & Oudejans, 2010; Baumeister & Showers, 1986; Vine et al., 2013). Yet, not every situation that involves high arousal, as many situations in sports are, will impair the gaze fixation on target. The way that an individual evaluates the situation will have major effect on motor task performance as a whole, and specifically on quiet eye. To that effect, Moore, Vine, Wilson and Freeman (2012) recruited 127 participants to take part in yet another putting trial. This time, the high arousal was manipulated by stating that participants’ performance will be compared to others, participants that underperformed will be interviewed and a cash reward will be given to high-performers. The participants were randomly assigned to either a challenge group or a threat group, whereas the challenge group’s instructions were to meet the task as a challenge they should, and able, to overcome while the threat instructions focused on how difficult the task at hand will be. Emotions, putting kinetics, muscle activity, performance and gaze fixation behavior were recorded.

The challenge group showed more positive emotions (less anxiety), more efficient muscle activity and putting kinetics, better performance and longer quiet eye periods. Moore et al., (2012) argued that presenting the same high arousal task as challenging rather than threatening will result in high motivational state that will help focus attentional resources on the task. In other words, the state of arousal will be interpreted as positive (challenging) rather than negative (threatening) and the attentional impairment associated with anxiety will not occur. Specifically to this review, viewing a task as a challenge will result in longer gaze fixation on target that will help improve performance.

Considering another sports related situation that is highly arousing and representing a real-life situation, a research has been conducted using penalty kicks procedure while observing the gaze behaviors of goalkeepers. A penalty kick in football is a free kick awarded when a player is being fouled in the opponent team's box, in which he kicks the ball towards the goal from 11 meters while the goalkeeper is trying to save the ball getting inside the goal, and it is quite common in football games. Concerning the goalkeepers, it was found that more numerous gaze shifts were associated with failing to save the ball, while fixating on the visual pivot (the area between the ball and the kicking leg) or the ball was associated with successful saves. In addition, 40 of the 41 saves performed in this study occurred when the final fixation, or the quiet eye period, was on the visual pivot or the ball. This finding comes to show that in some situations the athlete should know to identify the target he needs to fixate on (Piras & Vickers, 2011). Unlike other types of sports mentioned in this review thus far, which have one clear target to focus on (e.g. shooting and putting), in sports like football there are several potential targets to fixate on, and the athlete needs to know which target will give him more information to process.

Yet, sometimes the athlete knows on which target he should focus on but he will end up focusing on an irrelevant target instead, which will ultimately lead to shorter quiet eye period on the relevant target and to poor performance. These occurrences are referred to as ironic effects, in which the athlete is doing the opposite of what was intended. To test the effect of ironic effects on quiet eye duration, a penalty kicks paradigm was used, using a recorded goalkeeper projected on a screen from a kicking player point of view. The participants were instructed to kick towards the screen and to avoid the goalkeeper "save" the kick. They were given one of the following 3 instructions: kick as accurate as you can, kick as accurate as you can but be careful not to kick within the range of the goalkeeper (not-keeper condition) or kick as accurate as you can and be careful to shoot into the open space (open-space condition). The results show that the "not-keeper" condition made the participants focus more on the goalkeeper and less on the open space they are about to kick the ball into, thus causing an ironic effect. This caused less fixation on the open space target and impaired the accuracy of the kicks, while on the other conditions the quiet eye period was longer and performance was better (Binsch, Oudejans, Bekker & Savelsbergh, 2010). Hence, in some cases knowing that he or she needs to avoid gazing at an irrelevant target will make the athlete focus on it more on the expanse of quiet eye quality on the relevant target.

In other cases, fixation on the wrong target could be a result of wrongly interpreting environmental cues. Using penalty kicks, Wood and Wilson (2010) inspected the gaze behavior of 18 football players under two conditions: Firstly, high and low threat conditions by promising the players large sums of money for succeeding scoring (high threat) or not giving any money stipulation (low threat). Secondly, they introduced a distraction condition in which the goalkeeper was asked to wave his arms before the kick, and a no distraction condition in which the goalkeeper was asked to stand still. The results reveal that unlike previous studies, the level of threat was not effecting quiet eye period and performance. Yet, distraction was found to significantly decrease both quiet eye period on the relevant target (the open space were the player is intended to kick) and performance, causing the players to kick more frequently to the middle of the goal, thus making it easier for the goalkeeper to save the kick (Wood & Wilson, 2010). The players tended to focus on the waving goalkeeper for longer period of times, impairing their final fixation on target. Therefore, it can be derived that regardless of anxiety levels, distraction from the environment might cause an athlete to focus his attention on irrelevant information, thus affecting his quiet eye period and information processing.

2.9 Quiet eye and self-talk

As it can be seen from the previous review, Self-talk might provide crucial attentional focus that can be beneficial to quiet eye duration, whether by serving as a reminder to athletes to keep their focus on target, thus directing their attention (Galanis et al., 2016), prolonging the final gaze fixation in stressful situations (Hatzigeorgiadis, 2009) and/or help athletes avoid distraction and “keep their eyes on the prize” (Charachousi et al., 2015; Galanis et al., 2004). With that in mind, it can be speculated that the quiet eye might be an attentional underlying mechanism of Self-talk, hence, that giving explicit, verbal cues to oneself might help the athlete fixate on target for a longer period of time, thus improving performance. In fact, the link between Self-talk and quiet eye period as already been naturally established, perhaps inadvertently, in several quiet eye interventions that used Self-talk cues as reminders of fixating on target (e.g. Vine & Wilson, 2011).

Perhaps the most important indirect evidence linking quiet eye and self-talk comes from the study of Bell and Hardy (2009) that investigated the effects of self-talk on internal and external focus of attention. Focus of attention can be internal, meaning the athlete is focused on his own body movement, or external, meaning the athlete is directing his or her focus on objects relevant to the task. In this study, participants were explicitly asked to focus their attention whether internally; on their own body movement, proximally externally; on the tip of the golf club, or distally externally; on the ball, while performing a golf putting trial. In addition, participants were randomly selected into a self-talk experimental group and a control group.

Results indicated that besides the main effect of self-talk on performance, the self-talk group under the distal external attention condition performed better than the other attention focus groups. In other words, participants that used self-talk to help them focus on the ball, instead of on their body movement or the club, performed better (Bell & Hardy, 2009). Although quiet eye duration was not directly measured, it can be seen that when instructed to use self-talk cues to focus on the golf ball resulted in better results. One can argue that the focus of attention on the ball caused a longer quiet eye period on the relevant target, therefore enhancing performance.

3 PURPOSE OF THE STUDY

Therefore, the aim of the current investigation was to examine whether Self-talk will affect quiet eye duration, and thus performance, while performing a sport related task, golf putting. The Self-talk cue that was used in the current research was instructional in nature, given the evidence which shows the effectiveness of instructional Self-talk while performing novel tasks that involve fine motor movement (Hatzigeorgiadis et al., 2011). Hypothesis 1 was that the usage of Self-talk cues will lead to longer quiet eye durations. Hypothesis 2 was based on existing literature (Hatzigeorgiadis et al., 2011), and predicted that self-talk will lead to better performance. Hence, participants undergoing the instructional Self-talk intervention will show longer quiet eye duration and score better in a golf putt trial than participants in the control group, which will undergo golf putting training without the instructional Self-talk element. Hypothesis 3 was that quiet eye duration will be positively correlated with performance, has been reported widely in the literature (Mann, Williams, Ward & Janelle, 2007).

4 METHODS

4.1 Ethics

The current research proposal was approved by the Florida State University's Institutional Review. The research was deemed by the board a "minimal risk research" given its non-invasive and non-deceptive nature. All data collected from the participants remained anonymous throughout every stage of the research, from data collection to data analysis. All the data was digital and was protected under the researcher's personal username and password. The researcher was the only person with access to the data. Participants were explained about the nature of the study and what is asked of them upon arrival. Participants were informed both orally and in written form that they may stop the research at any point of time if they feel uncomfortable without any implications. Before leaving the lab, the participants were given a brief debriefing about the research aims. Participants were given the researcher's and the head of department's contact info in case they had any questions or concerns after they left the lab.

4.2 Participants

A convenient sample of 30 participants was recruited from Florida State University. The participants were either approached by the researcher and asked to take part in the research, or recruited from the Florida State University participant pool to gain one credit. The participants were students with no, or little prior experience in golf putting. The participants were between the ages of 19 - 37, and 17 of the participants were male, and 13 female (see Table 1 for demographic details).

Table 1- Demographic information

N(30)	**Overall**	**Self-talk group (N=15)**	**Control Group (N=15)**
Age in years M (SD)	24.37 (4.99)	25.27 (5.05)	23.47 (4.93)
Gender N (%)			
Male	17 (56.7)	9 (60)	8 (53.3)
Female	13 (43.3)	6 (40)	7 (46.7)
Ethnicity N (%)			
White	19 (63.3)	10 (66.7)	9 (60)
Asian	1 (3.3)	1 (6.7)	0 (0)
Hispanic	7 (23.3)	3 (20)	4 (26.7)
Black	3 (10)	1 (6.7)	2 (13.3)
Education N (%)			
Freshman	1 (3.3)	1 (6.7)	0 (0)
Sophomore	4 (13.3)	1 (6.7)	3 (20)
Junior	5 (16.7)	1 (6.7)	4 (26.7)
Senior	6 (20)	4 (26.7)	2 (13.3)
Graduate	11 (36.7)	6 (40)	5 (33.3)
Other	3 (10)	2 (13.3)	1 (6.7)
Major N (%)			
Sports science	17 (56.7)	8 (53.4)	9 (60)
Psychology	8 (26.6)	6 (40)	2 (13.3)
Other	5 (16.7)	1 (6.7)	4 (26.7)

4.3Apparatus

SensoMotoric Instruments (SMI) eye tracker was used to measure the quiet eye duration. This device utilizes two features: the pupil and corneal reflection to calculate point of gaze at 60 Hz. A circular cursor, representing 1 degree of visual angle with 4.5 mm lens, indicating location of gaze in a video image of the scene was viewed by the researcher in real time using a Samsung Galaxy 4S, installed with iView ETG software, directly plugged to the eye tracker. Recorded data was then transferred to a computer located in the lab (Alienware) installed with BeGaze 3.7 eye movement analyzing software, using a Secure Digital (SD) 64 gigabytes drive. The data was then viewed and analyzed by the researcher on the computer screen or on a laptop screen (HP envy x360) proximally connected to the lab's computer.

Apple iPad pro touchpad device installed with iOS 10.2 and a wifi connection to the internet was used to digitally collect participants' informed consents, health and demographic data, performance measurements and manipulation checks data (see instrumentation).

4.4 Instrumentation

Quiet Eye Period. The quiet eye period was measured using the SensoMotoric Instruments (SMI) eye tracker. Quiet eye period is operationally defined as the final fixation towards the golf ball prior to the initiation of the backswing (Vickers, 2007). quiet eye onset occurred before the backswing, and quiet eye offset occurred when the gaze will be deviated off the fixated object by 1 degree or more for more than 100 ms. A fixation was defined as a gaze maintained on the golf ball within 1 degree of visual angle for a minimum of 100 ms (Moore, Vine, Cooke, Ring & Wilson, 2012).

Performance Outcome. Smith and Holmes (2004) index of putting proficiency was used in the current study. According to the index, five points are awarded to putts that entered hole, three to putts that hit the lip of the hole but failed to go in (with control over their pace), two points to putts that went past the hole (with control over their pace) and one point to putts that finished short of the hole.

Manipulation Check. A manipulation check for the use of self-talk was administered to the participants after the completion of the measurements. Participants in the experimental group were asked (a) to indicate on a 10-points scale the degree to which they used the instructed cue (1 - not at all, 10 - all the time), (b) to report whether they used any other cue, (c) if so, what was the cue, and (d) if so, the degree in which they used this other cue (1 - not at all, 10 - all the time; see appendix 1). Participants in the control group were asked (a) to report whether they were thinking of something specific during the execution of the task, (b) if so, what thoughts?, and (c) if so, to what degree they used this cue (1=not at all, 10=all the time; see appendix 2). This manipulation check was reported to be a reliable and valid tool to measure self-talk use (Zourbanos, Hatzigeorgiadis, Bardas & Theodorakis, 2013).

General Health and Lifestyle Questionnaire (GHLQ; British Colombia Department of Health, 1975). A modified version of the GHLQ was administered in order to assess the participants' ability to perform the required protocol tasks. The questionnaire consists of an item about the participants' dominant arm, followed by 8 yes/no items on coronary and cardiovascular conditions. If a participant answered positively to one of the items he was prompted to elaborate on his or her condition. The questionnaire also included the item "do you have any problem squeezing a handgrip". The GHLQ has been wildly used in sports science investigations (e.g. Razon et al., 2010; see appendix 3).

Demographic Information. The form obtained basic demographic information including: gender, age, ethnicity, grade level, major and whether the participant is a professional or semi-professional golf player. The latter served as an exclusion criteria (see appendix 4)

4.5 Manipulation

Following the self-talk training protocol of Hatzigeorgiadis, Zourbanos and Theodorakis (2007), participants in the experimental or Self-talk group underwent a brief explanation about the use of instructional Self-talk focusing on what is self-talk, when and why to use it, giving an example of the use of Self-talk while throwing darts. What refers to which Self-talk cue will be used, giving an example of the word "focus" or "target". When refers to the timing in which the cue should be used, specifically in dart throwing, right before the throw. Why refers to the reason the cue is used, in the following example to remind the participants to focus their gaze on the target (see appendix 5).

The explanation was followed by a dart throwing trial consisting of 10 sets of 3 consecutive dart throws, in which the participants were asked to use an instructional Self-talk cue before each throw. The participants were given a choice whether to use the Self-talk cue given in the example or to create their own Self-talk cue, and whether to use the Self-talk cue overtly or covertly In accordance with Hatzigeorgiadis et al., (2011) meta-analysis. At the end of the dart throwing procedure, the participants were asked to transfer the use of instructional Self-talk to the golf putting trial, using the “what, when, why” method and be given an example as of how to apply instructional Self-talk in golf.

The example focused on maintaining eye contact with the golf ball before and during the putt. The cues in the example were “focus” and “ball”, it was used before the start of the swinging motion and the cue’s purpose was to remind the participants to keep their focus on the ball before engaging in the putt procedure. Once again, the participants were given a choice to use one of the examples as a cue or to create a cue of their own, and whether to use the cue overtly or covertly. The Control group underwent the dart throwing trial without the instructional Self-talk training. Each participant conducted a dart throwing trial of 10 sets of 3 consecutive dart throw.

4.6 Procedure

Prior to the experiment all questionnaires and performance outcome formats were uploaded to Qualtrics Survey Software website to create a digital format of all the necessary documentation. In addition, prior to the participants’ arrival, the lab was prepared for collecting data using a premade protocol (see appendix 6). The participants arrived to the sports psychology lab at Florida State University’s Department of Education. Upon arrival, participants were briefed they are about to take part in an experiment measuring their eye movement during a putting trial and they filled out an informed consent form (see appendix 7), the General Health and Life Type Questionnaire and their demographic information digitally using the iPad device. The participants were familiarized with the standard length (90cm) golf club and the distance from which they performed the putt (3 meters). Then, the participants were given technical instructions on how to putt, considering Pelz’s (2000) protocol with minor modifications. The protocol involved the following instructions: (1) take your stance with your legs shoulder width apart, (2) set your position so that your head is directly above the ball looking down, (3) keep your club-head square to the ball, (4) allow your arms to remain loose, (5) the putting action should be pendulum-like, making sure that you accelerate through the ball, (6) after contact, follow through but keep your head still and facing down, and (7) try to keep your eyes on the ball throughout the putting movement. While the Pelz (2000) protocol is comprised of the first 6 instructions, the 7^{th} instruction was added by the researcher to emphasize the importance of keeping the gaze fixated on the ball while putting. The instructions were given both orally and in a printed form (see appendix 8).

The participants then started the familiarization stage, in which they performed 10 putts, aiming at putting the ball into a circular mark 10.8cm in diameter illustrating a golf hole, while reviewing the instructions. After they got familiarized with the technical movement of putting, the participants were fitted and calibrated with the eye tracker, following the calibration protocol (see appendix 6). These adjustments were followed by another short familiarizing session of 5 putts in which the participants got accustomed to putting with the eye tracker and the researcher observed that the equipment is working properly. The researcher then located himself at the side of the putting green to minimize distractions and the data was recorded to subsequent analysis. After the participants were familiarized with the putting procedure, the baseline measurement took place. The participants performed 2 sets of 10 consecutive putts in which their quiet eye period and the performance scores were recorded digitally using the iPad device (see appendix 9).

Upon completion of the baseline measure, each participant was assigned to a control or experimental group. Participants in the experimental group underwent the manipulation procedure (see manipulation section). The control group performed a dart throwing trial without the instructional Self-talk components. Following the dart throwing trial, the participants took part in another 2 sets of 10 putts session in which their quiet eye period and performance were measured again. Before the putting session, the experimental group was asked to use an instructional Self-talk cue during the trial. After the session, the administration of the aforementioned manipulation check took place and debriefing was then followed.

4.7 Data analysis

A frame-by-frame analysis was conducted to determine the quiet eye period duration in accordance with the stipulations presented in the tools section. In addition, a sum of the putts scores of both baseline and post intervention was calculated to represent the level of performance using the scoring system of Smith and Holmes (2004). An average score for individual putts was then calculated for both quiet eye duration and performance. SPSS 20 was used to analyze the data. Two 2 x 2 (group x time) repeated measures ANOVAs with quiet eye duration and performance as dependent variables were performed to test the study's first and second hypotheses, hence, to examine rather instructional self-talk improved quiet eye duration and putting performance. A Pearson correlation test with the variables quiet eye duration and performance was performed to test the third hypothesis, examining the correlation between quiet eye duration and performance. In order to examine group differences in baseline measurements for quiet eye duration and performance, two independent t-tests were performed. Results reveal no significant baseline differences between the self-talk group and the control group in both quiet eye duration $t(28) = .33$, $p = .75$, and performance $t(28) = -.25$, $p = .81$. Data were tested for normality for quiet eye duration ($p = .116$) and performance ($p = .20$).

5 RESULTS

The manipulation checks means and standard deviations showed participants in the self-talk group made adequate use of self-talk (*M* = 9.6, *SD* = .74). Regarding the control group, no indication of systematic self-talk use was reported (*M* = 1.6, *SD* = .51). Therefore, all of the participants were included in the subsequent analyses.

In order to examine group differences in irrelevant demographic variables, Preliminary tests show no difference between the self-talk group and the control group in gender $\chi^2(1, N = 30) = .14$, p=.71, ethnic or racial group $\chi^2(3, N = 30) = 1.53$, $p = .68$, grade level $\chi^2(5, N = 30)$=4.89, $p = .43$, dominant hand $\chi^2(1, N = 43) = 0$, $p = 1.00$, and age $t(28)$= .99, $p = .33$

To examine the main research hypothesis, a 2x2 (group x time) repeated measures ANOVA with quiet eye duration as the dependent variable was conducted. Results indicate a main effect for time $F(1, 28) = 31.35$, $p < .001$, *partial* $\eta^2 = .53$, meaning that participants had a significantly longer quiet eye durations in the post-intervention measurement (*M* = 11.09, *SD* = 10.85) than in the baseline measurement (*M* = 18, *SD* = 15.37). In addition, a main effect for group was found significant $F(1, 28) = 4.9$, $p = .03$, *partial* $\eta^2 = .15$, hence participants in the self-talk group (*M* = 19.19, *SD* = 12.25) showed longer quiet eye durations than participants in the control group (*M* = 9.9, *SD* = 10.65). The main effects were overshadowed by an interaction effect of time x group $F(3, 28) = .41.71$, $p < .001$, *partial* $\eta^2 = .6$. A post hoc Bonferroni test reveals that the source of the interaction is that participants in self-talk group showed significantly longer quiet eye durations (*M* = .26.62, *SD* = 15.43) than participants in the control group (*M* = .9.37, *SD* = 9.59) during the post-intervention measurement (see Figure 1).

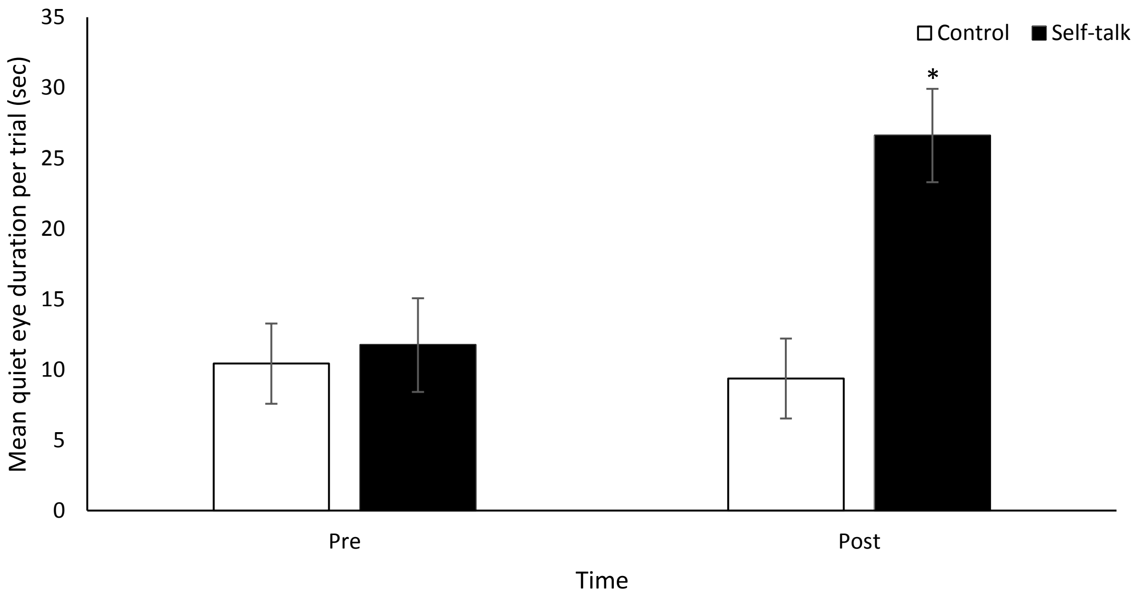

Figure 1. Comparisons of quiet eye duration means between the self-talk and control groups, pre and post intervention. *p<.001

To examine the second research hypothesis, a 2x2 (group x time) repeated measures ANOVA with performance as the dependent variable was conducted. Results indicate a main effect for time $F(1, 28) = 30.60$, $p < .001$, *partial* $\eta^2 = .523$, meaning that participants performed significantly better in the post-intervention measurement ($M = 56.9$, $SD = 8.46$) than in the baseline measurement ($M = 51.67$, $SD = 8.73$). The main effect was overshadowed by an interaction effect of time x group $F(3, 28) = 13.72$, $p = .001$, *partial* $\eta^2 = .33$. A post hoc Bonferroni test revealed that the source of the interaction is that participants in self-talk group performed significantly better post intervention ($M = 60$, $SD = 8.75$), than participants in the control group ($M = 53.8$, $SD = 7.15$) that did not show significant improvement post intervention (see figure 2).

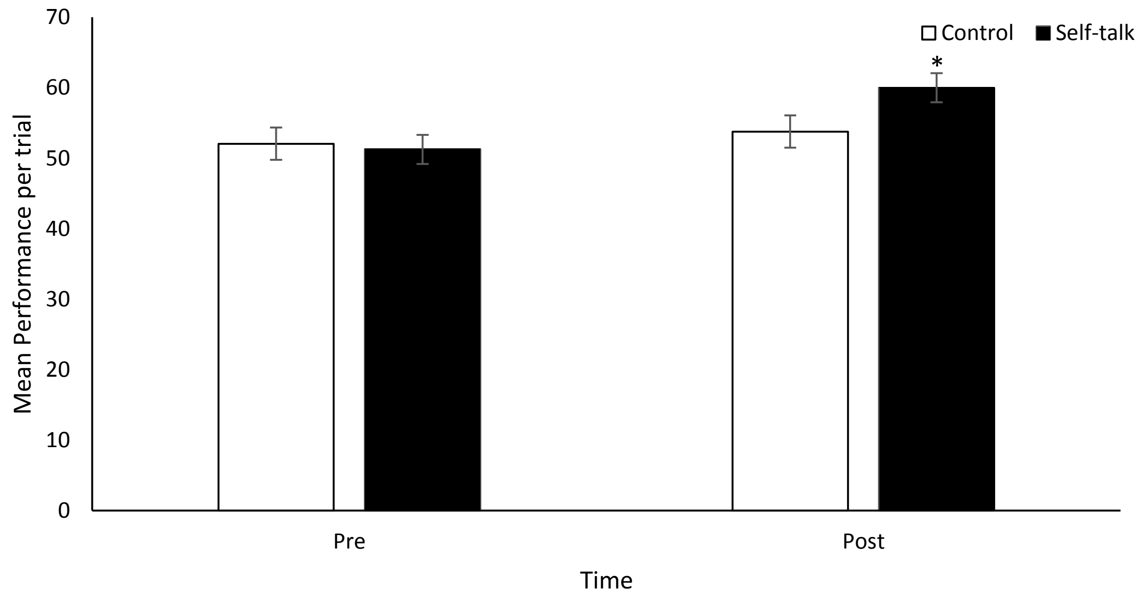

Figure 2. Comparisons of performance means between the self-talk and control groups, pre and post intervention. *p = .001

To examine the third research hypothesis a Pearson product-moment correlation coefficient was computed to assess the relationship between quiet eye duration and performance. Results reveal a nonsignificant correlation $r(28)=.09$, $p=.64$, hence putt average quiet eye duration was not correlated with putt average put performance (see Figure 3).

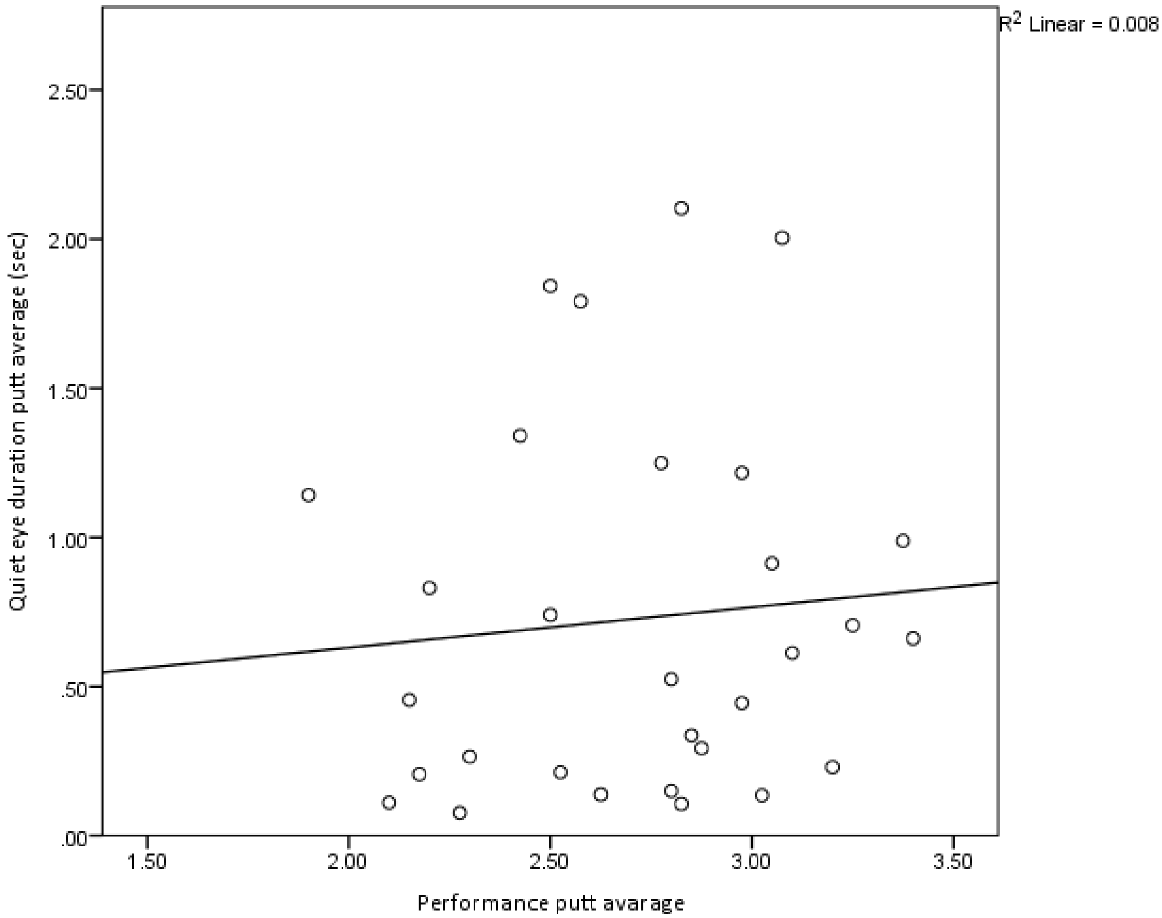

Figure 3. Scatterplot of quiet eye duration and performance avereges.

6 DISCUSSION

The main aim of the current investigation was to explore the effect of instructional self-talk on the quiet eye period while performing a novel task that includes fine motor movement. In addition, the investigation was directed to reproduce findings in the literature that link instructional self-talk with performance (Hatzigeorgiadis et al., 2011) and quiet eye duration with performance (Mann et al., 2007). Indeed, the current experiment yielded that the usage of instructional self-talk led to longer quiet eye durations and better performance, yet the link between quiet eye duration and performance failed to be established.

When it comes to the main hypothesis, the current investigation demonstrates that the quiet eye period might be an underlying attentional-cognitive mechanism of self-talk. As well established in the literature, self-talk is associated with better performance (Hatzigeorgiadis et al., 2011), yet the reasons of why self-talk is effective in enhancing performance are yet to be adequately explored. While research found several attentional and cognitive mechanisms that might be at the base of self-talk (Galanis et al., 2016), these findings were established by either using indirect measurements or not using sports related tasks. The current investigation tried to address these issues and to investigate an attentional-cognitive mechanism using a direct measurement while performing a golf putting task.

In fact, quiet eye is considered the first step in decision making, in which the athlete gathers visual cues from the environment and somatic cues from his or her body, and using the information processed in order to decide how to execute a goal-oriented movement (Vickers, 2007). Hence, the current research’s findings show that instructional self-talk can have a positive effect on decision making even from the earlier stage of information processing from the environment and the self. An athlete performing a new task while using verbal cues to be reminded of where to focus his or her gaze will prolong the quiet eye duration. Longer quiet eye duration will in turn lead to better quality information processing and better decision making, thus better execution of a movement.

Visual input is of the utmost importance when it comes to sports as it serves as the first step for anticipation and eventually decision making (Williams, Davids & Williams, 1999). Therefore, self-talk might serve as a powerful tool in order to increase the quality and quantity of processed visual intake by reminding the athlete what he should focus is attention on and when, especially when it comes to newly acquired skills in which the motor programming is not yet automatic (Allard & Starkes, 1991).

In the current investigation, self-talk was also found to have a positive effect on performance. This finding falls in line with evidence provided in the literature about the benefits of self-talk usage, and more specifically that instructional self-talk is effective when it comes to performing novel and fine motor tasks (Hatzigeorgiadis et al., 2011). The aforementioned finding provides further partial support to the matching hypothesis and shows that the use instructional self-talk is recommended when acquiring new motor skills (Theodorakis et al., 2000).

Yet, contrary to the literature, the current investigation failed to establish a link between quiet eye duration and performance. As mentioned, quiet eye is positively linked with performance, hence the longer the quiet eye period's duration, the better the performance (Mann et al., 2007). In the current study, the link has failed to materialize. There are several reasons that might cause the failure to link quiet eye and performance in the current study. Firstly, because of the way the data was analyzed, the total sums of quiet eye durations per trial were extracted and not per putt. Therefore, an average was calculated for putt quiet eye duration by dividing the trials' sum by the number of putts and the same procedure was performed to the performance scores. Therefore, a correlation between averages was investigated, and not correlation of actual durations and scores. Previous studies usually used a single-subject analysis to investigate the values of each putt separately (e.g. Mann et al, 2011). A single-subject analysis investigated the correlation between quiet eye and performance separately and might have yielded better results if performed in the current study. The fact that on average participants' quiet eye duration was not linked with performance does not necessarily means that such link between quiet eye and performance did not exist.

In addition, while the participants in the current study were novices, different levels of golf putting expertise should be taken into account. The exclusion criteria was pro or semi-pro golfers, yet there is a wide range of experience in golf putting within novice golfers. Participants in the study could range from recreational golfers with prior knowledge of putting and total beginners who never performed a putting task before. The different levels of expertise could have contributed to the lack of correlation between quiet eye and performance. As a recent meta-analysis showed, while the quiet eye period has a major contribution to performance, this contribution is accounted to approximately 25%. Meaning, that only a quarter of the performance can be explained by longer quiet eye durations (Lebeau et al., 2016). The rest can be attributed to skill, mastery, talent etc. It may very well be that the different golf putting experience participants had in the current study overshadowed the unique contribution of the quiet eye period.

Moreover, when it comes to novices, prolonging the quiet eye duration might not immediately be translated to better performance, since they are still learning the movement and are inconsistent with their performance. Needless to say that keeping the eye on the ball is just one phase in performing a putt (Pelz, 2000) and that other elements in the execution of the putting movement might have contributed to the results more than the quiet eye durations. While a future investigations can address these issues by devising more rigorous inclusion and exclusion criteria, the researcher of the current investigation can fall back on the vast evidence linking quiet eye and performance and safely assume that the correlation was not apparent because of the aforementioned research design issues.

While considering the current research’s findings, some methodological and conceptual limitations need to be addressed. When it comes to research design, a sample size of 30 participants, while being sufficient to support the main research hypothesis according to the power analysis that was conducted, is considered rather small and is raising some external validity issues. The focus on students as participants, and recruiting students mainly from sports courses or sports programs, also limits the generalization of the findings and may raise some construct validity issues as well, since some of the participants might have underwent, or even conducted similar studies, hence they might had a preconceived notion as to what the aims of the research were. Given that participants were mainly recruited by either volunteering or through the Florida State University participant pool to gain credits, it might be assumed that participation was due to sheer interest or due external motivation. Since the participants were not questioned as of what is the reason for their participation in the study, it cannot be determined if such constructs as motivation to participate effected the results, as there is ample evidence in the literature of motivation effect on performance (Deci & Ryan, 2010). Future studies might avoid these limitations by using bigger, more diverse samples and by enquiring for the reasons of participation.

Yet another limitation in the current study is the lack of double blind design. While the researcher tried to keep randomization between the experimental groups by interchangeably assigning participants into the self-talk or the control group (first participant to the self-talk group, second into the control group etc.), inevitably, the researcher was aware of to which group each participant was assigned to. While the researcher kept to the protocol and script, researcher bias cannot be completely ruled out. As shown in the literature, when the researcher is aware of the participants' experimental condition, it can lead to subconscious bias that might cause the participants to predict what is expected from them (Wood et al., 2008). In the current study's case, the researcher tone of voice, comments, body language and other factors might inadvertently encouraged participants in the self-talk group to perform better, whilst hinting to the control group to put less effort into the putts, thus creating a participant bias.

The alleged researcher bias might have influenced the way performance was measured in the current study. While the index of putting proficiency (Smith and Holmes, 2004) is a straightforward and instructive scoring system (see methods section), it still leaves some room for subjectivity and interpretation of the rater. The index leaves room for interpretation especially with the instruction "with control over the pace" since it is hard sometimes to determine whether the participant had control over the putt. Since, as mentioned, the study lacked double blind design, the researcher's scoring might have been affected by his desire to see significant results. In addition, the researcher was conducting data collection by himself, therefore there was no inter-rater reliability procedure with another research assistant. The fact that instead of a hole the green surface had a circle representing a hole contributed to the subjectivity of the scoring since whether the putt ended up with the ball entering the hole was also open to interpretation and prediction. These limitations might have affected the results encoded by the researcher.

The aforementioned limitations can be addressed in the future by creating a more strict, double blind procedures in which the researcher will not know to which experimental group each participant belongs to. It can be achieved by training research assistants to conduct the manipulation and collecting data while being blind to other experimental conditions. Moreover, if the index of putting proficiency is to be in future research, it is recommended that the putts will be scored by two independent raters to increase the reliability of the scoring. Also, Alternative and more objective measures of putting performance might be used in future research. For instance, the usage of a grid system as part of a motion analysis system. This technology was used in Mann et al (2011) putting experiment, in which a grid is projected over the green surface after each stroke and the score is given in accordance to the distance from the hole, might serve as a more objective way of scoring the result of each putt.

In addition, the same technology could be used for other measurements of performance. It has been suggested that when it comes to novel skills acquisition, using knowledge of performance; the way the skill is performed, can be a viable measurement of performance (Weeks & Kordus, 1998). Therefore, future research can determine how performance is effected by self-talk using knowledge of performance measurements as well as, or instead of knowledge of results measurements. Motion analysis technology can provide that data. The movement of the participant can be analyzed, scored and be used as a feedback on what needs to be improved or corrected (Barris & Button, 2008).

When it comes to conceptualization limitations, the current study used Vicker's (1996) definition of quiet eye, the final gaze fixation before the execution of a goal-oriented movement. While this definition is used in several quiet eye golfing experiments (e.g. Mann et al., 2011), some use contradictory, or more extensive definition. Prior research has conceptualized quiet eye in golf as the gaze fixation on the ball prior to the stroke, during the stroke and after the stroke (Vickers, 2007; Wilson & Pearcy, 2009). It is hypothesized that while the gaze fixation prior to the stroke, or pre-quiet eye, as measured in the current study, is related to motor preparation and information processing. The gaze fixation during (or online quiet eye) and after (or dwell quiet eye) are related control over the movement (Vickers, 2007). A shift in attention from the ball in the later stages is potentially disrupting and might lead to poor contact with the ball (Vine, Moore & Wilson, 2011). Therefore quiet eye may serve another function other than mere pre-programming of movement (Oudejans, van de Langenberg & Hutter, 2002; Panchuk & Vickers, 2009).

Indeed, research as shown that the putting action is continuously being adjusted while it is being performed, after the initial pre-quiet eye before the execution of the movement (Coello, Delay, Nougier & Orliaguet, 2000; Craig, Delay, Grealy & Lee, 2000). In addition, a basketball study has shown that players prefer late visual information, rather than early predictive information as a guide for their movement (Oudejans et al., 2002). Moreover, there is evidence that anxiety is more disruptive while executing a movement rather than before the execution of the movement, showing that even after the pre-quite eye stage there may be factors that will effect performance (Lawrence, Khan & Hardy, 2012). A recent research confirms this and shows that failure in execution, or choking, is related to shorter quiet eye duration during the execution of the movement, or online quiet eye, rather than shorter per-quiet eye duration (Vine et al., 2013).

While taking into consideration the broader, more comprehensive conceptualization of quiet eye that includes gaze fixations during and after the execution of the movement, future research should take into account a more holistic measurement of quiet eye. Instead of just measuring the gaze fixation prior the execution of the movement, subsequent measures of online quiet eye and dwell quiet eye should be taken into consideration while looking into the effects of self-talk and this cognitive-attentional mechanism.

Therefore, consideration of the different dimensions of self-talk might be in order while conducting future investigations. Since online quiet eye seems to be more susceptible to stress and anxiety (Vine et al., 2013), and self-talk literature shows that motivational self-talk is an effective technique to regulate anxiety (Hatzigeorgiadis et al., 2009) it will be beneficial to investigate if there is a different effect to the motivational and instructional dimensions of self-talk on the different stages of quiet eye. Future research, with both motivational and instructional self-talk interventions might help determine the unique benefits the different types of self-talk have on the quiet eye period, and implementation of self-talk interventions could differ depending on the desired outcome. It might be that instructional self-talk is effective in the pre-quiet eye period and thus helps with the information processing and better preparation for the movement, whilst motivational self-talk could be effective on the late stages of quiet eye and thus contributes to the control over the movement during the execution. This could be the line of future investigations.

With these limitations in mind, it can be concluded that the quiet eye period is a possible underlying attentional mechanism of self-talk. Using instructional verbal cues, whether overtly or covertly, can increase the duration of the quiet eye period as well as improve performance. The current investigation has shown that using instructional self-talk is a viable strategy to help the athlete prolong the quiet eye period and to increase the performance when it comes to learning and acquiring a new skill, at least when it comes to closed sports like golf.

Despite the fact that quiet eye duration was not linked with better performance in the current study, this might be due to the issues and limitations mentioned above, and there is ample evidence in the literature that is establishing the link between the two. Therefore, it can be recommended to use instructional self-talk to serve as a reminder on what environmental cues the athlete should focus visual attention on in order to increase the duration of the quiet eye period.

Given the increased interest in and growing popularity of interventions aimed to train athletes to increase their quiet eye durations (Vickers, 2007) it is the researcher recommendation that instructional self-talk will be included in such interventions as a tool to help and prolong the quiet eye period. Such interventions will help to establish the ecological validity of the current investigation's findings and will help established more valid and reliable intervention protocols for quiet eye training. Because of the versatility of self-talk, such interventions could be adjusted and practiced in different type of sports and even be used as a tailored made quiet eye training programs for athletes on an individual level.

This investigation also shades light on the attentional mechanisms that are working when an athlete is using self-talk, and further investigations in the future, in the lines recommended by the researcher above, might help to paint a clearer picture about the mechanisms at the base of self-talk and how it effects the different levels of information processing, anticipation, decision making and even the feedback received after the execution of the movement.

7 REFERENCES

Allard, F., & Starkes, J. L. (1991). Motor-skill experts in sports, dance, and other domains. *Toward a general theory of expertise: Prospects and limits*, 126-152.

Barris, S., & Button, C. (2008). A review of vision-based motion analysis in sport. *Sports Medicine*, *38*(12), 1025-1043.

Baumeister, R. F., & Showers, C. J. (1986). A review of paradoxical performance effects: Choking under pressure in sports and mental tests .*European Journal of Social Psychology*, *16*(4), 361-383.

Bell, J. J., & Hardy, J. (2009). Effects of attentional focus on skilled performance in golf. *Journal of Applied Sport Psychology*, *21*(2), 163-177.

Binsch, O., Oudejans, R. R., Bakker, F. C., & Savelsbergh, G. J. (2010). Ironic effects and final target fixation in a penalty shooting task. *Human Movement Science*, *29*(2), 277-288.

Blanchfield, A., Hardy, J., de Morree, H. M., Staiano, W., & Marcora, S. M. (2014). Talking yourself out of exhaustion: Effects of self-talk on perceived exertion and endurance performance. Medicine and Science in Sport and Exercise, 46, 998-1007.

British Columbia Department of Health (1975). The physical activity readiness questionnaire: Validation report for the 1975 modified version. Vancouver, BC: Author.

Burton, D., & Raedeke, T. (2008). Sport psychology for coaches. *International Journal of Sports Science and Coaching, 3*, 291-292.

Callicott, K. J., & Park, H. (2003). Effects of self-talk on academic engagement and academic responding. *Behavioral Disorders, 29*, 48–64.

Causer, J., Bennett, S. J., Holmes, P. S., Janelle, C. M., & Williams, A. M. (2010). Quiet eye duration and gun motion in elite shotgun shooting. *Med Sci Sports Exerc*, *42*(8), 1599-1608.

Chang, Y. K., Ho, L. A., Lu, F. J. H., Ou, C. C., Song, T. F., & Gill, D. L. (2014). Self-talk and softball performance: The role of self-talk nature, motor task characteristics, and self-efficacy in novice softball players. Psychology of Sport and Exercise, 15, 139-145.

Charachousi, F., Christodoulou, E., Gourgoulias, K., Galanis, E., & Hatzigeorgiadis, A. (2015). Increase in internal focus of attention as a factor explaining the effectiveness of self-talk strategies Proceedings, 23rd International Congress of Physical Education and Sport,(p. 89), Komotini, Greece.

Coello, Y., Delay, D., Nougier, V., & Orliaguet, J. P. (2000). Temporal control of impact movement: the time from departure control hypothesis in golf putting. *International Journal of Sport Psychology*, *31*(1), 24-46.

Craig, C. M., Delay, D., Grealy, M. A., & Lee, D. N. (2000). Guiding the swing in golf putting. *Nature*, *405*(6784), 295-296.

Dagrou, E., Gauvin, L., & Halliwell, W. (1992). [The effects of positive, negative and neutral self-talk on motor performance]. *Canadian journal of sport sciences= Journal canadien des sciences du sport*, *17*(2), 145-147.

Deci, E. L., & Ryan, R. M. (2010). *Self determination*. John Wiley & Sons, Inc..

Galanis, E., Hatzigeorgiadis, A., Zourbanos. N., Papaioannou, A., & Theodorakis, Y. (2016). Self-talk and attention. Manuscript submitted for publication.

Galanis, E., Hatzigeorgiadis, A.,Sarampalis, A., &Sanchez, X.(2016).Aneffortless-attention interpretation of self-talk effectiveness: A look through the eye-tracker. Manuscript in preparation.

Hamilton, R. A., Scott, D., & MacDougall, M. P. (2007). Assessing the effectiveness of self-talk interventions on endurance performance. *Journal of Applied Sport Psychology*, *19*(2), 226-239.

Hardy, J., Hall, C. R., & Alexander, M. R. (2001). Exploring self-talk and affective states in sport. *Journal of Sports Sciences*, *19*(7), 469-475.

Hardy, J., Oliver, E., & Tod, D. (2009). A framework for the study and application of self-talk in sport. In S.D. Mellalieu & S. Hanton (Ed*.), Advances in applied sport psychology: A review*(pp. 37-74). London: Routledge.

Hatzigeorgiadis, A., Bartura, K., Argyropoulos, C., Zourbanos, N., & Flouris, A. (2016). A psychophysiological approach to the effectiveness of self-talk for endurance performance in the heat.Manuscript submitted for publication.

Hatzigeorgiadis, A., Galanis, E., Zourbanos, N., & Theodorakis, Y. (2014). Self-talk and competitive sport performance. *Journal of Applied Sport Psychology*,*26*(1), 82-95.

Hatzigeorgiadis, A., Theodorakis, Y., & Zourbanos, N. (2004). Self-talk in the swimming pool: The effects of self-talk on thought content and performance on water-polo tasks. *Journal of Applied Sport Psychology*, *16*(2), 138-150.

Hatzigeorgiadis, A., Zourbanos, N., Galanis, E., & Theodorakis, Y. (2011). Self-talk and sports performance a meta-analysis. *Perspectives on Psychological Science*, *6*(4), 348-356.

Hatzigeorgiadis, A., Zourbanos, N., Goltsios, C., & Theodorakis, Y. (2008). Exploring the functions of self-talk: The mediating role of self-efficacy on the self-talk performance relationship in young tennis players. The Sport Psychologist, 22, 458-471

Hatzigeorgiadis, A., Zourbanos, N., Mpoumpaki, S., & Theodorakis, Y. (2009). Mechanisms underlying the self-talk – performance relationship: The effects of self-talk on self-confidence and anxiety. Psychology of Sport & Exercise, 10, 186-192.

Hatzigeorgiadis, A., Zourbanos, N., & Theodorakis, Y. (2007). An examination on the moderating effects of self-talk content on self-talk functions. *Journal of Applied Sport Psychology*, *19*, 240-251.

Jahanshahi M, Hallett M (2003) The Bereitschaftspotential: what does it measure and where does it come from. In: Jahanshahi M, Hallett M (eds) The Bereitschaftspotential: movement related cortical potentials. Kluwer Academic/Plenum Publishers, New York, pp 1–17.

Kahneman, D. (1973).Attention and effort. Engelwood Cliffs, NJ: Prentice Hall.

Kamann, M. P., & Wong, B. Y. L. (1993). Inducing adaptive coping self-statements in children with learning disabilities through self-instruction training. *Journal of Learning Disabilities, 26*, 630–638.

Kendall, P. C. (2006). Guiding theory for therapy with children and adolescents. In P. C. Kendall (Ed.), *Child and adolescent therapy: Cognitive-behavioral procedures* (3rd ed., pp. 3–32). New York: Guilford Press.

Klostermann, A., Kredel, R., & Hossner, E. J. (2013). The "quiet eye" and motor performance: Task demands matter!. *Journal of Experimental Psychology: Human Perception and Performance*, *39*(5), 1270.

Kornspan, A. S., Overby, L., & Lerner, B. S. (2004). Analysis and performance ofpre-performance imagery and other strategies on a golf putting task. *Journal of Mental Imagery*, *28*, 59-74.

Lebeau, J. C., Liu, S., Sáenz-Moncaleano, C., Sanduvete-Chaves, S., Chacón-Moscoso, S., Becker, B. J., & Tenenbaum, G. (2016). Quiet Eye and Performance in Sport: A Meta-Analysis. *Journal of Sport and Exercise Psychology*, *38*(5), 441-457.

Land, M. F. (2009). Vision, eye movements, and natural behavior. *Visual neuroscience*, *26*(01), 51-62.

Lawrence, G. P., Khan, M. A., & Hardy, L. (2013). The effect of state anxiety on the online and offline control of fast target-directed movements. *Psychological research*, *77*(4), 422-433.

Mann, D. T., Coombes, S. A., Mousseau, M. B., & Janelle, C. M. (2011). Quiet eye and the Bereitschaftspotential: visuomotor mechanisms of expert motor performance. *Cognitive Processing*, *12*(3), 223-234.

Mann, D. T., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology*, *29*(4), 457.

Michenbaum, D. (1977). Cognitive-behavior modification: An integrative approach. *Nueva York: Plenum*.

Moore, L. J., Vine, S. J., Cooke, A., Ring, C., & Wilson, M. R. (2012). Quiet eye training expedites motor learning and aids performance under heightened anxiety: The roles of response programming and external attention.*Psychophysiology*, *49*(7), 1005-1015.

Oudejans, R. R., van de Langenberg, R. W., & Hutter, R. V. (2002). Aiming at a far target under different viewing conditions: Visual control in basketball jump shooting. *Human movement science*, *21*(4), 457-480.

Panchuk, D., & Vickers, J. N. (2009). Using spatial occlusion to explore the control strategies used in rapid interceptive actions: Predictive or prospective control?. *Journal of Sports Sciences*, *27*(12), 1249-1260.

Perkos, S., Theodorakis, Y., & Chroni, S. (2002). Enhancing Performance and Skill Acquisition in Novice Basketball Players With Instructional ST. *Sport Psychologist*, *16*, 368-383.

Pelz D (2000) *Putting Bible: the complete guide to mastering the green*. Publication Doubleday, New York.

Piras, A., & Vickers, J. N. (2011). The effect of fixation transitions on quiet eye duration and performance in the soccer penalty kick: instep versus inside kicks. *Cognitive processing*, *12*(3), 245-255.

Raalte, J. L. V., Brewer, B. W., Lewis, B. P., Linder, D. E., Wildman, G., & Kozimor, J. (1995). Cork! The effects of positive and negative self-talk on dart throwing performance. *Journal of Sport Behavior*, *18*(1), 50.

Razon, S., Basevitch, I., Filho, E., William, L., Thompson, B., Biermann, M., Tenenbaum, G. (2010). Journal of Imagery Research in Sport and Physical Activity.

Rokke, P. D., & Rehm, L. R. (2001). Self-management therapies. In K. S. Dobson (Ed.), *Handbook of cognitive-behavioral therapies* (pp. 173–210). New York: Guilford Press.

Smith, D., & Holmes, P. (2004). The effect of imagery modality on golf putting performance. *Journal of Sport and Exercise Psychology, 26*, 385–395.

Theodorakis, Y., Hatzigeorgiadis, A., & Chroni, S. (2008). Self-Talk: It works, but how? Development and preliminary validation of the Functions of Self-Talk Questionnaire. Measurement in Physical Education & Exercise Science, 12, 10-30.

Theodorakis, Y., Weinberg, R., Natsis P., Douma, E., & Kazakas, P. (2000). The effects of motivational versus instructional ST on improving motor performance. The Sport Psychologist, 14, 253–272.

Treadwell, K. R. H., & Kendall, P. C. (1996). Self-talk in youth with anxiety disorders: States of mind, content specificity, and treatment outcome. *Journal of Consulting and Clinical Psychology, 64,* 941–950.

Vickers, J. N. (1996). Visual control when aiming at a far target. *Journal of Experimental Psychology: Human Perception and Performance*, *22*(2), 342.

Vickers, J. N. (2007). *Perception, cognition and decision training: The quiet eye in action*. Champaign, IL: Human Kinetics.

Vickers, J. N., & Lewinski, W. (2012). Performing under pressure: Gaze control, decision making and shooting performance of elite and rookie police officers. *Human movement science*, *31*(1), 101-117.

Vine, S. J., Moore, L., & Wilson, M. R. (2011). Quiet eye training facilitates competitive putting performance in elite golfers. *Frontiers in psychology*, *2*, 8.

Vine, S. J., Moore, L. J., & Wilson, M. R. (2014). Quiet eye training: The acquisition, refinement and resilient performance of targeting skills. *European Journal of Sport Science*, *14*(sup1), S235-S242.

Vine, S. J., Lee, D., Moore, L. J., & Wilson, M. R. (2013). Quiet eye and choking: Online control breaks down at the point of performance failure. *Medicine & Science in Sports & Exercise*, *45*(10), 1988-1994.Vine, S. J., & Wilson, M. R. (2010). Quiet eye training: effects on learning and performance under pressure. *Journal of Applied Sport Psychology*, *22*(4), 361-376.

Vine, S. J., & Wilson, M. R. (2011). The influence of quiet eye training and pressure on attention and visuo-motor control. *Acta Psychologica*, *136*(3), 340-346.

Weeks, D. L., & Kordus, R. N. (1998). Relative frequency of knowledge of performance and motor skill learning. *Research Quarterly for Exercise and Sport*, *69*(3), 224-230.

Williams, A. M., Davids, K., & Williams, J. G. P. (1999). *Visual perception and action in sport*. Taylor & Francis.

Wilson, M. R., & Pearcy, R. C. (2009). Visuomotor control of straight and breaking golf putts. *Perceptual and Motor Skills*, *109*(2), 555-562.

Wood, L., Egger, M., Gluud, L. L., Schulz, K. F., Jüni, P., Altman, D. G., ... & Sterne, J. A. (2008). Empirical evidence of bias in treatment effect estimates in controlled trials with different interventions and outcomes: meta-epidemiological study. *Bmj*, *336*(7644), 601-605.

Wood, G., & Wilson, M. R. (2010). A moving goalkeeper distracts penalty takers and impairs shooting accuracy. *Journal of Sports Sciences*, *28*(9), 937-946.

Zastowny, T. R., Kirschenbaum, D. S., & Meng, A. L. (1986). Coping skills training for children: Effects on distress before, during, and after hospitalization for surgery. *Health Psychology*, *5*, 231–247.

Zetou, E., Vernadakis, N., Bebetsos, E., & Makrari, E. (2012). The effect of self-talk in learning the volleyball service skill and self-efficacy improvement

Zourbanos, N., Hatzigeorgiadis, A., Bardas, D., & Theodorakis, Y. (2013). The effects of self-talk on dominant and non-dominant arm performance on a handball task in primary physical education students. *The Sport Psychologist*, *27*, 171-176.

Appendix 1: Manipulation check for self-talk group:

Please indicate on a 10-points scale the degree to which they used the instructed cue (1 - not at all, 10 - all the time): ___________

Did you use any other cue? ☐ No ☐ Yes

If so, what was the cue?

____

If so, please indicate on a 10-point scale the degree to which you used the other cue (1 - not at all, 10 - all the time): _______

Appendix 2: Manipulation check for control group

Were you thinking of something specific during the execution of the task? ☐ No ☐ Yes

If so, what thoughts? ____

If so, please indicate on a 10-point scale the degree to which you used that cue (1=not at all, 10=all the time): ________

Appendix 3: The General Health and Life Type Questionnaire (GHLQ)

Dominant hand: ☐ Right ☐ Left

Time:

Please answer the following questions to the best of your knowledge about yourself. Check below any medical conditions, treatments or problems that concern you.

HAVE YOU RECENTLY HAD:

__Y / N___ Chest pain

__Y / N___ Shortness of breath upon exertion

__Y / N___ Heart palpitations

__Y / N___ Cough on exertion

__Y / N___ Cough up blood

__Y / N___ Swollen, stiff, or painful joints

__Y / N___ Dizziness

__Y / N___ Lightheadedness

__Y / N___ Fainting

__Y / N___ Back Problems

__Y / N___ Gastrointestinal disturbances (nausea, vomiting, diarrhea, abdominal pains)

Please explain any conditions you checked above:

____

_____

Please describe your present medical condition and anything we should be aware of concerning your health:

____

_____

Date of last physical examination: ________________________________

Do you have any problem squeezing a handgrip? ☐ Yes ☐ No

If Yes, please describe:

____

____

I certify that my responses to the foregoing questionnaire are true, accurate, and complete.

Signature: ___________________________ Date: ___________________

Appendix 4: Demographic Information

1) Age: __________

2) Gender: ☐ Male ☐ Female

3) What ethnic group or racial group do you belong to or identify with the most?

☐ White (not of Hispanic origin) ☐ Black (not of Hispanic origin)

☐ Hispanic ☐ Native American or American Indian

☐ Asian or Pacific Islander ☐ Some other group: Please specify

☐ Don't know

4) What grade level are you in school:

☐ Freshman

☐ Sophomore

☐ Junior

☐ Senior

☐ Graduate

☐ Other: ___________________

6) What is your major? ____

7) Are you playing, or played in the past, golf professionally or semi-professionally?

☐ Yes ☐ No

Appendix 5: Instructional Self Talk explanation

Self-talk refers to any verbal cues we are giving ourselves, whether out loud or in our mind, while performing a task. We will use self-talk to keep us focused on the task, remind ourselves what we need to do, to calm ourselves, to keep us motivated and so on. Athletes tend to use self-talk cues for the aforementioned purposes and research has shown that the use of self-talk can improve performance. When we want to use self-talk we need to ask ourselves 3 questions: What, when and why?

What refers to content of the Self-talk cue you will be using, when refers the timing we will be using the cue and why refers to the purpose we are using the Self-talk cue. Let us take dart throwing for example. In dart throwing you want to focus on the center of the target because a hit closer to the center will give you more points. So, if you want to use Self-talk to improve your dart throwing you might use the word “focus” or “target” as a cue. You will need to say it to yourself right before you are throwing the dart because this will remind you to focus on the center of the target, as you can see in this example:

What	When	Why
“Focus”	Just before the throw	To focus on the center of the target

Now, try using a cue to keep you focused on the center of the target while throwing darts. You can use the cue from the example or make up your own cue. You can also decide whether to say the cue out loud or say it to yourself.

Appendix 6: Quiet-eye Study Protocol

Before you begin you must be sure that the Putting green is correctly placed, the Eye-tracker and the iPad are working properly.

Lab set-up

1. Remove all the tables from the lab (including the TV table next to the door).
2. Take the eye tracker briefcase (metallic briefcase inside the grey cabinet), and calibration board (under the ET cart) out of that area (before you stack all the chairs) and then put all the chairs towards the cabinets or outside.
3. Try to clear as much space as possible in the center of the lab.
4. Make sure that a non-adjustable chair is near the participant's area (she/he needs to sit down for calibration and breaks).
5. Hang the darts target on the designated wall and see that all the darts are accounted for
6. Qualtrics Informed consent and Demographic questionnaire. Connect the iPad to the wifi and go to the following link http://idc.az1.qualtrics.com/SE/?SID=SV_d7ox49ItcODj9u5 via email or by typing it manually
7. Have a Word document open and ready if you need to take notes.

Putting green:

1. *Unpack the putting green. There are two big boxes containing the 2 foam layers that make up the putting green.*
    a. *When unpacking and rolling out the lhmayers, start from the wall and roll it to the door.*
2. *Start by unpacking the bottom layer (the smaller box), the box should have a sign of "Bottom". This layer has "normal" foam on both sides. Extend it on the whole length of the lab. This layer is a little bit longer than the lab, so make sure that the excess it's against the entrance of the lab. (Try to have the door clear so you can open and close it).*

3. *Unpack the "Green" box. This layer has one side of "normal" foam and the other side has a texture. Make sure that the grain texture is on top. On the "normal" side of the upper layer there is an arrow next to a label. Make sure that the label is in the end towards the wall and the 'Fast' arrow is pointing towards the wall, away from the entrance door.*
4. *Align the green against the back wall of the Lab.*
5. *Align both layers and make sure that the "alignment" holes are in the right position (you may have to turn around the 'bottom' layer).*
6. *sproperly aligned and the grain has the correct orientation.*
7. *As long as the putting green looks good and with no waves, leave it as it is. The layers were not cut perfectly, so you'll see that it doesn't match perfectly.*
8. *Make sure that there are no "waves" on the green.*
9. *Clean the green, especially the center of the green.*
10. *Double-check that the putting green is correctly assembled and you are done with this set-up.*

SMI Eye-tracker:

1. *Take the whole glasses case. Remove from the case: The eye tracking glasses, the Non-shaded glasses and both nose-rests (blue and red).*
2. *Take out the Samsung Galaxy out of the case and make sure it and the eye-tracking battery attached to it are charged and the SD card is inserted.*
3. *Charge the backup batteries*
4. *Place the non-shaded glass on the eye-tracker. Be careful, try to slide the glass into both corners and slightly bend to secure the middle part. Make sure that the scene's camera hole is correctly aligned.*

Do the following steps while the participant is finishing the paperwork so the ET doesn't overheat.

5. *Connect the eye-tracker cable to the Samsung Galaxy. Make sure that it's connected on an SS USB port.*

6. *Wait for a minute (the drivers need to be installed and running,).*
7. *The 'iView ETG' program will automatically open.*
8. *ETG is ready (you should see the eye-tracker live).*

Do the following steps in order to calibrate the eye tracker

9. *Choose the pre-created folder "ST quiet eye" to save the recordings into that folder*
10. *Press "run" and "participant name" to define the number of the participant and whether the recording is the pre-intervention or post intervention by writing "pre" or "post" respectively.*
11. *Press the "calibrate" button and then the "3 points calibration" protocol*
12. *Ask the participant to focus on the first mark, to the upper right side of the board, see if the eye tracker dot is aligned with the mark and adjust it if needed. Tap the screen to calibrate*
13. *Do the same with the second mark, at the upper left side of the board, and the third on the lower center of the board.*
14. *Press the red "record" button to start recording the session*

Appendix 7: informed consent

Florida State University Quiet-Eye Behaviors in Golf

The purpose of this research is to better understand shot gaze behaviors in golf. Your participation in this study is strictly voluntary and there are no consequences if you decide not to participate in the study or if you decide to withdraw at any point. This study is being conducted under the supervision of Dr. Gershon Tenenbaum of the Department of Educational Psychology and Learning Systems. During this study, you will be asked to play three rounds of putting while you are wearing eye-tracker glasses. While engaging in the task your gaze behavior will be analyzed by the camera directed at your eyeball. In addition to playing golf, your participation will be ask to complete a dart throwing trial. Although it is not expected, you may feel some discomfort by the eye-tracking glasses or symptoms of dizziness may occur. If any of these conditions arise, please inform the researcher and your participation in the study will stop. You may stop participating in the research project at any point in time. You can also be assured that all answers to questions, surveys and videos will be kept confidential to the extent allowed by law. Responses to the demographic form, questionnaires, and videos will be stored in a secure personal portfolio and destroyed on July 15, 2017. In addition, all identifying information on the demographic form filled out for the purpose of this study will be removed from the researcher’s copy of the demographic form. Participants’ responses will only be identified by a randomly assigned identification number. Results of the study may be published, but your name will not appear on any of the results. In addition, individual responses will be combined with group findings for reporting purposes. Although there are no direct benefits to your participation in the study, your participation will aid in the advancement of research on gaze behaviors in sports like golf. If you have any further questions please contact me, Yonatan Sarig, at Sajonatan@gmail.com or Dr. Gershon Tenenbaum (850) 644- 8663 or by email at gtenenbaum@fsu.edu. If you have any questions about your rights as a participant in this, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Vice President for the Office of Research at (850) 644-7900 or by email at humansubjects@fsu.edu. Please indicate whether you understand the risks and benefits associated with the present study? Please check Yes or No. Please describe one of the benefits associated with this study:

____

____

____

____

I have read the information in this consent form and agree to participate in this study. I have had the chance to ask any questions about this study, and they have been answered for me. Although the investigator will make every effort to maintain confidentiality, I understand the research records must be available to FSU's IRB, if they are requested. Printed

Signature____

Date____

Appendix 8: Golf putting instructions:

(1) Take your stance with your legs shoulder width apart,

(2) set your position so that your head is directly above the ball looking down,

(3) keep your club-head square to the ball,

(4) allow your arms to remain loose,

(5) The putting action should be pendulum-like, making sure that you accelerate through the ball,

(6) After contact, follow through but keep your head still and facing down, and

(7) Try to keep your eyes on the ball throughout the putting movement.

Appendix 9: Putting performance worksheet:

5 points- entered hole; **3 points-** hit the lip of the hole but failed to go in (with control over their pace); **2 points-** past the hole (with control over their pace); **1 point-** finished short of the hole.

Familiarization 1:

____ + ____ + ____ + ____ + ____ + ____+ ____+ ____ + ____ + ____

Familiarization 2:

____ + ____ + ____ + ____ + ____

Pre:

____ + ____ + ____ + ____ + ____ + ____+ ____+ ____ + ____ + ____

____ + ____ + ____ + ____ + ____ + ____+ ____+ ____ + ____ + ____

Post:

____ + ____ + ____ + ____ + ____ + ____+ ____+ ____ + ____ + ____

____ + ____ + ____ + ____ + ____ + ____+ ____+ ____ + ____ + ____