EXAMINING THE ROLE OF PRESSURE AND ATTENTION IN GOLF DRIVING DISTANCE AND ACCURACY

by

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(Under the Direction of Patrick O'Connor)

ABSTRACT

A number of studies have shown that an external focus of attention is beneficial for learning and performing golf skills, but golf driving is less researched. This experiment examined the interaction of a pressure and focus of attention intervention on golf driving performance. Volunteer golfers (n=30) with a handicap index < 15 were block randomized to focus either internally (n=14) or externally (n=16) and tested in both low- and high-pressure conditions. Drive carry distance and accuracy were measured with the Flightscope Mevo+. No statistically significant main or interaction effects were found via 2x2 ANOVA for pressure or focus of attention for either performance outcome. It was concluded that in contrast to results from prior studies of golf putting and chipping, neither attentional focus, pressure, nor the combination of the two influence how far or straight a sample of experienced, above average golf performers hit the golf ball with the driver.

INDEX WORDS: attention, pressure, performance, golf, driving

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DEDICATION

I would like to dedicate this paper to my friend, Jaeho Yoon, a kind soul and friend who I hoped I would be able to celebrate this moment with. Rest in peace, while we carry on your legacy.

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First and foremost, I would like to thank my family for their unwavering support of me as I have pursued multiple degrees at this great university. To my loved ones, your support is the reason I have made it this far. I would also like to thank those who have facilitated my academic growth, from Dr. Jay Hegdé's initial tutelage to Dr. Philip Tomporowski's motor skill expertise and thought-provoking questions to Dr. Bryan McCullick's willingness to venture into Exercise Psychology to provide insight on the sport world. To my fellow students—Em Kern, Mattie Gibson, Uthra Balamurugan, and Leila Huffman-- who have helped my complete this project, thank you for your time and dedication. To Clinton Udell, Matt Peterson, and the rest of the staff at the golf course, thank you for allowing us to use your facilities which made this study possible. And finally, to my advisor, Dr. Patrick O'Connor, thank you for your faith in me and all of the time you have spent conferring your knowledge to help me succeed in the world. I would not be at this point without your support and generosity, and I hope to pay it forward across my career.

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CHAPTER 1

INTRODUCTION

The golf swing is a motor skill that contains characteristics of both closed loop and open loop skills. The backswing is a full body movement that takes from about 0.75 seconds to more than 1.00 second to complete, representing the closed loop part of the circuit[1,2]. The downswing is much quicker: there is approximately a 3:1 ratio of backswing to downswing. The downswing contains less of a cognitive component, representing the open loop part of the circuit. In an individual who has practiced enough for the golf swing to become a well-learned skill, there is little conscious processing during routine skill execution. This is because the brain develops a motor program; that is, a pre-planned sequence and timing of the muscle activations needed to complete the golf drive movements[3].

One phenomenon in performing motor skills, often during competition, is performance decrements, that are sometimes labelled as "choking"[4]. Even though a well-learned skill is typically executed with consistency and minimal flaws, at times, for certain individuals, the skill is suddenly performed with much greater variability, often associated with psychological "pressure". Pressure has been defined as "any factor or combination of factors that increase the (perceived) importance of performing well on a particular occasion (p. 610)"[4]. It is thought that some people are more susceptible to pressure. The potentially relevant individual difference variables include personality traits, such as trait anxiety and self-consciousness, mood states such as state anxiety and confidence, and cognitive processes such as an internal versus an external attentional focus[5,6]. Research has primarily debated two hypothesized explanations for the effect

of increased pressure on reduced performance; both emphasize attentional focus. One explanation attributes sub-optimal execution of a skill in a high-pressure situation to the failure to allocate sufficient attentional resources to the task at hand, often by being distracted or focusing on non-task other stimuli[7]. The opposing viewpoint is that increased pressure causes "explicit monitoring" (aka "conscious reinvestment") in a well-learned behavior. Explicit monitoring (i.e., cognitively rehearsing key steps in a movement pattern that is already established as effective) is argued to cause a reduction in performance due a shift in attention toward internal cognitive processes, thereby preventing movement automaticity[4]. Several research studies have been conducted to better understand the root cause of these performance decrements under different pressure conditions[8].

1.1 Brief review of foundational research on pressure

Wine (1971) proposed that test-anxious individuals struggle in testing situations because they do not dedicate adequate attentional resources to the task, instead focusing attention on non-task things[9]. Baumeister (1984) disagreed with this interpretation and made two claims[4]. First is that pressure increases self-consciousness, potentially through heightened arousal, and this change toward an internal focus of attention negatively affects skilled performance. Second is that pressure can cause a person to focus on the importance of the task and therefore consciously monitor the skill execution. The explicit attention on the skill impairs the execution of the motor program which is facilitated by automaticity. These claims were not investigated using golf-based tasks but rather they were tested by running a series of six experiments. These studies involved performance on a Shoot-the-moon tabletop style game[4,10], and established a link between increased pressure and decreased performance in the skill, exacerbated by an intervention aimed to increase self-focus.

1.2 Application of pressure research to golf putting

Masters (1992) paved the road in related golf research and found that when novices learned putting without explicit instructions on how to perform the movement, they were less likely to show performance decrements when tested under high stress conditions than those with explicit knowledge of the skill[11]. Without explicit knowledge of the task, it is harder to focus internally on the mechanisms of the swing. Lewis and Linder (1997) concluded that self-focus, not distraction per se, was the reason for performance decrements seen in a putting protocol for novices[12]. Those who performed a distracting cognitive task did not perform worse under pressure, and neither did those who practiced under self-conscious conditions. The only group to perform worse under pressure was the one that had no strategy or had not adapted to self-awareness via specific practice to prevent "misregulation" of attention. Beilock & Carr (2001) agreed with these results and expanded on them through a series of experiments[13]. These experiments revealed that when participants practiced under high self-conscious conditions, induced via videotaping, they did not show the same putting performance decrements. These results were consistent when offered a cash prize to improve performance that those who did not practice under high self-conscious conditions did. Beilock referred to this phenomenon as an "inoculation" to pressure[13].

1.3 Studies on attention and golf chipping and pitching performance

The foundational work on the influence of internal/external focus of attention on golf non-putting short-game shot performance has been conducted by Dr. Gabriele Wulf and colleagues. Wulf published several studies on golf chipping accuracy with an external focus of attention (i.e., focusing attention of the intended movement effect) compared to an internal focus of attention (i.e., focusing on body movements)[14,15]. The research team consistently finds that performance is

better with an external vs internal focus of attention[14]. Others have taken this blueprint and continued this research, such as Bell and Hardy (2009). A golf pitching task (which hits the ball slightly farther than chipping) was used, similar to Wulf's chipping tasks, and the researchers found that performance was worst when attention was focused in an internal manner, better in a proximal external manner, and best in a distal external manner[16]. Researchers Lundin & Eskerin (2022) designed a similar experiment to test the effects of internal versus external attention on distance and accuracy with a 7-iron golf club[17]. Better performance was seen for distance and accuracy when attention was focused externally compared to internally when this longer club was used.

1.4 Modified Attention Studies

Several other studies have expanded on previous work with their own unique interventions. These interventions test variations of internal/external focus tasks. Gucciardi & Dimmock (2008) found that putting performance declined from low to high anxiety (presumably what would happen under higher pressure) when participants were instructed to use cues that encourage explicit internal monitoring[7]. On the other hand, performance was unchanged from low to high anxiety when attention was focused on an external irrelevant task or a single swing thought. Land & Tenenbaum (2012) showed that in experienced golfers, putting performance declined from low to high pressure when no cues were given (control), but was unchanged when a cognitive task was given (either relevant or irrelevant to the putting task) that required external focus[18]. Balk et al. (2013) also tested three conditions that involved low to high pressure situations[19]. Participants in the control condition, who were told to freely experience their emotions, made significantly fewer putts under high pressure. The re-appraisal group, which was told to keep a positive attitude, declined slightly but not significantly in performance under high

pressure. Lastly, the distraction group, which was instructed to think about a song they know well, improved significantly under pressure. These studies all support the hypothesis that increased self-focus (internal attention) in high pressure situations accompanies performance decrements, while tasks that focus attention externally attenuate performance decrements.

1.5 Summary

In reviewing the relevant literature on attentional focus and performance under pressure, most authors have published work that favors the explicit monitoring hypothesis of internal focus being responsible for performance decrements. Baumeister, Beilock, Masters, Gucciardi, Tenenbaum, and Balk have all published research that shows motor skill performance decrements in high pressure situations under conditions of increased self-focus. Wulf, Bell, and Lundin offer a similar explanation, choosing to attribute performance decrements more broadly to an internal focus of attention. Additionally, Gucciardi, Tenenbaum, and Balk have published research that would support the idea of distraction (external focus) as a coping technique to mitigate performance decrements in high pressure golf putting. Logical fruitful directions for future research include, but are not limited to, stronger pressure manipulations, more ecologically valid testing environments compared to laboratory-based research, and expansion of golf skill testing to clubs that are more difficult to control such as the long irons and woods.

1.6 The present experiment

The present experiment extends prior research in the area of effects of attention and pressure on motor skill performance in several ways. The investigation centered on outdoor golf driving in a sample of better than average golf performers. Many of the prior studies included less skilled performers in a laboratory environment. The field setting, compared to most prior studies which have been conducted in a laboratory setting, emphasized ecological validity. Use of the driver

was chosen because the driver is generally only pulled in the teeing area, where you are able to hit from a manually adjusted tee on flat ground every single time. Compared to golf putting or chipping, golf driving better represents a closed task because the environment in which it is performed is more similar every time compared to other golf clubs which often require shots hit while the ball is on a slope[3]. This environmental consistency, as well as the longer club length, may make the golf drive swing more susceptible to performance decrements under pressure if the previous ideas about internal focus impeding motor program execution are correct[20].Building on methods from previous research, the primary purpose of the present experiment was to investigate the interactive effects of attentional focus (internal and external) and psychological pressure (low and high) on golf driving performance in an outdoor golf setting. Based on prior research, a significant interaction was hypothesized such that there will be no difference in driving distance and accuracy from low to high pressure when participants focus attention externally, but that distance and accuracy will both decrease from low to high pressure when participants focus internally.

CHAPTER 2

METHODS

2.1 Research Design

A 2x2 (pressure x focus of attention) mixed experimental design was used to test the hypothesis. The first factor, pressure, was tested within-subjects, and consisted of two levels: low and high pressure. The second factor, focus of attention, was tested between-subjects, and also consisted of two levels: internal and external. Participants were randomly assigned to either the internal or external focus of attention condition to eliminate potential carry over effects. Research Randomizer (https://randomizer.org) was used (by PJO) to create blocks of four so each block would have an Internal Focus-Low then High Pressure, Internal Focus-High then Low Pressure, External Focus-Low then High Pressure, and External Focus-High then Low Pressure participant, assigned in a random order. This approach was used to minimize the potential for the testing order or participant performance expectations about focus of attention or pressure to systematically influence the outcome of the study and allow for any potential effect of order to be tested statistically (e.g., was there better performance when the low-pressure condition was completed first?).

2.2 Participants

A sample size calculation using G*Power[21] with the assumptions of alpha error of 0.05, statistical power of 0.80, and a mixed-model 2x2 ANOVA research design, indicated a minimum sample size of 28 was necessary to detect a small interaction effect size (f=0.125). Thirty total participants volunteered to complete the study (male=28, female=2). The minimum age to

participate in this study was 18, and there was no maximum age limit; participants ranged in age from 18 to 67 (M=25.6, SD=12.6). The participants were recruited through flyers, emails, and word of mouth in a college town in the southeastern United States. In order to participate, individuals were required to present a handicap index of <15 (M=4.5, SD= 5.3) from a reputable source, such as United States Golf Association's Golf Handicap Information Network (GHIN)[22]. Handicap is an index that combines prior scores in relation to rated course difficulty to provide a measure of golfer ability[23]. Figure 1 provides a flow chart of the screening process and group assignment. The study was approved by the university's institutional review board, and written informed consent was obtained in-person prior to the start of the first testing session. Participants received a ticket for a free 9-hole round of golf as compensation for their time.

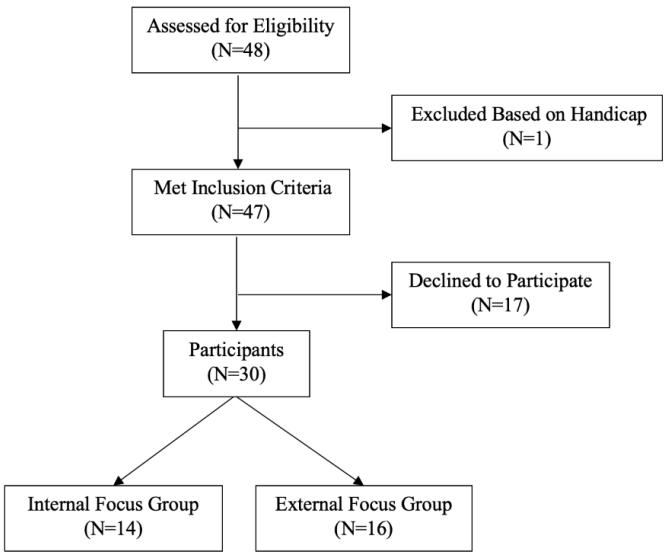

Figure 1. Flow chart of screening process and random assignment to focus condition.

2.3 External Focus Condition

In the external focus of attention condition participants were told to focus their attention on the ball, specifically, the "V" symbol that was printed on every golf ball used during the study (see Figure 2). Participants were told to position the ball on the tee so that they were aimed to hit the

V with the face of the driver, to focus their attention on the ball as they performed the golf swing, and to say out loud the phrase “hit the V” every trial directly before they began their swing. Using golf balls with alignment markings to help direct the player’s attention externally is an approach used by many golfers, including professionals, and it is associated with better putting performance[24]. The researcher provided an initial visual demonstration by presenting the ball to the participant and pointing to the V they were supposed to hit with the face of the driver. In order to make sure that the task was understood, the participant was required to explain back the task to the researcher, who confirmed their understanding before proceeding.

Figure 2. Ball illustrating the “V” which served as the external focus of attention cue.

2.4 Internal Focus Condition

In the internal focus condition, participants were told to focus their attention on the feelings in their hands during the swing[17]. Participants were required to say out loud the phrase “hands up” directly before each trial. This internal focus condition was selected because a good swing with the driver is one that hits up on the ball. Golf instructors commonly tell players to hit up when using the driver[25]. During the instructions phase, the researcher also provided a visual to convey

the desired action ~~(Figure 3)~~. After the instruction phase, the picture was not made available to the participants. Confirmation of an understanding of the task was conducted in the same manner as the external focus condition.

~~Figure 3. Visual shown to participants to convey the desired hand movement.~~

2.5 The Task

Using their own driver, and standing on the far-left side of an outdoor driving range to minimize interactions with other golfers, participants were instructed to hit three blocks of 10 drives as if each was a tee shot on a par 5 hole in which distance and accuracy would help their score. Using an alignment stick in front of the mat, researchers described a 40-yard wide mock "fairway" for this task that extended 20 yards both left and right of the alignment stick for hundreds of yards. Participants were reminded that this was not a long drive contest, and that the goal was to be both long and accurate. Distance was measured by carry distance and accuracy was measured by distance laterally from the line created by the alignment stick (i.e. being perfectly in line with the stick would give a lateral score of "0 yards").

2.6 Baseline

Before the pressure manipulation and introduction of the attentional focus cue, participants were asked to hit 10 drives to establish "baseline measurements". While not mentioned to the participants, this baseline served as a reference point to assess if the internal and external groups

differed in performance prior to the experimental manipulations. The baseline also allowed for determining if the introduction of a cue, regardless of pressure, substantially impacted the driving performance results.

2.7 Low Pressure

The low-pressure condition involved telling participants that the next 10 shots would not count towards their scoring or performance-based monetary earning potential, but instead would serve to train a new artificial intelligence feature in the golf ball launch monitor.

2.8 High Pressure

Participants were told that this block of 10 trials would count towards their scoring and earning potential in the study. As done in prior studies[13,19], deception was used in certain aspects of the pressure manipulation in order to attempt to increase perceived pressure without following through on what could have been interpreted as unnecessary embarrassing consequences. High pressure was induced via videotaping, financial incentive[13], and a procedure to increase ego relevance, as combining these elements has produced documentable evidence of increased anxiety and pressure[18]. Trials were recorded with a camera mounted on a tripod behind the golfer and the launch monitor, and participants were told that videotapes of these swings would be sent to a PGA professional for analysis of swing errors. This was untrue, as recordings were deleted immediately after the testing session. Additionally, participants were offered a cash prize of $20 if they were able to decrease lateral dispersion by 20% relative to the baseline measurements, and an additional cash prize of $200 if they showed the biggest decrease out of all participants. This was not a deception and was indeed honored. To ensure that participants did not purposely score low on baseline measurements to give themselves a better chance at winning the cash prize, the specifics of how the cash prize was won was kept purposely vague in the informed

consent document (i.e. the metric and timepoint were not disclosed) and specified to the participants only after they completed the baseline testing. Finally, participants were told that their average scores on the task would be added to a ranked list posted in the driving range clubhouse at the golf course (that all golfers must enter and exit to use the range) that would show how every participant in the study performed. This procedure to increase ego relevance was also a deception. Participants were fully debriefed as to these deceptions at the end of the session and were allowed to withhold the data collected if they chose to. All participants consented to allow their data to be used after being informed of the deceptions.

2.9 Shot Data

The Flightscope Mevo+ was used to collect all golf shot data. Evidence supports the reliability and validity of the Flightscope Mevo+ compared to the TrackMan 4 launch monitor[26]. This unit, when connected to a smart device, provides 15 intercorrelated metrics related to distance, speed, ball spin, ball angles, and flight of the shot. Although all measures were collected for each shot, the primary apriori identified outcome variables of interest were driving distance and accuracy. Specifically, distance was measured as carry distance: the yards the golf ball flew through the air before it landed. Accuracy was measured via lateral distance: the absolute error distance in yards the ball traveled left or right from the straight line created by the alignment stick. Due to the uneven terrain of the testing environment (i.e., a sloped portion of the driving range landing area), total distance, consisting of carry and roll, was not used as a primary outcome measure in order to optimize reliability.

In order to maximize reliability between testing sessions, a strict routine was followed for the setup of the launch monitor. The monitor was placed on a flat board 8 feet behind the ball for each testing session, and calibrated to within the required parameters for angle horizontally and

vertically. Additionally, alignment sticks were placed both in between the monitor and the ball, as well as in front of the ball to establish a continuous line both for calibration purposes and for participant alignment. The researcher (RJA) ensured that the monitor was actively tracking shots throughout each session, and noted all discrepancies.

2.10 Questionnaires

After informed consent was obtained and prior to completion of shot trials, participants completed a short series of questionnaires. First, background information about demographics (e.g., age, height, weight), prior night's sleep duration, and caffeine use the day of testing was gathered using standardized questions. For sleep the following question was used: "how many hours of sleep did you get last night to the nearest 15 minutes?". For caffeine the following question was used: "have you consumed any caffeinated beverages today? (Y/N)", with "dose/amount" and "time of consumption" listed as follow-up questions if caffeine was consumed. Two traits with well-established potential to moderate the influence of pressure on performance were measured: trait anxiety and self-consciousness[4,27].

2.11 Trait Inventories

Trait anxiety was assessed using the State-Trait Anxiety Inventory (STAI)[28]. There is a large body of evidence supporting that the scores from this measure are a reliable and valid index of the frequency that people feel anxious. Variations in the tendency toward self-consciousness was measured using the 22-item Revised Self-Consciousness Scale (SCSR)[29]. The SCSR has three sub-scales that query perceptions about one's self (private self-consciousness), how one is perceived by others (public self-consciousness), and interactions with others (social anxiety).

2.12 State Inventories

Prior to the low- and high-pressure blocks, several state variables with potential to moderate performance under pressure were assessed: state anxiety, state motivation and perceived importance of the shots[30,31]. State anxiety was measured via the 10-item short form of the STAI[28]. Researcher developed 5-point Likert scales of motivation to perform well and perceived importance. Motivation was assessed with the question "how motivated are you to hit the next 10 drives long and accurately", with the following possible responses (and scoring): not at all (1), a little (2), moderately (3), quite a bit (4), extremely (5). Perceived importance of the upcoming trials was assessed with the question "how important is it for you to perform well during the next 10 drives", with the following options: not important (1), a little important (2), important (3), very important (4), extremely important (5).

2.13 Manipulation Checks

In order to gauge how well the manipulation worked, two additional questions, developed by the researchers, were presented to the participant immediately following each of the low- and high-pressure testing blocks. Compliance to the focus of attention manipulation was assessed with the question "during the 10 shots, how frequently did you actually focus on the given cue", with the following options (and scoring): never (1), rarely (2), sometimes (3), often (4), always (5). Pressure felt during the trial block was measured with the question "during the 10 shots, on average how much psychological pressure to perform well did you experience" with the following response choices (and scoring): none at all (1), a little (2), a moderate amount (3), quite a bit (4), an extreme amount (5).

2.14 Procedure

Two researchers met each participant at an outdoor driving range and took the participant through the informed consent process. One researcher (RJA) was in charge of ensuring that the

launch monitor was properly set up and successfully tracking shots throughout the session. The second researcher, one of three college-aged female research assistants, delivered the entire script (as well as questionnaires) to the participant. Participants were informed that the purpose of the study was to learn the extent to which golf performance is related to hitting drives under different sets of instructions. To mask the exact purpose of the investigation, it was not explicitly stated that the combined effect of psychological pressure and focus of attention on driving distance and accuracy was the true purpose. This minor deception was approved by the IRB. After informed consent was obtained, participants completed the background information questions and trait questionnaires. Next, participants were allowed to stretch and given 10 golf balls to hit with any club(s) of their choice to warm up. The launch monitor did not record these shots. After the warm-up, participants were read the instructions pertaining to hitting the driver both as long and accurately as possible. A bucket with 10 balls was placed 10 feet from the hitting area for all subsequent shots, and participants were required to walk back to the bucket after each trial to better stimulate real golf play and to minimize fatigue from rapid hitting. Next, 10 shots were hit to provide baseline measurements with the launch monitor turned on. Following the baseline testing, participants were read the instructions related to their attentional focus condition and asked to repeat back the instructions to confirm the instructions were understood. Next, the two pressure conditions were completed, each consisting of 10 shots. Each pressure condition was preceded by the appropriate researcher-read instructions and equipment setup (such as the camera in the high-pressure condition). State questionnaires were completed before each block of 10 trials, and manipulation check questions were completed after each block of 10 trials. After completion of these testing responsibilities, participants were fully debriefed about the true nature of the study and its intent to measure the efficacy of internal vs

external focus of attention in relation to a low- and high- pressure condition. At this point the participants were allowed to have their data withheld if they chose to, and signed another consent form to either release or withhold their data. All participants released their data for use in the final statistical analysis. Finally, participants were thanked for their time and compensated with a ticket to play a free 9-hole round of golf at the golf course ($15 value). Days later, they received a follow-up email from the lead researcher with a summary of their shot data, as well as a confirmation of if they did or did not win the larger cash prize because of their outstanding performance.

2.15 Preliminary Analyses

Questionnaire data was collected via paper copies of questionnaires. Shot data was collected via the launch monitor and a paired smartphone with the Flightscope app. All the relevant data collected was entered into Microsoft Excel and checked for accuracy separately by two members of the research team. All data discrepancies were identified and resolved. All data ultimately were entered into an IBM SPSS version 28.0.0 spreadsheet and this software was used for the final analyses.

Across the 900 total trials comprising this study's shot data for all participants, the launch monitor failed to capture 23 shots (2.6%). For golf shots that never flew in the air (i.e. a "topped" ball), carry and lateral distance were standardized and inputted as 0 yards carry, 0 yards lateral (n=6). For airborne golf shots that the monitor failed to pick up, when possible, researchers estimated the carry and lateral distance based on comparing the golf ball flight in the unrecorded trial to the adjacent recorded trial (n=9). The researcher was unable to generate a confident/valid estimate of carry and lateral distance on 8 shots, so these were excluded from analysis. Thus, the

mean values for individuals in these eight pressure/focus conditions was based on a sample of 9 shots rather than 10 shots.

ANOVA assumptions of normality and homogeneity of variance were assessed and found to be violated for the lateral distance outcome. Consequently, four outliers, two in the external high-pressure condition (lateral), one in the internal low-pressure condition (lateral), and one in the internal high-pressure condition (carry), were adjusted to maintain their rank in the data set but were reduced to the closest non-outlier value to satisfy the assumption of normality (i.e., the Winzorization procedure was used). The significance of the ANOVA results were unchanged in preliminary analyses based on the raw scores compared to when these four adjusted scores were used. All other assumptions were met for their respective statistical tests.

Among our participants, four individuals reported feeling higher psychological pressure in the low-pressure condition relative to the high-pressure condition. All four of these individuals completed the high-pressure condition first and then reported a one-point increase in psychological pressure in the low-pressure condition. The ANOVA results did not change when these four individuals were removed in a sensitivity analysis, thus these data were included in the primary analysis.

2.16 Primary analyses

Mixed model 2x2 ANOVAs with pressure as a within-subjects factor and attention as a between-subjects factor were used to test for main and interaction effects on driving performance. Driving performance was further explored using ANCOVA models that improved accuracy of the analysis by considering the following covariates: golf handicap, trait anxiety, private self-consciousness, public self-consciousness, and social self-consciousness. Additionally, mixed model 2x2x2 ANOVAs with order of pressure conditions (low then high and high then low

orders) as an additional between-subjects factor was used to test for a potential order effect of the within-subjects factor. One-way ANOVA was used for both carry distance and lateral distance with three levels (baseline, first pressure condition, second pressure condition) to determine if the introduction of the cue impacted performance separate from attention. Independent-samples *t* tests were used to discern differences for trait and state psychological variables between attentional focus conditions. Paired-samples *t* tests were used to discern within-group differences for state psychological variables at different timepoints (pressure conditions) throughout the testing session.

CHAPTER 3

RESULTS

3.1 Manipulation checks

Compliance to the instructions to focus on the internal or external cues was high, 83 percent of the total sample (25/30 and 81-85% in the two groups) indicated that the attention cue was focused on "often" (rating of 4) or "always" (rating of 5). There was no average group difference in compliance to the attentional focus cue (p = .839) when comparing ratings in the low-pressure condition (M = 4.23, SD = 1.01) to ratings in the high-pressure condition (M= 4.27, SD = .828). The pressure manipulation was effective on average. Mean psychological pressure was increased by a small, statistically significant (p = .021) magnitude (M change = 0.47; *d* =0.45) to a moderate level of perceived pressure (rating of 3) in the high-pressure condition (M = 2.97, SD = .85) compared to the lower-pressure condition (M = 2.53, SD = 1.01).

Table 1. Descriptive statistics for carry distance and lateral distance at baseline and for low- and high-pressure conditions by focus of attention condition.

	Attention Condition	Mean	Std. Deviation	N
Baseline Carry	Prior to Internal	233.7	30.3	14
	Prior to External	243.6	28.8	16
	Total	*238.9*	*29.4*	*30*
Low Pressure Carry	Internal	232.2	34.8	14
	External	238.8	25.6	16
	Total	*235.7*	*29.9*	*30*
High Pressure Carry	Internal	232.0	37.9	14
	External	239.9	36.4	16
	Total	*236.2*	*36.7*	*30*
Baseline Lateral Distance	Prior to Internal	22.6	*8.2*	14

	Prior to External	18.5	5.7	16
	Total	*20.4*	*7.1*	*30*
Low Pressure Lateral Distance	Internal	23.7	9.5	14
	External	18.9	6.9	16
	Total	*21.2*	*8.4*	*30*
High Pressure Lateral Distance	Internal	22.9	10.2	14
	External	20.8	10.5	16
	Total	*21.8*	*10.2*	*30*

3.2 Carry Distance

The 2x2 mixed ANOVA for carry distance revealed there was no significant main effect of pressure level on carry distance $F\ (1, 28) = \ .018, p = \ .894, \eta^2 = \ .001$. Carry distance was nearly identical in the two pressure conditions. There was no significant main effect of attentional focus on carry distance $F\ (1, 28) = .372, p = \ .547, \eta^2 = \ .013$. The external group had a higher average carry distance than the internal group (M=8.76 yards), but the effect size was small ($d = .26$) and the difference at baseline data was similar (M=9.91 yards). There was no significant interaction effect for pressure by attention $F\ (1, 28) = .040, p = .843, \eta^2 = .001$. The significance of all these results did change when any of the covariates were added to the model: testing order, handicap, trait anxiety, private self-consciousness, public self-consciousness, or social self-consciousness.

3.3 Lateral Distance (Accuracy)

The 2x2 mixed ANOVA for lateral distance revealed there was no significant main effect of pressure level on lateral distance $F\ (1, 28) = .096, p = .759, \eta^2 = .003$. Accuracy was nearly identical in both the low- and high- pressure conditions. There was no significant main effect of attentional focus on lateral distance $F\ (1, 28) = 1.371, p = .251, \eta^2 = \ .047$. While the external group was more accurate than the internal group by a small amount (M=3.45 yards; d = 0.37), this difference was similar at baseline. There was no significant interaction effect for pressure by

attention $F\ (1, 28) = .596, p = .447, \eta^2 = .021$. The significance of all these results did not change when any of the covariates were added to the model: testing order, handicap, trait anxiety, private self-consciousness, public self-consciousness, or social self-consciousness.

3.4 Background Information

Table 2. Characteristics of participants and testing environment, including by focus condition.

Age (years)	**Mean (SD)**
Total sample	25.63 (12.6)
Internal	29.79 (16.7)
External	22.00 (5.8)
Height (in)	**Mean (SD)**
Total sample	71.73 (2.70)
Internal	72.29 (2.46)
External	71.25 (2.89)
Weight (lbs)	**Mean (SD)**
Total sample	176.3 (26.82)
Internal	178.21 (20.26)
External	174.63 (32.10)
Sleep (hours)	**Mean (SD)**
Total sample	7.4 (1.44)
Internal	7.59 (1.67)
External	7.22 (1.24)
Temperature (°F)	**Mean (SD)**
Total sample	68.57 (9.2)
Internal	68.14 (9.0)
External	68.94 (9.7)
Handicap	**Mean (SD)**
Total sample	4.53 (5.34)
Internal	6.46 (4.17)
External	2.84 (5.79)

Independent-samples *t*-tests revealed there were no significant differences between the two focus of attention groups in age (p = .117) , height (p = .303) , weight (p = .721) , previous night's sleep duration (p = .492) , or environmental ambient temperature at start time of testing (p =

.819). The difference in handicap index between the attention groups was not significant (p = .062), but the external group (M = 2.84, SD = 5.79) did have a moderately lower handicap than the internal group (M = 6.46, SD = 4.17). The difference of 3.62 handicap points represents a moderate effect size (d = .76).

Table 3. Selected characteristics of the participants, including by focus condition

	Sex **M : F**	**Time of Day** **Morning : Afternoon**	**What handed golf clubs do you play?** **Right : Left**	**Have you consumed any caffeinated beverages today?** **Yes : No**	**Which of the following best describes you?** **Race**
Everyone	28 : 2	6 : 24	27 : 3	11: 19	White= 28, Asian= 2
Internal	14 : 0	4 : 10	12 : 2	5 : 9	White=14, Asian = 0
External	14 : 2	2 : 14	15 : 1	6 : 10	White= 14, Asian= 2

3.5 Trait Psychological Questionnaires

Table 4. Trait psychological variables for participants, including by focus condition.

Trait Anxiety	**Mean (SD)**	**Mean (SD) Norm**
Total sample	31.1 (6.37)	39 (10)
Internal	29.43 (5.27)	
External	32.5 (7.05)	
SCSR Private	**Mean (SD)**	16 (5)
Total sample	15.4 (4.02)	
Internal	14.93 (4.6)	
External	15.81 (3.54)	
SCSR Public	**Mean (SD)**	14 (4)
Total sample	11 (3.6)	
Internal	11 (3.98)	
External	11 (3.46)	
SCSR Social	**Mean (SD)**	9 (4)
Total sample	5.23 (3.6)	
Internal	4.5 (3.37)	
External	5.88 (3.76)	

Between attentional focus conditions, there was no significant difference for trait anxiety (p = .193), private self-consciousness (p = .557), public self-consciousness (p = 1), or social self-consciousness (p = .303). At baseline and for the total sample (n=30), the covariates in Table 4 were weakly related to the golf drive performance measures. In contrast, the golf handicap covariate was moderately and positively associated with dispersion (r = .31) and significantly negatively associated with carry distance (r = .50, p = .005).

3.6 State Psychological Questionnaires Between Groups

There was no difference between attentional focus groups in any of the state psychological variables measured shortly before the golf driving task, suggesting that neither cue, when introduced, impacted current feelings about oneself or the task.

3.7 State Anxiety Questionnaires

Table 5. State psychological variables for participants for low- and high-pressure conditions.

State Anxiety (10-items)	**Mean (SD)**	**Effect size (d)**
Low	16.23 (4.45)	**0.01**
High	15.87 (4.20)	
Pressure (1-item)	**Mean (SD)**	**0.47**
Low	2.53 (1.01)	
High	2.97 (0.85)	
Motivation (1-item)	**Mean (SD)**	**0.33**
Low	4.20 (.761)	
High	4.43 (.626)	
Importance (1-item)	**Mean (SD)**	**0.39**
Low	3.20 (.925)	
High	3.57 (.971)	
Focus Manipulation Check (1-item)	**Mean (SD)**	**0.04**
Low	4.23 (1.01)	
High	4.27 (.828)	

Paired-samples *t*-tests revealed there was no significant increase in participant state anxiety from low to high pressure. Using the 10-item Self-Evaluation Questionnaire, participants' scores did not reflect an increase in state anxiety ($p = .544$) from low pressure ($M = 16.23$, $SD = 4.45$) to high pressure ($M = 15.87$, $SD = 4.2$).

3.8 Psychological Pressure to Perform

The pressure manipulation was effective in increasing psychological pressure to perform felt by participants. The difference in psychological pressure from the low-pressure condition ($M = 2.53$, $SD = 1.01$) to the high-pressure condition ($M = 2.97$, $SD = .85$) was significant ($p = .021$) and corresponded to a large effect ($d = .971$). In spite of this large effect, high-pressure scores on average were consistent with a "moderate" amount of pressure to perform.

3.9 Motivation

Greater motivation to perform well was seen before the high-pressure condition ($M = 4.43$, $SD = .626$) relative to the low-pressure condition ($M = 4.20$, $SD = .761$), with the small difference ($d=.33$) bordering on significant ($p = .05$). Motivation was still very high at both timepoints, meaning that participants likely gave their full effort in both conditions, regardless of reward for doing so.

3.10 Importance

Perceived importance of performing well in the upcoming block of trials was significantly greater ($p = .005$) before the high-pressure condition ($M = 3.57$, $SD = .971$) than the low-pressure condition ($M = 3.20$, .925). Importance was still no lower than "important" (3/5 on a 5-point Likert scale), suggesting that participants viewed all trials with a degree of importance.

3.11 Compliance

Participants reported strong compliance to the focus of attention manipulation for the low-pressure condition (M=4.20, SD= 1) as well as the high-pressure condition (M=4.27, SD= .83), with no difference between conditions (p = .839). This corresponded to participants, on average, reporting focusing on the cue between "often" and "always".

3.12 Impact of Introduction of Cue

There was no impact of the introduction of the cue per se compared to the baseline on either carry distance or lateral distance relative to baseline. Also, there was no effect of order, independent of the low vs high pressure condition on these outcomes. One-way ANOVA was used to compare group means across baseline, first pressure condition, and second pressure condition (because participants varied in which pressure condition came first). There was no significant main effect of timepoint on carry distance (p = .874) or lateral distance (p = .322).

Table 6. Descriptive statistics for carry distance and lateral distance by timepoint.

	Pressure Condition	**Mean**	**Std. Deviation**	**N**
Carry Distance by Timepoint	Baseline	238.9	29.4	30
	First Pressure Condition	234.7	34.2	30
	Second Pressure Condition	237.2	32.7	30
	Total	*236.9*	*31.8*	*90*
Lateral Distance by Timepoint	Baseline	20.4	7.1	30
	First Pressure Condition	22.1	9.5	30
	Second Pressure Condition	20.9	9.2	30
	Total	*21.1*	*8.6*	*90*

CHAPTER 4

DISCUSSION

The findings of the present experiment do not support the hypothesis that an external focus of attention is better than an internal one for golf drive performance outcomes, contrary to other published studies using golf putting[7,18,19] and chipping[14,15,32]. There are multiple plausible explanations for this. One is that focusing either on the movements you are making (internally) or away from the movements you are making (externally) truly is not a major factor in what determines the quality of skill execution in golf drive performance. This idea runs counter to most of the prior related research. However, since the undertaking of this project, a meta-analysis was published by McKay et al that suggests that publication bias is responsible for the beneficial effects of learning and performing with an external focus of attention[33]. It is possible that the general view on the topic will change once this research is more thoroughly disseminated and more experiments have been conducted.

Another explanation is that the hitting the driver in golf as a skill is affected differently by pressure and reward than other skill-related aspects of the game, such as putting or chipping. Many golfers practice putting and chipping more frequently than driving which could reduce movement variation compared to driving and make an effect of a focus intervention more likely to emerge compared to motor skills less frequently practiced. Practice histories of the participants were not obtained in the present investigation; however, there is evidence that greater practice consolidates motor learning and reduces movement errors[34]. Compared to chipping and putting, driving in golf requires activation of more muscles and with larger forces

and a faster rate of force production which could introduce greater variability and make it more difficult to show a significant effect of a focus intervention, especially if the true effect is small[35]. Also, the driver is a longer club than those used to chip and putt, it is plausible that greater movement variability with the longer club makes it more difficult to reveal a small effect of external versus internal focus[36,37]. It cannot be ruled out that if the methods of the study were executed differently, such as with a more distal external focus cue or stronger pressure manipulation, that the theorized relationship between external focus and performance decrement prevention would have occurred.

This study incorporated a wide range of golfers by handicap index (20 "strokes" from the "best" to "worst" golfer). On one side of the spectrum, it is beneficial to represent a wider skill range of golfers as skill level might moderate responses to pressure and performance overall. On the other side, having such a wide skill range can mean that if differences do exist in pressure response and performance between golfers of different skill levels, this study was insufficiently powered to detect several categories of different skill level, hence no such analysis was undertaken. While the use of random assignment in theory should have prevented large differences in handicap emerging across the conditions, the fact that the external group on average had a lower handicap than the internal group (aka a lower scoring average over many rounds of golf) means they may be longer and more accurate with their driver in general.

In relation to the cues given for focus of attention, we elected to only have two: an internal focus cue and an external focus cue. Previous research by authors such as Wulf have highlighted potential differences in responses based on the proximity of the external cue to oneself (e.g., more proximal such as a V printed on a golf ball vs more distal – the flight of the ball), suggesting that performance might correspondingly increase as attention is focused more

distally[38]. This study only uses a proximal external cue. This was chosen in order to simplify the experiment by drawing a stark contrast between two conditions, and to maintain the robustness of the sample size randomized to only two conditions. It is possible that a greater distal focus of attention group may have shown significantly different responses to the introduction of pressure and direction of attentional focus. Participants were also not exposed to both focus of attention conditions, instead being randomly assigned to just one. While a fully within-subjects design could be propounded as a potential solution, the introduction of multiple cues could have muddied the results in that certain participants may have chosen to focus only on the cue they found most helpful.

4.1 Strengths

In spite of the finite number of golfers who meet the screening criteria in the population, the sample size was sufficiently powered to detect a hypothesized small-sized effect, which adds weight to the findings. Participants also completed a number of trials per condition consistent with existing research[7,19]. Other strengths of this study lie in the consistency of the testing environment. All testing for each participant was completed in a single visit on one day that lasted roughly an hour each, meaning the testing environment was essentially the same for all pressure timepoints for each person. This is especially important because testing took place outdoors, which is an additional strength because it provided a more ecologically valid testing environment for the sport, as well as allowed participants to get better visual feedback from watching each shot, relative to an indoor testing setup. The measurement device also worked adequately, failing to capture only 23 trials out of 900. Additionally, adherence to the attentional focus cue was high in both low- and high-pressure conditions, suggesting the manipulation was successful in directing participants' focus to their given cue.

4.2 Limitations

This study was not without limitations. Arguably the most important limitation was that the high-pressure manipulation did not induce on average a high level of perceived pressure, but rather only a moderate level. While a combination of several factors was used to attempt to increase psychological pressure and state anxiety of the participants, this almost certainly falls short of tournament conditions that competitive golfers face that involve more ego threat and monetary gain. The present investigation was similar to prior investigations in the struggle to create an undeniable "high pressure" condition. Balk et at (2013) only managed to manipulate perceived pressure in the high pressure condition to 3.16 on a 7-point Likert scale[19] despite using videotaping, competition, monetary rewards, and a procedure to increase ego relevance. Gucciardi & Dimmock (2008) attempted to manipulate somatic anxiety across two pressure conditions (and did not find a significant difference) and cognitive anxiety (where a significant difference was found, but no raw scores were given)[7] despite the use of competition and rewards. Land & Tenenbaum (2012) employed ego relevance and videotaping and only managed to increase perceived pressure in the high-pressure condition to an average of 4.95 on a 0-10 scale[18]. There is reasonable debate as to whether most participants in any ethical golf research study context can be induced to truly feel a high amount of pressure to perform.

Additionally, the measurement tools are inherently imperfect. Callaway range balls were used for every participant, but variations in the quality of individual golf balls may have impacted the outcome of certain shots. Due to financial constraints, we were unable to purchase new golf balls for every participant, nor were we able to afford an automatic hitting machine to test each ball. As mentioned previously, an additional level to the attentional focus manipulation (a distal external condition) was not employed due to limitations in recruitment. Future research should

investigate the effects of a distal focus of attention on golf driving performance in concert with a more intense pressure manipulation.

CHAPTER 5

CONCLUSION

The primary goal of this study was to examine the interaction between pressure and focus of attention as it relates to golf driving performance. Using a classical mixed experimental design with 2 levels of pressure and 2 levels of attentional focus, no differences were found between the internal focus of attention group and the external focus of attention group across low- to high-pressure conditions for driving carry or accuracy. Additional psychological questionnaires revealed that participants on average did report a moderate increase in psychological pressure to perform from the low- to the high-pressure condition, but this did not affect their performance in relation to the primary outcome variables. Reducing error variance using the covariates of handicap index, trait anxiety, and the trait self-consciousness variables did not change the results. It was concluded that in contract to results from prior studies of golf putting and chipping, neither attentional focus, pressure, nor the combination of the two influence how far or straight a sample of experienced, above average golf performers hit the golf ball with the driver.

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SAMPLE PROCEDURAL SCRIPT

Initial Questionnaires:

1. "Thank you for choosing to participate in our study. First, we have a short series of questionnaires for you that will provide us more information about you. If any questions make you uncomfortable, you may skip over them without penalty."
    a. *Presentation of demographics sheet, trait anxiety, trait self-consciousness*

Warm-up:

1. "We are going to begin this session with a warm-up period. You have been provided 10 golf balls to hit during this period. You may hit these with any club or clubs of your choosing. You may begin now."
    b. *Completion of 10 warm-up shots*

Introduction:

1. "For this entire testing session, we want you to simulate hitting a drive on a par 5 hole in which both distance and accuracy will help your score. The "fairway" for this exercise extends 20 yards left and 20 yards right of the alignment stick in front of you, so, the ideal landing point is as far away as you can hit the golf ball within this designated fairway. This is not a long drive contest. The goal is to be both long AND accurate. Distance will be measured by carry distance, and accuracy will be measured by distance laterally from the target. Do you have any questions? Can you please explain back to me what the task is?"

Baseline:

1. "We will now collect baseline measurements of your swing with the driver. There are 10 golf balls in the bucket for you to hit. Please hit every ball as long AND as accurately as you can down the "fairway". Please grab only one ball at a time, and walk back to the bucket to grab a new ball after each trial. Do you have any questions?"
2. "You may begin now."
    a. *Completion of 10 trials*

Explanation of INTERNAL attentional focus task: "We are investigating how focus of attention impacts performance with the driver. Your task is to focus your attention on the feelings in your hands as you perform the golf swing. A good swing with the driver is one that hits up on the ball. Directly before you swing the club every time, please say out loud the phrase "hands up", then swing immediately. You must say it loud enough for us to hear. Do you have any questions? Can you please explain back to me what the task is?"

Explanation of EXTERNAL attentional focus task: "We are investigating how focus of attention impacts performance with the driver. Your task is to focus your attention on the ball as you perform the golf swing. There is a "V" directly below the Callaway script on each golf ball that makes up the logo. Please position each ball on the tee so that you are aimed to hit the "V" with your driver. Directly before you swing the club every time, please say out loud the phrase "hit the V", then swing immediately. You must say it loud enough for us to hear. Do you have any questions? Can you please explain back to me what the task is?"

Low pressure:

1. "We want to have you help us train a new artificial intelligence feature in the launch monitor. This next set of drives will help the launch monitor gather data and enhance its AI capabilities. These shots will not count towards your scoring or influence how much extra money you can make. There are 10 golf balls in the bucket for you to hit. Using your attentional focus cue, please still hit every ball as long AND as accurately as you can. Please grab only one at a time, and walk back to the bucket to grab a new ball after each trial. Do you have any questions?
2. "Before we begin, I have a few questions for you to answer regarding your feelings at this very moment."
    a. *Presentation of self-evaluation questionnaire and three state Likert scales*
3. You may begin now
    a. *Completion of 10 trials*
4. "We have two more questions for you to answer regarding your feelings about the task
    a. *Presentation of manipulation check Likert scales*

High pressure:

1. "We are offering incentives for individuals who can improve their performance from the baseline measurements taken at the beginning of the testing session. This phase will determine if you receive additional rewards. If you improve driving accuracy calculated in the baseline period by 20% or more without losing distance, you will receive a $20 Amazon gift card. Additionally, the participant in this study who improves accuracy the most without losing distance will receive a $200 Amazon gift card. During this phase, your trials will be recorded by a camera mounted behind the launch monitor, and the recordings will be sent for evaluation of swing errors to a PGA professional who is assisting us with this study. At the conclusion of your participation today, your average performance on these next 10 shots will be added to a ranked list posted at the entrance to the range that shows how every study participant has performed. There are 10 golf balls in the bucket for you to hit. Using your attentional focus cue, please hit every ball as long AND as accurately as you can. Please grab only one ball at a time, and walk back to the bucket to grab a new ball after each trial. Do you have any questions?"
2. "Before we begin, I have a few questions for you to answer regarding your feelings at this very moment."
    a. *Presentation of self-evaluation questionnaire and three Likert scales*
3. "You may begin now"
    a. *Completion of 10 trials*
4. "We have two more questions for you to answer regarding your feelings about the task
    a. *Presentation of manipulation check Likert scales*

Compensation and Debriefing:

1. “Thank you for your participation in this study. Here is your ticket for a free 9 holes of golf at the UGA Golf Course. We will analyze the data as soon as possible to determine if your performance improved significantly enough to earn the $20 Amazon gift card and I will send you an email informing you if you did or did not. Additionally, you will receive an email from me at the conclusion of the study regarding whether or not you won the $200 Amazon gift card.”
2. “Now that the study is over, can you tell me what you think is the purpose of this study?”
3. “Do you know anyone who has already participated in the study? If so, did they tell you what the true purpose of the study was?”
4. “We now are going to debrief you on the true nature of the study. The goal of the study was to determine how focus of attention affects driving performance in two different pressure conditions. The machine learning condition was an attempt to create a low-pressure condition, and the improvement for monetary reward condition was an attempt to create a high-pressure condition. While we will honor the promised financial rewards if earned, we would like you to know that the recording we took will not be shared with a PGA professional and instead will be destroyed immediately, and your name will not be posted on a ranked list in the clubhouse by your performance level. We are sorry for the minor deception, but previous research has shown that those minor deceptions are sufficient ways to make participants feel increased pressure. Because the study relies on these minor deceptions to function properly, we would appreciate you not discussing what we have told you with friends of yours who may participate in this study, as this could compromise the validity of our findings. Thank you again for your participation.”