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Original Research

A Repeated-Measures Assessment of Golf Shot Performance at Varying Distances in Collegiate Female Golfers using the Trackman Portable Launch Monitor

Kevin M. Fisher *

** PhD, CSCS, Department of Physical Education and Sport, Central Michigan University*

ABSTRACT

The Trackman portable launch monitor has become a popular tool of assessment and feedback among elite golfers, including tour professionals and U.S. collegiate teams. The device meets important criteria for assessing golf performance, including portability, accuracy, reliability, and instantaneous feedback. The goals of this study were to evaluate potential benefits of introducing the Trackman to a collegiate golf team and critically examine performance based on device data. In a pretest-posttest design, female collegiate golfers (n = 10) with an average handicap of six strokes were assessed on shot performance at varying distances at two different time points eight weeks apart using the Trackman "Combine" Standardized Test. Results indicated no significant interaction between the time point of assessment and shot distance ($p = .625$) and no significant main effect for time point ($p = .995$). However, there was a main effect for distance ($p < .001$), such that golfers struggled more with short and long shots when compared with those in the middle of the spectrum. Performance at the shortest yardage of 60 was significantly worse than 100 ($p = .009$), 120 ($p = .019$), and 140 yards ($p = .047$). Performance at longer distances of 160 and 180 yards was significantly worse than 100 ($p = .020$, $p = .010$, respectively) and 120 ($p = .041$, $p = .020$, respectively) yards, and driver performance was significantly worse than 80 ($p = .001$), 90 ($p = .001$), 100 ($p < .001$), 120 ($p < .001$), and 140 ($p < .001$) yards. These findings suggest that eight weeks of orientation and practice with such technology do not significantly alter baseline testing results regarding shot quality at varying goal distances. Furthermore, golfers in the current study comparably excel at golf shots of intermediate lengths (i.e., 80 – 140 yards) while demonstrating higher levels of variability outside this range. Implications for practice structure and performance are discussed.

Keywords: Golf Performance, Trackman Portable Launch Monitor, Motor Skill Assessment.

Introduction

Background

The Trackman portable launch monitor has become a popular tool of assessment and feedback among elite golfers, including PGA and LPGA tour professionals and U.S. collegiate teams [4,6]. This device meets important criteria for assessing golf performance, including portability, accuracy, reliability, and instantaneous feedback. The Trackman 4 measures and displays the full trajectory of any golf shot, ranging from 6-foot (2 m) pitches to 400-yard (350 m) drives, pinpointing the landing position with an accuracy of 1½ feet (±0.5 m) at 160 yards (150 m). The device also maps the shot's 3-D trajectory in real time along with impact and launch information.

Evaluating the performance of elite golfers through data tracking and analysis has become more prominent as these methodologies have become more prolific [3]. One of the most important pieces of information that a golfer needs for elite performance is the distance that each club in the bag is likely to project the golf ball, on average [2]. Knowledge of this information facilitates accurate decision-making on shots under changing conditions, including variables such as the angle to the pin, the lie or the turf (e.g., the fairway or the rough), or the weather (e.g., calm conditions, wind, or rain). Such information can mean the difference between hitting the ball into a hazard (e.g., water or sand) or hitting it onto a green in regulation (GIR), which can have a significant impact on scoring. While many golfers go to the practice range and utilize targets or other environmental factors to guess the approximate distance that a shot has travelled, the Trackman provides

precise data regarding ball flight characteristics, including carry and overall distance. This increased accuracy and precision during practice with the Trackman device is likely to facilitate competitive performance due to both the level of detail and information that is provided (i.e., a strategic benefit) and the confidence that is associated with using such technology to supplement practice (i.e., a psychological benefit).

According to Johansson et al. (2015), better golfers tend to have superior control of the clubhead at impact, hit the ball straighter, and swing in a flatter plane than novice golfers; however, the most distinguishing characteristic of better golfers is their consistency [4]. Although the Trackman device provides substantial information to the golfer and coach, the length of time required to document benefits in performance as a result of using the device is unknown. Additionally, device measurements can offer significant insight into the shots that are most challenging for a golfer based on distance.

Purpose and Hypotheses

The goals of this study were to evaluate the potential benefits of introducing the Trackman portable launch monitor to a collegiate golf team and critically examine strengths and weaknesses in performance based on device data. The first hypothesis of this study was that there would be a significant improvement in performance on the Combine standardized test from Time Point 1 (i.e., Week 1) to Time Point 2 (i.e., Week 8) as a result of practice effects and familiarity with utilizing the device (e.g., performance conditions, software functionality, data output, etc.). The second hypothesis of this study was that golfers would exhibit lower performance scores on longer shots when compared with shorter shots due to the increased physical and technical demands associated with the former category.

Material & Methods

Participants

The study included 10 Division I collegiate female golfers who ranged in age from 18 – 22 years old *(Mean* = 20, *SD* = 1.66) and possessed an average self-reported handicap of approximately five strokes (*Mean* = 5.44, *SD* = 2.96). Participants had an average of approximately 10 years of golf experience (*Mean* = 9.89, *SD* = 4.14). Each person signed an informed consent agreement approved by the university's Internal Review Board prior to participation.

Task and Materials

The task involved hitting a golf ball varying distances using a golf club of choice at an indoor range while being monitored by the Trackman 4 device. Each shot was struck from artificial turf meant to simulate a teeing area and subsequently hit into a net approximately 20 feet high. The necessary materials included golf balls, golf clubs, the Trackman 4, and a laptop computer featuring the Trackman software program. Figure 1 displays the experimental configuration.

Figure 1. The experimental configuration.

Procedure

In a pretest-posttest design, participants were assessed on shot performance using the Trackman 4 Indoor Model at varying distances at two time points eight weeks apart using the "Combine" Standardized Test included with the Trackman software package. These distances included the following yardages: 60, 70, 80, 90, 100, 120, 140, 160, 180, and driver.

Dependent Measures

The dependent measure of the current study was golf shot performance as indicated by the Trackman software. After a golf shot was successfully completed, information from the Trackman 4 was delivered to a laptop computer, which featured the Trackman software program. Data regarding each ball flight was collected and scored on a scale from 0-100 based on accuracy, which was determined by distance (i.e., carry) and direction (i.e., proximity to target). Scores that were closer to zero indicated shots of poor quality while scores that were closer to 100 indicated shots of high quality.

Statistical Analysis

In order to assess potential differences in performance, a 2 (time point) ×10 (distance) repeated-measures analysis of variance (ANOVA) was performed. For all post-hoc pairwise comparisons, Sidak analyses were used. The alpha level for all analyses was set at .05, and partial eta squared values were reported where appropriate.

Results

Golf Shot Performance

Results of the current study were automatically calculated in the Trackman 4 software and transferred to Microsoft Excel and SPSS for storage and analysis, respectively. Results indicated no significant interaction between the time point of assessment and shot distance, F (1, 9) = .791, p = .625, η2 = .042, and no significant main effect for time point, F (1, 9) = 0.00, p = .995, η2 = 0.00. However, there was a main effect for distance, F (9, 160) = 7.06, p < .001, η2 = .297, such that golfers struggled more with extremely short and long shots when compared with those in the middle of the spectrum. Performance at the shortest yardage of 60 was significantly worse than 100 (p = .009), 120 (p = .019), and 140 yards (p = .047). Performance at longer distances of 160 and 180 yards was significantly worse than 100 (p = .020, p = .010, respectively) and 120 (p = .041, p = .020, respectively) yards, and driver performance was significantly worse than 80 (p = .001), 90 (p = .001), 100 (p < .001), 120 (p < .001), and 140 (p < .001) yards.

Table 1. Summary of performance by distance

Shot Length (Yards)	**Performance *Average***	**Performance *SD***
60	62.01	10.00
70	67.44	12.36
80	73.27	7.67
90	72.75	10.39
100	76.15	9.97
120	75.38	8.93
140	74.38	9.42
160	62.85	15.68
180	62.09	12.71
Driver	56.59	7.26

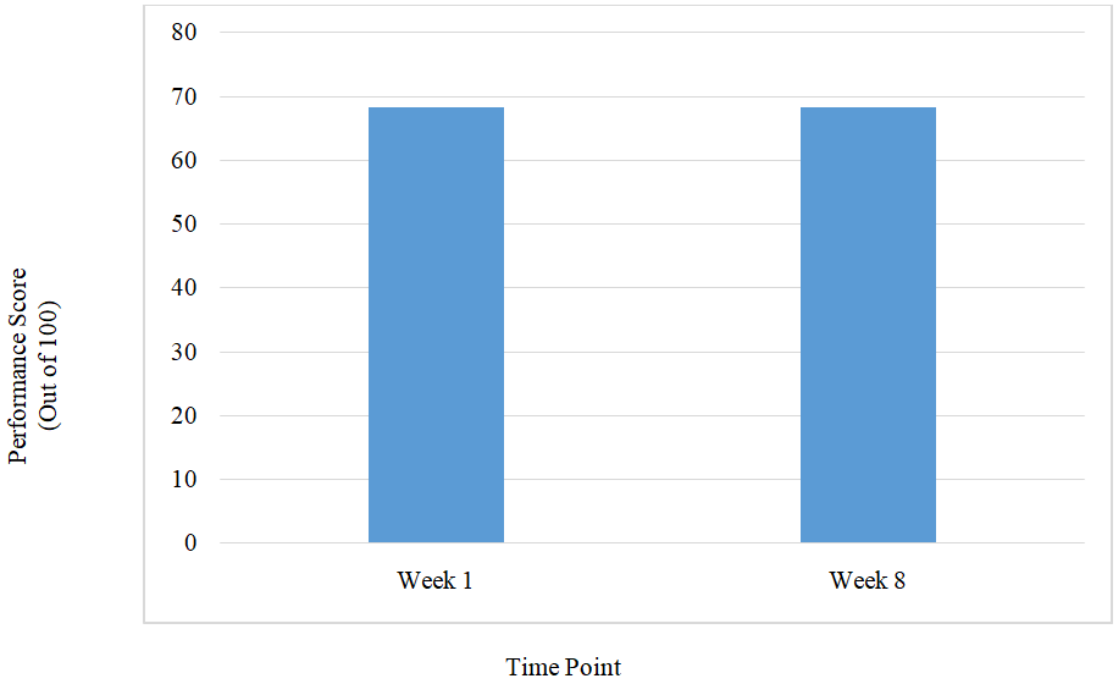

Figure 2. Average pretest and posttest scores on the Combine standardized assessment.

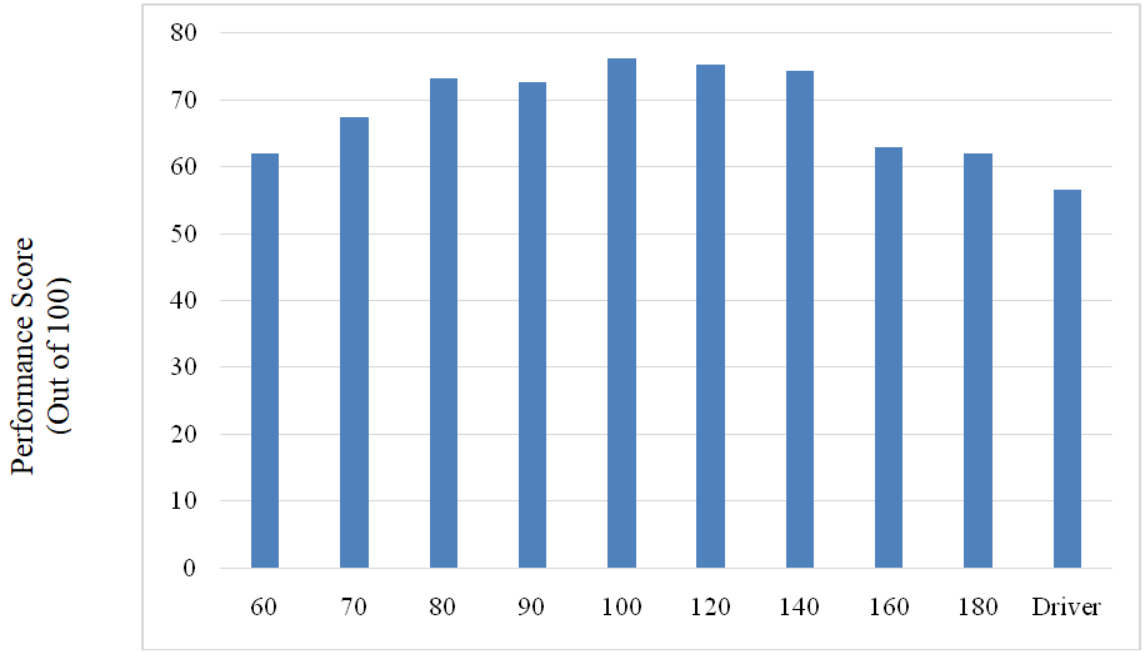

Figure 3. Summary of performance by distance.

Discussion

Findings and Implications

The current study examined the initial exposure of a collegiate golf team to the Trackman 4 indoor golf launch monitor along with scores on a standardized test of golf performance (i.e., "The Combine") that evaluated shot performance at various distances. The first hypothesis of this study suggested that scoring averages on the combine test would significantly improve as a result of eight weeks of training using the Trackman device. However, this hypothesis was not supported. Results suggest that eight weeks of orientation and practice with such technology do not significantly alter baseline testing results regarding shot quality (i.e., accuracy and distance control) at varying goal distances. Based on these results, it seems that more time is required with the device to significantly increase assessment scores. The second hypothesis of this study suggested that golfers would demonstrate lower scores on longer shots when compared with shorter shots. This hypothesis was partially supported. Findings indicate that there is a tendency for golfers in the current study to comparably excel at golf shots of intermediate lengths (i.e., 80 – 140 yards) while demonstrating higher levels of variability on shots outside of this range. Based on these results, it is suggested that collegiate golfers, or other performers of a similar skill level, fitting this demographic emphasize shots of shorter distances such as 60 or 70 yards and those of longer distances such as 160, 180, or further during practice sessions to improve consistency and versatility.

Broadie (2012) examined PGA Tour strokes gained, which is a performance statistic that was implemented by the tour in 2011 and constitutes a measure of each shot's contribution to a golfer's total score, and broke the analysis into three categories: long-game (i.e., shots greater than 100 yards), short-game (i.e., shots less than 100 yards), and putting [1]. Results indicated that elite performance on tour was associated with high levels of performance in all three aspects of the game; however, long-game shots accounted for approximately two-thirds of the score variability among PGA Tour golfers. As a result, it may be beneficial for elite golfers to practice and refine longer shots that tend to be more variable than shorter shots such as

those meeting or exceeding 160 yards. A golfer who excels on such longer shots may have an advantage against the field in a competitive setting. In the current study, participants demonstrated a decline in performance at shorter distances of 60 or 70 yards and longer distances such as those beyond 140 yards, but results indicated that the decline in performance was more pronounced at longer rather than shorter distances.

Lengthier shots require a higher swing speed than shorter shots and thus, place greater physiological demands on the golfer. As a result, the increased variability at longer distances is likely due to the biomechanical and physical challenges of hitting a longer club with force and precision and a phenomenon of motor control known as *the speed-accuracy tradeoff (SATO)*, which suggests that movements of increased speed (i.e., to generate force) are likely to be less accurate and vice versa [5]. As golfers use longer implements (e.g., a driver) instead of shorter implements (e.g., a wedge) to strike a golf ball, distance control and accuracy may be more of an issue for longer clubs due to the increased speed with which these clubs are likely to be swung and the resulting challenges associated with contact and timing.

On the opposite end of the spectrum, it is also important to consider the potential reasons for decreased performance levels at shorter distances such as those of 60 or 70 yards in the current study. The performance decrements at shorter distances are likely due to a practice structure that emphasizes the full swing rather than a partial swing. While there is variability in the distance generated by various clubs among golfers (e.g., one golfer may hit a 56-degree wedge 75 yards while another may hit the same club 100 yards), shots that are relatively short such as those ranging from 60 – 70 yards are less likely to require the full swing than longer shots; instead, a partial swing must be utilized to generate the appropriate force parameter. As this type of shot is generally practiced less than the full swing due to the limited frequency with which it will be comparatively utilized in a performance or competitive context, it not surprising that even elite golfers may tend to struggle with accuracy and consistency on this type of shot. The motor memory pathways for a swing with a length of 65% or 75% (i.e., a partial rotational movement) have not been rehearsed and established as well as those with a length of 100% (i.e., a full rotational movement) but with varying clubs in hand.

Wiseman and Chatterjee (2006) suggest that greens in regulation (GIR) and putting are two important variables for explaining the variability in scoring average at elite levels [8]. However, trends suggest a decline in the importance of driving performance due to the strengthening of an inverse relationship between driving distance and driving accuracy. In other words, golfers are seemingly able to get away with hitting a driver less accurately off the tee if they can hit the ball exceptionally far. Each golf course presents unique challenges to the players, but similarities in design and conditions are likely to require some combination of power and precision to generate scoring opportunities. Previous findings may speak to the need to develop power and distance in young golfers off the tee while also emphasizing the importance of accuracy on longer shots that range from 160 – 200 yards, as the current study would support. A golfer who is gifted both biomechanically and physically may be able to produce lengthy drives and “overpower” certain holes on a golf course, but he or she is not likely to avoid all approach shots that fall within the range of 160 – 200 yards. A few common examples might include a par-3 of 200 yards, a par-4 of 450 yards in which the average driving distance is approximately 275 yards, or a par-5 of 500 yards in which the average driving distance is approximately 300 yards. Likewise, longer hitters off the tee may find themselves with an approach shot of 50 – 70 yards into par-4 holes that are relatively short in overall length (e.g., 350 yards), so it is important for a player to realistically assess his or her typical performance off the tee to determine the types of approach shots that will typically be encountered in a round. Situations that are more commonly encountered should be emphasized in practice, especially considering that golf is a complex sport involving many types of shots and practice time is inherently limited, even for professional athletes. As potential

weaknesses in a player's game are more likely to be exposed as the level of competition increases, so eliminating these "gaps" in performance may become a higher priority as the athlete advances in skill.

Limitations

While the current study involved the use of modern technology with experienced golfers, the sample size of the current study was small. Thus, additional participants are needed to determine if these results generalize and transfer to other populations. Additionally, all golf shots were performed indoors, which may decrease external validity. For the current study, there were no measures of warm-up activities or physical exercise prior to golf shot execution. According to Wells and Langdown (2018), even elite golfers do not use consistent methods to warm-up prior to competition, and this aspect of preparation and performance seems to be highly variable and unique from one golfer to the next [7]. It may be the case that participants who used warm-up routines grounded in science were able to outperform those who utilized routines that were less detailed. As a result, more research regarding the physical preparation of golfers is needed.

Conclusions

The current study implies that experienced golfers may struggle with the execution of shots that are at extreme ends of a spectrum with regards to distance: those that are short (e.g., 70 yards or less) and those that are long (e.g., 160 yards or greater). Based on these results, it would be beneficial to know if similar trends may be observed in other populations such as amateurs who perform at novice or intermediate levels and professionals who perform at elite levels. Additionally, further research is needed to address the potential benefits of specific practice in these two areas of deficiency. Presumably, increased practice in these areas would result in a competitive advantage for the golfer who excels in areas that typically represent weaknesses for his or her opponents.

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Corresponding Author: Assistant Professor Kevin M. Fisher, Department of Physical Education and Sport, Central Michigan University. Email: fishe1k@cmich.edu