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A Study Of The Relationship Between Golf Performance And Depth Perception, Arm/Hand Steadiness, Grip Strength And Dynamic Balance

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A STUDY OF THE RELATIONSHIP BETWEEN GOLF PERFORMANCE AND DEPTH PERCEPTION, ARM/HAND STEADINESS, GRIP STRENGTH AND DYNAMIC BALANCE

RUOT

A Study of the Relationship Between Golf Performance and Depth Perception, Arm/Hand Steadiness, Grip Strength and Dynamic Balance

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BY

Charles W. Ruot

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Abstract

A STUDY OF THE RELATIONSHIP BETWEEN GOLF PERFORMANCE AND DEPTH PERCEPTION, ARM/HAND STEADINESS, GRIP STRENGTH AND DYNAMIC BALANCE

Charles W. Ruot

The purpose of this study was to determine if there was a significant statistical relationship between one's golf performance as measured by handicap scores and the elements of depth perception, arm/hand steadiness, grip strength and dynamic balance.

Thirty male right-handed golfers ranging in ages from 18 years to 70 years participated in the study. Each subject had an established handicap score for the year 1987 at the golf course of Mattoon Country Club, Mattoon, Illinois.

Each subject completed a written questionnaire concerning specific descriptive measures, level of golf experience and pre-test information. Scientific equipment measuring depth perception, arm/hand steadiness, grip strength and dynamic balance were administered to the subjects.

Pearson Product Moment Correlation Coefficients were used to determine any significant relationship between the handicap score and the laboratory test variables; and between the handicap score and the

data gathered through the questionnaire. A Pearson Product Moment Correlation Coefficient level of .355 was required to denote a statistically significant relationship at the .05 level of confidence.

The correlation coefficients indicated there was no statistically significant relationship between handicap scores and depth perception, arm/hand steadiness, grip strength and dynamic balance. However, there was a statistically significant relationship between handicap score and frequency of playing golf per week.

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Table of Contents

List of Tables

CHAPTER 1

Introduction

There has been much written on how to improve one's golf game. Since golf is a sport that involves different motor skills and physical traits there are equally as many theories on what is necessary to play good golf. There has been limited golf research reported in the scientific literature therefore this study attempted to determine some parameters that are related to golf performance.

Statement of the Problem

The purpose of the study was to determine if there was a significant relationship between one's golf performance, as measured by handicap scores, and the elements of depth perception, arm/hand steadiness, grip strength and dynamic balance.

Null Hypotheses

There is no significant statistical relationship between an individual's depth perception and his handicap score.

There is no significant statistical relationship between an individual's arm/hand steadiness and his handicap score.

There is no significant statistical relationship between an individual's grip strength and his handicap score.

There is no significant statistical relationship between an individual's dynamic balance and his handicap score.

Limitations

Since only 30 male right-handed golfers volunteered as subjects the study is likely not representative of all golfers.

Definition of Terms

The following terms have been defined for this study.

Dynamic Balance

Dynamic balance is the ability to maintain balance during vigorous movement.

Handicap Score

A deduction from a golfers gross score devised to match his score against par and to equate differential abilities of other players.

Par

A numerical standard of scoring excellence per hole, based on yardage and two putts per green.

CHAPTER 2

Review of Related Literature

There seems to be a limited amount of golf research in the scientific literature and comparatively less study concerning factors that are related to golf performance, other than the swing itself. The review of related literature presented here provides some information and background for the topics involved in this study.

Successful sport performance is not totally dependent on skill development but also on the psychological attributes and physiological characteristics of the athlete. Assessment of elite athletes who participate in a sport allows researchers to identify the variables associated with successful performance.

A study by Crews, et al (1986) identified the psychological and physiological attributes of a selected sample of elite female golfers. The subjects included 23 Ladies Professional Golf Association (LPGA) tour players who ranged in ranking from 1 to 135 on the 1981 money list (LPGA Player Guide, 1982). The golfers ranged in age from 22 to 49 years, with a mean age of 33 years. The average score from one year of competitive play was used as the primary criterion of performance. The

subjects were tested on three practice days prior to the start of a tournament.

Eight physiological tests were conducted on the subjects as well. The physiological measurements included resting heart rate and blood pressure, height, weight, grip strength in both the dominant and non-dominant hand, body density, percent body fat and maximal oxygen consumption. Analysis of the data indicated that percent body fat, locus of control, personality type and relative strength predicted 61 percent of the variation in the average score among participants. The authors suggested that elite golfers should not limit their training to golf skills but should also include physiological and mental training.

In addition, two psychological inventories, the Jenkins Activity Survey for Health Prediction Form and the Rotter (1966) Internal-External Control Scale (I-E), were administered to the subjects. The Jenkins Activity Survey measured personality type. The Rotter Scale measured locus of control-the perception that rewards and punishments in life are a result of luck, chance or fate, as compared with a belief that a person controls his own life and destiny.

In another study by Crews and Boutcher (1984) 11 male and ten female collegiate golfers were tested on various physiological characteristics. Results between groups were compared with established

norms. Male golfers possessed half the body fat percent, twice the grip strength and over twice the leg strength of female golfers.

	Males	Females
Percent Body Fat (%)	10.3	22.2
Grip Strength Rt. Hand (kg)	55.9	32.7
Grip Strength Lt. Hand (kg)	53.6	32.1
Leg Strength-Hamstrings (ft-lb)	105.0	45.8
Leg Strength-Quadriceps (ft-lb)	275.0	23.9

Compared with other collegiate athletes, females had average body fat percentage while males had lower than average percent fat. Both males and females had good to fair grip strength. The investigators concluded that lower percent body fat and increased grip and leg strength may contribute to golf performance.

Authors Jewell (1979) and Rotella and Bunker (1981) have commented on the importance of cognitive and behavioral strategies utilized immediately before the execution of motor skills in sports such as golf, archery, tennis, and foul shooting. It has been suggested that these pre-shot routines, which consist of set patterns of thoughts and actions, may be used by athletes as an aid to enhance performance.

Keele (1973) suggested that these pre-shot routines may help performance by diverting attention from irrelevant information, therefore focussing thoughts away from the performance of a well-learned

skill, or helping to establish the optimal physiological and mental state for the following task, as stated by Schmidt (1981).

Visual and kinesthetic feedback are important sources of sensory information in the learning and performance of motor skills. Researchers have attempted to identify the role of sensory information in performing various motor tasks.

In a study on golf putting, Cockerill (1980) compared high and low skilled golfers' performances under two conditions of visual feedback. Golfers putted by looking at the ball in one condition and by looking at the hole in the other condition. Although high-skilled golfers were more accurate than low-skilled golfers, there was no difference between the two feedback conditions.

In a similar study Wannebo and Reeve (1984) further examined the role of sensory information in golf putting. Twenty-two subjects classified as either high or low in skill, putted under three sensory conditions at two distances. The distances were five and 15 feet and the conditions were relevant visual cues of looking at a ball, no visual cues because of blindfold and irrelevant cues of looking at an offset marker. Results showed that relevant visual cues encouraged greater accuracy than did no visual cues or irrelevant cues. The authors

concluded that relevant visual cues are an important source of sensory information in golf putting.

In a review of research conducted during the 1952 Olympic Games, Graybiel et al (1955) reported moderate correlations between athletic performance and depth perception. Drowatzky (1975) makes reference to a comprehensive investigation by Miller (1960) which indicated that depth perception was one of the main factors differentiating outstanding sports performers from low-skilled persons.

Strength, in varying degrees, underlies success in all motor performance. A weakness in any area of the body may limit the coordination and effort needed for the performance of a skill. Specifically in golf it is necessary that the grip pressure exerted by the golfer be sufficient to withstand the centrifugal force developed by the club-head during the swing. Grip pressure is developed by activating the muscles in the lower arm through the tendons in the wrist. Consequently Cochran and Stobbs (1968) in a study involving the analysis of the golf swing, found that increasing grip pressure decreases the mobility of the wrist activity at ball club-head impact. These conflicting requirements of wrist behavior near impact demonstrate that the grip pressure is an important factor to a successful golf swing.

The ability to maintain body position, often referred to as balance, is necessary for the successful performance of sports skills. Balance required for each skill varies, and is unique to the skill employed. Richards, et al (1985) used a forceplate to test 20 male right handed golfers for two-dimensional weight transfer patterns during the golf swing. The results showed there to be a specific weight transfer pattern during the golf swing while maintaining the necessary balance.

Summary

The amount of previous research completed concerning golf performance limits the breadth of this chapter. However, it is evident that there is a basis for further research into this area. Percent body fat and grip strength seem to be the most related factors at this time. It also appears that there are other factors related to golf performance as demonstrated by their importance to general sports performance and motor skills. The the choice of elements for this study however, were dependent upon the the availability of equipment in the Human Performance Laboratory at Eastern Illinois University.

CHAPTER 3

Methodology

This chapter describes the subjects, preliminary procedures, and the testing procedures used in the study.

Subjects

Thirty male right-handed golfers who participated in the study ranged in age from 18 years to 70 years. Each subject had established a handicap score for the golf course at the Mattoon Country Club, Mattoon, Illinois. A minimum of five regular rounds (18 holes) of golf played during 1987 was needed to establish the handicap score. A description of the subjects has been presented in Table 1.

Preliminary Procedures

Each subject read and signed an informed consent form (Appendix A) prior to his participation in the study. Next, the subject completed a written questionnaire (Appendix B) concerning specific descriptive measures, level of golf experience and pre-test information.

Table 1

Description of the Subjects

Characteristic	Mean	Units
Handicap Score	14.53	Strokes (+) above or (-) below par
Age	41.40	years
Height	5'8"	feet/inches
Weight	171.66	pounds
Age First Played Golf	17.20	years
Frequency of Playing Golf/week	2.90	Nine holes or more

Testing Procedures

Testing was conducted June 13 through 19, 1987 in a room adjacent to the men's locker room, at the Mattoon Country Club in Mattoon, Illinois. Tests were administered to subjects on non golfing days or prior to their play on any given day so as to factor out any fatigue which may have been present as the result of a previous round of golf.

The testing procedure consisted of four different tests administered in the following order: depth perception, left and right arm/hand steadiness, left and right grip strength and dynamic balance. Verbal instructions were provided for the subjects before each test. Test results were shared with the subjects at the completion of the entire test battery.

Depth Perception

A Lafayette Instrument Company (Lafayette, Indiana) Depth Perception Box was placed on a table that was 36 inches tall. The subject was then seated in a chair positioned ten feet from the box. Strings attached to two vertical wooden dowel rods mounted inside the box, were used by the subject to adjust the position of the rods. When the subject perceived the two rods to be at the same depth or equidistant from the subject, the investigator measured the amount of

depth perception error using the scale on the top of the box. Measurements were recorded to the nearest .01 (1/100) of a centimeter. The subject was given two trials with the average of the two scores being used for statistical analysis.

Arm/Hand Steadiness

A conventional metal steadiness tester with a stylus and nine holes placed according to decreasing diameter size was used to determine arm/hand steadiness. The device was made by the Lafayette Instrument Company (Lafayette, Indiana).

The subject was given a maximum of 90 seconds to attempt all nine holes. He was seated in a chair at a comfortable arm's length away from the testing device placed on a table approximately 30 inches high. The subjects were not allowed to rest the arm or hand being tested on the table or use the opposite arm to assist. The subject was given a 15 second warm-up practice period prior to the right arm/hand trial and prior to the left arm/hand trial.

When the stylus came in contact with the side of a hole, it completed an electric circuit to activate a counter. The counter was used as a way to measure the arm/hand tremor during the test. The objective of the test was to insert the stylus into each hole to a depth

of at least one inch deep, as signified by a black mark on the stylus, and then remove it from the hole, making as few contacts as possible.

The total number of contacts, as measured by the counter, for the right arm/hand trial and the left arm/hand trial was then used for statistical analysis.

Grip Strength

A steel tension hand dynamometer made by the Ann Arbor, Michigan Instrument Works Company (Ann Arbor, Michigan) was used to measure alternately the grip strength of the right and then the left hand. The subject, standing upright with arms at his side, squeezed the handle of the dynamometer to his maximum ability. Two trials were given for each hand and measurements were recorded to the nearest pound. The best score for each hand was then used for statistical analysis.

Dynamic Balance

A stabilometer made by the Lafayette Instrument Company (Lafayette, Indiana) was used to measure dynamic balance. This wooden board-like device mounted on a 3'x 4' wooden platform was electrically connected to three clocks which recorded the total amount of time the subject stayed in balance. The stabilometer was calibrated at three and nine sixteenth (3 9/16) inches, meaning the subject was considered to be "in balance"

as long as the balance board on which he was standing did not deviate from the parallel described by the 3 and 9/16 inches calibration point.

The subject was given a brief practice period on the stabilometer board before the actual testing. Three, 15 second trials were given with the objective of the test being to stay in balance for as long as possible during each trial. The subject stood in an upright position, bending at the knees if desired. He was allowed to use his body in any fashion he chose while balancing. The feet were required to remain in the pre-designated foot pad areas located at approximately shoulder width on the balance board. Balance times were recorded to the nearest .01 (1/100) of a second. The best score of the three trials was then used for statistical analysis.

CHAPTER 4

Analysis of the Data

The purpose of this study was to determine if there was a significant relationship between one's golf performance, as measured by handicap scores, and his depth perception, arm/hand steadiness, grip strength and dynamic balance.

Thirty male right-handed golfers with established handicap scores participated in the study. Each subject's level of depth perception, arm/hand steadiness, grip strength and dynamic balance were measured using laboratory equipment. The results of the tests were recorded and then used for statistical analysis.

Statistical Analysis

The raw data (Appendix C) were entered into a MICC terminal at the Eastern Illinois University Computer Center and analyzed using the SPXXs system. Pearson Product Moment Correlation Coefficients (r) were used to determine any significant relationship between the handicap scores and each test variable. Pearson Product Moment Correlation Coefficients were also used to determine if any significant relationship existed between the handicap score and the data gathered

through the questionnaire. A Pearson Product Moment Correlation Coefficient level of .355 was required to denote a statistically significant relationship at the .05 level of confidence. (Cohen and Holliday, 1979)

Findings and Discussion

Means and Standard Deviations for Elements Tested

The mean and standard deviation values for the tested variables are shown in Table 2. According to the data in Table 2 the subjects had an average depth perception error of .620 centimeters from the equidistant point of the dowel rods inside the box. It also appears the right hand grip strength score was greater than the left as demonstrated by the 113.433 pounds in the right hand compared to 102.633 pounds in the left hand. The right arm and hand seemed to be more steady, according to the fewer number of contacts during the test with the right arm and hand than the left arm and hand. On the average, the subjects could only stay in balance 5.86 seconds out of a total of 15 seconds.

Since no norms were available for the elements tested, it would seem inappropriate to comment about the magnitude of the scores.

Table 2

Means and Standard Deviations for Elements Tested

Factors	Mean	±SD	Units
Depth Perception	.620	.692	Centimeters
Left Arm/Hand Steadiness	25.6	10.368	Number of Contacts
Right Arm/Hand Steadiness	22.6	7.243	Number of Contacts
Left Grip Strength	102.633	21.938	Pounds
Right Grip Strength	113.433	19.532	Pounds
Dynamic Balance	5.86	2.248	Seconds in Balance

Correlations: Handicap Scores
Versus Elements Tested

The relationships between handicap scores and the elements tested are shown in Table 3. The correlation coefficients indicate there is no statistically significant relationship between handicap scores and depth perception, arm/hand steadiness, grip strength and dynamic balance. Therefore the null hypotheses must be accepted.

These findings are not consistent with some of the basic concepts suggested in previous sports skills research. In the review of literature it was found that a comprehensive investigation by Miller (1960) indicated that depth perception was one of the main factors differentiating outstanding sports performers from low-skilled persons. Wannebo and Reeve (1984), in a study examining the role of sensory information in golf putting concluded that relevant visual cues are an important source of sensory information in golf putting.

Crews, et al (1986) tested elite female golfers for psychological and physiological attributes that were related to their performance. The investigators determined that relative strength was one of the predictors of variation in scores among participants. In another related study Crews and Boutcher, (1984) tested male and female collegiate golfers on various physiological characteristics. The

Table 3

Relationship Between Handicap Scores and Elements Tested

Factors	Correlation Coefficient (r)
Depth Perception	.136
Left Arm/Hand Steadiness	-.037
Right Arm/Hand Steadiness	.013
Left Grip Strength	.201
Right Grip Strength	.194
Dynamic Balance	-.093

investigators concluded increased grip strength may contribute to improved golf performance.

Finally, Richards, et al (1985) found there to be a specific weight transfer pattern during the golf swing while maintaining the necessary balance.

The fact that the results from the current study conflict with some previous research findings could be attributable to several different factors. First of all there appears to be limited scientific research completed considering the parameters that may predict the successful golfer. Secondly, the researcher in this study used slightly different methodology and equipment thus making comparisons with other investigations rather difficult. Thirdly, grip strength differences certainly could be explained by motivational extremes. Finally, individual subject variability and the small sample size could account for the lack of agreement with other golf studies.

Other Observations

Secondary to the variables tested using laboratory equipment and more as a point of interest, the investigator chose to perform some additional correlations on descriptive measures gathered through the questionnaire. Table 4 reveals the relationships between the handicap

scores and the age, height, weight and frequency of playing golf per week for subjects in the study.

Age and height do not have a statistically significant relationship to the handicap score with correlation coefficients of .242 and .069 respectively. Interestingly enough, the frequency of playing golf per week had a statistically significant relationship to the handicap scores, with a correlation coefficient of -.422. This inverse relationship indicates that the more an individual plays, the more he is liable to have a lower handicap score. The relationship of body weight to the handicap score was not statistically significant, though it was very close to the value of .355 required for statistical significance in this study.

The fact that frequency of playing golf per week was found to have a statistically significant relationship to handicap score is not too surprising. One would think that the more often golf skills are practiced through playing that performance should improve.

Table 4

Relationship Between Handicap Score and Individual Descriptive Measures

Individual Descriptive Measures	Correlation Coefficient (r)
Age	.242
Height	.069
Weight	.333
Frequency of Playing Golf/Week	-.422

CHAPTER 5

Summary, Conclusions and Recommendations

The purpose of this study was to determine if there is a significant statistical relationship between one's golf performance as measured by handicap scores and the elements of depth perception, arm/hand steadiness, grip strength and dynamic balance.

Thirty male right-handed golfers ranging in ages from 18 years to 70 years participated in the study. Each subject had an established handicap score at the golf course of the Mattoon Country Club for the year 1987.

Subjects completed a written questionnaire concerning specific descriptive measures, level of golf experience and pre-test information. Laboratory testing equipment measuring depth perception, arm/hand steadiness, grip strength and dynamic balance was used to test the subjects.

Pearson Product Moment Correlation Coefficients were computed to determine any significant relationship between the handicap score and the elements tested. Other correlations between the handicap score and the data gathered through the questionnaire were determined. A Pearson

Product Moment Correlation Coefficient level of .355 was required to denote a statistically significant relationship at the .05 level of confidence.

Conclusions

The correlation coefficients indicated there was no statistically significant relationship between handicap scores and depth perception, arm/hand steadiness, grip strength and dynamic balance. However, there was a statistically significant relationship between the handicap score and the frequency of playing golf per week.

Recommendations

From the results of this study and in light of the fact there is limited golf research reported in the scientific literature the following recommendations are made:

1. More golf studies need to be done using scientific equipment for measurements and assessment of performance rather than field tests and subjective observations.

2. A golf study with a large number of subjects should be performed utilizing Multiple Regression Analysis to determine which elements are most important to successful golf performance.

APPENDICES

APPENDIX A

INFORMED CONSENT

I, _____, agree to participate in the research project conducted by Chuck Ruot.

The purpose of this study is to determine if depth perception, arm/hand steadiness, grip strength and dynamic balance are related to performance in golf. I understand my participation will require approximately 15 minutes of time on one occasion. The benefit of this study is to learn my personal abilities in these measured parameters and how they may be related to my golf game. The risks involved are minimal. I may experience some slight arm and leg fatigue. There is always a change of falling when attempting to balance on an unstable object (stabilometer). If I have any questions, Chuck Ruot has offered to answer them. I consent to the anonymous use of my information in this research project and in future related studies. Any photographs or films taken during this study may be used in the research report and/or lectures concerning this study.

I have read the above statements and understand all of the associated benefits and risks of the study. I freely and voluntarily consent to participate in this study.

Date: _____ Date: _____

Volunteer: _____ Witness: _____

APPENDIX B

GOLFER'S PROFILE

1. NAME _____

For the following questions circle the single most appropriate answer.

DESCRIPTIVE MEASURES

2. AGE (years)
20-27 28-35 36-43 44-51 52-59 60-67 68 & over

3. HEIGHT (feet/inches)
4'10"-5'1" 5'2"-5'5" 5'6"-5'9" 5'10"-6'1" 6'2"-6'5"
6'6"-6'9" 6'10"or more

4. WEIGHT (lbs)
<130 130-149 150-169 170-189 190-209 210=229 230 or more

GOLF EXPERIENCE

5. At what age (years) did you first play golf?
5-13 14-22 23-31 32-40 41-49 50-58 59 & over

6. In a typical golf season during the last 5 years how many times per week did you play?
0 1 2 3 4 5 6 or more

7. How many round (9 holes or more) have you played this year?
0-2 2-4 4-6 6-8 8-10 10-12 12 or more

APPENDIX B (continued)

GOLFER'S PROFILE

PRE-TEST INFORMATION

8. Have you consumed any of the following items or engaged in the following activities within the last 3 hours? If so then circle the appropriate time; if not then circle the response none.

	TIME PRIOR TO TEST (hours: minutes)						
Coffee	None	:30	1:00	1:30	2:00	2:30	3:00
Tea	None	:30	1:00	1:30	2:00	2:30	3:00
Candy	None	:30	1:00	1:30	2:00	2:30	3:00
Alcohol	None	:30	1:00	1:30	2:00	2:30	3:00
Snack or meal	None	:30	1:00	1:30	2:00	2:30	3:00
Smoked a cigarette . . .	None	:30	1:00	1:30	2:00	2:30	3:00
Fatiguing exercise or work	None	:30	1:00	1:30	2:00	2:30	3:00
Played golf	None	:30	1:00	1:30	2:00	2:30	3:00

APPENDIX C

Raw Data: Handicap Scores and Tested Variables

Subject	Handicap Score	Depth Perception cm of Error	Arm/Hand Steadiness Right Contacts	Arm/Hand Steadiness Left Contacts	Grip Strength Right Pounds	Grip Strength Left Pounds	Dynamic Balance Seconds
1	0	.95	19	9	92	69	8.31
2	18	.8	19	15	117	100	12.70
3	6	.35	23	33	95	70	6.99
4	19	1.4	22	27	135	117	4.74
5	18	1.2	15	15	121	117	5.10
6	5	1.5	12	18	95	84	3.50
7	26	2.55	27	42	106	119	3.90
8	19	1.25	31	45	99	98	5.04
9	27	1.0	19	22	94	91	3.70
10	69	.85	35	50	95	90	4.19
11	18	-.05	33	32	94	95	2.34
12	20	.45	32	28	128	151	5.65
13	8	.45	27	49	107	82	5.57
14	7	-.05	22	35	110	94	7.24
15	15	.8	27	28	135	131	4.93

APPENDIX C (continued)

Raw Data: Handicap Scores and Tested Variables

Subject	Handicap Score	Depth Perception cm of Error	Arm/Hand Steadiness Right Contacts	Arm/Hand Steadiness Left Contacts	Grip Strength Right Pounds	Grip Strength Left Pounds	Dynamic Balance Seconds
16	10	.7	26	24	126	111	5.35
17	27	.3	23	20	140	122	6.72
18	30	-.50	18	15	147	111	5.56
19	14	.35	32	23	139	120	10.58
20	8	.3	16	14	91	89	7.80
21	11	.4	28	23	122	106	3.00
22	1	-.05	22	22	132	132	5.19
23	10	.8	18	17	112	112	6.11
24	6	.6	20	27	142	132	4.88
25	20	1.6	11	21	122	104	8.35
26	13	-.50	9	18	127	120	8.09
27	19	.7	35	32	70	65	5.61
28	15	-.85	26	22	90	82	3.34
29	18	.95	19	22	100	61	6.95
30	22	.35	12	20	120	104	4.36

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