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Suttie, James Kenneth

A BIOMECHANICAL COMPARISON BETWEEN A CONVENTIONAL GOLF SWING/LEARNING TECHNIQUE AND A UNIQUE KINESTHETIC FEEDBACK TECHNIQUE

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A BIOMECHANICAL COMPARISON BETWEEN A CONVENTIONAL GOLF SWING/LEARNING TECHNIQUE AND A UNIQUE KINESTHETIC FEEDBACK TECHNIQUE

James Kenneth Suttie

A dissertation presented to the
Graduate Faculty of Middle Tennessee State University
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for the degree Doctor of Arts

May, 1983

A BIOMECHANICAL COMPARISON BETWEEN A CONVENTIONAL GOLF SWING/LEARNING TECHNIQUE AND A UNIQUE KINESTHETIC FEEDBACK TECHNIQUE

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ABSTRACT

A BIOMECHANICAL COMPARISON BETWEEN A CONVENTIONAL GOLF SWING/LEARNING TECHNIQUE AND A UNIQUE KINESTHETIC FEEDBACK TECHNIQUE

James Kenneth Suttie

This study was designed to determine the effectiveness of two methods of teaching the golf swing to beginning golfers. One group of beginners was taught the golf swing using conventional methods of instruction while the other group was taught using a combination of kinesthetic techniques. In order to compare the golf swing mechanics of both groups before and after instruction it was necessary to compare the filmed results of each beginner to a model golf swing. The model was determined by computing the mean results of 1,928 linear and angular measurements of the swings of ten professional golfers in what was thought to be the ten most important positions of the golf swing. Two 16 mm high speed cameras were used to simultaneously record the movement from the side and behind the performer. Measurements were taken of nineteen body joints and segments, as well as the ball and club, at each of the ten positions of the swing. Results produced 1,928 linear and angular displacement, velocity, and acceleration scores for each performer. The beginning golfers were filmed before instruction (pretest) and after instruction (posttest) using the same procedures used with the professional golfers. The beginners' values were then compared to the swing model's values. Statistical analyses (*t* test) indicated that, although both groups improved significantly over the ten-week instructional period, the group that learned the kinesthetic feedback technique brought about significantly greater improvement in golf swing mechanics than did the group that learned by using conventional methods.

DEDICATION

The writer wishes to dedicate this work to his deceased father, Dr. Grant Suttie. It was the writer's father who introduced him to the great game of golf. It was the writer's father who gave up much so that his children would have opportunities that many persons never have.

It was the writer's father who always encouraged the writer to try to be the best. Dad often said, "Life only requires that you try to do your best. If you have done your best, then you have contributed to both society and yourself at the same time and nothing else can be expected of you." It is hoped that this project will contribute to society in memory of Dad.

ACKNOWLEDGEMENTS

The author wishes to express appreciation to the many people who contributed to the completion of this project. He wishes to express his thanks to his major professor, Dr. Jon MacBeth, for his suggestions, enthusiastic support and constant encouragement.

The writer also wishes to thank Dr. A. H. Solomon, second reader on the committee, for helping develop procedures for the study and for introducing the writer to the field of biomechanics. Dr. Solomon's invaluable assistance, especially toward the end of this project, was directly responsible for its successful completion.

Thanks also go to Dr. Wallace Maples for his professional advice and suggestions.

Special thanks go to Dr. Ralph Mann at the University of Kentucky. Dr. Mann's expertise in computers and film analysis made the ideas for this study become a reality. Dr. Mann's consuming interest in the project, as well as his interest in the writer as a student, resulted in a learning experience for both of us.

The writer would also like to thank the P.G.A. tour directors for giving him permission to film ten professional golfers at the Heritage Golf Classic.

Also, the writer would like to thank Dr. James Covington, a true friend, for his help and counsel. Special thanks also go to Wilma Grant, the writer's typist, for her sincere interest in the quality of this dissertation.

And, finally, the writer wishes to express his thanks to his mother, Mrs. Grant Suttie, his sister, Mary Ann, and his brothers, Tom and Mike. Their financial sacrifices and emotional support really enabled dreams of this study to become a reality.

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CHAPTER ONE

Introduction

Experts agree that the performance of an efficient golf swing is one of the more difficult motor skills to master. This is particularly true when teaching the golf swing to beginners. Because of this, golf instructors have continued to search for a better teaching method which would contribute to the development of the proper golf swing.

Conventional golf instruction places the main emphasis on ball striking and ball flight results in order to make swing corrections. Motor learning experts refer to this feedback information as "Knowledge of Results."[1] The emphasis on feedback information concerning the flight of the ball may, however, inhibit the learning of the correct swing pattern. This is thought to occur because of the beginner's tendency to focus on the criterion of success, which is the flight of the ball. Since the measure of success is linked directly to striking the ball, the emphasis is placed on projecting the ball and not on developing a biomechanically efficient swing pattern. This

[1] Richard A. Schmidt, Motor Control and Learning: A Behavioral Emphasis (Champaign, Ill.: Human Kinetics Publishers, 1982), p. 481.

problem, as well as the fallacy of linking the flight of the ball to proper swing mechanics, is summarized by Cochran and Stobbs when they state:

> The beginner is not really able to discriminate between a swing that caused a good shot and a swing that caused a poor shot. The beginner's feedback loop is very unreliable because there are numerous ways he may produce the same shot. Since he hasn't established a consistent motor pattern yet, he really doesn't know what a good golf swing is.[2]

The usefulness of the information available from the flight of the ball (knowledge of results) is limited since success in beginners is not highly correlated to this criterion.

Since focusing on the results of the swing may not be an effective teaching approach, a different emphasis could be utilized. To affect efficiently the result of the activity (ball flight), there should be a focus upon the cause. Thus, the actual swing pattern should be the focus of the teaching efforts. Since the development of a good swing pattern largely depends upon repetition and practice, it should not be changed each time the ball flight result is not acceptable to the learner. The focus of the learner should be directed, instead, toward feedback information emphasizing the correct swing pattern. Cochran and Stobbs vividly point this out when they state:

> The beginner may think he has made a good swing, but the ball may dribble on the ground and only go a few

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[2]Alastair Cochran and John Stobbs, The Search for the Perfect Swing (Philadelphia: J. B. Lippincott Co., 1968), p. 107.

> yards into the bushes. Based on this feedback information and the verbal corrections his instructor gives him, he will probably change his entire motor pattern to what he thinks is his new "corrected form." With his "so-called" corrected form, he may pull hook the ball 160 yards down the left center of the fairway. Because his feedback loop is not conditioned yet, the beginner doesn't know that his first swing, when he topped the ball off into the bushes, was actually a better swing than his corrected swing where he hit the ball 160 yards down the left center of the fairway.[3]

Therefore, the ultimate boal of learning an efficient golf swing might be to learn the correct swing first and then concentrate on striking the ball.

Golf instructors might be more successful in teaching an efficient swing pattern to beginners if they were to concentrate on what Gentile calls "Knowledge of Performance" and its associated feedback mechanisms.[4] This type of feedback technique relies on verbal cues from the instructor indicating the quality of swing performance. When using this type of performance feedback information, it is not necessary to use a golf ball or rely on ball flight information in order to make swing corrections. Each student is taught to focus all of his attention on the performance of a correct pattern and the kinesthetic feelings associated with that pattern. Eventually, after

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[3]Ibid.

[4]A. M. Gentile, "A Working Model of Skill Acquisition with Application to Teaching," Quest, 17 (January 1972), 8.

continued verbal feedback from the instructor as to the quality of the swing, the student comes to rely on subjective reinforcement from his kinesthetic feedback mechanisms.

The golf swing requires only one movement pattern to be learned. Practice of the pattern should be consistent and repetitive in developing an efficient swing pattern. This type of skill is classified as "closed" because during the performance of the skill the environmental conditions are stable and stationary, and the learner is attempting to become consistent in producing one movement pattern.[5] This "closed" skill classification is important. Gentile[6] and Marteniuk[7] have suggested that knowledge of performance feedback information is much more useful than knowledge of results feedback information when learning this type of skill. Research has shown that, when utilizing knowledge of performance information in learning a closed skill like the golf swing, it is important that beginners receive verbal information regarding the correct biomechanical

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[5]E. C. Poulton, "On Prediction in Skilled Movement," Psychological Bulletin, 54 (November 1957), 472.

[6]Gentile, p. 21.

[7]R. G. Marteniuk, Information Processing in Motor Skills (New York: Holt, Rinehart and Winston Publishers, Inc., 1976), p. 40.

pattern[8] and not base their swing corrections on ball flight results.

Statement of the Problem

The purpose of this study was to compare and assess the quality of efficient golf swing performance between two methods of teaching golf. Two beginning golf classes at Middle Tennessee State University were used for this study. A control group was taught a conventional golf swing/learning method while an experimental group utilized a kinesthetic feedback/learning technique. The control group, using a golf ball, made swing corrections based on feedback that they received from ball flight information (KR). The experimental group, without the use of a golf ball or ball flight information, based their swing corrections on verbal feedback information regarding the quality of the performer's swing (KP).

The qualities of swing performance among the two groups were determined through biomechanical analyses. All of the subjects in the study were compared to a swing model that contained the components of excellent swing mechanics.

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[8] S. A. Wallace and R. W. Hagler, "Knowledge of Performance and the Learning of a Closed Motor Skill," Research Quarterly, 50 (May 1979), 265-271.

Need for the Study

Most conventional teaching methods evaluate the performance of the golf swing on knowledge of results information. In regard to this, Cochran and Stobbs point out "that basing movement execution on previous ball flight results seems to be a rather unreliable source of error information."[9] Schmidt concurs with Cochran and Stobbs when he states:

> The hope is that the information about movement outcome will eventually (in some way) lead to the most effective movement pattern in the subject. This use of outcome information may seem odd to those of us who have had extensive practice at some sport or athletic activity. It would seem far more effective to provide information about the patterns of movement the person made rather than just the outcome of that movement. For example, a coach might tell a gymnast to "pull earlier" or to "pike harder" after a movement, referring to a particular pattern of action that the learner is attempting to produce. Such information about the movement pattern, rather than outcome of those movements in the environment is termed knowledge of performance.[10]

Because of this, there is a need to develop a new golf instructional method that would emphasize the quality of the swing pattern and not the results of the swing pattern. Research is needed to determine if beginning golfers could learn the golf swing more effectively utilizing knowledge of performance information in the absence of knowledge of results information. This method assumes that the presence

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[9] Cochran and Stobbs, p. 107.

[10] Schmidt, p. 533.

of the ball and the resulting ball flight information would not serve as useful instructional tools in developing a golf swing in the early stages of learning. Utilizing this method, the instructor would emphasize movement execution information (the swing pattern) in the absence of movement outcome information (ball flight results).

There is also a need to develop better ways in which the performance of the golf swing can be scientifically measured. Traditionally, golf instructors have measured the quality of the movement pattern based on outcome information related to the flight of the ball. For example, the instructor falsely assumes that because the golf ball goes the required distance and direction the movement pattern must have been biomechanically correct. This is not necessarily true since there are many biomechanically inefficient ways to produce an acceptable degree of a desired result.

There have also been attempts by golf instructors to evaluate the beginner's golf swing through the use of rating systems. When using this method, the instructor relies on his sense of vision and his knowledge gained from years of teaching experience. This method of rating the beginner's golf swing is little more than an opinionated guess and seems to be a very subjective and unscientific method of evaluation.

An attempt was made in this investigation to find a more effective and scientific method of evaluating the movement pattern of the golf swing. Using biomechanical film analysis techniques, the proper mechanics of the golf swing were determined, then compared to each performer. This method of movement analysis has long been used to identify the performance characteristics of skilled performers; however, it has not found acceptance as a tool to measure changes in movement patterns produced by instruction due to the enormous amount of time involved in the analysis procedure. With the advent of computers and faster data-reduction techniques, researchers are beginning to look at biomechanical analysis techniques as a potential tool for the measurement of motor skill performance.

Also of significance to this study was the attempt to provide indications of the most effective way of teaching a closed motor skill to beginners. Recently, motor learning experts have concluded that, when teaching beginners a closed motor skill, the movement pattern of that skill should be emphasized rather than the result of that movement pattern.[11] This conclusion has been reached due to the

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[11]Gentile, p. 21; P. Del Rey, "Feedback Provided Through Videotape Display," The Physical Educator, 29 (1972), 118-119; G. E. Hampton, "The Effects of Manipulating Two Types of Feedback--Knowledge of Performance and Knowledge of Results--in Learning a Complex Motor Skill," Diss. Columbia Univ., 1970; John N. Drowatzsky, Motor Learning: Principles and Practice (Minneapolis: Burgess Publishing Co., 1975),

belief that this type of feedback would emphasize the proprioceptive information that the learner receives from his body. For this information to be effective, however, the beginner should base all of his learning on a model of correctness and be continually provided with concurrent and terminal verbal cues about the efficiency of the movement pattern.[12]

Although all the sensory modes are important when learning a given skill, most skill learning emphasizes one particular sensory mode. Since the learning of the golf swing is a closed skill, and research has indicated that the successful performance of these types of skills can be carried out without reference to the environment,[13] it would seem important to emphasize kinesthetic feedback information rather than to rely on visual information when learning this skill. Accordingly, this research attempted to indicate what sensory feedback mechanisms to emphasize when teaching the golf swing to beginners.

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pp. 93-100; Wallace and Hagler, p. 271; Marteniuk, p. 40; K. M. Newell, "Knowledge of Results and Motor Learning," in J. Keogh and R. S. Hutton (eds.), Exercise and Sport Science Reviews (Santa Barbara, Calif.: Journal Publishing Affiliates, 1976), p. 68.

[12] Gentile, pp. 2-23.

[13] Poulton, p. 472.

Hypothesis

For the purpose of this study, the following null hypothesis was developed:

There will be no significant difference between the conventional golf swing instructional technique (control group) and a kinesthetic feedback technique (experimental group) as determined by biomechanical analyses.

Delimitations

For the purpose of this study, the following delimitations were recognized:

1. This study was delimited to twenty male students between the ages of 18 and 35 who were classified as beginning golfers. These twenty subjects were randomly selected from two beginning golf classes at Middle Tennessee State University.

2. This study was delimited to include instruction from only an experienced golf instructor.

3. During this study the investigator taught both classes with equal enthusiasm so as not to bias the results.

Limitations

For the purpose of this study, the following limitations were recognized:

1. During this study both classes were encouraged to practice during class at an equal intensity level.

2. During this study both groups of beginning golfers were told not to practice outside of class.

Implications for Teaching

The primary reason beginners have such difficulty in learning the golf swing is their inability to determine what their swing errors are and how to correct those errors. Traditionally, golf instruction and golf swing corrections have been based on information that both the instructor and the student received from the flight of the golf ball. For example, if the ball slices to the right, both the student and the instructor receive certain visual information that indicates that a swing correction should be made. The hope is that this information received from the ball flight results will eventually lead to a more correct swing pattern on the next trial. Presumably, the beginning golfer makes successive adjustments in the movement pattern on the basis of this ball flight information until the outcome becomes closer and closer to achieving the environmental goal. Since there are so many swing patterns that may produce a given poor shot, it would seem illogical for instructors to base swing corrections primarily on ball flight information.

The premise of this study is based on the hypothesis that the ball flight information should serve only as an indicator of the beginning golfer's swing problems and should be treated as such. For example, since the beginner has yet to establish a consistent swing pattern, it would be ill-advised to change that pattern every time the ball flights were unacceptable. This type of teaching approach would be slow and ineffectual because the learner would be changing the swing pattern each time a disappointing ball flight result was produced.

A more effective method of teaching the golf swing might be through a kinesthetic feedback technique. This method would encourage the beginner to establish a proper swing pattern, initially, without the presence of the ball. Later, after a proper habit pattern has been established, the ball could be introduced and minor swing corrections made based on ball flight information.

This kinesthetic feedback method would eventually allow the learner to self-determine the errors being committed in the swing since the emphasis is placed on the mechanics of the movement pattern and the swing "feelings" associated with those mechanics. An important element in this kinesthetic method of learning golf is the development of an internalized "model of correctness." This model is formulated by matching the student's sensory feedback information about the swing performance with the verbal and visual reinforcement received from the instructor. With continued practice and repetition, the student should become less dependent on the instructor's verbal feedback concerning the quality of the swing and more dependent on intrinsic and kinesthetic information. When the student reaches this stage, the proper swing pattern has become a habit, and self-correction of swing errors can be performed.

The kinesthetic feedback type of learning method might also have important implications for the teaching of other closed motor skills. If the goal of the learner in a closed environment is to develop a consistent and repetitive motor pattern, it appears that the use of proprioceptive feedback information should best accomplish that goal.[14] Likewise, it would also seem appropriate to teach other closed motor skills in this manner.

Emphasizing knowledge of performance and movement execution information in the absence of knowledge of results and movement outcome information would indeed seem to have important implications for the teaching of closed motor skills. Furthermore, this method of teaching the golf swing has the potential for changing the whole traditional concept of teaching golf to beginners.

Definitions of Terms

For the purpose of this study, the following terms will be applied as defined.

Augmented feedback--feedback that is added to the normal sensory feedback system, sometimes called extrinsic

[14] Drowatzsky, p. 100.

feedback. This is additional information concerning the movement or the degree of goal attainment. There are two types of augmented feedback: (1) knowledge of performance and (2) knowledge of results.[15]

Ball flight laws--impact factors that occur when the golf club strikes the ball and influences its flight.[16] These laws include: (1) clubface positioning at impact relative to the golfer's swingpath; (2) the path in which the clubhead is traveling at impact; (3) the impact point or the place on the club where the ball is compressed; (4) the amount of clubhead speed at impact; and (5) the angle of approach of the clubhead on the downswing.

Ballistic movement--a movement that is initiated by muscular contraction, but where the muscles then relax and permit momentum and centrifugal force to complete the movement.[17]

Beginning golfer--a person who has not played golf, been taught golf, or been exposed to golf in any way.

Biomechanics--the scientific analysis of the mechanics of motion.

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[15] Gentile, pp. 20, 21.

[16] Gary Wiren, "Introduction to the Laws, Principles and Preferences," P.G.A. Magazine, 33 (April 1976), 23.

[17] Katherine F. Wells, Kinesiology (Philadelphia: W. B. Saunders and Co., 1966), p. 385.

Closed loop system--a control system employing feedback, a reference of correctness, computation of errors and subsequent correction in order to maintain a desired state of performance; sometimes called a servomechanism or servo.[18]

Closed skills--skills that are performed in a stable and predictable environment. They place less reliance on environmental information and more emphasis on internally derived feedback information. They depend on the development of a repetitive habit pattern. Closed skills only require the learner to master one movement pattern. Some examples are: gymnastics, diving, bowling, tumbling and golf.[19]

Concurrent feedback--feedback that is presented as the performer is performing the activity.[20]

Conventional golf instruction--instruction that emphasizes the use of the verbal and visual sensory modes by the learner. This type of instruction bases error correction on the flight of the golf ball.

Exercise--the act of performing physical activity.[21]

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[18] Schmidt, p. 235.

[19] Poulton, p. 472.

[20] Schmidt, p. 562.

[21] D. W. Edington and V. R. Edgerton, The Biology of Physical Activity (Boston: Houghton Mifflin Co., 1976), p. 8.

Exteroceptors--those sense receptors located outside the body. Examples are the ears, eyes, nose, mouth and skin.[22]

Extrinsic feedback--feedback that is added to that which is typically received in the task; also called augmented feedback.[23]

Feedback--sensory information that is based upon having produced a movement.[24]

Golf drills--golf swing exercises that are designed to help the performer "feel" and identify the correct swinging action.

Golgi tendon organs--small stretch receptors located at the musculotendonous junction providing very precise information about muscle tension.[25]

Guidance procedures--a series of techniques in which the behavior of the learner is limited or controlled by various means to prevent errors.[26]

Interoceptors--those sense recptors that are located in the visceral organs.[27]

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[22] Schmidt, p. 195.

[23] Ibid., p. 562.

[24] Ibid.

[25] Ibid., p. 236.

[26] Ibid., p. 525.

[27] Ibid., p. 193.

Intrinsic feedback--that feedback normally received in the conduct of a particular task.[28]

Joint receptors--a common term used for a number of different receptors that are located in the joint capsules, presumably providing feedback information about joint position.[29]

Kinesthesia--"kin" relates to motion and "esthesia" relates to sensation. Put together, this word means "sensation of motion."[30]

Kinesthesis--the discrimination of the positions and movements of the body parts based on information other than visual or verbal. It includes perception of the internal and external tensions and forces that move or stabilize the joints. Sometimes "kinesthesis" is called "getting the feel" for the movement. The stimuli arise from changes in muscle length and tension. It includes the awareness of the position of the body parts while moving and the amplitude of that movement.[31]

Kinesthetic cues--verbal cues that encourage the learner to get the "feel" for the movement pattern.

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[28]Ibid., p. 562.

[29]Ibid., p. 236.

[30]Ibid., p. 202.

[31]George H. Sage, Introduction to Motor Behavior: A Neuropsychological Approach (Reading, Mass.: Addison-Wesley Publishing Co., 1971), p. 117.

Kinesthetic feedback technique--a system of instruction that utilizes a combination of verbal, visual and kinesthetic cues. This technique emphasizes the proper mechanics of the movement pattern and the corresponding "feelings" that are associated with those mechanics. When using this method the instructor should do as much as possible to de-emphasize the environmental outcome of the movement pattern. This is accomplished through the use of kinesthetic cues and visual occlusion techniques.

This entire instructional technique is dependent upon the student receiving a clear "reference of correctness" from the instructor. This "reference of correctness" is given in three ways: (1) through demonstration by the instructor, (2) through kinesthetic cues given concurrently that encourage the student to get the "feeling" of the desired movement pattern, and (3) through terminal verbal feedback indicating the quality of the student's swing (knowledge of performance).

As the student continues to practice, he is constantly being supplied with a "reference of correctness" from his instructor. The student continually compares his own kinesthetic sensory feedback information with the reference of correctness being supplied by the instructor. Eventually, with high repetition practice techniques, the student becomes less dependent upon the instructor as a source of error information and more dependent upon his own kinesthetic sensory mechanisms.

Kinesthetic figural after-effects--perceived modification in the shape, size or weight of an object or perceptual distortion of limb position, of movement and/or of intensity of muscular contraction as a result of experience with a previous object. For example, this usually occurs after the performer has swung a weighted bat or a weighted golf club.[32]

Knowledge of Performance (KP)--augmented feedback related to the nature of the movement pattern produced; sometimes called intrinsic feedback.[33] As it is used in this study, it refers to verbal feedback from the instructor indicating the qualities of swing performance.

Knowledge of Results (KR)--augmented feedback related to the nature of the result produced in the environment; also, sometimes called extrinsic feedback.[34] As it is used in this study, it refers to ball flight results.

Learning--a relatively permanent change in behavior brought about by structuring the environment.

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[32]Sage, pp. 123-124.

[33]Schmidt, p. 562.

[34]Ibid.

Modeling--a demonstration technique used by the instructor for presenting a learning task so that the learner can get an idea of the correct movement pattern.[35]

Motor learning--a set of internal processes associated with practice or experience leading to a relatively permanent change in motor skills.[36]

Motor training or skill training--training that utilizes techniques that are directly related to the improvement of the skill being learned.

Muscle spindle--small spindle-shaped structures located parallel with the extrafusal fibers that provide information about muscle length.[37]

Negative feedback--verbal and visual feedback received from the environment and the instructor that emphasized what the performer did wrong.

Negative transfer--the loss in habit for one task as a result of practice or experience in some other task.[38]

Open skills--those skills that are learned in an unpredictable and constantly changing environment so that the performer cannot effectively plan the response. They rely more on visual and auditory information and tend to

[35] Ibid., p. 525.

[36] Ibid., p. 471.

[37] Ibid., p. 236.

[38] Ibid., p. 471.

modify movement on the basis of information received from the environment. Some examples of open skills are tennis, football, volleyball, basketball and others where the environmental conditions and players are always changing positions in space during the activity.[39]

Overlearned skill--a skill that is consciously learned through hours of practice and repetition until it can be subconsciously performed.

Overload principles--the process of subjecting the muscles to more than their usual demand. This principle states that:

> Increases in muscular hypertrophy, strength and endurance result from an increase in the intensity of work performed in a given unit of time. According to the principle, work may be intensified by increasing the number of repetitions or by increasing the resistance against which the muscles contract.[40]

Part-whole method of learning--the learning technique in which the task is broken down into its parts for separate practice. In this method, the learner first learns the parts of the golf swing and then is presented the entire movement pattern.[41]

Performance feedback information--feedback information that indicates to the learner the quality of the movement pattern.

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[39]Poulton, p. 474.

[40]Harold B. Falls, Exercise Physiology (New York: Academic Press, 1968), p. 399.

[41]Drowatzsky, pp. 247-249.

Positive transfer--the gain in habit in one task as a result of practice or experience on some other task.[42]

Progressive resistance exercise--this type of exercise specifies that the total work done by the muscles in a given time in regular exercise periods must be increased progressively. This may be done by either increasing the resistance which the muscles are required to overcome or by increasing the number of repetitions against the same resistance in work periods of equal duration.[43]

Proprioceptors--sensory receptors which are located in the muscles, tendons and joints that allow the individual to monitor his own movements by knowing the relative position of the different parts of the body.[44]

Proprioception--a word used by the physiologists to indicate the learner's sense of position and movement of the body and the body parts as well as the forces and pressures on the body or its parts.[45]

Reference of correctness--a model or standard against which performance is judged. It is the structure against which feedback from the movement is compared in order to

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[42]Schmidt, p. 471.

[43]Falls, p. 399.

[44]Schmidt, p. 193.

[45]Richard A. Magill, Motor Learning: Concepts and Applications (Dubuque, Iowa: Wm. C. Brown Co., Publishers, 1980), p. 68.

compute an error in the response.[46] The "reference of correctness" is usually transmitted to the student through the student's visual sensory mode. Some examples of this are: slides, movies, and demonstration techniques by the instructor. Although not as effective, the "reference of correctness" can also be transmitted through the verbal and auditory sensory modes.

Result feedback information--feedback information that indicates to the learner the environmental outcome of the movement pattern.

Schema--a rule, based on practice or experience, between certain aspects of the past responses; e.g., between past commands and response outcomes.[47]

Servo mechanism--self-regulating control system that is capable of automatically correcting an incorrect response based on incoming feedback information compared against a reference of correctness.[48]

Specificity of training--according to this training method a specific exercise will elicit a specific response in a specific individual at a specific point in time. The

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[46] Schmidt, p. 480.

[47] Ibid., p. 525.

[48] Ibid., p. 187.

end result of an exercise is directly determined by the specific exercise.[49]

Specificity of learning hypothesis--this hypothesis states that the environmental conditions surrounding learning of a movement should simulate those in which the task will eventually be performed.[50]

Suzuki method--a method of teaching the violin in which the sounds produced by the proper technique are presented prior to physical practice. After the learner hears the correct sounds, he then tries to duplicate this reference of correctness.[51]

Subjective reinforcement--a term used to describe the learner's self-generated error signal based on comparing feedback against a reference of correctness.[52]

Terminal feedback--feedback by the instructor or the learner himself that is produced after the response is completed.[53]

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[49]Edington and Edgerton, p. 8.

[50]Schmidt, p. 525.

[51]Ibid., p. 481.

[52]Ibid., pp. 588-589.

[53]Ibid., p. 562.

Training--the result of physiological adaptations achieved after repeated exercise bouts over a period of several days, weeks, or months of exercise.[54]

Transfer of training--the influence of a previously practiced skill on the learning of a new skill.[55]

Weighted club--a golf club weighing approximately six ounces more than a conventional golf club or a total of 19.5 ounces.

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[54]Edington and Edgerton, p. 8.

[55]Magill, p. 245.

CHAPTER TWO

Review of Related Literature

There have been volumes of books and articles written on the subject of how to teach beginning golfers. Although many of these ideas are sound, most of them represent the authors' opinions. Virtually all of the teaching methods advocated are based on error correction and feedback information received from the flight of the golf ball.

It was the writer's goal to find a new method of teaching golf that would relieve the beginner's fear of failure. The writer assumed that this fear of failure was caused by the beginner's apprehension that the ball would not always go where he wanted it to go. The beginner has been inundated with so many facts that he has been said to suffer from "paralysis by overanalysis." To eliminate these fears and communication problems the investigator eliminated the golf ball and devoted the entire teaching session to learning the correct form of the golf swing.

In investigating the literature relating to this topic, the writer categorized information into six areas. These areas were: conventional golf instructional techniques, feedback systems used when learning a closed motor skill, specificity of training and motor skill learning utilizing overload techniques, the use of swing drills in learning golf, the effects of the presence or absence of the ball when learning golf, and kinesthetic feedback techniques used when learning a motor skill.

Literature Related to Conventional Methods of Golf Instruction

Conventional golf instruction relies on verbal cues, demonstration and conceptual "word pictures" to communicate with the student. It places heavy emphasis on the verbal and visual modes of communication during the learning process. Also, golf swing corrections are based on the feedback that the student receives from the flight of the ball.

In 1976, Gary Wiren, director of learning and research for the P.G.A. of America, categorized certain "impact factors" that have been traditionally taught in conventional golf instruction. These "impact factors" were coined "Ball Flight Laws" by Wiren. According to Wiren, and other knowledgeable instructors, much of the learner's progress in making swing corrections is based on an understanding of these laws.[1] These laws or impact factors include: (1) clubhead speed at impact; (2) clubhead path at impact; (3) centerface contact at impact; (4) clubface position relative

[1]Gary Wiren, "Introduction to Laws, Principles and Preferences," P.G.A. Magazine, 33 (April 1976), 23.

to swingpath at impact; and (5) angle of approach prior to impact. Theoretically, the knowledge of this information is thought to help the beginning golfer make swing corrections. The trouble with this idea is that the beginning golfer doesn't have enough knowledge of which swing fundamentals caused these specific impact factors and the resulting ball flight. The student is totally dependent upon the instructor's knowledge of the principles of the swing. "Unfortunately, most instructors cannot possibly pick up the actual swing errors that are causing the resulting poor shots."[2] As a result, oftentimes the beginning golfer is working on a swing correction that is unrelated to his errant ball flight results. Furthermore, it is probably less likely that the instructor's verbal cues were communicated effectively.

Cochran and Stobbs, who did the most complete and up-to-date research on golf swing learning, point out that judging swing efficiency on ball flight results is a rather unreliable source of error correction because there are numerous swing patterns that might produce a given poor shot.[3] For example, in conventional golf learning, each time the flight of the golf ball is not acceptable to the

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[2]Alastair Cochran and John Stobbs, The Search for the Perfect Golf Swing (Philadelphia: J. B. Lippincott Co., 1968), p. 107.

[3]Ibid.

learner he will change his swing pattern until he gets acceptable results. In so doing, he might try five or six different swing patterns in as many attempts. The beginner really doesn't know what a good swing is. Actually, he can only identify with where the ball went. Therefore, he tends to practice and repeat only those swing patterns that get the ball into the air even though they may be bio-mechanically incorrect. It is not uncommon to see a beginning golfer practicing a contorted "lurch" at the golf ball just because that movement seems to get the ball into the air. With so many swing patterns available, it would seem difficult to base swing performance on ball flight results.

Conventional golf instruction also tends to be corrective and not constructive.[4] This corrective information is sometimes presented through the use of negative verbal cues. Some of these verbal cues that are frequently used in such an approach might be: "Keep your head down!", "Don't bend your left arm!", "Don't sway!", "Don't cut across the ball with an open clubface!", and so on. These are clear examples of the instructor teaching the result of the movement pattern and not the cause of it. This is basically a negative way to teach because the instructor is concentrating on developing parts of the swing instead of

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[4]"Methods of Teaching," P.G.A. Home Study Manual, P.G.A. Publication, 1972, p. 2.

whole movements. Because of these negative verbal cues, the student starts concentrating on things he is trying to avoid in the swing instead of concentrating on things he is trying to do.

Conventional instructional teaching techniques encourage the beginner to want to know what has gone wrong with his golf swing as soon as the ball flight results become apparent. As soon as the golfer hits a bad shot he will ask, "What did I do wrong?" His instructor gives him three or four things to correct before making the next swing. In reference to this, Peter Kostis, the director of the Golf Digest instruction schools, states:

> In the first place, you shouldn't be concerned with what you did wrong but rather what you didn't do right. And you shouldn't worry about one particular shot. There could be a hundred reasons why you struck it badly.[5]

Hoth feels that one of the greatest mistakes an eager instructor can make is to deluge the student with a running commentary on everything he is doing wrong.[6] This type of feedback seems to encourage the golfer to focus on the negative instead of the positive.

Drowatzsky points out that beginners appear to benefit more from feedback that directs them toward the correct

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[5]Peter Kostis, Inside Path to Better Golf (Norwalk, Connecticut: Golf Digest Publications, 1982), p. 48.

[6]Sandra Hoth, "The Language of Motor Learning," Quest, 23 (January 1975), 72.

performance pattern than from feedback that points out their errors.[7] Emphasis on errors is less effective because of the continued change in the nature of errors committed by beginners. They tend to commit so many errors that it would be difficult to specifically point out one error as the major contributing cause of all the other errors.

The goal in teaching the golf swing to beginners is to help the student establish new habits. Habits are the result of practice and repetition. In the conventional golf instructional process there are many obstacles to effective communication. For example, the student's perception of what he hears from the instructor might be entirely different than what the instructor intended. Also, the instructor's use of vague and unclear golf terminology might confuse the beginner. For example, the instructor might say, "Grip it firm with the left hand," or "Use your left side more," or "Release the club," or "Start the downswing with leg drive," or Turn your body," or "Get your hands high at the top," or "You swing over the top of the ball." It seems that every instructor has his own verbal cliches. The beginner is new to the sport and has no idea what some of these terms mean. The weakness of verbal cues in conventional golf learning techniques is readily evident.

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[7] John N. Drowatzsky, Motor Learning: Principles and Practice (Minneapolis: Burgess Publishing Co., 1975), p. 10.

Boomer thinks that the beginner should not be obsessed with getting the ball up in the air and in the hole but with the swing that will produce that movement. And these movements are controlled by "remembered feel."[8]

The fault with much golf teaching today is that the teacher tries to eradicate specific faults by issuing specific instructions. But the real aim of the student should be to carry out the teacher's instructions irrespective of the immediate results. This would allow the student to build up the feel or muscular memory for the shot. The golf instructor develops controls in the beginner's swing by teaching the feel of the swing and not by conscious application of principles. He concludes by saying that control of these feelings is accomplished through the constant repetition of the correct movement pattern.[9]

Conventional golf instruction, besides being dependent upon verbal and visual cues, is also very dependent upon the modeling and demonstration techniques used by the instructor. Demonstration by the instructor is said to give the student a clear visual image of how he is supposed to perform the swing. Unfortunately, this method of communication is very dependent on the verbal and visual

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[8]Percy Boomer, On Learning Golf (New York: Alfred A. Knopf Co., 1946), pp. 101-112.

[9]Ibid.

sensory modes. Furthermore, modeling and demonstration techniques are only as effective as the quality of the model. For example, if a given swing fundamental is demonstrated poorly, the students will start practicing and imitating what they have seen.

It seems that verbal and visual cues are less than effective in helping the beginner learn the golf swing because of some unavoidable weaknesses in the translation from instructor to student. Golf swing film analyses and video tape replays tend to support this conclusion. For example, there is usually a definite difference between what a golfer thinks he is doing wrong and what, in fact, he is actually doing.

In reviewing the literature concerning conventional golf instructional techniques, it was found that all of the studies reviewed depended upon effective communication translated through the visual and verbal sensory modes. The only real differences involved their points of emphasis and their teaching methodology. But, in all instances, the presence of the golf ball and its eventual ball flight was an integral part of the learning process.

Feedback Systems and Learning a Closed Motor Skill

It has been shown that feedback is important in learning simple motor skills as well as in mastering complex athletic movements.[10] Feedback has also been shown to be an important variable in motor learning generally[11] and golf skills specifically.[12] Further, research suggests that such feedback is most effective if delivered immediately after the trial.[13] Information concerning the value of feedback is in the learning of the golf swing and the way it can be used to improve the swing that follows.

In learning a motor skill such as golf, the student should receive feedback that indicates that progress is being made. There are basically two kinds of feedback information that the student may receive during the performance of the golf swing: internal and external. Internal feedback, or kinesthetic feedback, is associated with how the movement felt and is sometimes referred to as the kinesthetic sense or muscle sense.

Oftentimes, a golfer will hit a ball well and exclaim, "That felt good!" This would be an example of internal

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[10] S. E. Henderson, "Role of Feedback in the Development and Maintenance of a Complex Skill," Journal of Experimental Psychology: Human Perception and Performance, 3 (1977), 224-233.

[11] A. F. Smode, "Learning and Performance in a Tracking Task Under Two Levels of Achievement Information Feedback," Journal of Experimental Psychology, 56 (1958), 297-304.

[12] D. H. Thompson, "Immediate External Feedback in the Training of Golf Skills," Research Quarterly, 40 (1969), 589-594.

[13] J. Greenspoon and S. Foreman, "Effect of Knowledge of Results on Learning a Motor Task," Journal of Experimental Psychology, 51 (1956), 226-228.

feedback. This type of feedback is received from the sensations that the golfer gets from his body.

On the other hand, external feedback refers to the feedback that the golfer receives from his vision and hearing. Most error correction in golf is based on the feedback that the golfer receives from his vision of the flight of the golf ball. If the ball's flight is not long and straight, the golfer will make changes until the ball flight is acceptable. In using external feedback mechanisms, the individual is primarily using his sense of sight and hearing in order to learn the skill.

When learning golf, the beginner is exposed to a set of three different stimuli: (1) he must hit the ball; (2) he must be aware of the target; and (3) he must try to make a good swing. With these three things on his mind at the same time, there is little wonder the beginning golfer is afraid of failure and susceptible to what Gentile called "goal confusion."[14]

Although ball striking and target awareness are important aspects of learning golf, ultimately all golf instruction is based upon the idea of helping the student make a better swing so that his resulting ball flight will improve. For this reason, it is important that the feedback

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[14]A. M. Gentile, "A Working Model of Skill Acquisition with Application to Teaching," Quest, 17 (January 1972), 15.

mechanism and cues that are used to teach golf are the most efficient methods of communication available.

According to Gentile, the teacher can provide augmented feedback of two types: (1) information concerning the movement's execution, which she called knowledge of performance, or (2) information about the degree of goal attainment, which she called knowledge of results.[15] In a closed skill such as golf, the student is trying to increase the consistency with which the movement is produced. He is trying to develop a repetitive motor pattern. If augmented feedback seems warranted, the most appropriate type of information the teacher could provide for closed skills seems to be knowledge of performance.[16] Knowledge of results, or movement outcome, is sometimes used in referring to ball flight, whereas knowledge of performance refers to the actual correctness of the movement pattern as perceived by the learner.

When a golf instructor is working with a student in a golf net, he is making corrections based on the student's swing as compared to a reference of correctness. This feedback, or knowledge of performance, is very important when learning the proper swing. When the golf instructor is out on the driving range and is making error correction based on

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[15]Ibid., p. 8.

[16]Ibid., p. 21.

the flight of the golf ball, he is using feedback associated with knowledge of results. When basing error correction on the flight of the ball, it is hoped that this ball flight information will help the golfer correct his motor pattern. But the relationship between ball flight (knowledge of results) and swing efficiency (knowledge of performance) is indeed a tenuous one for the beginning golfer.

Cochran and Stobbs pointed out that the beginner is not able to discriminate between a swing that caused a good shot and one that caused a poor shot.[17] There are numerous ways or types of swings that will cause the same result. For example, the beginner may hit three shots in a row and after each shot ask his instructor for feedback information on his swing efficiency. Since the beginner is basing his error correction on the flight of the golf ball and his instructor's directions, he probably will get three different motor patterns in as many swings. The beginner is searching for a swing that will get the ball into the air. As a result, a swing that tops the ball off the tee and into the bushes might be a far better swing than one that is hit off the heel of the golf club and goes 160 yards down the middle.[18] Yet, because the ball got up in the air, the beginning golfer will stay with the motor pattern that

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[17]Cochran and Stobbs, p. 107.

[18]Ibid.

caused those acceptable ball flight results. Thus, the beginning golfer begins to develop a motor pattern that, although inefficient, seems to get the ball airborne. The inherent weakness of basing error correction on the feedback based on knowledge of results information (ball flight) is readily evident.

In conventional golf instruction, both the students and the instructor are conditioned to rely primarily on the flight of the golf ball in order to make swing corrections. Because of this, the student is primarily dependent upon his auditory and visual senses for this error information. And one of the biggest weaknesses in conventional golf instruction is the golfer's dependence upon these types of cues. In discussing the use of verbal cues, Joe Dey, the executive director of the United States Golf Association, states: "Why can't we always translate the words of our instructors into effective swings? One of the biggest reasons is we really don't understand what our instructor is saying."[19]

Verbal communication almost always leaves a learning gap. What the instructor is trying to communicate and how the student interprets this verbal communication might be two entirely different concepts.

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[19]Joseph C. Dey, "Gospel and Quackery in Golf Instruction," Golf Digest, 33 (September 1982), 20.

Hoth states:

> Physical educators are not able to speak the language to the beginner. Often times instructors are unable to communicate with students in terms that are meaningful. The verbal cues that they use are like a foreign language to the neophyte, and the teacher and student alike feel frustration and disappointment when the desired motor pattern is not forthcoming.
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> To use meaningful, descriptive cues, an instructor should first determine the kinesthetic and mental conceptual cues for the movement he is attempting to elicit. It is generally recognized that verbal instructions are more meaningful for the advanced learner, partially because he has already learned the language and has associated certain movement patterns with certain verbal symbols. The typical physical education teacher cannot really communicate with the beginning students in terms that are meaningful.[20]

In reference to the use of verbal cues in teaching the golf swing, Bertholy concurs with Hoth by saying:

> Far too much golf instruction is based on the erroneous conception of expectation of execution by suggestion, either by the written or spoken word. Attempting to teach the golf swing through the ear is about as logical as trying to feed a hungry man a steak through his big toe.[21]

Hunter feels that, in addition to verbal cues, visual information is also necessary when teaching the golf swing. According to him, "it is difficult to teach any golf lesson without visual help. Words alone are inadequate, particularly in showing the arc and plane of the swing."[22]

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[20]Hoth, p. 68.

[21]Paul Bertholy, The Bertholy Method: How to Become a Complete Golfer (Melrose Park, Ill., 1971), p. 17.

[22]Mac Hunter, "Arc and Plane," P.G.A. Magazine, September 1981, pp. 32-33.

Cook emphasizes that visual cues are more productive than verbal cues in starting a habit or in breaking a habit.[23] These cues may be in the form of personal demonstration, video tape, or still pictures. Hoth,[24] Gentile,[25] Schmidt,[26] and Wallace[27] would say that these visual cues are only as effective as the comparison made between the visual medium and the reference of correctness.

In speaking of visual feedback, Gardner believes that this type of feedback is of prime importance in a great many types of skilled voluntary activities, but it is not indispensable. Feedback from other sensory sources are responsible for producing coordination among the numerous muscles concerned in any movement. She says that many of these feedback mechanisms operate at the subconscious level.[28]

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[23]Charles Cook, "Correcting Bad Swing Habits Via Verbal, Visual and Kinesthetic Cues," P.G.A. Magazine, October 1981, pp. 32-33.

[24]Hoth, p. 71.

[25]Gentile, p. 21.

[26]Richard A. Schmidt, Motor Control and Learning: A Behavioral Emphasis (Champaign, Ill.: Human Kinetics Publishers, 1982), p. 480.

[27]S. A. Wallace and R. W. Hagler, "Knowledge of Performance and the Learning of a Closed Motor Skill," Research Quarterly, 50 (May 1979), 296.

[28]Elizabeth B. Gardner, "The Nueromuscular Base of Human Movement: Feedback Mechanisms," Journal of Health, Physical Education and Recreation, 36 (October 1965), 61-62.

Cochran and Stobbs point out that:

> Much like driving a car or handling a spoon, the golf swing must be learned until it becomes a conditioned automatic response. Expert golfers don't consciously think of their swing when they are performing. They have ingrained a habit pattern into their subconscious mind until they can perform it automatically. The only way the swing can be programmed is by using the senses and the feedback systems in correcting errors in performance. During the swing, for example, the eyes send information about the position of the ball and the sense organs in the muscles and joints, also called proprioceptors, continually send information about the movements and position of the various parts of the body. While a golfer is swinging the club, only a limited amount of information can reach him by way of his eyes, but his brain is continually receiving messages from the proprioceptors which tell him the position of his limbs and joints, and the state of contraction of his muscles.[29]

Therefore, it is important to determine what sensory mode to emphasize when learning a particular skill. It is obvious that the different sensory feedback channels operate at different rates. According to Schmidt, vision is the slowest sensory feedback made and proprioception is the fastest.[30] Therefore, when learning a ballistic movement like the golf swing, it would be necessary to emphasize the fastest sensory mode available.

Cochran and Stobbs succinctly sum up the frustrating experience of the beginning golfer when they say:

> The beginner reaches a stage where he can grip the club correctly, stand to the ball correctly and even

[29]Cochran and Stobbs, p. 101.

[30]Richard A. Schmidt, "A Scheme Theory of Discrete Motor Skill Learning," Psychological Review, 82 (July 1975), 252.

> swing smoothly and elegantly; but on a percentage of swings, he completely misses the ball. Even the professional's reassurance that the swing was basically a good one cannot stem the feeling of anger which rapidly rises as successive attempts fail to make contact. Eventually, in an obsessive desire simply to hit the ball, he completely forgets style and form and makes a wild--and sometimes successful--lunge at the ball. This in the long run can have a disastrous effect on his progress.[31]

Gentile describes this as a "surprise experience" that results when the goal is attained but not by the movement that was planned.[32] This is oftentimes the case when the beginning golfer hits the ball well in spite of his poor technique. Typically, this "surprise experience" occurs most frequently with conventional golf instruction because of its emphasis of getting the ball up in the air. Sometimes the beginner is so preoccupied with the ball flight results that he will swing in any manner just to achieve his goal. If, for example, he gets the ball up in the air with poor technique, he must make a decision of whether to use the poor technique that gets the ball airborne or to try to use the correct technique that has had disappointing results for him. Unfortunately, the beginner usually starts developing a muscle memory for the poor technique because of the immediate reinforcement he receives from the desired

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[31] Cochran and Stobbs, p. 107.

[32] Gentile, p. 10.

ball flight. Most beginners do not really care if the swing that they made was biomechanically efficient, but they do care if that particular swing got the ball up in the air.

Thus, the beginner may be hitting the ball reasonably well with poor technique. Since the beginner has yet to establish a consistent and repetitive motor pattern, he will tend to change his motor pattern each time the flight of the ball is poor. By so doing, he fails to ingrain the proper habit pattern.

Poulton classified motor skills as either open or closed. He defined closed skills as those that are performed in a stable or predictable environment and open skills as those for which the environment is constantly changing so that the performer cannot effectively plan the response in advance.[33] His classification of skills depends upon the extent to which the skill is dependent on exteroceptive rather than interoceptive feedback information.[34] According to this definition, the golf swing would be classified as a closed motor skill because the golfer is trying to find the one consistent motor pattern that produces the same results every time. Because of these factors, Gentile says that, when learning a closed motor

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[33] E. C. Poulton, "On Prediction of Skilled Movements," Psychological Bulletin, 54 (November 1957), 472.

[34] Ibid.

skill, the knowledge of performance (the swing itself) should be emphasized over the knowledge of results (the ball's flight).[35]

Drowatzsky says:

> Closed skills place heavy demands on a person's ability to use internal cues, since visual cues are not an integral part of these tasks. Consequently, closed skills require the replication of movements on the basis of proprioceptive feedback so that sensitivity to kinesthetic information is a prerequisite for success.[36]

It is obvious that some type of feedback must follow the performance if learning is to occur. Because closed skills require the ability to perform stereotyped movement patterns, Drowatzsky feels that feedback should be geared to movement-produced information. A performer must learn to recognize his body position and the location of his or her body in space through proprioceptive feedback. The performer must learn both the correct movement pattern and the correct "feel" of that pattern. He theorizes that beginners appear to benefit more from feedback that directs them toward the correct performance pattern than from feedback that points out their errors.[37] Other authors tend to agree with Drowatzsky's theory that, when learning closed skills, knowledge of performance information should be

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[35]Gentile, p. 8.

[36]Drowatzsky, p. 93.

[37]Ibid.

emphasized over knowledge of results information. For example, Marteniuk found this to be particularly true in a closed skill such as the basketball set shot where the environmental conditions are stable or stationary and the learner is trying to become consistent in producing an efficient movement pattern.[38]

Wallace and Hagler tested Gentile's hypothesis which stated that knowledge of performance is the most effective form of augmented feedback for the acquisition of a closed motor skill.[39] They gave one group of subjects both knowledge of performance and knowledge of results information and the other group was given only knowledge of results information and verbal encouragement following each basketball shooting trial with the non-dominant hand. Although both groups improved, the groups that received both knowledge of results and knowledge of performance information seemed to improve more. The subjects who received information regarding the proper mechanics of the shot (also called the K.P. subjects) were able to develop a more consistent and efficient movement pattern. This, in turn, increased the probability of the desired outcome. They also found that, once the subjects learned the correct form,

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[38] R. G. Marteniuk, Information Processing in Motor Skills (New York: Holt, Rinehart and Winston Publishing Co., 1976), p. 102.

[39] Wallace and Hagler, p. 265.

knowledge of performance information could be removed and the subjects continued to learn faster than the knowledge of results subjects. They concluded that knowledge of performance is a strong feedback source in the acquisition of a closed motor skill.[40]

Both Gentile[41] and Marteniuk[42] have suggested that knowledge of performance information concerning movement execution is more useful than knowledge of results information. According to these authors, this is particularly true when learning a closed skill. The research of Wallace and Hagler[43] indicates that useful feedback information is especially critical in the early stages of skill acquisition.

Whiting states that it is important to make the distinction between those skills which are primarily controlled by information coming from the external environment (e.g., ball flight or knowledge of results) and those skills in which almost complete reliance is put on monitoring proprioceptive information for control.[44]

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[40]Ibid., pp. 265-271.

[41]Gentile, p. 21.

[42]Marteniuk, p. 44.

[44]Wallace and Hagler, p. 271.

[45]H. T. A. Whiting, Acquiring Ball Skill (Philadelphia: Lea and Febiger, Publishers, 1969), p. 102.

According to Whiting, closed skills are habitual, whereas open skills are predominately perceptual.[45] This would indicate that closed skills should be taught with emphasis on knowledge of performance so that a habit pattern could be developed and open skills should be taught to rely on verbal and visual cues in order to enhance the learner's knowledge of results. He feels that certain feedback mechanisms should be emphasized when learning a particular type of skill. For example, when learning a skill like golf that is basically a momentum or "ballistic" type of movement, it must be assumed that information from the external environment (ball flight) can have little or no regulatory function on the movement pattern.[46]

Concerning this, Newell investigated the role of visual and auditory flight feedback in the learning of a projectile task which required the subject to strike a ball with the aid of a mallet a given distance up a controlled trackway. Over a series of trials in which knowledge of results information was available to the performer, flight feedback was found to be a nonsignificant factor in learning the projectile task. This indicated that seeing or hearing the ball provided only redundant information for response

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[45]Ibid., p. 10.

[46]H. T. A. Whiting, "Theoretical Framework for Understanding of the Acquisition of Perceptual Motor Skills," Quest, 17 (1972), 24-34.

selection when knowledge of results information was available to the learner.[47]

One important question emerging from Newell's study was the extent to which the response recognition was based on the after sensations of the movement itself, flight feedback, or a combination of both forms of feedback.[48] A second study by Newell suggested that the withdrawal of visual flight feedback failed to produce a decrement in the performance of the participant.[49]

According to Magill, the overemphasis on the wrong sensory mode may, in fact, inhibit learning.[50] Take, for example, the beginning typist. If he is taught by watching the keys or by watching his fingers, his typing speed will be drastically reduced. The pianist can suffer the same problem by watching the piano keys. In learning motor skills, most of our information comes to us through our visual, auditory and proprioceptive sensory modes. As

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[47]K. M. Newell, "Flight Feedback and Learning a Projectile Task," Journal of Motor Behavior, 5 (1973), 65-72.

[48]Ibid.

[49]K. M. Newell, "Visual Flight Feedback as a Determiner of Motor Response Recognition," Research Quarterly, 42 (May 1975), 241.

[50]Richard A. Magill, Motor Learning: Concepts and Applications (Dubuque, Iowa: Wm. C. Brown Co., Publishers, 1980), p. 70.

teachers, we should be able to recognize which sensory mode to emphasize for the learning of a particular skill.

If closed skills are primarily habitual and open skills are perceptual as Whiting[51] has suggested, then both of these skills should be taught with the instructor emphasizing the proper feedback mechanisms and sensory modes. For example, if the golf swing is a closed skill, and research has told us that closed skills should be taught through the use of proprioceptive feedback information, then the instruction should emphasize this type of feedback information. Similarly, if the backhand in tennis is considered an open skill, then it should be taught through the use of visual and verbal feedback information.

Closed skills would include such activities as golf, bowling, archery, gymnastics, tumbling, diving and any other skill where the environmental stimuli stay relatively constant as the performer creates the movement. Examples of open skills would include basketball, football, tennis and other activities where the performer is moving and the surrounding conditions and players are also changing. Most of the research done on closed skills suggests that intrinsic feedback information improves performance when learning this type of skill. Also, this research seems to

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[51] Whiting, Acquiring Ball Skill, p. 10.

indicate that feedback information that enhances intrinsic cues produces better retention of the skill.

Gentile used the term "knowledge of performance" to mean extrinsic and augmented feedback received from someone else who gives the performer information about the movement itself rather than the outcome of that movement.[52] Knowledge of performance, as it relates to a golfer, refers to the golfer's technique and form. This additional information could take the form of verbal description, demonstration, instant replay videotape or graph-check sequence pictures. For example, knowledge of performance might refer to verbal feedback which was concurrent or terminal, indicating that the golfer's backswing was too long, while knowledge of results would refer to the outcome of that backswing in terms of hitting the ball.

In the case of closed skills like gymnastics and golf, where the performer is required to make the same repetitive motor pattern under unchanging environmental conditions, knowledge of performance is all important for success. Intrinsic or kinesthetic feedback information would be most important in these types of skills.[53]

Hampton used both knowledge of results and knowledge of performance when teaching the shotput. This is a skill

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[52] Gentile, p. 21.

[53] Drowatzsky, p. 100.

performed in a closed environment. He concluded that augmented knowledge of performance provided through the use of a graph-check sequence camera, in the presence of normal knowledge of results, significantly improved the distance the shot was put.[54]

Del Rey investigated the effect of the presence or absence of video tape replay on the learning of the fencing lunge practiced under open or closed conditions. The subjects in the closed conditions seem to have developed better form and higher accuracy scores than the subjects in the open conditions.[55]

Cooper and Rothstein investigated the use of video tape replay and its effect on the open skill of the tennis ground stroke and the closed skill of the tennis serve. They found that both the ground strokes and the serve were learned best under a combination of knowledge of results and knowledge of performance feedback information. It was noted that knowledge of performance information was least effective for the open skills (the ground strokes) and that knowledge of results information was the least effective feedback

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[54] G. E. Hampton, "The Effects of Manipulating Two Types of Feedback--Knowledge of Performance and Knowledge of Results--in Learning a Complex Motor Skill," Diss. Columbia Univ., 1970.

[55] P. Del Ray, "The Effects of Videotape Feedback on Form Accuracy and Latency in Open and Closed Environments," Journal of Motor Behavior, 3 (1971), 281-287.

mechanism for the closed skill (the serve). They recommended that, in a closed skill environmental condition, where the environment is stable and predictable, a combination of knowledge of performance and knowledge of results feedback information be given where possible. If both types of feedback cannot be given simultaneously, then knowledge of performance feedback information should be used primarily in closed skill situations. They also stated that, in a closed skill situation, knowledge of results information should not be given alone. In open skill environments where conditions are unstable and unpredictable a combination of knowledge of results and knowledge of performance feedback information appears to be most successful.[56]

But, in order for knowledge of performance to be used as an effective feedback mechanism, it should be administered after every trial so that the performer will constantly be reminded of what constitutes the correct form. This can be done by providing a "reference of correctness" for the response before any practice trials have been provided. This "reference of correctness" is the heart of the closed loop theory of motor learning. It is the

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[56] Laura Kessler Cooper and Anne L. Rothstein, "Videotape Replay and the Learning Skills in Open and Closed Environments," Research Quarterly for Exercise and Sport, 52 (1981), 191-199.

structure against which feedback from the movement is compared in order to compute an error in the response.[57]

One crude way that such references of correctness can be established is through verbal instruction. For example, in giving information about the golf swing while the movement is in progress, the instructor might say, "Can you feel your shoulders tightly coiled at the top of your swing?" or "Can you feel your right elbow come into your side on the downswing?" This description of the golf swing warns the performer about the upcoming sensory feedback from the movement and provides a rough basis for the performer's knowing that he or she did something wrong if this pattern of feedback does not occur during the movement.[58]

A reference of correctness can be established in numerous ways. Perhaps the most famous of these is the Suzuki method for teaching young children to play the violin.[59] In the Suzuki method, a recorded piece is played to the student over and over again. It is hoped that this will establish a memory about how the properly played music should sound. After constant exposure to the correct sound, the student is then allowed to practice. Presumably, as the student attempts to play, he compares the sounds that he

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[57]Schmidt, Motor Control and Learning, p. 480.

[58]Ibid.

[59]Ibid.

is making against the reference of correctness established by the recorded violin sounds. Deviations from the student's own reference of correctness indicate errors that must be corrected in future attempts.[60]

In discussing modeling by the instructor and his ability to provide a good reference of correctness, Bertholy comments that nearly all of the great golfers in the last fifty years developed their swing while they were children. Most of these fine golfers learned chiefly by mimicry while their imitation powers were at their highest level. These young golfers truly learned the golf swing by feel and imitation with a minimum of mental or conscious involvement when learning.[61]

Whiting would agree with the idea of establishing a model to imitate. Although, according to him, all skill learning is based on preprogrammed information.[62] This would mean that all important feedback information can take place only after the movement has been performed. He says this would be especially true when learning a ballistic movement like the golf swing because the movement happens so fast that concurrent feedback would be ineffective.[63]

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[60]Ibid.

[61]Bertholy, p. 17.

[62]Whiting, Acquiring Ball Skill, p. 10.

[63]Ibid.

Cochran and Stobbs concur with Whiting when they describe the golf swing as a preprogrammed event. According to them:

> The brain programs the whole series of events of the golf swing in advance. It sends all the necessary instructions to the muscles before the movement actually starts. But, the beginner doesn't know what to program into his swing so he will therefore have an inconsistent motor pattern each time. When a budding golfer is starting to learn, he is aware of many separate feelings from the various parts of his body, and, as he begins to move, he has to check them individually. For example, he has to make sure that his left elbow doesn't bend, that his wrists cock in the right direction, that his head doesn't move, that his shoulders turn correctly and so on. But gradually, after repeating the moves of, say, the backswing a few thousand times he becomes less aware of feelings from the individual parts of the body and begins to gain a much more general impression of the whole movement.[64]

These statements by Cochran and Stobbs seem to indicate that the golf swing is basically an overlearned skill. An overlearned skill is a skill that is consciously learned but subconsciously performed. For example, one of the characteristics of the highly skilled performer on any task is the limited awareness of how the activity is carried out. Such a person does not need to think about what he is doing because he has developed a habit pattern. In fact, if he does attempt to make his performance conscious, he runs the risk of interfering with the smooth operation of the movement.[65]

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[64] Cochran and Stobbs, pp. 103-104.

[65] Whiting, Acquiring Ball Skill, p. 102.

Many researchers would argue that the learner does not really need outcome information (ball flight) in order to evaluate movement execution information correctly. This might be the reason why so many golf instructors seem to have a great deal of success when they are giving a lesson in a golf net. When learning golf in the net, the learner is more concerned with making a good swing than hitting the ball.

Motor learning research up to this time has emphasized knowledge of results information or movement outcome and not knowledge of performance information or movement execution. Some researchers falsely assume that, if the outcome of the movement is achieved, then the movement that was produced must be biomechanically correct. "This is not necessarily true because there are many biomechanically inefficient ways to produce the desired outcome of a movement."[66] This can be readily evidenced when one looks at many unorthodox golf swings on the P.G.A. tour that have been highly functional in terms of prize money won. Wallace and Hagler reiterate that learning the most efficient motor pattern for a closed skill in the early stages of development should increase the probability that the desired outcome is achieved later in skill acquisition.[67]

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[66]Wallace and Hagler, p. 270.

[67]Ibid.

There is obviously a relationship between the goal or outcome (knowledge of results) and the plan or movement that created that outcome (knowledge of performance). Kostis discusses this relationship as it applies to golf by saying:

> Have you noticed that when you're swinging well, you seem to strike the ball with the sweet spot of the club everytime. But, when your swing is a little off, no shot feels solid. On center hits and a good swing go hand in hand, as do on center hits and consistent ball flight pattern. Golf is a bit of Catch-22 in that a good golf swing creates on center hits, whereas, on center hits are needed to create a good golf swing.[68]

When basing error correction on the ball's flight, which is also called knowledge of results, the hope is that the information about movement outcome will eventually lead to a more effective movement pattern. Hopefully, the learner makes successive adjustments in the movement pattern on the basis of this knowledge of results information so the outcome comes closer and closer to the intended goal.

Aultman feels that the visual image of the flight of the golf ball directly affects how the golfer will swing on the next trial: "When we see our shots slicing to the right, we instinctively swing more to the left, which leads to more slicing and other problems as well."[69]

The question is: What type of feedback should the golfer rely on? Gentile says, "With closed skills, the

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[68]Kostis, pp. 43-44.

[69]Dick Aultman, Better Golf Swings in Six Swings (Norwalk, Connecticut: Golf Digest Publishing, Inc., 1982), p. 11.

performer need only learn the movement that satisfies the goal and that the outcome of that movement is not as important as the movement creating that outcome."[70]

According to Schmidt, it would seem to be far more effective to provide information about the patterns of movement the person made rather than the outcome of those patterns.[71] If it is the pattern of movement that we are trying to perfect, then why do golf instructors keep basing the learning of that pattern on outcome information? In golf, part of the problem stems from the instructor's inability to recognize the fact that good technique is directly related to good ball striking. If the swing is biomechanically correct, then good ball striking should follow. In reference to this, Mann stated that the process of using the muscles of the body in the proper sequence to produce linear force on an object has been called many things, but the most often employed term is "timing." Timing is critical when linear force is needed to propel an external object.[72] It follows, then, that, if the application of linear force of the body parts is in the correct sequence, good ball striking will follow.

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[70]Gentile, p. 21.

[71]Schmidt, Motor Control and Learning, p. 553.

[72]Ralph B. Mann, "Introduction to Kinesiology" (Lexington, Ky.: University of Kentucky, unpublished book, 1981), Chapter 7, p. 16.

In investigating the "Human Factors that Influence the Golf Drive for Distance," Wiren concluded that strength and timing seem to be the two most important factors influencing the golf drive.[73] In contrast to this, a swing may look good to the naked eye but be mechanically inefficient because the body parts are out of their timed sequence.

In learning the skill of golf, it would seem more logical to learn the correct technique first and let the results of that technique follow. "Even the psychologists have told us to emphasize form at the expense of accuracy in learning new skills."[74] Wells believes that, once the proper form and technique are acquired when learning a new skill, accuracy will develop with regular practice.[75]

Knowledge of performance information and knowledge of results information are important feedback mechanisms that give the student reinforcement that he uses to check or confirm his performance. Besides reinforcing the learner, they also have motivational qualities as well. Oxendine reiterates the importance of receiving feedback information from all the senses, but says that in complex movement

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[73]Gary Wiren, "Human Factors Influencing the Golf Drive for Distance," Diss. Univ. of Oregon, 1968.

[74]Katherine F. Wells, Kinesiology (Philadelphia: W. B. Saunders and Co., 1966), p. 386.

[75]Ibid.

activities such as the golf swing the proprioceptors in the muscles, tendons and joints are especially important.[76]

Learning becomes skillful when the learner is capable of discriminating between what is a right movement and what is a wrong movement.[77] Since the beginner does not know what a good golf swing is during the early stages of development, he has to be constantly reinforced as to the quality of his movement pattern. As has been previously cited, in conventional golf swing learning techniques this reinforcement usually comes from acceptable ball flight results. If the ball flight results are unacceptable to the beginner, then he will continue to search for a swing pattern that might work.

An alternative method of providing reinforcement to the beginning golfer concerning the quality of his swing performance would be through the use of verbal cues while totally disregarding and eliminating the golf ball. This method would allow the beginner to start developing a swing pattern which would enable him to discriminate between a good swing and a bad swing. As Oxendine has pointed out,

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[76]Joseph B. Oxendine, Psychology of Motor Learning (New York: Appleton-Century-Crofts Publishing Co., 1968), p. 57.

[77]Whiting, Acquiring Ball Skill, p. 18.

"As one's familiarity with a particular task increases, the degree of purely random activity decreases."[78]

According to Drowatzsky, knowledge of performance feedback information is intrinsic to the task and always present. Closed skills require the replication of movement guided by proprioceptive feedback. The degree of accuracy in one's performance is related to accuracy of feedback.[79]

In contrast to this, it would appear that sports skills classified as "open" may be made up of skills that are guided by external feedback or knowledge of results information.[80] When learning an open skill, the performer must concentrate on learning two things: the correct movement pattern and the correct way to respond to the changing environmental conditions. For example, open skills usually involve a moving ball and opponents who are also moving. The performer must learn the skill and the response pattern associated with the changing environmental conditions. Open skills depend more on visual and verbal cues in order to achieve efficient performances. The performer must adapt to different situations. Learning the "feel" of the activity is not as important as acquiring the proper mechanics. Open skills are not as concerned with knowledge of performance

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[78]Oxendine, p. 18.

[79]Drowatzsky, p. 104.

[80]Whiting, Acquiring Ball Skill, p. 10.

feedback information as closed skills seem to be. Open skills seem to be more concerned with the outcome of the activity (knowledge of results) and not as concerned with the intrinsic feedback mechanisms. For example, a basketball player is more concerned if he were getting the ball in the basket than how he actually performed that shot. Just the opposite would be the case in learning a closed skill like golf. In golf, proper technique or form is all important for success. This type of skill would be dependent upon kinesthetic and intrinsic feedback. A performer in open skills learns to use cues such as the flight of the ball, his or her court position, the opponent's court position, the position and type of defense being used by his opponents, and the playing styles of others in order to develop success patterns.[81] Performers in closed skills only have to develop one habitual movement pattern and are not dependent on the environmental conditions surrounding them for the development of that pattern.

Bilodeau, Bilodeau, and Schumsky state that the evidence is quite clear that without post-response error information in the form of knowledge of results or knowledge

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[81]Drowatzsky, p. 100.

of performance no learning can occur.[82] There can be no improvement without it and it does tend to strengthen habit formation as well as to provide extrinsic motivation.

Wallace and Hagler found that, with the addition of knowledge of performance information to knowledge of results information, the performer can attain an even higher level of skill. But, for this type of feedback to be effective, learners must establish in the memory a model of correctness which they can copy.[83] By doing so, they can use internal or intrinsic information on how the movement felt and be able subjectively to rate their own performance on succeeding trials. This internal information, combined with augmented verbal feedback from the instructor, gives the student an idea of the correctness of his movement pattern.

Several studies have indicated that learning could occur without the learner being aware of the results of the movement. For example, even though Bilodeau, Bilodeau, and Schumsky found that, after sufficient practice was provided and a habit pattern developed, learning could continue in the absence of knowledge of results information.[84]

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[82] E. A. Bilodeau, I. M. Bilodeau, and D. A. Schumsky, "Some Effects of Introducing and Withdrawing Knowledge of Results Early and Late in Practice," Journal of Experimental Psychology, 58 (1959), 142-144.

[83] Wallace and Hagler, pp. 265-266.

[84] Bilodeau, Bilodeau, and Schumsky, pp. 142-144.

Similarly, Solley, using a motor driven chair that the subject could operate by a two-way finger switch, found that learning could continue in the absence of knowledge of results information.[85] Wrisberg and Schmidt found similar results with a linear positioning task.[86] These findings would indicate that learning can occur without the learner being aware of knowledge of results information. This research also indicates that, when learning certain skills, the learner should depend on subjective reinforcement that he receives from intrinsic sources. By so doing, the learner can internalize the movement pattern.

Schmidt found that, if knowledge of results information is withdrawn and the subject has information about response correctness received through subjective reinforcement based on proprioceptive feedback, performance can be maintained.[87] If sufficient knowledge of results practice precedes knowledge of results withdrawal, the subject should be able to continue to learn without knowledge of results information since subjective reinforcement can provide a substitute

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[85]C. M. Solley, "Reduction of Error with Practice in Perception of the Postural Vertical," Journal of Experimental Psychology, 52 (1956), 329-333.

[86]C. A. Wrisberg and R. A. Schmidt, "A Note on Improved Motor Performance without K.R.," Journal of Motor Behavior, 48 (1973), 232-233.

[87]Schmidt, "A Scheme Theory of Discrete Motor Skill Learning," p. 252.

for outcome information normally provided by knowledge of results information.[88] He also feels that some movements are too rapid to allow feedback information to be communicated while the movement is in progress. According to him, only terminal feedback information would be valuable to the learner.[89]

Learning a closed skill like golf, in the absence of the golf ball, and receiving feedback information as to the correctness of the swing is dependent on the closed loop theory of motor learning. This theory provides for receipt of feedback, and that feedback is continually checked against some reference of correctness. The learner is continually comparing his swing performance to the reference of correctness. If, after receiving feedback information from the instructor as to the correctness of the response, the learner can then make corrections. After several trials, the learner becomes more dependent on subjective reinforcement which he receives from his own body. This kinesthetic feedback information eventually allows the learner to become totally dependent on himself for error correction.

Adams' theory is probably the most well known of all the closed loop theories. His theory states that there are

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[88] Ibid.

[89] Ibid.

two states of memory, termed the memory trace and the perceptual trace.[90] The memory trace is analogous to recall memory in verbal learning. According to him, the recall memory is responsible for initiating the movement, choosing its initial direction, and determining the earliest portions of the movement. Its strength is developed as a function of knowledge of results and practice. The perceptual trace, on the other hand, is analogous to the recognition memory in verbal tasks and is responsible for guiding the limb to the correct location during the movement pattern. The perceptual trace is formed from the past experience with feedback from earlier responses and represents the sensory consequences of the limb when it is in the correct position. During the movement, the subject compares the incoming feedback (from the eyes, ears, proprioceptors, etc.) against the perceptual trace to determine if the limb is in the correct location. If it is in the right position, he stops responding and, if it is not, he makes a small adjustment and the comparison is made again until the limb is in the correct location. With increased exposure to feedback and knowledge of results, the perceptual trace is strengthened, and the learner becomes more accurate in his responding.[91]

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[90] J. A. Adams, "A Closed Loop Theory of Motor Learning," Journal of Motor Behavior, 3 (1971), 111-150.

[91] Ibid.

The major feature of Adams' theory is that it provides a means for the subject to determine, in the absence of knowledge of results, his swing errors. This is called subjective reinforcement, and it serves as a means for maintaining performance, or to continue to learn without knowledge of results information. Subjective reinforcement is totally dependent on the learner establishing the correct memory trace and utilizing kinesthetic feedback information until the correct movement pattern is internalized.[92] Theoretically, the subject uses the perceptual trace and feedback during the movement pattern to guide the limbs to the correct positions.[93]

Schmidt disagrees with the closed loop theory of motor learning. Instead of being based on a reference of correctness, he bases motor memory and learning on a preprogrammed approach. In his schema theory of motor learning he states that when an individual makes a movement he stores four things: (1) the initial conditions; (2) the response specifications for the motor program; (3) the sensory consequences; and (4) the outcome of that movement. He says that there are two states of memory: a recall memory that is responsible for the production of movement and a recognition memory that is responsible for response

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[92]Ibid., pp. 111-150.

[93]Ibid.

evaluation.[94] For rapid ballistic movements such as the golf swing, recall memory is involved with the motor programs. These motor programs are structured in advance to carry out the movements, with minimal involvement from peripheral feedback. The basic premise is that with practice people develop rules called schema about their own motor behavior which are then stored in their motor memory.[95] This theory says we learn skills by learning rules about the functioning of our bodies. With experience, we come to form a relationship between how our muscles are activated, what they actually do, and how those actions feel. He says, when the subject is presented with the correct movement, he stores the sensory consequences along with the desired outcome, and the recognition schema begins to be developed or preprogrammed for future responses.[96]

Regardless of what theory is used to explain the learning of the golf swing, it is apparent that feedback is an integral part of the learning process. Feedback and knowledge of results information inform the student about the proficiency of the movement either during or after the response.

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[94]Schmidt, Motor Control and Learning, pp. 593-594.

[95]Ibid.

[96]Ibid.

If the feedback is initiated by the instructor's comments concerning the proficiency of the movement, it is called augmented external feedback. This type of feedback is commonly used in giving the student error correction based on knowledge of how the performer moved his body. Feedback received by the learner from the learner's body, during or after the performance, is commonly called kinesthetic or intrinsic feedback. This type of feedback would include how the movement felt, sounded, or looked and is dependent on the student's clear concept of a standard reference of correctness of how the movement should be performed.[97]

In order for learning to occur and the various feedback mechanisms to work, the learner must have a clear-cut goal of what he is trying to accomplish.[98] If the learner's ultimate goal is to learn a correct golf swing, then he will improve more if he receives feedback information about the relationship of his performance to his goal.[99]

The instructor's primary goal in presenting knowledge of results and knowledge of performance to the learner is to eventually make the learner independent enough so he will

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[97]Oxendine, p. 57.

[98]Hoth, p. 70.

[99]Oxendine, p. 57.

come to depend only on his intrinsic feedback system. This would allow the performer to make self-corrections in the absence of external feedback information.

Although all sensory modes are important as a basis of feedback information when learning a motor skill, experts seem to agree that one particular sensory mode should be emphasized.[100] Therefore, the type of sensory mode that is emphasized and the corresponding feedback system that is used is dependent upon the particular skill being learned.

Literature on Specificity of Training and the Use of Overload Techniques in Learning a Motor Skill

Athletes have always trained for a variety of sports and games. Golf is no different. The whole purpose of a training program is to improve the performance and skill level of the participant. This is why it is important to differentiate between two types of training: (1) training to improve certain physical qualities of the body such as strength, power, endurance, flexibility and agility and (2) skill training or motor training. It is the latter type of training in which the writer is interested.

[100] Magill, p. 70.

[101] Ibid.

Regardless of whether the training program is trying to develop a better physical structure or to develop a skill, the qualities of strength and speed seem to be of prime importance to the trainee. It has been found, for example, that progressive resistance exercises will increase the strength and speed of the movement pattern.[102]

Langford attempted to prove this by putting a group of golfers through a training program. He found that strength training, using progressive resistance exercises with free weights and barbells, increased the distance of the golf drive. His study also indicated that there is no evidence to prove that strength training during the season had any kind of detrimental effect on the accuracy of golf shots. He concluded that golfers who lack sufficient distance with their drive should engage in strength training.[103]

Wenzel found similar results with highly skilled golfers. He tested ten highly skilled golfers on the golf

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[102]E. F. Chui, "Effects of Isometric and Dynamic Weight Training Exercises Upon Strength and Speed of Movement," Research Quarterly, 35 (1964), 264-257; D. H. Clarke and F. M. Henry, "Neuromuscular Specificity and Increased Speed from Strength Development," Research Quarterly, 32 (1961), 315-325; G. B. Dintiman, "Effects of Various Training Programs on Running Speed," Research Quarterly, 35 (1964), 456-463; L. E. Smith, "Influence of Strength Training on Pre-Tensed and Free Arm Speed," Research Quarterly, 35 (1964), 554-561.

[103]E. E. Lanford, Jr., "The Effect of Strength Training on Distance and Accuracy in Golf," Diss. Brigham Young Univ., 1976.

drive for distance and chipping accuracy. He put these ten golfers through an eight-week program of isotonic and isometric exercises. He used nine isotonic and four isometric exercises. Workouts were scheduled for twice a week for eight weeks. His posttest results showed that the golfers improved their golf drive for distance and their chipping ability. He attributed the improvement to an increase in strength and improved physical condition of the golfers.[104]

According to DeVries, the gain in speed has also been shown to result from both strength training that used the same movement as was tested or from strength training that merely improved the strength of the involved muscles but avoided training in the same movement.[105]

But several people think that strength should be increased at that particular point where maximum speed is utilized to the greatest degree.[106] Progressive resistance

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[104]Dick Wenzel, "Weight Training and Its Effect on the Golf Drive," Thesis Univ. of North Dakota, 1967.

[105]Herbert A. DeVries, Physiology of Exercise for Physical Education and Athletics (Dubuque, Iowa: Wm. C. Brown Co., Publishers, 1966), p. 355.

[106]Marion R. Broer, Efficiency of Human Movement (Philadelphia: W. E. Saunders Co., 1968); John W. Bunn, Scientific Principles of Coaching (New York: Prentice-Hall, Inc., 1962); Theodore Hettinger, Physiology of Strength (Springfiled, Ill.: Charles C. Thomas Publishers, 1961); Phillip J. Rasche and Roger K. Burke, Kinesiology and Applied Anatomy (Philadelphia: Lea and Febiger, 1967).

exercises, weight training and Nautilus programs are all useful in developing strength, but participants often have difficulty in integrating this new found strength into a coordinated and rhythmic motor pattern when performing a complex skill such as golf. For example, a lineman for the Los Angeles Rams is obviously stronger than Bob Toski, the well known golf instructor. Although Toski weighs only one hundred thirty-five pounds, he is able to drive the ball well over two hundred fifty yards, while the lineman for the Los Angeles Rams probably cannot hit it one hundred yards. This would indicate that the strength Toski does have is being applied correctly. This would indicate that the technique of the movement involved when swinging a golf club is far more important than the sheer development of strength. If the improvement of skill and technique is considered more important than some of the more obvious physical factors in learning the golf swing, then it would seem logical to emphasize these skills when training.

According to Pratt and Jennison:

> The golf swing is a conditioned automatic response. Coordination is the combination of a number of muscles working together in a smooth pattern. The development of coordination depends upon the repetition of this precisely performed pattern. As the activity is visualized and repeated many times, a habit pathway is formed and the activity can be performed with less and less conscious awareness. Success in shotmaking

is first and foremost a combination of sensory perception and muscle memory.[107]

Bergeron pointed out that, if a performer wants to improve his skill through resistance training, strength and speed gains seem to occur at specific points in the range of movement of the body segments.[108] Based on these findings, it would seem logical to use progressive resistance training as the performer goes through the entire range of motion of the motor skill being learned.

Sterling's study indicated that strength gains would be present throughout the entire range of motion when using isotonic training, but would be greatest where the most resistance was applied.[109] Armstrong investigated the specificity of strength training and its effect on the left arm. He concluded that improvement in performance is based on the specificity (to the performance skill) of the training program.[110] Similarly, Gardner stated that he

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[107]William A. Pratt and Keith Jennison, Year Around Conditioning for Part-Time Golfers (New York: Athenuem--S.M.I. Publishers, Inc., 1977), p. 32.

[108]Phillip Bergeron, "The Effects of Static Strength Training at Various Positions and Dynamic Strength Training Through a Full Range of Motion on Strength, Speed of Movement, and Power," Diss. Louisiana State Univ., 1963.

[109]Duane Ray Sterling, "Isometric Strength Position Specificity Resulting from Isometric and Isotonic Training as a Determinant in Performance," Diss. Louisiana State Univ., 1969.

[110]Charles Richard Armstrong, "Forearm Flexion Strength and Ergometric Performance Following Training at Specified Angles," Thesis San Diego Univ., 1965.

found strength increases are quite specific to the angle at which the limb is exercised.[111] All of these studies suggest that the training effects are specific to the muscles being exercised and the training program being utilized.

The specificity of training principle states that the effects of training are specific to the type of training being used.[112] According to Edington, the specificity principle simply means that a specific exercise will elicit a specific response in a specific individual at a specific point in time.[113] Some examples of this principle include: if a performer is trying to increase his criterion performance in strength, he should engage in strength-producing exercises; if a performer is trying to increase his flexibility, he should engage in flexibility exercises; if a performer is trying to increase his endurance, he should engage in endurance exercises; and, if a performer is trying to improve his agility and coordination, he should

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[111] Gerald W. Gardner, "Specificity of Strength Changes of the Exercised and Non-Exercised Limb Following Isometric Training," Research Quarterly, 34 (March 1963), 98-101.

[112] Wayne D. Van Huss, Roy K. Niemeyer, Herbert W. Olson, and John A. Friedrich, Physical Activity in Modern Living (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1969), p. 46.

[113] D. W. Edington and V. R. Edgerton, The Biology of Physical Activity (Boston: Houghton Mifflin Co., 1976), p. 8.

engage in coordination and agility-producing exercises. Similarly, if an individual is trying to improve his skill, he should practice that particular skill. Specificity expresses the principle that a person gets that for which he works. For the athlete who wishes to improve a specific skill or capability, the best method of training is to practice for that activity.[114]

According to Wells, skillful and efficient performance in a particular technique can best be developed through practice of that technique.[115] As much as possible, training exercises should duplicate the exact conditions under which the activity will be performed.[116]

Clark and Henry's research proved that arm strength and arm speed could be increased through the use of progressive resistance exercises that imitated the desired movement pattern.[117] Logan and McKinney had similar recommendations. They said that, in addition to a general physical development program, the performer should utilize specific resistive exercises that duplicate the exact range of

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[114] James A. Peterson, Conditioning for a Purpose (West Point, N.Y.: Leisure Press, 1977), p. 13.

[115] Wells, p. 385.

[116] Ibid.

[117] Clark and Henry, pp. 315-325.

motion used by the athlete when he is performing his activity.[118]

The aim of training for athletic competition is to bring about those adaptations that allow the body to improve its ability to perform a specific task.[119] But, in order for a training program to be effective, some training principles must be followed. First, overload is mandatory for improved performance. This implies that, to achieve a training effect, it is necessary to exercise at an intensity level greater than one's already existing capacity. Second, the rate of improvement is directly related to the intensity of training. Third, the effects of training are specific to the type of training used. Fourth, repetition is essential for muscular efficiency and coordination. Fifth, the response to training is individual and unique. And, sixth, motivation is essential for effective training.[120]

It is reasonable to ask whether the specificity of training principle is relevant for motor skills learning situations. Two theories presently exist that attempt to answer this question. The first theory is based on Henry's

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[118]G. A. Logan and W. C. McKinney, Kinesiology (Dubuque, Iowa: Wm. C. Brown and Co., 1970), p. 82.

[119]Edington and Edgerton, p. 270.

[120]Ibid.

specificity hypothesis that sees motor skills as being quite specific, bearing only superficial resemblance to each other.[121] He implied that changing the motor task only slightly produces an entirely new motor task for which a new motor program must be learned. According to him, it does not matter if a motor skill is learned under rested or fatigued conditions as long as the nature of the motor pattern being learned remains basically the same. Thus, according to him, practicing a motor skill utilizing overload techniques would be an acceptable way of learning a given skill.

The second theory that tries to explain if the specificity of training principle is relevant for motor skills learning situations is called the "optimal conditions view."[122] According to this theory, practice under rested conditions will always provide more efficient learning of the skill than practice under fatigued conditions. This theory states that learning a motor skill utilizing overload techniques would not be an efficient way to learn the skill because of the inhibiting influence of fatigue. Barnett,

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[121] F. M. Henry, "Specificity vs. Generality in Learning Motor Skills," Proceedings of the College Physical Education Association, Washington, D.C., 1958.

[122] Mary L. Barnett, Diane Ross, Richard A. Schmidt, and Bette Todd, "Motor Skills Learning and the Specificity of Training Principle," Research Quarterly, 44 (December 1973), 441.

Ross, Schmidt and Todd's findings supported this "optimal conditions" theory and pointed out that practice under non-fatigued conditions produced more effective learning than practice under fatigued conditions.[123]

In spite of the controversy over the specificity of training principle and its relevancy for motor skill learning situations, there have been numerous studies utilizing overload techniques when learning a motor skill. Most of these studies are interested in the effects of utilizing overload techniques on accuracy and velocity. Most of the research is very inconclusive as to the effects of a weighted object or implement on the development of a motor pattern, and further research should be initiated that would clear up any inconsistencies.

Regarding this, Van Huss et al. found that subjects who warmed up with a weighted baseball significantly improved their velocity of throwing regular baseballs immediately following the "overload" warm-up with an eleven ounce baseball. But, at the same time, he reported no improvement in throwing accuracy under the same conditions. However, as the speed of the throw was increased, the subjects' patterns of throwing were significantly changed.[124]

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[123] Ibid., p. 440.

[124] W. D. Van Huss, L. Albrecht, R. Nelson, and R. Hagerman, "Effect of Overload Warmup on the Velocity and Accuracy of Throwing," Research Quarterly, 33 (1962), 472-475.

A study by Rowlands was designed with the purpose of investigating the effects of progressive resistance exercises upon the throwing speed and strength of baseball players. His experimental group participated in a weight program designed to increase strength at critical points in the range of motion. He concluded that the series of exercises that were used in his study resulted in significant gains in throwing power.[125]

Sinks investigated the longitudinal effects of progressive overload on speed and accuracy in baseball pitching. In his study, an experimental group of seven pitchers threw a weighted baseball for twenty minutes on Monday, Wednesday and Friday for six weeks. The control group trained on the same schedule with a regulation ball. Sinks concluded that practice with a weighted ball produced a significant speed increase but a significant decrease in accuracy.[126]

Creek tested seventy-four softball players on the effects of warming up with a weighted ball. He found that the subjects who warmed up with the weighted ball had adverse effects on their accuracy. But, with repeated

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[125] Donald J. Rowlands, "The Effects of Weight Training Exercises Upon the Throwing Power and Strength of College Baseball Players," Diss. Univ. of Wisconsin, 1962.

[126] Michael Gordon Sinks, "Longitudinal Effects of Progressive Overload on Speed and Accuracy in Baseball Pitching," Thesis Michigan State Univ., 1962.

tests, this effect appeared to diminish. This led him to the conclusion that inexperience in throwing a weighted softball might be related to the initial adverse effects in accuracy.[127]

Whitely and Smith investigated the effects of isometric, isotonic, dynamic overload, and free arm exercise on the speed and strength of a lateral arm movement. The isometric-isotonic group engaged in weight training. The dynamic overload group trained on a specially designed device that duplicated the test movement, while the free swing group used no weights or devices while imitating the test movement. Following training, there were significant speed increases in both the isometric-isotonic and dynamic overload groups. Significant strength gains were also found in these groups. But no gains were found in either the free arm swing or the control groups. They concluded that, regardless of the type of strengthening exercises used, increasing the strength of the muscles involved in a specific movement makes it possible for an individual to execute a faster limb movement.[128]

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[127] Ronald Eugene Creek, "The Effects of Overload Warm-up on the Accuracy of Throwing a Twelve Inch Softball," Thesis Eastern Illinois Univ., 1964.

[128] James D. Whitely and Leon Smith, "Influence of Three Different Training Programs on Strength and Speed of Movement," Research Quarterly, 37 (March 1966), 132-142.

Polluck felt that resistance training, if individualized to match a particular skill, can bring about an increase in speed through an increase in strength. He thought that, in order to achieve significant gains in throwing ability, it is critical to design a program that would strengthen these particular muscle groups that would be used in the throwing motion. As may be seen from the literature on specificity, it is not only necessary to strengthen particular muscle groups, but critically important to add strength at a particular point in the range of motion so that the resultant increase in speed of movement will actually increase the efficiency of the particular skill. As a result of these ideas, he investigated the effects of training with an eleven ounce baseball on throwing velocity. The results showed that the experimental group showed significantly more improvement than the control group in throwing velocity after a seven week training session.[129]

Some studies have shown that the use of overload techniques have had little or no influence on throwing velocity and accuracy of the baseball. For example, Minor investigated the effect of two kinds of overload exercises on the throwing power of high school baseball

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[129] Douglas Jan Polluck, "The Effects of Training with a Weighted Baseball on Throwing Velocity," Thesis California State Univ. at Northridge, 1975.

players. Over a four week period, subjects trained with a two and one-half pound baseball. The second kind of overload exercise that was used involved the training with four and eight pound dumbbells simulating the throwing motion. He found that training with dumbbells had a greater effect upon strength than did training with the weighted ball. He concluded that it was difficult to build up strength and throwing power with a single exercise.[130]

Egstrom conducted a study utilizing fifty-six college students to determine if there were differences in the degrees to which accuracy in throwing with the non-preferred hand was developed when practiced with projectiles of varying weights. The results showed that practice with the light ball was as effective as practice with the heavier ball in developing skill to throw a heavy ball. Practice with a heavier ball did not demonstrate any corresponding effects upon accuracy.[131]

Brose and Hanson tested twenty-one male freshmen baseball players at the University of Maryland. They were divided into three groups of equal size. Two groups supplemented a baseball throwing program by specific

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[130]Donald Lemont Minor, "The Effects of Weight Training on Throwing Power of High School Baseball Players," Thesis Univ. of Wisconsin at Madison, 1958.

[131]Glen Egstrom, "Accuracy of Throwing Skill Involving Projectiles of Varying Weights," Research Quarterly, 31 (October 1960), 420-425.

overload training. One group threw weighted baseballs while the other used a pulley device to resist the mechanics of throwing. After six weeks, both groups experienced significant increases in throwing velocity as a result of training, but there was no significant change in accuracy. However, no significant difference was found among the training groups and the control group.[132]

Elias also used weighted baseballs in his study. Twelve freshmen pitchers were used as his subjects. Six of the subjects were used in the control group and threw regulation baseballs three times a week. The six subjects in the experimental group threw seven ounce balls the first two weeks and eleven ounce balls the last two weeks. The subjects were tested for throwing velocity both before and after the training period. No significant difference was found between either group. Neither group was found effective in improving throwing velocity.[133]

Straub used forty-eight boys ranging from fourteen to nineteen years old to train for six weeks throwing regulation baseballs or baseballs of progressively increasing weight. Another group of sixty boys were

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[132]Donald E. Brose and Dale L. Hanson, "Effects of Overload Training on Velocity and Accuracy in Throwing," Research Qaurterly, 38 (December 1967), 528-533.

[133]John Elias, "The Effect of Overload Training on Speed in Baseball Pitching," Thesis Springfield College, 1964.

classified as either fast or slow throwers and tested to determine the effect of warming up with regulation or weighted balls. Ball speed was measured as well as accuracy. He found that the warm-up had no significant effect on the speed or accuracy of either high or low velocity throwers. He concluded that overload training had no effect on either group. Control subjects, who trained with regulation balls and had equal speed and accuracy emphasis, threw as fast and as accurately as subjects who trained with progressive overload and speed and accuracy emphasis. He also concluded that using a weighted ball produced no immediate or long-range improvement in throwing speed or accuracy.[134]

Birchy's study indicated that training with weighted baseballs produced no significant increase in velocity measures. He also found that the group that trained with the regulation baseball was far more accurate in throwing ability.[135]

Brown investigated the effects of three intensity levels of warm-up on reaction time and speed of movement in the baseball swing. He concluded that no difference existed

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[134] William F. Straub, "The Effect of Overload Training Procedures Upon the Velocity and Accuracy of the Overarm Throw," Diss. Univ. of Wisconsin, 1966.

[135] Thomas L. Birchy, "The Effect of Specific Overload Training on Task, Accuracy by the Highly Skilled," Thesis Univ. of Maryland, 1968.

between the use of regular warm-up techniques and overload warm-up techniques as they related to movement time.[136]

Overload techniques have been used in other activities as well. Bell designed a series of exercises to improve the speed of the tennis serve prior to the playing season. The program consisted primarily of simulating a tennis stroke using a five pound dumbbell and swinging a tennis racket with a weighted racket cover. He found that both exercises created significant gains in strength in the shoulder and forearm muscles. Through films, however, he determined that significant gains in the speed of the serve did not occur.[137]

Lindeburg and Hewitt conducted an experiment to determine whether practice with a basketball that was slightly larger and heavier than regulation size would aid or hinder one's performance with a regulation basketball. They concluded that the use of a larger and heavier basketball resulted in no differences in the shooting and dribbling tests, and there was a slight negative effect on passing skills.[138]

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[136] Paul Timothy Brown, "Effects of Three Intensity Levels of Warm Ups on Reaction Time and Speed of Movement in the Baseball Swing," Diss. Indiana Univ., 1971.

[137] Dudley S. Bell, "A Proposed Pre-Season Tennis Program," Thesis Springfield College, 1962.

[138] F. A. Lindeburg and J. E. Hewitt, "Effect of an Oversized Basketball on Shooting Ability and Ball Handling," Research Quarterly, 36 (1965), 164-167.

Kinser and Kennison found different results than those Lindeburg and Hewitt recorded. Kinser investigated the effect of practicing with varied weights of basketballs on free throw skills. In his study, fifty-nine male college students were divided into four matched groups. The three experimental groups practiced free throw shooting with the non-preferred hand for four weeks using a one pound basketball, a regulation basketball, and a two and eight-tenths pound ball. He found that the group using the lightest ball developed significantly greater accuracy.[139]

In basketball shooting accuracy, Kennison found that twenty-five subjects who practiced with a heavy basketball failed to improve their shooting ability, while the twenty-five subjects who used normal basketball did improve their shooting abilities. He concluded that the strength of the muscle groups involved is not a significant factor in developing accuracy in a motor skill when the skill is performed within normal distances and when using objects that an average performer can handle.[140]

Hopek studied the effect of overload on the accuracy of throwing the football. During each of the thirteen periods,

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[139] Jay Kinser, "The Effect of Practicing with Varied Weights of Basketballs on Free-Throw Skills," Thesis Southwest Missouri State College, 1966.

[140] James Edward Kennison, "The Effects of Four Training Programs on the Acquisition of Speed and Accuracy in Motor Performance," Diss. Louisiana State Univ., 1966.

subjects threw the football fifteen times at a moving target ten and fifteen yards away. The results showed that the experimental group improved more in accuracy than did the control group, but statistically there was no significant difference in either group's improvement of accuracy.[141]

Bass tested fifteen women students in a synchronized swimming class. The experimental group added weights to their ankles and wrists. Correlations revealed that there were no apparent statistically significant differences between the gains of the experimental and control groups.[142]

Kober tested sixteen high school hockey players matched on the basis of ice skating speed. They were randomly assigned to an experimental or control group. The experimental group practiced with ankle weights on. He found no significant differences between the groups when testing for speed and endurance.[143]

Lukes' study investigated the effects that a weighted shoe had on jumping performance, agility, running speed, and endurance of college basketball players. He found that the group using the weighted shoe had significantly greater

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[141] Richard Hopek, "Effect of Overload on Accuracy of Throwing the Football," Thesis Eastern Illinois Univ., 1967.

[142] Beverly S. Bass, "The Effect of Progressive Overload Training on the Development of Sculling in Synchronized Swimming," Thesis Florida State Univ., 1970.

[143] William M. Kober, "The Effect of Training with Ankle Weights on Ice Skating Speed and Endurance," Thesis Springfield College, 1972.

gains in the vertical jump, agility test and endurance tests than the control group.[144]

Behuniak found similar results when testing the effects of overload techniques on the vertical jump. He found that from zero to fifteen percent overload produced significant improvement in thirty consecutive maximal vertical jumps.[145]

Other researchers found just the opposite results. Gallon investigated the use of weighted shoes in basketball conditioning. He found that the players who practiced without the weighted shoes actually improved more on speed run tests than the experimental group.[146] A similar finding was reported by Winningham on his investigation of the effects of training with ankle weights.[147]

Stockholm and Nelson reported the immediate effects of a weighted vest upon vertical jumping ability. The subjects performed vertical jumps with the weighted vest followed by jumps without the weights. They found no improvement in the

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[144] Wayne Lukes, "The Effect of a Weighted Training Shoe on the Jumping Performance, Agility, Running Speed, and Endurance of College Basketball Players," Thesis, Univ. of Wisconsin, 1960.

[145] Gregory J. Behuniak, "The Effect of Overload Vertical Jump Training Upon Performance of Thirty Vertical Jumps," Thesis Univ. of Maryland, 1966.

[146] A. J. Gallon, "Use of Weighted Shoes in Basketball Conditioning," paper presented to C.A.H.P.E.R. Southern District Meeting, Santa Barbara, Calif., October 27, 1962.

[147] S. N. Winningham, "Effect of Training with Ankle Weights on Running Skill," Diss. Univ. of Southern California, 1966.

vertical jump performance after the overload technique was used.[148]

In Chambers' study, fifteen boys wore ankle weights during an eight week basketball unit involving calisthenics, running, basketball fundamentals, and offensive and defensive patterns. At the same time, the control group practiced without ankle weights. He found that the practice itself increased agility but the ankle weights made little apparent difference.[149]

Van Huss et al described speed overload training as the rate of movement in a power activity while progressively increasing the weight being used during the execution of the specific rapid body movement in which improvement is desired.[150] Some examples of this type of overload would include: practicing high jumping with a weight on the back; running in weighted shoes; and shotputting with an over-weight shot. Van Huss states that the technique of speed overload usually will not develop maximum strength since maximum loads are not being used but, since the emphasis is on both speed and strength, power is developed.[151] He feels

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[148] A. J. Stockholm and R. Nelson, "The Immediate After-Effects of Increased Resistance Upon Physical Performance," <u>Research Quarterly</u>, 36 (1965), 337-341.

[149] Ted A. Chambers, "The Effect of Wearing Ankle Weights Upon Running Agility of Junior High Boys," Thesis Univ. of Iowa, 1966.

[150] Van Huss, Niemeyer, Olson, and Friedrick, p. 44.

[151] Ibid.

that, to improve a skill, a training program should be set up to specifically overload for the desired results. And, in order to achieve maximum efficiency in learning a skill, the principle of repetition must be followed.[152] According to him, if skill is the desired outcome, then the subject should specifically train for this skill. Rate of improvement is directly related to the intensity and frequency of training.[153]

Lee's study nicely summarizes the relationship between overload training techniques and motor ability measures. He says that all of the training programs that he used improved muscular strength but produced mixed results with motor ability measures. Strength improvement in specific muscle groups can improve motor ability performance in activities requiring the use of those muscle groups. Furthermore, if the activity requires a fast movement, then training must be performed at a fast rate.[154]

Although he did not have any research findings to confirm his ideas, Bertholy was one of the first people to apply the specificity principle to golf swing improvement.

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[152] Ibid.

[153] Ibid.

[154] Kang-Pyung Lee, "The Comparison of the Effectiveness of Muscular Strength and Power Development Through Training Programs with the External Moment Force Pulley System and the Pre-Weight Training Method Using Slow and Fast Speeds of Training," Diss. Univ. of Toledo, 1978.

In the early 1970's, several thousand people were using his method to condition and train for a better golf swing. He developed an isometric exercise program that used a series of seven isometric exercises. A weighted swing pipe and a weighted club were used. Each of his seven isometric positions represented what he called the key positions in the golf swing. He wanted participants in his program to hold each position for ten seconds. In his method of teaching and training for the golf swing, no attempt was made to convey the principles of the swing with the spoken word. He called his program a conditioning program that would automatically develop the correct positions of the golf swing while at the same time strengthen the golf muscles. Also, he did not use a ball in his conditioning program. He theorized that, if a golfer would put his body in these seven different isometric positions and hold each of these for ten seconds, the student's kinesthetic sense and muscle memory would allow the student to automatically ingrain the conditioned response of the golf swing. He said that swinging the golf club was a kinesthetic experience for which kinesthetic factors must be developed through conditioning. He felt that the golf swing must be conditioned in order to conquer mental tension. To him, mental tension and fear were caused by the presence of the ball. The presence of the ball created that instinctive reflex action which he called the "hit impulse." Some professionals have called this being "ball bound." He theorized that his program would eradicate the faults caused by being "ball bound" and help train the golf student to learn a better swing. He believed that, once the precise sequential movement is incorporated into the kinesthetic memory, it would constantly be reinforced through conditioning. He thought that the hit impulse was instinctive in man, and man must train himself to swing and not to hit. He felt that his program would: (1) raise the golfer's kinesthetic awareness level for the golf swing and (2) create an improved muscular structure.[155] He stated:

> In logical golf swing development, the fine swing starts as a thought, becomes a sensation through proper guidance, and then, through precise repetition of an intensified nature, becomes a conditioned response.[156]

According to him, the greater the intensification through isotonics, weighted clubs or swing tools, the more the learning process is accelerated.[157]

Cochran and Stobbs disagreed with Bertholy's isometric method, theorizing:

> Certainly to practice a swing so slow that time movement is no longer ballistic is a waste of time, as the muscles and nervous system will have to act in quite a different way from the way they are supposed to act in a normal swing.[158]

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[155] Paul Bertholy, "How to Become a Complete Golfer," condensed handout, Melrose Park, Illinois, 1971.

[156] Ibid.

[157] Ibid.

[158] Cochran and Stobbs, p. 106.

Noble's experiments on the golf swing also disproved Bertholy's idea of isometric golf swing training. In his study, he wanted to know to what extent the golf swing was a guided movement or to what extent it was a ballistic movement in which continuous control cannot be exercised. His research pointed out that the golfer could control the golf club on the backswing but he had little or no control of the golf club on the downswing. His findings indicated that the golf swing is a ballistic movement and not a guided movement.[159] Thus, he would disagree with Bertholy's idea that isometric swing positions could improve a golfer's swing techniques. He would not argue that the isometric "swing positioning" exercises might increase the strength and flexibility of the muscles directly used in the golf swing. According to Noble, if the golf swing is a ballistic movement, it should be taught ballistically. He indicated that any other teaching or training method would not transfer into an efficient swinging action.[160]

Cratty and Hutton thought that the use of weighted clubs, bats, rackets, etc. to train and warm up with gave the

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[159] C. E. Noble, "Selective Learning," in E. A. Bilodeau, ed., Acquisition of Skill (New York: Academic Press, 1965), p. 51.

[160] Ibid.

performer a kinesthetic-figural after-effect.[161] For example, prior to coming to the plate in baseball, the batter is frequently seen swinging a heavy bat, purportedly to give him a feeling that the regulation bat is lighter than normal and, thus, may be swung faster and harder. A golfer warming up with a weighted headcover or club experiences similar feelings. Another example would include the subject pressing outward on a door frame with the backs of his hands for ten to fifteen seconds. After the subject terminates this pressing and tries to relax his arms at his side, he finds he is unable to do so without his arms automatically rising out from his sides. These two examples illustrate that one's sense of position and muscle tension is in extreme transition and is influenced by overload techniques and the nature of movement and position.[162]

The literature on kinesthetic after-effects suggests that they are rather short-termed and probably do not influence actual performance of the skill to any marked degree. At the same time, however, these kinds of tasks do influence how an individual feels when he moves his body.[163]

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[161] Bryant J. Cratty and Robert S. Hutton, Experiments in Movement Behavior and Motor Learning (Philadelphia: Lea and Febiger Publishers, 1969), pp. 105-106.

[162] Ibid.

[163] Ibid.

But some researchers postulate that kinesthetic-figural after-effects might have longer lasting consequences. They believe that a neurophysical pattern is learned quicker and retained longer when a heavy implement is used to learn a motor skill.[164] According to them, more motor units are recruited when using the heavy implement and, therefore, a greater training effect will occur. The overload principle, used in conjunction with this, states that, if muscles are forced to work against a resistance, then muscle strength, power, and speed of movement should result. Although most studies would agree that this type of training would not produce much strength, power, or speed of movement, they are not sure what the long-term kinesthetic after-effects might be on the actual learning of the motor skill.

As one knows, figural after-effects are maximal immediately after the experience with the weighted implement, and they diminish gradually. Although some after-effects may be of a long duration, no one really knows how long the after-effects will last after training has ceased.[165] Concerning this, Wertheimer and Loventhal found that after-effects remained as long as six months after

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[164] George H. Sage, Introduction to Motor Behavior A Neuropsychological Approach (Reading, Mass.: Addison-Wesley Publishing Co., 1971), p. 124.

[165] Ibid.

training.[166] Only further research on the effects of a weighted implement on the learning of a motor skill could determine the long-term after-effects of such a procedure.

Sage states that most investigations suggest that kinesthetic figural after-effects are not accompanied by any measurable improvement in performance in the skills that have been practiced using the weighted objects. He feels that any attempt to improve performance by utilizing objects that are slightly heavier than normal while practicing the movement pattern involved in that particular activity seems to be hardly worth the time spent and the money paid for the weighted object.[167]

Nelson and Nofsinger's study also refuted any positive evidence that training with weighted objects improved future performance. They measured the speed of elbow flexion just before and after applying various weights to the arm. They found no significant difference between the pre-overload speed and the post-overload speed, although the subjects stated that they had a feeling they were faster.[168]

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[166] M. Wertheimer and C. M. Loventhal, "Permanent Satiation Phenomena with Kinesthetic Figural After-Effects," Journal of Experimental Psychology, 55 (1958), 255-257.

[167] Sage, p. 126.

[168] R. C. Nelson and M. R. Nofsinger, "Effect of Overload on Speed of Elbow Flexion and the Associated After-Effects," Research Quarterly, 36 (1963), 174-182.

Oxendine mentions that some kinesthetic training aids should be used by the teacher to promote proper mechanics in the movement being learned. According to him, the use of weighted golf clubs, baseball bats and tennis rackets will help the learner develop the proper follow-through. Such a weighted bat or club will force the individual to follow-through and perhaps experience this sensation for the first time.[169]

Several noted golf professionals have advocated the use of a weighted golf club for one reason or another. Ken Venturi, well known golf instructor and golf analyst for a major television station, endorses the use of an off-season training program that utilizes swing drills and a weighted golf club without the presence of the golf ball.[170] He feels that this type of motor training allows the student to build up a conditioned response and automatically improve the mechanics of the golfer's swing.[171]

David Graham, the 1981 United States Open Golf Champion, suggests swinging a weighted club several times a day in order to generate extra power and length with the driver. He feels that the weighted club will help the golfer create a wider and longer backswing arc by improving

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[169] Oxendine, p. 297.

[170] Michael Dixon, "Spring Training for Golfers," Golf Magazine Yearbook, 24 (1982), 30.

[171] Ibid.

the golfer's flexibility. According to him, the weighted club should help the golfer train his shoulders to make a full upper body coil. Graham attributes much of his present success to the last two years of lengthening his swing working with a weighted golf club.[172] Jack Nicklaus, leading all-time money winner on the P.G.A. tour, states that a good way to loosen your golf muscles is to swing two clubs at once. A weighted wood headcover serves the same purpose as well as the two clubs. He also advocates swinging a weighted club during the off-season.[173]

Gary Wiren, the director of learning and research for the P.G.A. of America, states that the golfer might take an object heavier than a normal golf club, such as a weighted club, a bar from a barbell, a rake, or a homemade weighted device, and swing it like a golf club.[174] He also advocates doing a series of golf drills with a twenty to twenty-six ounce driver.[175] In addition to this, he feels the daily

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[172]David Graham, "Learn to Coordinate Your Upper and Bottom Halves," Golf Digest, 33 (February 1982), 64.

[173]Jack Nicklaus, Golf My Way (New York: Simon and Schuster, 1975), p. 197.

[174]Gary Wiren, Golf (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971), pp. 90-91.

[175]Gary Wiren, "Put Spring Into Your Game with These Winter Drills," Golf Digest, 25 (December 1974), 32.

use of a weighted club will extend the golfer's swing arc.[176]

Ben Crenshaw[177] and Johnny Miller,[178] both well known P.G.A. professionals on the P.G.A. tour, advocate the use of a weighted club in order to lengthen the swing.

The editors of Golf Magazine suggest that a golfer should swing a heavy club in order to stretch and strengthen the golf muscles. They feel that swinging a heavy club helps the golfer to find his optimum swing speed. They suggest buying a weighted headcover, a weighted club, or a weighted swing doughnut.[179]

Bob Toski and Jim Flick, both well known golf teachers, advocate using a weighted club, a weighted headcover, or a heavy doughnut. They feel the extra weight promotes motion in the golfer's arms and strength in the forearms and hands. They feel that the actual muscles that are used in the golf swing will be developed as a result of heavy club swinging. They advocate using a club that weighs between twenty and

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[176] Gary Wiren, "Is Your Body Ready for Jack's Advice?", Golf Digest, 32 (October 1981), 65.

[177] Ben Crenshaw, "Long vs. Short Swing," Golf Magazine, 24 (June 1982), 98.

[178] Johnny Miller, "Champ's Clinic," Golf Magazine, 24 (July 1982), 85.

[179] The Editors of Golf Magazine, "Should You Swing Hard?", Golf Magazine, 24 (August 1982), 44.

twenty-five ounces. By so doing, the golfer is more inclined to swing his arms first and not his body.[180]

Dave Regan, a former tour player, says he gets his swing back into shape after a layoff by swinging a heavy club. He says this strengthens his hands and arms and maintains his muscle tone. Furthermore, he believes that the idea of golf is to feel where the clubhead is during the swing. A weighted club helps the golfer develop this feel.[181]

Dave Marr, a P.G.A. professional and television golf analyst, states that the average golfer should concentrate on developing the muscles that will help him in hitting the ball better. He should participate in a regular program of exercise that includes the use of swinging a heavy practice club.[182]

Tom Nieporte says he keeps his hands and forearms in shape by swinging a twenty ounce driver fifteen times a day. He feels this keeps one's swing grooved and strengthens the hands.[183]

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[180] Bob Toski and Jim Flick, "How to Become a Complete Golfer" (Norwalk, Ct.: Golf Digest Tennis/Golf Publishers, Inc., 1978), p. 152.

[181] Jack Zangler, Exercises for Better Golf (Camden, New Jersey: Thomas Nelson Publishers, 1965), p. 135.

[182] Ibid.

[183] Ibid.

Teaching professional and former famous amateur golf champion Frank Strafaci says he swings a six pound driver one hundred times every night. He believes this is the most important exercise for golf because it forces all body movements during the swing to work as a unit. If these movements are not in unison, it will immediately become apparent while doing this exercise.[184]

Willie Turnesa says that one method of strengthening the hands and forearms is getting a heavy club and swinging it every day for a few minutes. The extra weight will force the golfer to turn his body when practicing the swing.[185]

Cary Middlecoff recently stated that a golfer can improve his flexibility by swinging a weighted club. He feels that a golfer can add fifteen to twenty yards by swinging a weighted club five or six times a week.[186]

Harry Orbitz, a noted teaching professional, suggests that golfers who want to increase their potential for swing speed should swing a heavy club every day.[187]

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[184] Raymond Schuessler, "Pumping Iron," Golf Illustrated Magazine, 20 (Summer 1981), 52.

[185] Zangler, p. 35.

[186] Cary Middlecoff, "Build Flexibility with a Weighted Club," Golf Digest, 33 (February 1982), 98.

[187] Editors of Golf Magazine, "Should You Swing Hard?", p. 45.

Pratt and Jennison theorize that swinging a weighted club is especially good for beginning golfers.[188] They feel that swinging a weighted club will help overcome some bad swing mechanics. They theorize that it will stop the premature uncocking of the wrists from the top of the swing. They contend that, if a golfer would swing a weighted club for a while, he would feel the muscles that are directly involved in the uncocking of the wrists. They also explain that the continual use of this weighted club, headcover or doughnut will give the golfer a slight increase in the strength of the golf muscles which, in turn, translates into more distance.[189]

Since almost six hundred muscles of one's body are involved when a golfer swings his club, the golfer's goal should be to tone his muscles evenly and not concentrate on the development of any single muscle area to the neglect of others. This objective, the literature states, can best be accomplished by swinging a weighted club every day.[190]

Even though most all of the P.G.A. tour professionals advocate the swinging of a heavy golf club to improve the swing, research results are very inconclusive as to whether this type of motor training is beneficial.

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[188] Pratt and Jennison, p. 77.

[189] Ibid.

[190] Ibid., p. 56.

It has been theorized that overload techniques and specificity of training might be a successful method of training for a motor skill. Furthermore, it has been thought that if the subject initiates his learning with a heavy implement and then goes to a regulation movement he might be able to sharpen his proprioceptive sensitivity for the movement pattern. At this time, this type of motor training is still being investigated, and quite possibly success in learning this way is most likely dependent on the skill in question.

Literature Relating to the Use of Swing Drills and Exercises

Golf swing drills and exercises have long been an important part of golf swing improvement. As far back as 1960, Rehling was writing about the importance of swing exercises.[191] In his writings he stated that he thought it was essential for a person to develop a keen "kinesthetic sense" in order to acquire skill in any neuromuscular activity. Therefore, he advocated the use of specific golf exercises in order to capture this "kinesthetic sense" which, in turn, would train the body to move correctly.[192]

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[191] Conrad Rehling, "Golf Exercises are Necessary," Athletic Journal, 18 (February 1960), 30-32.

[192] Ibid.

In the last five to ten years the use of swing drills has become a favorite method of improving a golfer's swing. Even with the recent popularity of swing drills, there has been little, if any, research on the subject. Therefore, most of the review in his text represents the opinions of several outstanding golf instructors.

According to Toski and Flick, the purposes of swing drills and exercises are to: (1) break down bad habits and create new ones as soon as possible; (2) identify the correct pattern of movement in the golf swing; (3) build correct movements and become familiar with those feelings; (4) help maintain good habits; and (5) keep the golfer's muscles in tone.[193]

Golf drills help the golfer identify with the correct movement pattern of the golf swing while, at the same time, give the golfer the correct "feelings" and sensations of that pattern.[194] Specifically, golf drills are used to develop motion.[195] According to Toski and Flick, drills also develop strength in the golf muscles.[196]

Golf drills try to isolate a certain part of the body and, in so doing, force the other body parts to work

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[193]Toski and Flick, p. 263.

[194]Ibid.

[195]Ibid.

[196]Ibid.

correctly. For example, if the golfer is having trouble identifying with the feeling of the arms swinging and the body following, he would be well advised to swing with his feet together to develop an arm swing[197] or possibly the golfer may be having trouble feeling his left side getting into the shot. In this case, he might swing the club with his left army only.[198] Similarly, if the golfer is having trouble turning his shoulders and shifting his weight, he might take some swings on his knees or on an uphill lie.[199] Toski and Flick also suggested that the golfer might practice swinging with the right arm only in order to train the right hand, side and arm to work correctly.[200] According to Toski and Flick, Golf drills seem to help the golfer develop sensations and proprioceptive sensitivity for the correct movement pattern.[201]

Aultman states that swing drills create correct feelings within the golfer that he can cultivate thereafter through practice.[202] He suggests practicing drills in order to create specific and instinctive responses that are

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[197] Ibid.

[198] Ibid.

[199] Ibid.

[200] Ibid., p. 264.

[201] Ibid.

[202] Aultman, p. 62.

automatically correct.[203] He says that these drills will produce responses that will bypass many conscious changes that would take much more time to correct.[204] He indicates that swing changes can be made subconsciously as the result of these swing drills.[205]

Pratt and Jennison point out that golf exercises or swing drills must be done correctly and with concentration, because one is not only trying to develop specific muscular capability but also a muscular memory for the movement pattern. To realize the full potential of the specific golf exercises, they must be done repeatedly and precisely.[206]

Bob Ross, head golf professional at Baltusrol Golf Club in Springfield, New Jersey, advocates the use of swing drills without the presence of the golf ball. He feels that this method of learning is especially helpful to the beginning golfer as it allows the beginner to concentrate on his swing and helps him eliminate the fear of missing the ball.[207]

Dave Ragen, a former tour player, says his theory about golf and exercise is this, "Play golf as naturally as

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[203]Ibid.

[204]Ibid.

[205]Ibid.

[206]Pratt and Jennison, p. 74.

[207]Dixon, p. 30.

possible and use supplementary exercises that simulate the golf swing."[208]

Toski says that a golfer should swing on one leg in order to help him learn the fundamentals of balance. This gives the golfer the feeling of hitting against and around the left side while at the same time learning to transfer his weight.[209] He also recommends that a golfer practice swinging a club with his left arm only.[210] Once the golfer reaches the top of his swing, he should hold that position for ten to twenty seconds. According to him, this exercise will strengthen the left side golf muscles and give the golfer more distance.[211]

Pratt and Jennison state that, in order to make the body turn naturally and instinctively, exact movement must be practiced. They suggest practicing turning the body with a golf club across the back of the shoulders trying to simulate the body rotation used during the golf swing.[212]

Kostis advocates using golf drills in order to cure bad habits in the golf swing. He says these drills give the

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[208]Zangler, p. 135.

[209]Bob Toski, "One Leg Drill," Golf Digest, 33 (September 1982), 54.

[210]Bob Toski, "More Distance," Golf Digest, 33 (December 1982), 61.

[211]Ibid.

[212]Pratt and Jennison, p. 26.

golfer the correct feelings and sensations to insure an instinctive response of the correct movement pattern.[213]

Probably the most beneficial aspect of using golf drills is that they give the proper feeling of the desired movement. The usual goal in motor learning is to reduce new movement patterns to the automatic subconscious mechanisms.[214]

The use of golf drills tends to put the movement pattern on the automatic subconscious level.[215] Kostis reinforces this theory when he says that, to learn something new, the learner must think about it consciously until he can reach the point where he can perform it subconsciously.[216] According to him, swing drills allow this subconscious learning to occur.[217] He believes that certain swing drills and exercises will train the muscles in the hands and wrists to move correctly. He breaks the learning of the golf swing down into stages. In each stage he advocates using a series of swing drills in order to train the body to learn automatically the correct movement pattern. He emphasizes the fact that, through the use of

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[213] Kostis, "Curing Golf's Most Common Fault," Golf Digest, 29 (July 1978), 58-61.

[214] Rasch and Burke, p. 32.

[215] Aultman, p. 62.

[216] Kostis, Inside Path to Better Golf, p. 47.

[217] Ibid.

these swing drills, a golfer can feel the sensations of the correct form of the golf swing. He goes on to list a series of fourteen swing drills designed to improve swing performance.[218]

Ron Rhodes, a well known teaching professional, advocates the use of four simple swing drills performed without a golf ball to facilitate the transition from an abbreviated training swing to a full swing. He uses this training swing because he feels that learning a full swing is too complex for beginning golfers.[219]

Wiren presented a series of nine swing drills designed to improve both the technique of the golf swing and the condition of the golf muscles. These drills are to be performed in the off-season without the ball. He suggested that, by performing these drills regularly, the golfer would improve his golf swing and condition his golf muscles.[220]

The National Golf Foundation has published a series of swing drills and exercises that are supposed to convey the "feel" of the movement pattern to the student when other means of communication might fail. The foundation states that the mark of a good golf exercise is one that conveys a

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[218]Ibid., pp. 90-127.

[219]Ron Rhodes, "Simple Exercises for Turning Your Swing," Golf Guide Magazine, Mid Summer Issue, 49 (1982), 12-16.

[220]Wiren, "Put Spring Into Your Game with these Winter Drills," p. 90.

simple kinesthetic message and produces the greatest number of desired movements automatically. All of the exercises that it recommends are performed without a golf ball and are designed to give the beginning golfer the correct kinesthetic feeling of the golf swing.[221]

Ken Venturi, former U.S. Open champion and well known golf analyst, states that the regular use of swing drills will help the golfer automatically ingrain the correct movement pattern used in the golf swing. He feels that the use of high repetition swinging with a heavy club can give the golfer an instinctive feel for the swing. He theorizes that the swing drills automatically improve the ten critical positions of the golf swing.[222]

Research seems to indicate that the golf swing is a ballistic movement.[223] If this is the case, then it should be taught ballistically. Any slow motion, static, or guided movements are of little, if any, benefit to the learner. The use of the swing drills insures the ballistic qualities of the movement and at the same time develops certain positional qualities of the swing.

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[221]National Golf Foundation, Golf Instructor's Guide (Chicago, Ill.: N.G.F. Publications, 1972), pp. 6-12.

[222]Maximum Golf Training Manual (Cleveland, Ohio: Maximum Golf Publishers, October, 1981).

[223]Noble, p. 51.

In discussing the acquisition of a habit pattern, Cochran and Stobbs emphasize the importance of high repetition during the early stages of learning. But repetition will not produce learning unless it is practiced correctly.[224] The use of swing drills insures that the correct movements are constantly reproduced and stored in the long-term motor memory.[225]

Hank Johnson, a well known teaching professional, theorizes that swinging a broom simulating the golf swing instinctively ingrains the correct downswing moves. He feels this drill automatically promotes the proper movements in the swing and gives the golfer a kinesthetic awareness of the downswing movements.[226]

Nicklaus states that a very fine device for improving the tempo of one's swing, smoothing out one's rhythm and improving one's balance is to swing with the feet together.[227]

On the concept of practice, Cochran and Stobbs state that, once a golfer has reached the stage of having a swing, he should deliberately introduce variations and extra

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[224] Cochran and Stobbs, p. 108.

[225] Ibid.

[226] Hank Johnson, "Use a Broom to Sweep Away Your Slice," Golf Digest, 33 (August 1982), 41.

[227] Nicklaus, Golf My Way, p. 163.

difficulty into practice sessions. By so doing, he broadens his experiences and develops alternative nerve and muscle routes for producing acceptable shots. He might try, for instance, hitting one-handed shots. This gives the additional benefit of building up the muscles of the hand and arm; or, he might try hitting full shots while standing on one leg or with the feet together.[228]

In speaking of developing tempo in the golf swing, tour professional Peter Jacobsen says,

> Drills are a good way to develop consistent swing tempo at the start of the season and to maintain it throughout the year. Spend a half hour or so doing the waist to waist one-half swing drill and you can't help but feel the proper one-two tempo, and consequently slow down your swing. . . . Practice the feet together drill without the shoes on.[229]

The authors of Play Better Golf Magazine advocate the use of golf drills in order to build a swing that will be naturally learned. They emphasize that golf drills allow the learner to feel the correct sensations of a properly executed golf swing. They explain that, once the golfer becomes accustomed to the fundamentals of alignment, posture and grip, he can begin to train the motions of the golf swing with other practice drill.[230]

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[228]Cochran and Stobbs, p. 108.

[229]Peter Jacobsen, "Tempo," Golf Magazine, 24 (March 1982), 43.

[230]Editors of Play Better Golf Magazine, "Seven Drills for a Natural Swing," Play Better Golf Magazine, 40 (Summer 1981), 8-12.

Sam Snead, winner of over eighty P.G.A. tour events and reputed to have one of the best golf swings in the history of the game, states that a golfer should practice with his shoes off. This, he says, will not let the golfer overswing and helps him identify how much force to use. As a result, this drill will help the golfer's overall balance and swing pattern.[231]

Gordin states that the best exercises for golf are those which simulate the golf swing.[232] He feels that, by swinging a weighted object and continually increasing the number of repetitions, the golf muscles will also be made stronger.[233]

The editors of Golf Magazine suggest doing a series of nine swing drills for swing improvement. In conjunction with this, they believe the golfer should swing a weighted club while doing these drills.[234]

Al Geiberger, who recorded the lowest round ever shot in competition on the P.G.A. tour, advocates the use of a drill that lets him develop a feeling of coordinating his

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[231] Sam Snead, "Barefoot for Balance," Golf Magazine, 23 (November 1981), 88.

[232] Richard D. Gordin, "The Role of the Golf Coach," National Golf Foundation Information Sheet (North Palm Beach, Florida: National Golf Foundation Publishers, 1973).

[233] Ibid.

[234] The Editors of Golf Magazine, "The Three Ways to Power," Golf Magazine, 24 (April 1982), 57-63.

hand, arm and shoulder action as well as putting him in the correct position at the top of his swing.[235] Toski teaches a drill that forces the golfer to swing his arms at a pace he can control. In this drill, the golfer gets down on his knees and hits balls.[236] Leslie King, famous British teacher, uses a series of drills to train the golfer to develop a free arm swing.[237] Jerry Pate, a P.G.A. tour professional, encourages golfers to swing with the left arm only. According to him, this gives the golfer a feeling for what the left arm does in the swing.[238]

There are many, many more P.G.A. tour professionals and teaching professionals who recommend the use of swing drills to enhance swing improvement. It seems that they all feel the use of swing drills automatically and subconsciously will improve the pattern and form of the swing. They also seem to concur that the use of swing drills builds strength in the golf muscles and gives the golfer a "feeling or sensation" for the correct movement pattern.

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[235] Al Geiberger, "Keep Hands, Arms and Shoulders in Tune," Golf Digest, 33 (February 1982), 87.

[236] Bob Toski, "The Papal Swing," Golf Digest, 32 (May 1981), 52.

[237] Leslie King, "Britisher Leslie King's Free Arm Swing Concept," Golf Digest, 33 (March 1982), 81-87.

[238] Jerry Pate, "The Nine O'Clock-Three O'Clock Drill," Golf Digest, 30 (February 1979), 89.

Literature Relating to the Absence of a Golf Ball when Learning the Golf Swing

Probably the most often repeated piece of advice in learning the golf swing is "to keep your eye on the ball." This information has been thought to be beneficial to the learner because of the precision needed to hit the ball with such a small clubface. It is hoped that the emphasis on eye contact with the ball helps the performer hit the ball in the center of the clubface.

Unlike most activities, the activity of golf demands that the performer concentrate on three things when hitting the ball: (1) the ball, (2) the target, and (3) the swing. His primary concern is getting the ball into the air. His secondary concern is getting the ball to the target by creating a correct swing. Unfortunately, overemphasis on hitting the ball often diminishes the golfer's chance of making a good swing.

The activity of golf is one of the few "closed skills" that place a heavy emphasis on watching the ball while the movement pattern is in progress. An example of a closed skill that places little, if any, emphasis on watching the ball when performing the skill is the free-throw shot in basketball. It would indeed be difficult for the shooter to concentrate on making the basket if he had to watch the ball while performing the skill. Similar problems would occur in other closed skills as well. Some other examples would include bowling, archery and horseshoes. These skills, much like other closed skills, require the performer to concentrate and to focus on the target and not the ball when performing the skill.

Most instructors have speculated that this emphasis on eye contact with the golf ball when learning to swing the club is caused by the student's preoccupation with keeping his head steady.[239] For example, it was thought that, if the student focused on the golf ball, this would encourage the head to stay steady. According to these early teachers, if the head stayed steady while the student was swinging the club, a consistent swing arc would result. But, as we now know, it is quite possible for the student to watch the ball while moving his head and still making a good swing arc.[240]

Whiting theorized that watching the ball after a decision to begin the stroke might be useful from the point of view of stopping or changing the stroke if, at a later stage, the stroke was deemed undesirable.[241] Noble's experiments on the golf swing disproved this theory. Noble proved that the golf swing is a ballistic movement and

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[239] Percy Boomer, On Learning Golf (New York: Alfred A. Knopf Co., 1946), p. 101.

[240] Toski and Flick, How to Become a Complete Golfer, p. 22.

[241] Whiting, Acquiring Ball Skill, p. 49.

not a guided movement.[242] According to him, visual information as to the location of the ball has no influence on the golfer's ability to alter his swing pattern once the downswing has started.[243] His results confirmed that no control which involves using sensory information can be exercised during the downswing.[244] He concluded that, in addition to the downswing being ballistic, the whole golf swing is to some extent a "programmed" event, in which visual information is unnecessary beyond quite an early stage.[245] Although the same may not be true of information received via the propriocepters, it seems plausible to hypothesize that successful golfers are those who succeed in programming their swings in such a way that no correction on the downswing is needed.

Beginning golfers, after having topped the golf ball, have been told that they took their eyes off the ball. But instructors have shown that it is not taking your eyes off the golf ball that produces poor shots. Rather, it is improper body motion that creates this. If this were not true, how could a blind person play golf? Blind people not

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[242] Noble, p. 51.

[243] Ibid.

[244] Ibid.

[245] Ibid.

only play golf but also some are excellent players.[246] They depend not on their vision but their proprioceptive feedback and sensitivity for the movement pattern. Since they are not concerned with the presence of the golf ball, they tend to focus all of their attention on the swing itself.

Cochran and Stobbs suggest starting the beginner with a larger ball when learning and then progressively introduce a smaller and smaller ball. They feel that this would enable the beginner to perfect the gross body movements involved in the swing without worrying about actually hitting the ball each time.[247]

Roberts also advocated the use of a larger than normal size golf ball during the initial stages of learning the swing. In her study she tested two groups of beginning golfers. One group, the control group, used regulation golf balls throughout the nineteen class periods. The other group, the experimental group, used a larger white sponge rubber ball during the first six lessons. She concluded that using the larger ball appeared to be slightly advantageous for both the woods and the irons in the early stages of development. She also indicated that later in the developmental process, after a swing pattern had already

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[246] Joe Lazaro, The Right Touch (Weston, Mass.: Hunter Publishing Co., 1978), p. 43

[247] Cochran and Stobbs, p. 107.

been learned, there appeared to be no significant difference between the two methods of learning.[248]

Throughout Gentile's writings, she stresses the importance of practicing closed skills under conditions which increase the consistency with which the effective movement is produced.[249] She speaks of the teacher simplifying learning conditions by reducing non-regulatory inputs.[250] According to her, this would include structuring the environment to make learning easier.[251] An example of this in learning the golf swing would be the removal of the golf ball. With the golf ball eliminated, the learner could devote all of his attention to the development of a correct swing pattern.

There have been many attempts to evaluate golf skills without the use of a real golf ball.[252] Most of these skill tests involved the use of cotton balls or plastic balls.

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[248]Jane Ann Roberts, "The Effect of a Particular Practice Technique on the Golf Swing," Diss. Univ. of Iowa, 1966.

[249]Gentile, p. 16.

[250]Ibid.

[251]Ibid.

[252]Mary Ellen McKee, "A Test for Evaluating the Full Swinging Golf Shot," Research Quarterly, 21 (1950), 40; Ellen R. Vanderhoof, "Beginning Golf Achievement Test," Thesis Univ. of Iowa, 1956); Doyice J. Cotton, Thomas Plaster, and Jerry R. Thomas, "A Plastic Ball for Golf Iron Skill," Journal of Physical Education, 70 (March-April 1973).

Even though these were not regular golf balls, evaluation techniques emphasized knowledge of results of where the ball went. Knowledge of performance, or how the swing form looked, was also evaluated through a subjective rating system but was not considered as important. Since most skill tests emphasize ball flight and accuracy, the student usually practices a swing that will accomplish these two goals even though the swing used might be biomechanically incorrect.

Eddie Merrins, the well known golf instructor and head professional at the Bel Aire Country Club in Los Angeles, had similar ideas about the effects that the golf ball had on the swing. He theorized that if the golfer focused on the back of the ball it would cause him to "hit at" the ball instead of "swinging through" the ball. According to him, this focus causes the golfer to decelerate his arm swing on the downswing. To avoid this tendency, he suggests that the golfer focus his attention on the ball as a whole just as he would if he were swinging at a blade of grass, a small coin, or a cigarette butt.[253]

According to Aultman, it is the presence of the ball that causes a conscious and ineffectual swing pattern.[254]

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[253]Eddie Merrins, Swing the Handle Not the Clubhead (Norwalk, Ct.: Golf Digest, Inc., 1973), p. 64.

[254]Aultman, pp. 111-112.

He says:

> It is indeed the ball that triggers the change from first making an effortless, unconscious swishing of the club at nothing in particular and then attempting an all too specific task with full and intense effort. It is the ball that makes us try and it is the trying that so often does us in. Most golfers make wonderful swings when knocking off dandelions, but only because it matters not whether the dandelion flies into the air, travels in a certain direction, and goes a goodly distance. These things matter only when the ball is involved and when we try to make them happen.[255]

Jack Nicklaus also states:

> One of the oldest mysteries in golf is how a golfer can take a practice swing that finishes high and full, yet, when confronted with the ball, the finish becomes a truncated, puny effort.[256]

He explains that the problem is that the mere presence of the ball can make the golfer "ball bound," and he ends up "hitting at" the ball instead of "swinging through" it.[257]

In discussing the importance of eye contact when learning a motor skill, Whiting differentiates between open and closed skills. He says that open skills are more perceptual in nature and are very dependent on vision for tracking the ball, whereas closed skills are more habitual in nature and less dependent on visual contact with the

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[255]Ibid.

[256]Jack Nicklaus, "Acceleration: The Key to Accuracy," Golf Magazine," 17 (January 1975), 30.

[257]Ibid.

ball.[258] Accordingly, if the golf swing is classified as a closed skill, then visual information received from the ball and its eventual flight would not be important to the learner.

According to Toski and Flick, one of the major myths in golf swing learning that has contributed to destroying the "feel" of the golf swing is the thought that the golfer should keep his eye on the ball. It is their contention that this causes the player to stare at the ball so intently that he loses the vividness of his target picture. He becomes "ball bound" and is unable to relate his swing to his target.[259]

Orbitz and Farley also feel that the presence of the ball can induce a condition of being "ball bound" in which the golfer tries to hit at the ball instead of swinging through it.[260] They feel that the golfer's eyes and whole mind tend to lock onto the ball leaving no part of the mind to attend to the business of swinging the club. They recommend that, when the beginner is learning the swing, he should pay attention to the swing and not the ball.[261]

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[258] Whiting, Acquiring Ball Skill, p. 65.

[259] Toski and Flick, p. 140.

[260] Harry Orbitz and Dick Farley, Six Days to Better Golf (New York: Harper and Row Publishers, 1977), p. 57.

[261] Ibid.

Myers believes that beginning golfers should learn early to swing the club towards the target and not at the ball. According to him, the ball should simply get in the way of the clubhead.[262]

Phillips also referred to the "hit impulse" in his study. He said that more than one-third of the subjects he tested made poorer scores at the end of the instruction period than they had made at the beginning of the instruction period. He said that it is possible that this might be due to the fact that, after the individuals found early that they could contact the ball by swinging as they should, they developed a tendency to "hit at" the ball in order to get more power, thereby altering the pattern of movement which resulted in a loss of accuracy.[263]

Ken Venturi, the well known golf analyst, has similar ideas about the presence of a golf ball when learning the golf swing. He states:

> A golfer's practice swing is usually his best swing because he doesn't think about hitting anything. Once a golfer develops the conscious intent to hit the ball,

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[262]Rod Myers, "Teaching and Coaching the Fundamentals," Golf Coaches Guide (North Palm Beach, Florida: National Golf Foundation Publication, 1975), p. 38.

[263]Bernath E. Phillips, "The Relationship Between Certain Phases of Kinesthesis and Performance During the Early Stages of Acquiring Two Perceptuo-Motor Skills," Research Quarterly, 12 (October 1941), 577.

> more often than not, he will release his right hand too soon and lose power and control.[264]

He relates a story of a blind golfer who, when told there was a ball present, got so tense he could hardly take the club back. But, when he was told there was no ball present (when in fact there was), he swung the club beautifully and hit the ball right down the middle of the fairway.[265]

Venturi theorizes that the secret of developing a good swing is to eliminate the intent to hit the ball. According to him, this can be done by blocking out the sight of the ball. The golfer should try to imagine that the object is not the ball but only something that gets in the way of the swing.[266]

Because of his belief that the presence of the golf ball has an inhibiting influence on the beginner's progress, he has endorsed an off-season training program for golf.[267] This program combines physical conditioning and golf swing training. The major feature of this program is that the participant uses a weighted club to perform swing drills in the absence of the golf ball. According to Venturi, this allows the student to concentrate on the performance of the

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[264] Ken Venturi, The Venturi Analysis (New York: Atheneum Publishers, Inc., 1981), p. 25.

[265] Ibid., p. 26.

[266] Ibid.

[267] Dixon, p. 30.

correct swing, and the "swing feelings" associated with that pattern, without interference from the ball.[268]

Recently, Dave Regan, a former P.G.A. touring professional, participated in a test to determine what effects the presence of the golf ball had on his swing. He hit ten balls on the Golftek Pro II Swing Analyzer. This machine instantly records the ball flight impact factors which include: (1) clubhead path, (2) clubface angle, (3) clubhead speed, and (4) clubface contact point at the point of impact. When he actually hit a golf ball on this machine, his mean performance after ten trials resulted in a clubhead path at impact that registered zero degrees and a clubface angle at impact that registered six degrees closed. This meant that his clubhead was traveling directly down the target line at impact, but his clubface was pointed six degrees left of that target line at the impact point. He again took ten swings on this machine without the golf ball. His mean performance indicated a completely different swing pattern. This time his mean performance resulted in a clubhead path that was six degrees inside-out at impact and a clubface angle that was eight degrees open. This meant that, at the point of impact, his clubhead was approaching from inside the target line and moving out to the right of that target line. At the same time, his clubface angle was

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[268]Ibid.

pointed at least eight degrees to the right of the target line. When he made a swing without a golf ball present, his clubhead path at impact changed six degrees and his clubface angle at impact changed fourteen degrees. His first swings with the ball indicated he was hitting pull-hooks into the left rough, whereas his swings without a golf ball indicated he was hitting push-slices into the right rough.

Regan concluded that the presence of the golf ball caused excessive tension and pressure in his hands, arms and shoulders and was responsible for the drastic differences in his swing pattern. He said that the actual presence of the ball caused his entire right side to tighten up and caused him to "hit at" the golf ball instead of "swinging through" the golf ball.[269]

Boomer also had some very interesting observations about the effects of the presence of the golf ball when learning the swing. He called the student's desire to hit the ball and to get it into the hole as the number one reason why the student has so much trouble attaining that goal.[270] He believes that most students are too concerned with getting the ball into the air and are not concerned

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[269] Dave Regan, "An Independent Test Investigating the Effects of the Presence of the Golf Ball on the Impact Point of the Golf Drive." Test conducted at Pro-Group, Inc., Chattanooga, Tennessee, October 26, 1982.

[270] Boomer, p. 34.

enough with the employment of the correct technique.[271] According to him, "Any good golfer knows that it is impossible to make a good drive when thinking of hitting the ball a certain distance and direction."[272] The point he is trying to make is that the ball cannot be hit with any certainty unless the end results (ball flight) are inhibited or made secondary to the actual swinging of the club. He says, "The golfer must feel the swing that will give the desired distance and direction and forget about the results of that swing."[273]

> The beginning golfer must not only be unaware of the actual presence of the ball, but he must not be concerned with where it is going. If the beginner is too conscious of the ball, it will be difficult to focus much attention on the swing.[274]

He relates a story of one of his struggling students. When asked to make some swings without the ball, the student replied, "I can always swing well when there is no ball present." "But," he said, "when the ball is introduced, everything changes." The reason for this difficulty, Boomer contends, is because the student is consciously trying to hit the ball instead of consciously trying to make a good

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[271] Ibid., p. 103.

[272] Ibid., p. 110.

[273] Ibid., p. 49.

[274] Ibid., p. 107.

swing.[275] He reasons that it is the overwhelming impulse to hit the ball that causes most of the problems in learning golf.[276] He theorizes that the beginner needs to learn how to see the ball. He states that the beginner must learn not to see the ball to the exclusion of all his other sense.[277]

Boomer also advocates swinging "through" the ball and not "to" the ball. According to him, if the golfer swings "to" the ball, he will end up decelerating the golf club and off-center hits will result. If the ball is the center of the golfer's attention, his clubhead speed will culminate at that point and negative results will occur.[278] The idea, Boomer says, is not even to be aware of the ball but to try to feel the swing.[279] So, how does the good player see the ball? In Boomer's opinion, he sees the ball through his highly developed sense of feel in his hands.[280] He believes that the value of "keeping your eye on the ball" is the assistance which it gives in building up sight through feel. Why is it that so often the ordinary golfer can make perfect swings when the ball is not there? Yet, when the mere

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[275]Ibid.

[276]Ibid., p. 29.

[277]Ibid., p. 103

[278]Ibid., p. 107.

[279]Ibid., p. 102.

[280]Ibid., p. 104.

presence of the ball becomes apparent, the golfer becomes absolutely frozen. What would happen if one could put down an invisible ball for the beginning golfer? Is it knowing that the ball is there that upsets his swing, or is it the actual sight of it that causes the many errant shots?[281] According to Boomer, the beginner's obsession to "hit" the ball inhibits his ability to make a correct swing.[282] He nicely sums up his entire theory by saying:

> If, after having missed the ball, the instructor says, "you looked up!" the chances are that during the next swing he will look at the ball so intently that he will miss the next shot too.[283]

The P.G.A. teaching manual states that the three greatest problems found in students during the learning situation are: (1) fear of missing the ball; (2) failure to keep things simple; and (3) lack of retention.[284] The beginning golfer fears that he will miss the ball and, therefore, he feels he must try to "hit at" the ball or even scoop underneath the ball in order to get it airborne. He does not trust his swing and loft of the club to get the ball up in the air. The beginner's failure to trust his swing and his fear of missing the ball often force him into

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[281] Ibid., p. 105.

[282] Ibid., p. 107.

[283] Ibid., p. 110.

[284] P.G.A. of America, "The Three Greatest Problems," Methods of Teaching (North Palm Beach, Florida: P.G.A. Publication, 1972), pp. 20-21.

a lot of physical inadequacies that would not otherwise occur.[285] The P.G.A. recommends giving the beginner his first five or six lessons indoors where a net is available. By doing this, the student will not be intimidated by initial poor ball flight results and is more likely to work on his swing.[286]

The P.G.A. expresses the opinion that the professional golf teacher should emphasize the target more and not the ball.[287]

> There are very few students who, after two or three lessons, are not capable of making a pretty good practice swing as far as the mechanical aspects are concerned. Yet, the same student isn't able to make that same movement when the ball is there. He becomes "ball bound." If a man can make the proper movement pattern in two or three sessions when he is making his practice swing, this means that he has the necessary physical ability to swing the golf club correctly. But, when he doesn't transfer that same motion over to the swing when the ball is present, it's obvious that we should not be trying to correct the swing physically.[288]

Besides the usual psychological problems associated with the appearance of a new stimulus, the problems seem to be that target-awareness has been undertaught and that physical and

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[285]Ibid.

[286]Ibid.

[287]P.G.A. of America, "Importance of Target," Methods of Teaching (North Palm Beach, Florida: P.G.A. Publication, 1972), p. 22.

[288]Ibid.

mechanical aspects of the swing have been overtaught.[289] They also suggest hitting some balls with the eyes closed in order to become more target oriented.[290] They conclude by saying, "Over the years there has been far too much emphasis in teaching golf by overfocusing on the ball."[291]

Whiting would agree with the P.G.A. recommendation that beginning golfers should become more target conscious and less ball conscious. He found that young boys, ages ten and eleven, did as well in ballistic aiming as adults when the boys used target vision and the adults used hand vision. Target vision yields greater accuracy, yet in some activities such as golf, for some reason, the golfer seems to be more concerned with the ball.[292]

Well known teaching professional Bob Toski states, "Anxiety and fear cause the hit impulse." He feels that the word "hit" is a detriment to good teaching and playing.[293] Ike Handy infers in his writings that the presence of the golf ball tends to freeze the body and make people think they have to "hit at" the golf ball instead of "swinging

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[289]Ibid.

[290]Ibid.

[291]Ibid., p. 17.

[292]H. T. A. Whiting and I. M. Cockerill, "Eyes on Hand--Eyes on Target?", Journal of Motor Behavior, 6 (March 1974), 27-32.

[293]Bob Toski, "How to Slow Down Your Swing," Golf Digest, 27 (March 1976), 38.

through" it. He gives examples of how some people make beautiful practice swings and then, once a ball is put in front of them, their motions change to ugly, swiping lunges.[294]

Many professional golf instructors have advocated hitting golf balls with the eyes closed[295] or practice putting with the eyes closed.[296] According to this theory, practicing in this manner will make the golfer less conscious of the ball and enable him to "swing through" the ball and not "at" the ball. This method also helps the golfer create a better tempo and pace in his swing and allows him to concentrate on the movements his body is making while swinging.[297]

Bertholy recommends that the ball must never be the objective when swinging the golf club.[298] He feels that the mind must never be involved with the ball or disastrous results will occur. According to him, the ball is incidental to the whole swinging process.[299]

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[294] Ike S. Handy, <u>It's the Damn Ball</u> (Chicago, Ill.: Twentieth Century Press, 1961), p. 56.

[295] Toski and Flick, p. 206; Carl Lohren, "One Move to Better Golf," <u>Golf Digest</u>, 26 (April 1975), 78-79.

[296] Al Barkow, "One for the Yipper," <u>Golf Magazine</u>, 24 (September 1982), 52.

[297] Ibid.

[298] Bertholy, p. 3.

[299] Ibid.

The literature seems to indicate that the presence of the golf ball has a retarding influence on the beginner's progress in learning the golf swing. There has not been enough research in this area to determine the exact reason for this, but from all indications it is most likely due to psychological as well as physical reasons. The beginner's fear of failure of being able to get the ball into the air and the unusual nature of the mechanics of the movement itself contribute to the inhibiting influence that the presence of the ball has on the beginning golfer's progress.

Literature Related to the Use of Kinesthetic Feedback when Learning a Motor Skill

There are many types of feedback information that enable a person to learn a motor skill. Most skill learning seems to rely on the type of feedback we receive from external sources. This would include feedback that we receive through our vision and hearing. Even though external feedback systems are extremely important in learning a motor skill, the importance of internal or intrinsic feedback information might be even more important when learning certain skills. This intrinsic information that a learner receives from his body is called kinesthetic feedback. For example, when a student is learning how to swing a golf club for the first time, it is not uncommon for the instructor to tell the student to "feel the movement."

According to Sage, "Kinesthesis is surely the most important perception man possesses. Without kinesthesis, a person could not even maintain an erect posture, let alone engage in motor activities."[300] He indicates the importance of kinesthesis in motor learning in the following paragraph:

> The sensory receptors which arise in the muscles, tendons, joints, and vestibular apparatus provide us with sensory data for discrimination of the position of body parts, discrimination of movement, and amplitude of the body to gravity. Without these sensory receptors, collectively known as proprioceptors, motor performance would be impossible. Every motor act depends upon proprioceptive information for its completion. Proprioceptive data are constantly being fed back to the individual who is in the process of performing a motor act. Indeed, this form of sensitivity is the basis for one of the most important feedback mechanisms of the body. The stimulus for one part of a movement pattern arises partly from the immediate preceding movement by the stimulation of the priopriocepto rs in certain parts of the body. Thus, an important part of motor performance does not depend on visual, auditory, or cutaneous stimuli, but rather depends upon internal stimuli which provide data for the perception of an awareness of the position of the body parts in space and any movements that may be occurring.[301]

Physical education instructors frequently attempt to get their students to use kinesthesis as a cue while learning and performing a motor task. For example, they might ask the student to concentrate on "getting the feel" of the correct movements as he performs the task, or they may place the student in the correct beginning or terminal

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[300]Sage, p. 118.

[301]Ibid., pp. 116-117.

positions for a given task and ask him to "sense" the limb angulations and muscular contractions. And, in recent years, various weighted objects have been used in motor skill instruction in the belief that the kinesthetic perceptual illusions, which occur when normal weight objects are subsequently used in performing the task, will produce improved performances. These are examples of utilizing kinesthesis as a learning modality.

Sage contends that, since kinesthesis is assumed to be dependent upon the proprioceptors, a possible approach to developing this sensory mode is to have the learner perform various movements with his eyes closed. The assumption with this method is that the learner's concentration will be on the movement rather than the outcome of the movement.[302] According to him, this will eliminate the various other visual stimuli in the environment that are distracting to the performance of the correct movement pattern.[303] A second method of developing kinesthesis has been a manual manipulation technique in which the learner relaxes as he is guided through the movement pattern.[304] The assumption is that, as the learner is guided through the movement, the proprioceptors associated with the movement will be

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[302]Ibid., p. 123.

[303]Ibid.

[304]Ibid.

activated, thus providing the learner with the correct cues. A final method which has been suggested for use in developing kinesthesis is that of activating and sensitizing more proprioceptors through the use of heavier equipment.[305]

In discussing the use of kinesthetic cues as they related to golf swing development, Cook explains:

> The most efficient cues in changing a swing habit or developing a new swing habit is through the use of kinesthetic cues. Kinesthetic cues create a physical feel for the desired action. These cues may be affected through the use of swing drills and self teaching devices (such as wrist devices, form fit grips, etc.) or actually guiding the performer through the entire movement.[306]

Although kinesthesis is a very valuable tool for motor skill learning, it is often a misunderstood and misused term. Sage defines kinesthesis as the discrimination by the learner of the positions and movements of the body parts based on information other than visual, auditory, or verbal.[307] Scott defined kinesthesis as the sense which enables us to determine the positions of segments of the body, their rate, extent and direction of movement, the position of the entire body, and the characteristics of total body motion.[308]

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[305]Ibid.

[306]Cook, pp. 32-33.

[307]Sage, p. 117.

[308]M. G. Scott, "Measurement of Kinesthesis," Research Quarterly, 26 (1955), 324.

Some writers differentiate between the terms "kinesthesis" and "proprioception." Typically, the psychologists refer to this muscle sense as "kinesthesis," while the physiologists and motor learning experts usually refer to it as "proprioception." At times, the two terms are used interchangeably. Magill, in discussing the difference between these two terms, refers to kinesthesis as a term that should be considered as limited to the sensations related to the movement of the limbs, whereas proprioception should be used to indicate the sense of the position and movement of the body and body parts as well as the forces and pressure on the body or its parts.[309] The golfer, for example, often determines how good his swing is by the "feel" of the swing. Golf instructors are constantly trying to get beginners to develop a rhythm in their swing, or to "groove" the swing. All this is based on proprioception, since the golfer cannot watch or hear his swing in order to make adjustments. Regardless of the terminology used, most motor learning experts agree that "kinesthesis" or "proprioception" is an integral and most misunderstood part of motor learning.

Rasch and Burke define kinesthesis as the perception of the position and movement of one's body parts in space.[310]

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[309] Magill, p. 68.

[310] Rasch and Burke, pp. 107-115.

According to them, it also includes the perception of the internal and external tensions and forces that move or stabilize the joints.[311] Various kinds of receptors contribute to kinesthesis.

Some of the more significant receptors are: (1) joint receptors resembling flower spray endings that give a steady discharge proportional to the change in joint tension; (2) joint receptors resembling elongated Pacinian corpuscles giving a discharge proportional to change in capsule tension during the movement; (3) Pacinian corpuscles sensitive to deep pressure; (4) Golgi Tendon organs; and (5) muscle spindles.[312] All of these receptors seem to contribute to the learner's awareness of muscular movement, tension and force. These kinesthetic perceptions are relayed to cortical centers of consciousness, although the process of motor learning may allow them to happen automatically or subconsciously.[313]

Kinesthesis is usually referred to as the muscle sense of the body. It has been popularly called man's sixth sense because it was the first recognized in addition to the original five senses. These nerve endings, also called spindles or proprioceptors, are located in the muscles,

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[311]Ibid.

[312]Ibid.

[313]Ibid.

tendons and ligaments and seem to aid in the coordination of movement. It is thought that the proprioceptors in the muscles are stimulated by the contraction or stretching of the muscle cells. Also, tendon and ligament proprioceptors are stimulated by the stretching or movement that results from muscular contractions. It is this constant feedback of stimuli from the receptors that enables a performer to sense the position of the body part without the benefit of vision.

Luttgens and Wells state that, without the rapid transmission and processing of information by the kinesthetic sense receptors, controlled movements could not proceed. They say that kinesthetic perception and memory are the basis of voluntary movement and motor learning.[314]

The usual goal in motor learning is to reduce the new pattern movement to subconscious automaticity. Complex coordinations cannot be mastered until certain basic movement patterns have been reduced to the automaticity of conditioned reflexes.[315] It is the kinesthetic feedback mechanism that helps to condition the learner's response so that the movement can be performed on the subconscious level. For example, the highly skilled golfer does not have to depend on his sense of sight to determine where a golf

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[314]Kathryn Luttgens and Katherine F. Wells, Kinesiology, Scientific Basis of Human Motion (Philadelphia: Saunders Publishing Co., 1982), p. 76.

[315]Rasch and Burke, p. 110.

ball went. He can feel where the ball was hit on the clubface.[316] In the final analysis, it is this intrinsic feedback information that allows the golfer to correct his own errors.

Scott stated, "Occasionally one hears a beginner when learning some activity say, 'that felt good that time' or 'that felt easier.'"[317] This recognition of movement sensations is one very important step in the learning process.

Learning a motor skill depends on several things including (1) the ability to sense or feel what forces one is exerting, (2) the ability to detect differences in feeling from one trial to another, and (3) the ability to elicit a consistent pattern of performance. These are all kinesthetic perceptions that rely on internal feedback mechanisms.

Several studies have investigated the influence of kinesthetic practice upon sports skill learning. Blindfolded golf swinging, tennis serving, and others have been investigated. The implication is that, when one acquires the feel of the movement, independent of vision, he is more likely to retain it. Also, it is assumed that, when using

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[316] Ellen Kreighbaum and Katherine M. Bartels, Biomechanics: A Qualitative Approach for Studying Movement (Minneapolis: Burgess Publishing Co., 1981), p. 132.

[317] Gladys Scott, Analysis of Human Motion (New York: F. S. Crafts and Company, 1942), pp. 375-376.

this type of learning technique, the learner's concentration will be on the movement pattern rather than the outcome of that pattern. According to this theory, visual stimuli in the environment interfere with the performance of the movement pattern.

According to the literature, it would seem that the dependence on kinesthetic feedback information assumes increasing importance with learning skills that are repetitive in nature.[318] These skills are those in which only one pattern of movement has to be developed. Poulton classified skills of this nature as "closed,"[319] whereas Knapp distinguished between skills of habit and those with a dominant reliance on perception.[320] In any case, the literature seems to indicate that closed skills are primarily dependent on proprioceptive feedback. Skills such as golf, discus throwing, high board diving and gymnastics have as their goal a habitual reproduction of a single motor pattern and, therefore, an increasing delegation of control to proprioceptive feedback. The ultimate aim in motor learning is the perfection of a skill with a minimum of

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[318] John Dickinson, Proprioceptive Control of Human Movement (Princeton, New Jersey: Princeton Book Co. Publishers, 1976), p. 117; Drowatzsky, p. 53.

[319] Poulton, p. 467.

[320] B. Knapp, Skill in Sport (London: Routledge and Kegan Paul, 1964).

conscious concern for the details of the movement. Gardner states that the smooth and harmonious coordination of the body segments in the pattern must be assured by the relatively automatic action of the muscles under the self-regulatory control of proprioceptive feedback.[321] She feels that deliberate application of proprioceptive techniques could shorten the time required to achieve the optimum or maximum performance level and perhaps increase the ultimate level of individual attainment.[322]

Regardless of whether the skill being learned is "open" or "closed," the importance of kinesthetic feedback information cannot be underrated. Some of the more significant studies utilizing this method have been listed below. Because of the complex, interrelated, and theoretical nature of this material, the writer organized the information into four sub-topics which include: (1) the relationship of kinesthesis to motor learning; (2) a review of the golf studies and the kinesthetic approach to learning the golf swing; (3) other related studies and important findings concerning the kinesthetic approach to the learning of motor skills; and (4) opinions about kinesthetic methods of

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[321]Elizabeth B. Gardner, "Proprioceptive Reflexes and Their Participation in Motor Skills," _Quest_, 12 (1969), 1-24.

[322]Ibid.

instruction from the accepted authorities in the golf profession.

Relationship of Kinesthesis to Motor Learning

If kinesthesis is an important part of learning a motor skill as many authors have suggested, then it can be concluded that kinesthesis and motor ability are highly related.

Taylor, in one of the pioneer studies on kinesthesis and motor skill learning, administered a battery of fourteen tests to two groups of college basketball players. The results showed that the differences between the "successful" (those who made the team) and the "unsuccessful" (those who did not make the team) players in single tests were of little significance, but they were all, with one exception, in favor of the successful players.[323] It was suggested that, whereas the unit difference was of little significance, the cumulative differences were highly significant.[324] In other words, boys who made the varsity basketball team scored better on the kinesthetic-test battery than did the unsuccessful candidates.

[323] W. J. Taylor, "The Relationship Between Kinesthetic Judgment and Success in Basketball," Thesis, Pennsylvania State College, 1933.

[324] Ibid.

Phillips attempted to determine the relationship between kinesthesis and performance during the early stages of acquiring two motor skills which simulated the "putt" and the "drive" in golf. He found a positive relationship between the two with respect to certain phases of kinesthesis.[325]

Lindsay found a low positive relationship between kinesthetic perception and the learning of a motor skill and a low significant relationship between kinesthesis and final achievement in a motor skill.[326]

Roloff investigated the relationship between kinesthesis and the motor learning of college women in certain motor skills. Over two hundred students were split into several bowling and tennis classes. They were given several motor ability tests and tests of Kinesthesis. The experimental class was taught by (1) emphasizing the feel of movement, (2) short demonstrations were used, and (3) drills were used in which the students closed their eyes. The tennis class was taught by methods attempting to stress the "feel" of each stroke. At the end of eight weeks they were rated by three judges on their form. Roloff concluded that

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[325]Bernath Phillips, "Relationship Between Certain Phases of Kinesthesis and Performance During the Early Stages of Acquiring Two Perceptuo-Motor Skills," Research Quarterly, 12 (October 1941), 571-586.

[326]Doreen Lindsay, "Relationship Between Measures of Kinesthesis and the Learning of a Motor Skill," Thesis Univ. of California, 1952.

there was a positive relationshop between motor ability and kinesthesis but there was no statistical significance to indicate that the kinesthetic approach in teaching these two motor skills was better than conventional teaching techniques.[327]

Wiebe's study also indicated a strong relationship between kinesthesis and motor learning. Using twenty-one different tests to measure kinesthesis, he found significant differences in the scores made by college athletes and non-athletes.[328] Without exception, the athlete's score on the kinesthetic tests was much higher than the non-athlete's score.[329]

Mumby found that the kinesthetic ability to maintain a constant muscular pressure under a condition of irregular change in pressure was significantly related to wrestling ability. On the other hand, he found that kinesthetic ability to maintain a constant arm position against the irregular force created by the testing apparatus was unrelated to wrestling ability.[330] Proof of championship

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[327]L. L. Roloff, "Kinesthesis in Relation to Learning Selected Motor Skills," Research Quarterly, 24 (1953), 210-217.

[328]V. R. Wiebe, "A Study of Tests of Kinesthesis," Research Quarterly, 25 (1954), 222-230.

[329]Ibid.

[330]H. H. Mumby, "Kinesthetic Acuity and Balance Related to Wrestling Ability," Research Quarterly, 24 (1953), 327-334.

wrestling ability without visual cues is furnished by the many blind wrestlers who have won wrestling tournaments. In fact, during practice sessions, many coaches will blindfold a wrestler to teach him to rely on his kinesthetic feedback information because this practice technique will give muscle force information to a much more satisfactory degree than visual cues.

In another study investigating the relationship of kinesthesis to motor learning, Phillips and Summers found evidence that there is a relationship between motor learning and positional measures of kinesthesis.[331] In their study, subjects were exposed to a particular arm movement and asked to replicate that movement. They found that familiarity with the movement influenced the degree of sensitivity that the subjects had because they found fewer errors in the dominant arm. Their study indicated that there was a relationship between learning to bowl and some kinesthetic measures. They concluded that in all cases kinesthetic sensitivity and kinesthetic sense are more important in the early stages of learning than the later stages of learning.[232]

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[331] Marjory Phillips and Dean Summers, "Relation of Kinesthetic Perception to Motor Learning," Research Quarterly, 25 (December 1954), 456-469.

[332] Ibid.

According to this research, there seems to be general agreement among the experts that there is a strong, positive relationship between measures of kinesthesis and motor learning. As will be shown in the following sections, this relationship is specific to the skill in question.

Golf Studies Utilizing the Kinesthetic Approach to Learning the Swing

Various golf studies have investigated the kinesthetic approach to learning the golf swing. When learning this way, the golfer is asked to close his eyes while performing the movement pattern. The assumption with this method is that the golfer will devote his attention to the movement pattern (the swing) rather than the outcome (ball flight) of that pattern. By so doing, it is hoped that the golfer will develop a better swing while also developing a "feel" for that swing.

Griffith's study was one of the first golf studies that investigated the use of a kinesthetic feedback technique. He found in his study on learning to drive a golf ball that the blindfolded method of practice aided the player in developing the "feel" of the correct shot.[333]

According to Hanley, learning to duplicate any skill requires that a control pattern be etched into the brain.

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[333]Coleman Griffith, "An Experiment in Learning to Drive a Golf Ball," Athletic Journal, 11 (June 1931), 11-13.

This etching process can be achieved by the student thinking about how the swing should look while trying to feel the kinesthetic sensations he is experiencing.[334] This form of mental practice automatically occurs when the performer is taught a motor skill kinesthetically.[335] Hanley believed that the teacher should stress the importance of kinesthesis when learning the golf swing and the student should try to recall the correct movements by way of the muscle sense. She believed that the greater the kinesthetic sensitivity, the more likely the student would learn golf.[336]

Coady indicated that kinesthesis is the basis for learning a motor activity in order that it may be repeated with the least amount of conscious thought.[337] In her study she compared the kinesthetic method of teaching golf with conventional methods. She concluded that golf skills were not significantly improved by the use of the kinesthetic approach.[338] Rollo also compared two methods of teaching beginning golf skills to college women. One group

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[334] Mrs. Stewart Hanley, "Sense of Feel in Golf," Journal of Health and Physical Education, 8 (June 1937), 336-367.

[335] Ibid.

[336] Ibid.

[337] Charlene Coady, "The Effect of Applying the Principles of Kinesthesis in Teaching Golf Skills to College Women," Thesis Indiana Univ., 1950.

[338] Ibid.

was taught by emphasizing kinesthetic perception, and the other group was taught by the traditional method. To assist kinesthetic perception, a blindfold was used. At the conclusion of her golf unit, she found no advantage of either method over the other.[339] Since neither Coady's nor Rollo's study allowed the students to use their vision at any time during the learning process, it might be inferred that the failure of the kinesthetic method was primarily due to the students' inability to form a reference of correctness in their minds. And, as has been previously mentioned, a reference fo correctness is difficult to translate through verbal cues.[340]

Ragsdale's findings were just the opposite of those found by Coady and Rollo. He found that, in teaching the golf drive, subjects performed better if some practice was given in the absence of visual cues.[341]

In Pash's study, he used hoods on the heads of two different groups of golfers. The hood necessitated that the golfer concentrate on the feel of the shot in predicting where the ball ended up. He wanted to know if the more

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[339] Ethel Todd Rollo, "A Comparison of Two Methods of Teaching Selected Golf Strokes," Thesis Univ. of Iowa, 1951.

[340] Schmidt, Motor Control and Learning, p. 480.

[341] C. E. Ragsdale, "Learning and Instruction, Part I," Forty-ninth Yearbook of the National Society for the Study of Education (Chicago: University of Chicago Press, 1959), p. 174.

proficient golfer could predict the direction of golf shots more accurately than beginning golfers. A secondary purpose of his study was to determine whether the accuracy of the prediction improved with practice. He concluded that, after being blindfolded with hoods, the proficient golfers estimated the results of their shots significantly better than beginning golfers.[342] Also, kinesthetic techniques and practice tended to improve the ball striking accuracy of all groups except the highly skilled experimental group.[343] The greater ability of proficient golfers to estimate the results of their golf shots from kinesthetic perception and to gauge improvement from practice at both proficiency levels indicated that kinesthetic perception was a learned rather than innate ability.[344]

The results on the kinesthetic method of learning golf have been very inconclusive. Some investigations have found this to be an efficient method of learning the golf swing while other studies have found it to be no better than conventional methods. More research is needed to determine the benefits of such a procedure.

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[342]Kaye Ladd Pash, "Improving Kinesthetic Perception," Thesis Univ. of Illinois, 1968.

[343]Ibid.

[344]Ibid.

Other Skills that Have Been Taught Utilizing the Kinesthetic Instructional Technique

Many studies using the kinesthetic approach to learning have also been tried in other motor learning situations. It has been found that there are many contradicting results from this research. Some researchers have stated that by putting the emphasis on the "feel" and the "form" of the movement pattern the performer will subsequently improve these areas.[345] In addition to this, they also assumed that the results of the movement pattern (accuracy and distance) will improve due to the improvement in the technique of the movement pattern.[346] Unfortunately, most of the research that has been done on kinesthetic approach to learning has tested outcome information. In other words, if the result (accuracy and distance) of the movement patterns were improved, then it was assumed that the kinesthetic approach to learning the skill must be an effective way to learn. Likewise, if the result of the movement pattern did not improve, the kinesthetic approach to learning was said to be an ineffective way to learn.

After a thorough review of the literature, the writer did not find any studies that tested movement information on a kinesthetically monitored instructional technique. The

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[345] Wells, p. 386.

[346] Ibid.

writer assumed that this was due to the difficulty in measuring such a procedure. For example, measuring where a tennis ball ends up (outcome information) is much easier than trying to measure the efficiency of the movement pattern. Presently, the only methods available for measuring movement efficiency have been through subjective ratings, film analyses and biomechanical analyses. It is the writer's contention that most of the contradictory nature of the kinesthetically-monitored instructional techniques were due to: (1) the measurement technique used; (2) the specific nature of the skill being learned; and (3) the different methods used to communicate the kinesthetic instructional techniques. Some of these kinesthetically monitored studies have been listed below.

As far back as 1930 Griffith suggested that basketball players should practice shooting free throws while blindfolded to get the "feel" of the movement and to correct any distance errors.[347] Barclay concurred with Griffith by stating that the less a player depends on vision in shooting a basketball, the more he can develop neuromuscular awareness of position and coordination and the better his chances for success.[348] Similarly, Gephart found that subjects who

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[347]Coleman Griffith, "Types of Errors in Throwing Free Throws," Athletic Journal, 1 (Sepbember 1930), 22-26.

[348]G. D. Barclay, "The Relationship Between Efficient Vision and Certain Sensory Motor Skills," Diss. New York Univ., 1938.

practiced free throwing in basketball blindfolded improved significantly more than subjects who had an equal amount of sighted practice.[349]

McGrath's study pointed out just the opposite results. In studying the effects of blindfolded practice on free throw accuracy, he concluded that visual cues seem to be more important than kinesthetic cues when learning this skill.[350] Durentini's results agreed with McGrath's findings. He, also, investigated the use of kinesthetic perception and the learning of the free throw in basketball. He did not find any significant improvement between the blindfolded group and the group that trained conventionally.[351]

Espenschade wanted to know if blindfolded subjects could reproduce a limb movement that was demonstrated to them. She also wanted to know how accurately a subject could direct a movement and to what extent the subjects would improve with practice. To perform this study, she

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[349] Gene Charles Gephart, "The Relative Effect of Blindfolded, Sighted and No Practice on Free Throw Accuracy," Thesis Univ. of Illinois, 1954.

[350] John Williams McGrath, "The Relative Importance of Kinesthetic and Visual Cues in Learning a Hand-Eye Coordination Skill," Thesis Univ. of California, 1952.

[351] Carol Louise Durentini, "The Relationship of a Purported Measure of Kinesthesis to the Learning of a Simple Motor Skill--the Basketball Free-Throw, Projected with and without Vision," Thesis Univ. of Massachusetts, 1967.

demonstrated a simple target-throwing skill to a group of seventy men and women. After the demonstration, she blindfolded the students and asked them to throw objects at a target twelve feet away. She found that the students increased their sense of distance in throwing but their accuracy did not improve.[352] Also, none of the students attributed their improvement to getting the "feel" of the activity. They all believed that their improvement was due to getting the "idea" of the activity and their ability to mentally visualize the target.[353] She concluded that a simple eye-hand coordination task could be learned without the aid of vision but, at the same time, she determined there was no evidence that an individual could learn the "feel" of the movement and be able to identify and associate it with subsequent performance.[354]

Benson investigated those skills which required the projecting of an object. She found that vision, as a factor affecting motor performance, appeared highly specific to the performance of an activity. She also stated that measures

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[352]Anne Espenschade, "Kinesthetic Awareness in Motor Learning," Perceptual and Motor Skills, 8 (1958), 142.

[353]Ibid.

[354]Ibid.

of kinesthesis showed a high degree of specificity to the skill in question.[355]

Studies from Adams and Creamor have pointed out the importance of proprioceptive variables in contributing to proficiency in performance. Movement gives rise to proprioceptive stimuli. The stimuli provide internal feedback information which, according to them, help the student create an identical movement pattern in future situations.[356] They conclude that proprioception has a role in information feedback and the timing of the movement.[357]

Gellinger's study attempted to determine whether blindfolded practice or conventional instructional techniques, directed at correction of common pitching faults, improved the pitching control of college baseball pitchers.[358] Most baseball writers have claimed that keeping the eye on the target is the most important fundamental for control in pitching. Since pitching without vision compelled the pitcher to concentrate on the body movements that he

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[355] Crolyn R. Benson, "A Factor Analysis of Tests of Balance, Kinesthesis and Motor Patterns for Projecting an Object with and without Vision," Diss. Univ. of Wisconsin, 1964.

[356] Jack A. Adams and Clyde R. Creamor, "Proprioception Variables as Determinants of Anticipatory Timing Behavior," Human Factors, 4 (1963), 217-222.

[357] Ibid.

[358] John Terrance Gellinger, "The Effect of Blindfolded and Instructed Practice on Pitching Control," Thesis Univ. of Illinois, 1965.

otherwise made unconsciously, Gellinger theorized that blindfolded practice should help the pitcher improve his accuracy by developing a better "feel" and a kinesthetic awareness of the pitching motion. After each one of the recorded throws, the scorer called out the score for that throw. Using this as a guide, the subjects were told to concentrate on the "feel" of the movement pattern. In summary, limited practice while blindfolded showed an appreciable, but not significant, increase in the number of strikes per twenty trials while verbal instructions during equal practice sessions resulted in no improvement.[359] Practice while blindfolded showed a tendency toward reducing the vertical variation of pitches and a significant reduction in horizontal variation.[360]

Marford stated that, since practice normally brings about an improvement in nearly any task that has not already been thoroughly learned, practice of a kinesthetically monitored task should result in improvement in the performance of the task. He also stated that adding supplementary non-kinesthetic information to the available kinesthetic information during the practice period would result in improved kinesthetic learning. He concluded that

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[359]Ibid.

[360]Ibid.

little if any improvement will occur when practice involves error information only.[361]

Haas investigated the relationship of kinesthetic acuity to bowling performance for beginning bowlers. She taught one group of beginning bowlers a kinesthetic-centered instructional method while the other group was taught a conventional method. She concluded that the relationship between bowling performance and kinesthesis was non-significant and that either method of learning bowling was equally effective.[362]

Wheeler investigated the use of kinesthetic feedback information in learning to perform two gymnastic stunts. She concluded that the group which focused their attention on kinesthetic feedback information did not learn the forward roll and handstand any faster than the group that was taught conventionally, but they did improve more rapidly in the front handspring.[363] It also appeared that the students were able to interpret kinesthetic feedback easier

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[361] W. R. Marford, "The Value of Supplementary Visual Information During Practice on Dynamic Kinesthetic Learning," Research Quarterly, 37 (October 1966), 393-405.

[362] Mary Ann Hass, "The Relationship of Kinesthetic Acuity to Bowling Performance for Beginners," Diss. Univ. of Iowa, 1966.

[363] Lynn E. Wheeler, "The Effectiveness of Directing the Learner's Attention to Her Kinesthetic Feedback in Learning to Perform Two Gymnastic Stunts," Thesis Washington State Univ., 1974.

from the slower stunts than from the faster stunts.[364] And, finally, the experimental group showed greater retention of the skill after a two week layoff.[365]

To show the importance of proprioceptive feedback, Price asked subjects to duplicate a movement pattern with the right arm only. He found that, when knowledge of the results of the movement was withdrawn, proficient performance was maintained. Performance became drastically worse when proprioceptive information was distorted.[366] This shows the importance of proprioceptive information when knowledge of results is withdrawn. It would be difficult to determine what sense is the most important but, in general, it has been found that reduction of proprioception alone causes greater performance decrements than reduction of other senses in most motor skill learning situations.[367]

Wilkinson found that the reaction time to a kinesthetic stimulus was significantly faster than the reaction time to a visual stimulus.[368] He concluded that, since

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[364]Ibid.

[365]Ibid.

[366]Laurence Price, "Proprioceptive Feedback and Motor Learning: A Test of the Adams' Closed Loop Theory," Thesis State Univ. College at Brockport, New York, 1974.

[367]Sage, p. 121.

[368]James J. Wilkinson, "A Study of Reaction Time Measures to a Kinesthetic and Visual Stimulus for Selected Groups of Athletes and Non-Athletes," Diss. Indiana Univ., 1958.

proprioception is the fastest mode of sensory feedback, it should be relied upon when learning reaction type of movements.[369] He also mentioned that the use or dependence on kinesthetic feedback is specific to the skill in question.[370]

Regardless of these findings, Cratty suggested that the proprioceptive sensory mode is probably of greater importance in the control of slow movements than ballistic movements.[371] He theorizes that these faster movements are just too fast to monitor and are, therefore, preprogrammed ahead of time.[372] His theory would be particularly relevant to the learning of the golf swing because this would indicate that kinesthetic feedback information could only be monitored before the movement began and during the slow moving parts of the backswing.

Sage concurred with Cratty by stating that kinesthesis probably plays an important role in the awareness of the limb's position just prior to starting the movement pattern and may be important in monitoring slow movements, but fast

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[369] Ibid.

[370] Ibid.

[371] Cratty and Hutton, Experiments in Movement Behavior and Motor Learning, p. 95.

[372] Ibid.

movements, once in progress, probably depend very little on kinesthesis.[373]

There has been a great deal of controversy about the value of emphasizing kinesthetic feedback information in the early stages of learning. For example, Fitts speculated that visual control is important while an individual is learning a new perceptual motor task.[374] According to him, as performance becomes more habitual, it is likely that proprioceptive feedback information becomes more important.[375] Phillips and Summers' research found just the opposite results. Their study indicated that the use of kinesthetic cues and feedback information was extremely important in the early stages of learning.[376]

Fleishman and Rich stated that individuals sensitive to proprioceptive cues do better in tasks requiring precise motor control. They felt that, as the performance of a complex skill movement improves, the importance of kinesthesis increases.[377] They indicated that kinesthetic

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[373]Sage, p. 121.

[374]P. M. Fitts, Engineering and Equipment Design, Handbook of Experimental Psychology, S. S. Stevens Edition (New York: Wiley Publishers, 1951), p. 82.

[375]Ibid.

[376]Phillips and Summers, pp. 456-457.

[377]Edwin A. Fleishman and Simon Rich, "Role of Kinesthetic and Spatial-Visual Abilities in Perceptual Motor Learning," Journal of Experimental Psychology, 66 (July 1963), 6-11.

cues are of little use in the initial stages of skill learning but only later on in the learning process do kinesthetic cues become important.[378]

Whiting also concluded that only after the performer reaches a certain skill level does proprioception become more important than vision in providing feedback information in the learning process.[379] According to him, the performer must have started to ingrain a habit pattern before proprioceptive information becomes important.[380]

Schmidt and Wrisberg found in their study that, as practice and repetition of a skill continues, vision and audition become less and less important in the error detection process.[381] They would agree with Fitts, Fleishman and Rich and Whiting regarding proprioception and its importance being emphasized after the initial stages of learning.

According to Singer, information about what the muscles are doing and their position during the movement is extremely important to the learner when learning a new skill.

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[378]Ibid.

[379]Whiting, Acquiring Ball Skill, pp. 56-57.

[380]Ibid.

[381]R. A. Schmidt and C. A. Wrisberg, "Further Tests of the Adams Closed Loop Theory: Response Produced Feedback and Error Detection Mechanism," Journal of Motor Behavior, 3 (1973), 155-164.

Regardless of this, he theorizes that kinesthetic ability seems to be related more to higher levels of performance than to beginning levels of performance.[382] He feels that the learner is more externally controlled by verbal and visual cues in the early stages of development and, as the learner gets more skillful, kinesthetic feedback assumes greater importance.[383]

Klein and Posner indicated that a performer will selectively choose between visual and kinesthetic feedback. They stated that, when visual cues are present, kinesthetic cues will be ignored.[384] They felt that the reliance on kinesthetic information would be enhanced if the performer practices the movement and associates the correct kinesthetic feel with that particular movement.[385]

Drowatzsky reported that kinesthesis alone does not provide enough information for learning new skills.[386] He thinks that kinesthesis becomes important only after other sensory sources have initiated the learning process.[387]

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[382] Robert Singer, Motor Learning and Performance (New York: Macmillan Publishing Co., Inc., 1975), p. 239.

[383] Ibid.

[384] R. M. Klein and M. I. Posner, "Attention to Visual and Kinesthetic Components of Skills," Brain Research, 71 (1968), 410-411.

[385] Ibid.

[386] Drowatzsky, p. 192.

[387] Ibid.

In more recent findings, Dickinson contended that subjects needed to become familiar with the task before experiencing training with occlusion.[388] But, in making this statement, he did not completely abandon the idea of learning a motor skill without the aid of vision. In fact, he saw a need to emphasize certain sensory modes during the learning process. With this in mind, he stated that the occlusion of certain visual cues, at times, speeds up the learning process and makes the learner more aware of performing the technique of the movement instead of the result of the movement.[389]

Hoth contended that beginning level performers do not have a vivid awareness of body position and, therefore, kinesthetic perceptual training may be of no real value to them.[390]

The results of Chew's study disagreed with most of the research regarding the use of kinesthetic error feedback in the early stages of learning. His study supported the use of kinesthetic error feedback in the early stages of learning.[391] He found that the use of kinesthetic cues were

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[388]Dickinson, p. 175.

[389]Ibid., p. 173.

[390]Hoth, p. 72.

[391]Richard A. Chew, "Verbal, Visual, and Kinesthetic Error Feedback in Learning of a Simple Motor Task," Research Quarterly, 47 (May 1976), 254-259.

equally as effective as verbal and visual cues in learning a simple motor task.[392]

Hellebrandt indicated that motor learning tends to occur below the level of conscious awareness.[393] This occurs because the body acts like a servo-mechanism when learning a new skill. In other words, when kinesthetic feedback is used by the performer in the error correction process, the correction involves a self-correction method that automatically occurs.[394]

"Kinesthesis," or "getting the feel of the movement," and "conscious muscle sense" are terms used in the literature many times with the apparent assumption that such sensing in skill adjustment was a conscious and rational type of learning. Experimental evidence does not support this viewpoint.[395] For example, it is thought that one learns to judge the correctness of one's movements by remembering former sensations and comparing these sensations consciously with present ones. Schmidt states that this is not a conscious process but a subconscious one.[396] To

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[392]Ibid.

[393]Francis A. Hellenbrandt, "Physiology of Motor Learning," Cerebral Palsy Review, 14 (July-August 1958), 11.

[394]Ibid.

[395]John D. Lawther, The Learning of Physical Skills (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1968), p. 57.

[396]Schmidt, Motor Control and Learning, p. 205.

demonstrate this, he gives an example of a golfer hitting a golf ball. According to him, after the ball is hit, the sensations of the swing are automatically analyzed.[397] A professional golfer probably can tell a great deal about the distance and direction of the golf shot just from the feel and sound of it.[398] This, of course, was proven by Pash in an earlier study.[399]

Schmidt convincingly states:

> We know that vision is not critical for all motor performances. Blind people have learned to respond to the environment with remarkable facility although it is clear that they are at a large disadvantage in many situations.[400]

It has been theorized that, if a skill is learned primarily through one sensory mode, it might be difficult to "transfer" that learning where it can be performed in another sensory mode.[401] For example, if the golf swing is learned without the aid of vision, what will be the consequences when visual cues are introduced and the student becomes aware of the ball and the other new stimuli? Sage states that the higher degree of similarity between the

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[397]Ibid.

[398]Ibid.

[399]Pash, pp. 3-4.

[400]Schmidt, Motor Control and Learning, p. 194.

[401]Drowatzsky, pp. 159, 160, 161.

component parts of the two skills, the greater amount of positive transfer.[402]

Connolly and Jones' study investigated the relationship between vision and proprioception and the transfer effects of learning in this way.[403] In their investigation, the subjects were presented a movement either visually, where the experimentor drew a line until it hit a stop while the subject watched, or kinesthetically, where the subject drew the line but was blindfolded. The subject was then asked to reproduce the line and was classified in one of four conditions: experience the movement visually and reproduce the movement visually; experience the movement visually but reporduce it kinesthetically; experience the movement kinesthetically and reproduce it kinesthetically; and experience the movement kinesthetically but reproduce it visually. The authors concluded that transferring from the visual to the kinesthetic mode leads to more errors than transferring the kinesthetic to the visual.[404]

Reeves and Cone also investigated the transfer effects of learning of a skill primarily through one sense and then

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[402] Sage, p. 355.

[403] K. Connolly and B. Jones, "A Developmental Study of Afferent-Reafferent Integration," British Journal of Psychology, 61 (1970), 259-266.

[404] Ibid.

performing it through another sense.[405] In their experiments, subjects actually learned a movement during many trials while blindfolded. They were then asked to reproduce the movement they had learned with vision either present or absent. It was found that subjects made greater errors when transferring from the kinesthetic mode of learning to the visual mode.[406]

Forward and Hagadone did a similar study on the transfer effects of learning in three different sensory modes. They studied three groups of nine subjects who learned, practiced and remembered a sequential motor task under three different guidance conditions: (1) visual-kinesthetic, (2) auditory-kinesthetic, and (3) kinesthetic. They found that kinesthetic subjects showed no loss of skill in transferring the task to the unpracticed left hand while the auditory-kinesthetic subjects retained and increased their motor skill during the non-practice period. They also found that, in the kinesthetic group, no real loss of skill occurred during transfer of task performance to the unpracticed left hand. It seems that responses guided by kinesthetic cues required more attention than those

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[405] T. G. Reeve and S. L. Cone, "Storage of Kinesthetic Location Information During Motor Skill Learning" (Abstract), in Proceedings of the Research Section of the Southern District Association of Health, Physical Education and Recreation, Little Rock, Arkansas, 1978.

[406] Ibid.

performed with visual or verbal guidance. They discovered that the visual group transferred the least skill which suggests that visual feedback from motor activity is less effective than cues from the kinesthetic and auditory systems for the development of motor ability.[407]

Opinions from Golf Authorities About Kinesthetic Methods of Instruction

A golfer is said to have a good kinesthetic sense when he has developed a "feeling" for the swing.[408] The sensation which is produced through the muscles, joints, nerves, and nervous system and is felt throughout the body with rhythmical sequence during the coordinated action is called the kinesthetic sensation.[409] Some authors contend that these feelings and sensations are implanted and stored into the subconscious as a muscle memory or simply one's instinctive "feel" for the swing.[410] Many golf authorities, instructors and players alike have stated that it is this highly developed kinesthetic sense upon which they base their teaching and playing.

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[407] Edna M. Forward and Marsha C. Hagadone, "Sensory Feedback and Motor Skill," Physical Therapy, 53 (June 1973), 614-620.

[408] Rehling, p. 30.

[409] Ibid.

[410] Bertholy, p. 3.

For example, Paul Bertholy, a well respected instructor, believes that the building of the golf swing is a kinesthetic experience.[411] He theorizes that the learning of the golf swing can be put into the kinesthetic memory through the conditioning process.[412] He felt that the harmful reflex action, often called the "hit impulse" by golfers, could be eliminated through conditioning.[413]

Alex Hay wrote a book called The Mechanics of Golf. In this book, while indicating that the mechanics of the golf swing were very important, he indicated that golf is a game of tremendous feel and it should be taught that way.[414]

Bob Toski, probably the most famous golf instructor in the world, has written an entire book on the "feel" method of learning golf. In this book, he describes the golf swing as a series of sensations that are stored in the golfer's subconscious computer. According to Toski, it is up to the player to remember these swing "feelings" from past success and use these "feelings" to reproduce a good swing when he is required to do so. He also uses many conceptual

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[411] Ibid.

[412] Ibid.

[413] Ibid., p. 5.

[414] Alex Hay, The Mechanics of Golf (New York: St. Martin's Press, 1979), p. 13.

word-pictures to help the golfer visualize and compare these swing feelings.[415]

Toski and Flick both state that in any sport the best players perform as instinctively and as naturally as possible.[416] In other words, they play by feel.[417] According to them, the golfer must play with a swinging sensation, a feeling of ease and grace, rather than worrying about the mechanics of putting the club into certain positions during the swing. In order to establish this "feel" they think it is absolutely necessary to start in the proper set-up position.[418] Their main concern in the golf swing is to get the golfer to "feel the force" rather than "force the feel."[419]

Joe Lazaro, the winner of seven national blind golf championships and the first blind person in history to score in the seventies, states that a blind person gets more feeling out of hitting the ball properly than a sighted person. He says he can feel the ball hitting the club all

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[415] Bob Toski, The Touch System for Better Golf (Norwalk, Ct.: Golf Digest Publsihers, Inc., 1971), p. 17.

[416] Toski and Flick, p. 139.

[417] Ibid.

[418] Ibid., p. 140.

[419] Ibid., p. 141.

the way up the shaft of the club and, besides this, he can predict where the ball will end up.[420]

Aultman contends that a true and lasting correction in a golfer's swing can occur only when the golfer can feel what he did to create the successful shot and has a way to recapture that feeling in the future.[421] He further states that golfers play their best when they play by feel and with as little conscious thought as possible.[422]

Peter Kostis, a well known golf instructor and director of Golf Digest Instruction Schools, suggests that the golfer should "feel" the ball come off the clubface.[423] This ability starts with the golfer "feeling" the position of the golf club throughout the entire swing.[424] He concludes by saying that the ideal way to play golf is simply with a total feel for the swing and no mechanical swing thoughts.[425]

Jack Nicklaus, winner of over nineteen major championships and over four million dollars on the P.G.A. tour,

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[420]Lazaro, p. 43.

[421]Aultman, p. 10.

[422]Ibid.

[423]Kostis, Inside Path to Better Golf, p. 44.

[424]Ibid.

[425]Ibid.

summarizes his swing thoughts this way: "Once I'm sure my fundamentals are right, what I work on is feel."[426]

Craig Stadler, the 1982 top money winner on the P.G.A. tour with over four hundred forty-two thousand dollars, was recently quoted as saying he plays the game by feel.[427] According to him, swing mechanics are important, but they should not be dwelled upon.[428]

In discussing muscle memory, the editors of Play Better Golf Magazine state that the theory behind muscle memory is that if you do anything long enough, such as walking, driving a car, or picking up a glass of water, you eventually do it automatically without much thought.[429] According to them, it is this subconscious and automatic muscle memory that allow the excellent performer to remember the "feel" of the correct swing.[430]

In a recent talk to a group of junior golfers, Calvin Peete, the most accurate striker of the ball on the P.G.A. tour and winner of four events in 1982, emphasized the

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[426]Nicklaus, Golf My Way, p. 198.

[427]Larry Dennis, "Stadler Power," Golf Digest, 33 (December 1982), 54.

[428]Ibid.

[429]Editors, "Make Use of Your Muscle Memory," Play Better Golf Magazine, 40 (Summer 1981), 22-24.

[430]Ibid.

importance of muscle memory and "swing feelings" in acquiring and building a good golf swing.[431]

De De Owens, a former L.P.G.A. player and now one of the most respected teachers in the world, advises young golfers to concentrate on swing technique rather than the results of that technique.[432] In doing this, she recommends that golfers key on their "swing feels" in order to develop a more consistent motion.[433]

Percy Boomer, a well known golf instructor who wrote a classic book titled On Learning Golf, expressed the opinion that the reason he thought the golf swing was difficult to learn is because one has to learn it through the sense of feel.[434] Since we have never learned anything this way, this becomes a difficult process for many students. He says that golfers learn through mental images.[435] Learning takes place when these mental images are translated into swing feelings.[436] He gives an example of teaching the pivot. He says, in teaching the pivot, the golfer should imagine he is

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[431] Calvin Peete, "The American Dream and Respect Are His," Florida Golfweek, 8 (July 1982), 12.

[432] De De Owens, "Three Steps to Understanding," Women Golfer's Week, 18 (May 1982), 5.

[433] Ibid.

[434] Boomer, pp. 59-61.

[435] Ibid.

[436] Ibid.

in a barrel. Once in the barrel, he should imagine he is turning his body without touching the sides of the barrel. The student must turn this "barrel image" into a sensation or "swing feel" in order for learning to take place. So, after visualizing the movement pattern, the student should try to get the feel of that pattern. According to him, the foundaiton on which the golf swing is built is feel, and he believes it should be taught through that sensory mode.[437]

According to Boomer's theory, when learning the golf swing, the student builds up muscle memory. This muscle memory can be defined as a memory for the correct "swing feelings." It is this muscle memory that allows the golfer to repeat the movement time after time without conscious thought.[438] Certainly the difficulty in teaching golf is recognizing that what one has to teach is a correct feel, and neither demonstration nor words can do that directly.[439] From his experiences of teaching and playing golf, he contends that only the poor golfer can actually see the ball out of his eyes. According to him, the good player "feels" the ball.[440]

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[437]Ibid.

[438]Ibid.

[439]Ibid., p. 147.

[440]Ibid., pp. 129-139.

Boomer relates a story of how, when playing, he played many of his shots with his eyes closed. He theorized that this method of playing would allow the other senses, especially muscular feel, to take over and dominate the swing.[441]

Toski theorizes that blindfolding a student should help him improve his swing pace. He relates a story of a golfer who had this fantastic sense of "feel" for the path and pace of his swing. He states:

> If I'd blindfolded him, I'm sure he still could have told me how far each shot went, how high it flew and which direction it curved. I know this is true because the man was, in fact, blind. And, he did tell me these things. Since then, I've often helped golf pupils improve the pace of their swings by having them strike balls with their eyes closed. Almost immediately they begin to swing at a slower pace and they feel that pace. It's amazing how our sensitivity increases when we are deprived of our sight. Hitting balls with eyes closed proves that the golfer doesn't have to fixate his eyes on the ball in order to hit it. In fact, it stops the golfer from becoming ball bound. It also helps the golfer develop a good pace in his swing. If, with the eyes closed, a golfer tries to consciously hit the ball, he will miss it. It forces the golfer to develop a swinging action and not a hitting action.[442]

In the final analysis, to perform effectively and consistently in golf, the learner must be guided by his own internal sensory cues. On the spot correction by the teacher is helpful, but usually not permanent. To be

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[441] Ibid.

[442] Bob Toski, "Drills," Golf Digest, 29 (December 1978), 57.

successful, the performer must know and understand his own swing and how to make adjustments when things go wrong. Since the golfer cannot see himself swinging, he must totally rely on his swing "feelings" for error correction when playing. Also, corrections based on swing "feelings" tend to be more permanent and lasting. If learning the golf swing is indeed a kinesthetic experience, as Bertholy has stated,[443] then it should be taught kinesthetically. And any method that enhances this experience should be included in the learning process.

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[443]Bertholy, p. 3.

CHAPTER THREE

Methods and Procedures

This chapter presents the procedures that were employed in this study. The material is subdivided into sections describing the subjects, teaching methodology, testing methodology, data reduction and statistical analyses.

Subjects

Twenty male subjects were used in this study. The subjects were randomly selected from two beginning golf classes at Middle Tennessee State University. Ten of these subjects from one class were assigned to be the control group, and ten of these subjects from the other class were assigned to be the experimental group. Only beginning golfers were allowed to participate in this study. A beginning golfer was considered to be someone who had never played or been taught golf. All of the subjects were between eighteen and thirty-five years of age.

The subjects were tested during the spring semester of 1982. The investigator assumed that all the students who volunteered for the study were, in fact, beginning golfers. By selecting subjects in this matter, the investigator also assumed that both groups were equal in golfing ability.

Teaching Methodology

Due to the increasing information of golf instructional techniques that emphasize the correct mechanics of the golf swing, this study was designed to determine the learning progression, based on mechanical efficiency, of two groups of beginning golfers. One group (the control group) was taught the golf swing using conventional methods of golf instruction, while the other group (the experimental group) was taught using a kinesthetic feedback method of golf instruction. Both groups met twice a week for ten weeks. The experimental group met at 1:00 p.m. on Mondays and Wednesdays, while the control group met at 10:50 a.m. on Tuesdays and Thursdays. Class periods were fifty minutes in length for both groups. The appendixes of this text contain the teaching methodology that was presented to each class.

To quantify the learning progress of the two groups, biomechanical cinematographical techniques were utilized. A swing model was developed from the filmed results of a number of elite golfers, then compared to both beginning groups. Improvement in the mechanics of the golf swing (learning) of the beginners was measured as the amount of improvement made by each beginner when compared to the swing model.

Control Group

The ten beginning golfers in the control group were taught the golf swing by using conventional methods of instruction. Conventional golf instruction relies on verbal cues, demonstration, and conceptual "word pictures" to communicate with the student. Golf swing corrections were based on the feedback that the student and the instructor received from the flight of the ball. It was hoped that this visual information the student received from the flight of the ball helped him change his swing pattern on the next response. Because virtually all of the current golf instructional methods utilize a ball during the learning process, and because of the heavy emphasis on the verbal and visual feedback information, this method was termed a conventional method of golf instruction.

During the first two days of class, the control group was made familiar with Wiren's Ball Flight Laws.[1] It was hoped that the knowledge of these laws would help the group understand why the golf ball traveled in a certain flight pattern. These ball flight laws included: (1) the direction that the clubhead was moving at the point of impact (swingpath), (2) the clubface position in relation to that swingpath at the point of impact, (3) the position on

[1]Gary Wiren, "Introduction to Laws, Principles, and Preferences," P.G.A. Magazine, 33 (April 1976), 23.

the clubface where the ball is compressed, (4) the velocity of the clubhead at the point of impact, and (5) the angle of attack in which the club approaches the impact area.

The control group was also given a handout sheet that included a series of golf swing fundamentals that would be learned during the following weeks of class. These fundamentals included: (1) grip, (2) stance, (3) posture, (4) ball position and distance from the ball, (5) body alignment, (6) clubface aim, (7) set-up and address, (8) weight distribution, (9) muscular tension, (10) shoulder coil and hip turn, (11) length of swing arc, (12) width of swing arc, (13) maintenance of target (left) arm radius, (14) height of swing plane, (15) downswing plane, (16) tempo, (17) timing, (18) rhythm, (19) target (left) side lead and control, (20) steady center, (21) footwork and leg action, (22) position at the top, (23) weight shift and dynamic balance, (24) maintenance of target (left) arm--clubshaft angle on the downswing, (25) target (left) wrist position throughout the swing, (26) release and rotation, (27) balance, and (28) follow-through. All of these fundamentals and mechanics were primarily taught through the use of demonstrations and other verbal and visual cues.

Each day, as the control group came to class, they were given a handout sheet that indicated what would be learned for that day. The group would then form a circle around the instructor and watch him demonstrate and explain the fundamentals that would be emphasized that particular day. Once the instructor was finished with his demonstration, he would ask the group to spread out and hit balls, practicing what had been presented. The instructor then went up and down the line giving individual help.

The control group was encouraged to hit at least 75 balls each class meeting. The emphasis with this group was on ball striking and making subsequent swing corrections based on the flight of the ball. As the control group hit balls, the instructor would verbally reinforce good flight patterns and good swings and constructively criticize poor flight patterns and poor swings. For example, if a member of the group sliced the ball to the right, the instructor would suggest two or three fundamentals to work on that would correct that ball flight pattern.

The control group spent the first eight weeks of the instructional period learning with the five and seven irons, while the last two weeks of the instructional period was spent learning with a number one wood club. The group was told not to practice outside of class, thus standardizing the number of balls that each person in the control group hit to approximately 1,500 during the ten-week learning period.

The instructor used the part-whole method of instruction in order to sequence the learning. In this method, the one-quarter swing was learned first; the half swing was learned next; the three-quarters swing was learned next until, finally, the full swing was learned. The group was making full swings by the third week of the learning period.

As in all conventionally-based golf instructional methods, the group had four different sets of stimuli on which to concentrate. These included: (1) the ball, (2) the swing, (3) the ball's flight, and (4) the target. The instructor did not try to emphasize any one of these four stimuli more than another, but he did attempt to make swing corrections based on the information he received from the flight of the ball.

Experimental Group

The ten beginning golfers in the experimental group used a kinesthetic feedback golf instructional method to learn the golf swing. This group was specifically told that it was trying to learn a correct golf swing. Five basic components make up this kinesthetically-based instructional technique: (1) the use of a weighted golf club, (2) the use of swing drills, (3) the absence of the golf ball, (4) the use of kinesthetic cues used during the swing process, and (5) the use of terminal augmented verbal feedback indicating the quality of the student's swing. It was thought that a combination of all five components would heighten the subject's kinesthetic sensitivity for the "feel" of the proper movement pattern of the golf swing.

The actual golf club used during the entire ten-week training period was a number one wood. Each club weighed sixteen ounces. A three and one-half ounce weighted head-cover was added to this original weight making the total weight of the club nineteen and one-half ounces. This weight is approximately six and one-half ounces heavier than a regulation-weighted number one wood. Also, each club had a pre-molded "reminder" grip that represented the correct neutral golf grip. This grip forced the student to put his hands on the golf club correctly.

The first period of class instruction was used to give the group a clear idea of the "reference of correctness" in which each student was to imitate and mentally focus upon during the entire ten-week learning period. This model, or "reference of correctness," was based on the ten positions that the instructor thought to be the most critical to the performance of a correct golf swing. These ten positions are represented with Figures 3 and 4 (see pp. 197 and 198). The instructor physically demonstrated these ten positions and then asked the group to perform them as well as possible.

During the following class periods, the experimental group was asked to utilize a series of thirty swing drills with the weighted club. All of these swing drills were performed ballistically and not in a guided fashion. They were also performed in the absence of the golf ball. Each drill was demonstrated by the instructor before the group was asked to perform the drill. The second and third class periods were spent showing the group how to perform the various swing drills. During these two periods, the instructor corrected any group member who was not performing the drills correctly. Also, during this time the instructor explained the effects that each drill had on the golf swing.

After the instructor was sure that the group members had a clear "reference of correctness" of how each drill was to be performed, they were asked to perform some repetitions of each drill. These first few attempts were performed with the eyes open.

Beginning with the fourth class period until the twentieth class period, the group participated in high repetition swinging. Each of the thirty drills was performed between ten and twenty times each class period. This meant that, by the end of the ten-week training session, each group member was swinging about four hundred times during each class period. In addition to this, half of these swings were performed with the eyes closed. This was intended to give the group a "kinesthetic" awareness of the proper swing mechanics. After each drill, the group members were allowed to open their eyes and watch the instructor perform the next drill in order to reestablish their "reference of correctness."

Throughout the entire ten-week training period, the group was continually reminded of the importance of trying to make a correct golf swing. This was accomplished by the instructor utilizing augmented verbal feedback. This was supplied both concurrently (during the swinging process) and terminally (after the swinging process). This feedback information was supplied to the group in one of two ways: (1) through the use of kinesthetic cues and (2) through the use of terminal feedback indicating the quality of the swing.

These kinesthetic cues were given while the group was in the swinging process. These cues encouraged the group to try to get the "feeling" of the correct swing. For example, in learning the proper shoulder turn, the group was asked if each of them could "feel" the tight coil of the muscles in the shoulder area. In teaching the release, each student was asked if he could "feel" the right hand turn over the left after impact. Each drill was designed to give the students certain "feelings" and "sensations" that were thought to be important fundamentals associated with learning the ten positions of a correct golf swing.

As the instructor saw fit, he also gave terminal augmented verbal feedback as to the quality of the individual group member's swing. This information concerning the correctness of the swing was referred to as "knowledge of performance."[2] It was hoped that, through continued practice and high repetition swinging, the group would come to rely less and less on the verbal feedback received from the instructor concerning the quality of the swing and become more reliant on the kinesthetic feedback mechanisms to monitor swing performance. It was thought this could be accomplished by the group comparing its sensory feedback information with the "reference of correctness" that was continually provided by the instructor. In so doing, a habit pattern would be established and the group could be said to have internalized the feelings of the correct swing.

The major feature of this kinesthetic feedback method of golf instruction is that it provided a means for the group to determine its swing errors in the absence of visual ball flight feedback information.[3] It also served as a means for the group to maintain its swing performance, or even to continue to learn, without knowledge of results information.[4] Since this kinesthetic feedback technique

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[2] A. M. Gentile, "A Working Model of Skill Acquisition with Application to Teaching," Quest, 17 (January 1972), 8.

[3] J. A. Adams, "A Closed Loop Theory of Motor Learning," Journal of Motor Behavior, 3 (1971), 111-150.

[4] Ibid., p. 121.

is totally dependent on the group remembering what a correct swing felt like, this could only be accomplished by utilizing kinesthetic feedback information until the correct swing was internalized. Once the habit pattern was internalized, corrections in the golf swing were thought to continue to be made through the student's subjective reinforcement system.[5]

In discussing how instructions should be given, Cochran and Stobbs tend to agree with the teaching methodology used with the experimental group. They state:

> Instructions should be given in the form of general feelings rather than specific details as to what any particular part of the body should be doing. In order that the feeling of a golf swing be developed, it is important that large units of the movement pattern are taught as one.[6]

Because the entire ten-week session was designed to build a habit pattern through kinesthetic and proprioceptive feedback, it was thought that when the group took the post-test in April that all its attention would be focused on the new stimulus (the ball) and not on making a good swing. It was theorized that this overemphasis on the new stimulus (the ball) might cause the beginner to develop a fear of not being able to hit it, and a poor swing pattern would result. For this reason, after the seventh week, the group was

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[5] Ibid., p. 132.

[6] Alastair Cochran and John Stobbs, The Search for the Perfect Swing (Philadelphia: J. B. Lippincott Co., 1968), p. 106.

allowed to hit ten balls each with the number seven iron. The group members were allowed to keep their eyes open while addressing the ball, but were told to close their eyes when actually making the swing. All of this ball striking was done after the fifty-minute training session was completed. It was thought that this small amount of ball striking gave the group a feeling of how the ball felt when it came off the clubface. Also, it allowed the group to gauge the distance from the ball and "find" the optimum ball position prior to the swinging process. It was thought that this procedure might help eliminate any fear that the group members might have as a result of the presence of the ball during the posttest filming.

All other teaching procedures that were used on the experimental group are recorded in the appendix.

The following equipment and procedures were used in establishing performance scores for two groups of beginning golfers and in arriving at a composite, idealized swing based upon the swings of ten professional golfers.

Testing Methodology

Equipment

Cameras: Two high speed Lo-Cam cameras, fitted with 12-120 mm Angenieux zoom lenses, were used to obtain film records (at 300 frames per second) of the performers.

Digitizer: A Graf/Pen sonic digitizer was used to reduce the film records. The image was rear projected on the frosted digitizing screen using a NAC 16mm analysis projector.

Computer: The digitized results were serialized with a SAC DC-6 Parallel to Serial Data Converter and sent to an IBM 370-165-II for processing.

Software: The performance parameters of interest were calculated with the aid of a program specifically developed for this project at the Biomechanics Laboratory at the University of Kentucky.

Ball Used: All the beginning golfers used the same golf balls for both the pre- and posttesting. Wilson-Pro Staff 90 compression golf balls were used.

All the professional golfers who were filmed also used the same golf ball. They used a 100 compression Hogan Apex golf ball.

Club Used: All the beginning golfers used the same golf club for both the pre- and posttesting. A Hillerich and Bradsby number one wood was used. This wood had the usual standard features, including: (1) a standard length of 43 inches, (2) a standard weight of 13 ounces, (3) a standard R-shaft, and (4) a standard loft of 11 degrees.

The ten professional golfers from which the swing model was developed were allowed to use their own number one wood for the filming.

Pre- and Posttest for Beginning Golfers

Dates and Weather Conditions: The pretest (prior to golf instruction) filming date was on Wednesday, February 3. The weather conditions on this date were cloudy and cold. The temperature was 45 degrees. The posttest (following golf instruction) filming date was on Monday, April 26. The weather conditions on this date were sunny and 65 degrees with very little wind.

Model Test for Professionals

The professional golfers were filmed at the Heritage Golf Classic on the Hilton Head Island, South Carolina. They were filmed on Monday, March 22. The weather conditions on that date were sunny and warm with a temperature of 70 degrees.

Procedures

Filming Procedures for the Beginning Golfers: To film each performer in three movement directions, one camera was positioned to record the vertical and horizontal motion, while the other was positioned to record the vertical and lateral motion. The cameras were aligned such that the optical axes bisected the middle of the filming area, and were 90 degrees apart. The cameras were placed at a sufficient distance to insure that paralax problems were minimized. The field of view was limited to include only the swing so that data reduction would not be compromised due to image size. Prior to filming, a scale marker (length = 3 feet) was filmed in the plane of movement for each camera.

The performer was positioned such that one camera recorded the "front" view while the other camera recorded the "rear" view of the swing. Prior to the filmed trial, each subject was allowed to warm-up and perform the movement until he felt he was prepared for his best effort. Also, in order to insure accurate measurements of the body parts, each performer was asked to strip down to only gym shorts and shoes. Once the performer was ready, the cameras were started; then the performer was orally cued to begin the swing. The cameras recorded the movement at 300 frames per second, insuring that the greatest error between the film records of the two cameras would be .0017 seconds. Qualitative information on the quality of each performance, as observed by the performer and the researcher, was recorded for each filmed trial. Personal data, including the subject's height, were also recorded.

To determine the improvement in skill over the duration of the study, each performer was filmed at the beginning and end of the study. In each case, the identical filming procedure was employed.

Filming Procedures for the Professional Golfers: The filming procedures for the professional golfers was exactly the same as that used for the beginning golfers, with one exception--the professional golfers were filmed in their casual golf attire due to the unusual circumstances of tournament play.

Summary of Data Reduction

In order to make a biomechanical comparison between a conventional golf swing/learning technique and a kinesthetic feedback/golf learning technique, it was necessary for the investigator to determine the qualities of a model golf swing. This was necessary in order to have a "reference of correctness" in which to compare the twenty beginning golfers.

This "model" golf swing was based upon the filmed linear and angular performance results of ten of the best golfers in the game. All of these golfers had won golf tournaments on the P.G.A. tour and were considered to have excellent swing mechanics. Each of the ten professionals was analyzed using linear position, velocity, and acceleration results at ten positions during the swing to determine the qualities of excellent performance. Nineteen body joints and segments, as well as the club and the ball were included. This produced 1,760 performance scores for each subject's swing. In addition to this, angular displacement, velocity and acceleration results produced 168 performance scores for the shoulders and hips that were determined at each of these ten positions in the swing. After all of these measurements were taken of the professionals' swings, the mean result of each of the 1,928 measurements was used as the best value for each measurement at the ten different positions. The mean of the ten golf professionals' swings in the ten different positions is graphically displayed in Figures 1 and 2.

Once the model golfer was established, a scoring system, included within this text, was developed to rate any golfer against this model performer. This same scoring system was used to evaluate the beginning golfers at the pretest and posttest periods in this study.

Data Reduction and Statistical Analyses

Data Reduction. The analyses of data were made on 1,928 performance scores consisting of linear and angular displacement, velocity, and acceleration scores of 19 body joints and segments, as well as the ball and club, at ten selected positions during the swing. As shown in Figures 3 and 4, the ten positions included address position (P1), the first occurrence of hotizontal shaft position (P2), the first occurrence of vertical shaft position (P3), the top of the swing position (P4), the second occurrence of vertical shaft position (P5), the second occurrence of horizontal shaft position (P6), the ball contact position (P7), the third occurrence of horizontal shaft position (P8), the

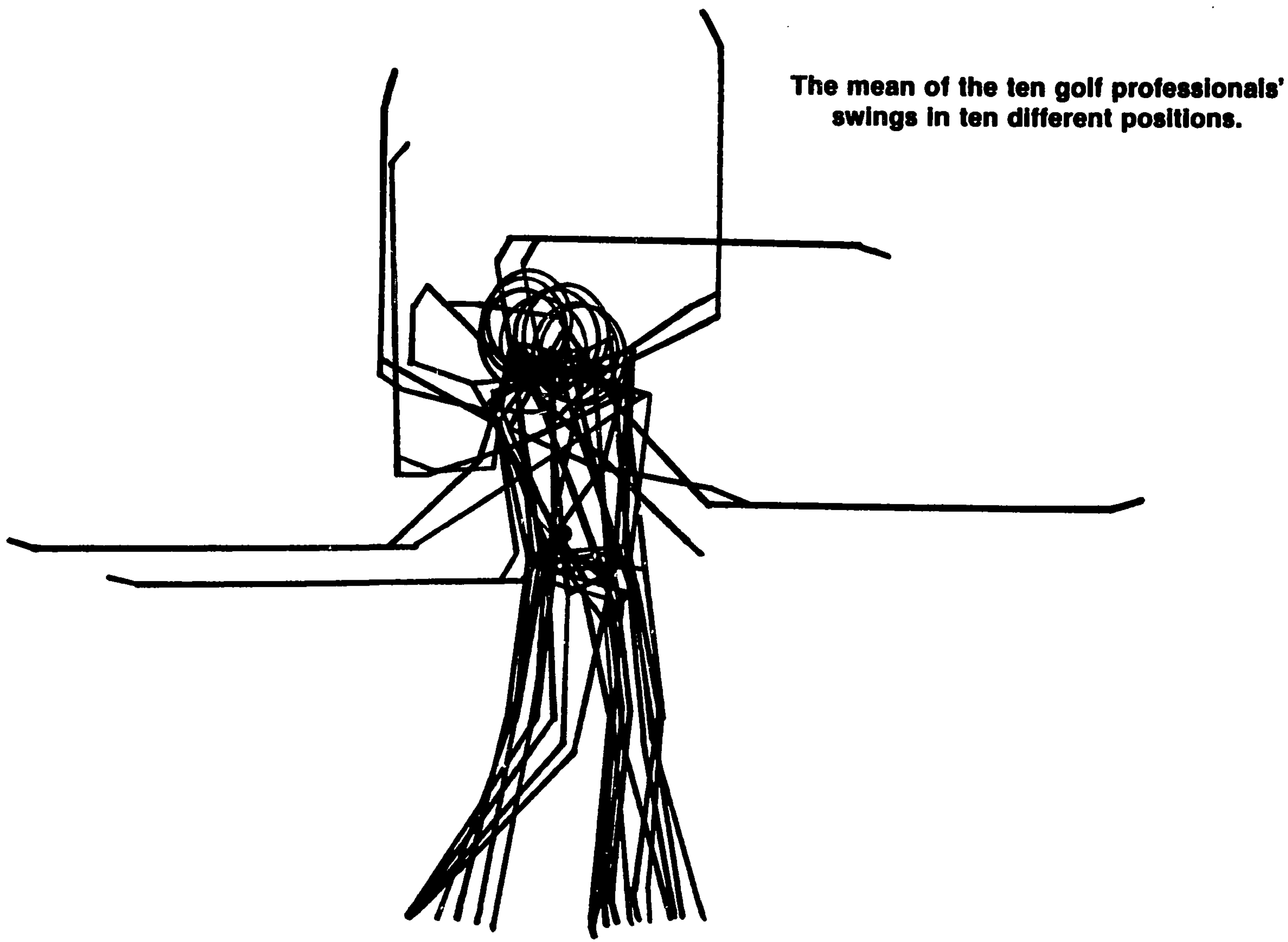

Figure 1. Front View

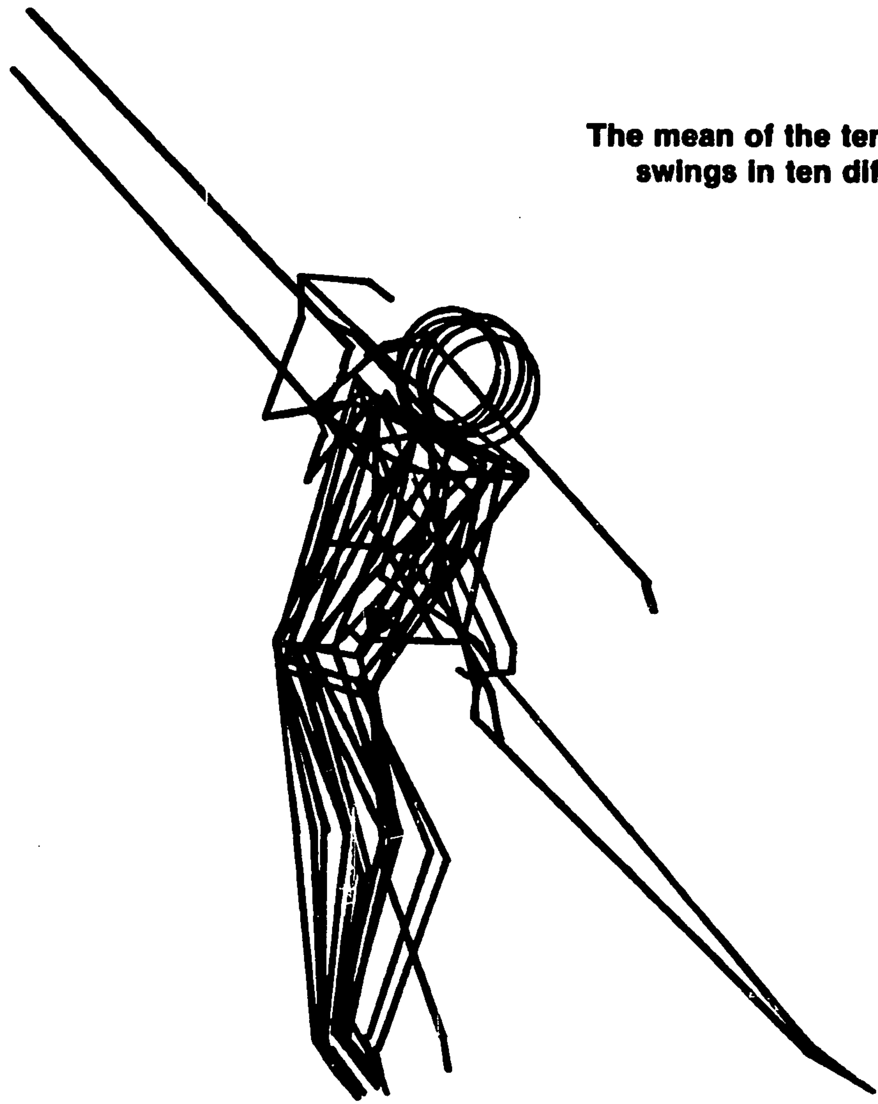

Figure 2. Back View

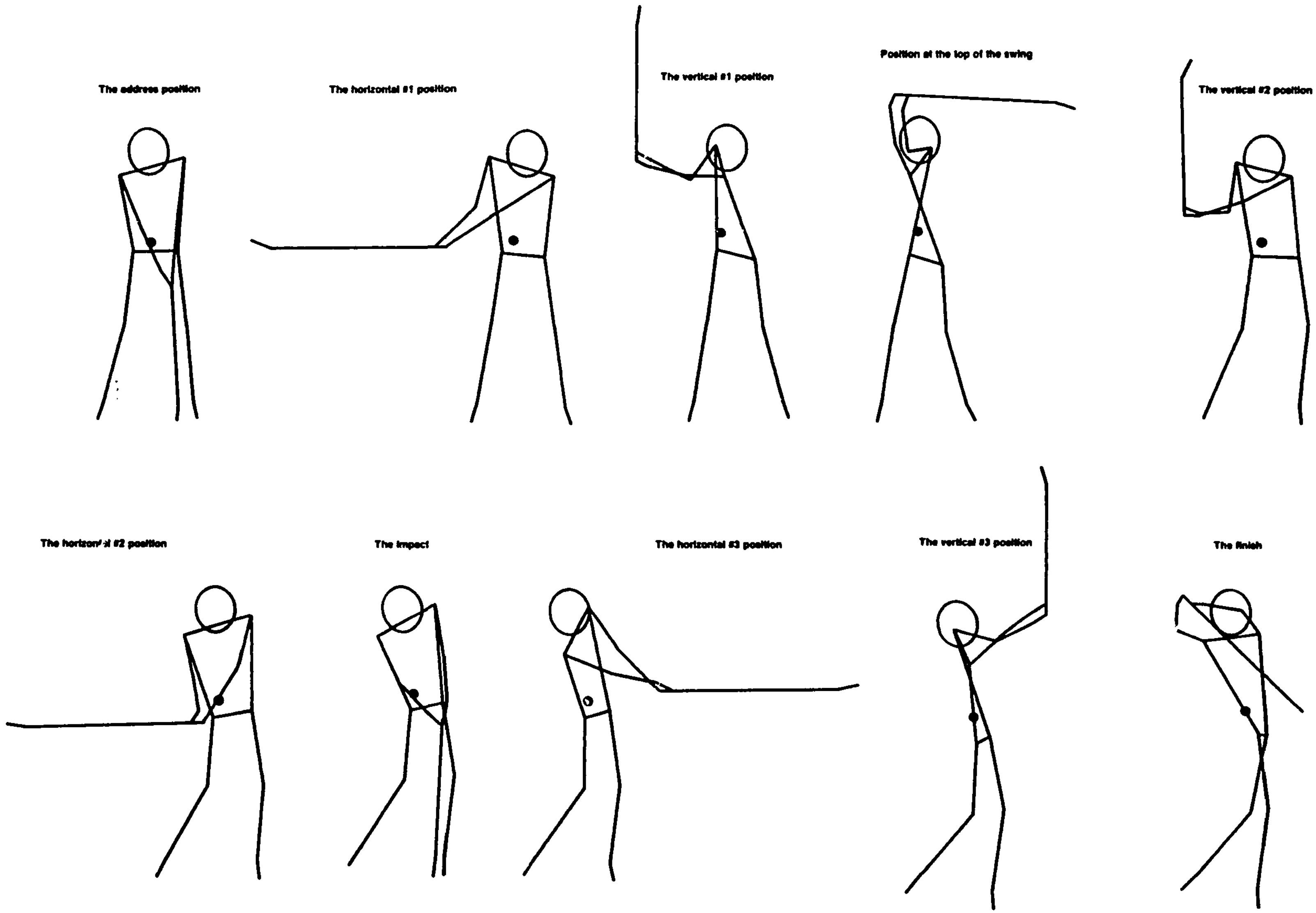

Figure 3. The Ten Positions (Front View)

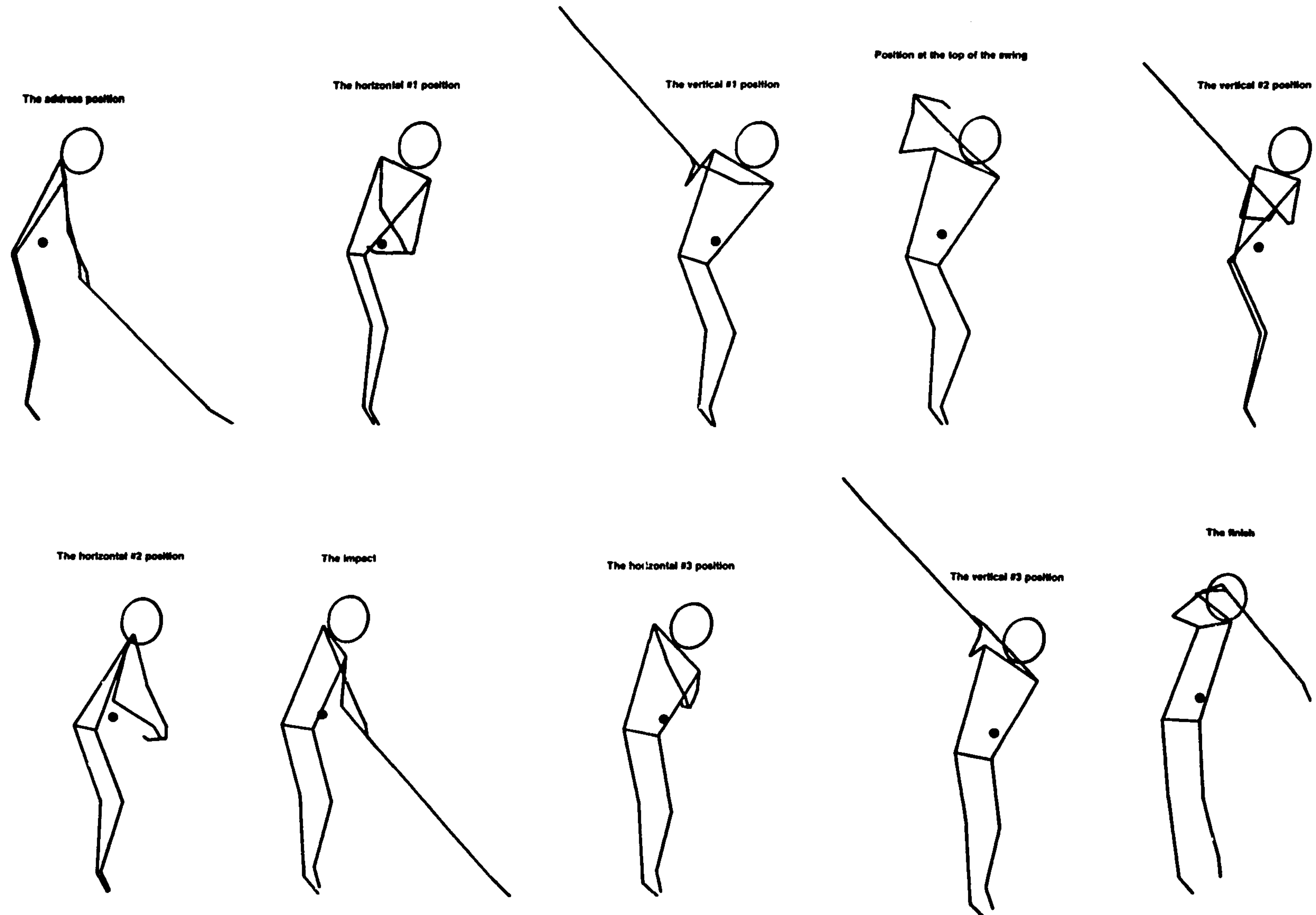

Figure 4. The Ten Positions (Back View)

third occurrence of vertical shaft position (P9), and the finish of the swing (P10).

As shown in Figures 5 and 6, at each of the ten positions, vertical, horizontal, and lateral linear displacement (referenced from the ball and standardized to subject height), velocity and acceleration values were determined for the body center of gravity, the left and right hand center of gravity, wrist, elbow, shoulder, hip, illiac, knee, ankle, and foot center of gravity, as well as the club head and the ball. In addition, angular displacement, velocity, and acceleration results for the shoulders and hips were determined at each of the ten positions. Each of the performers were scored using the following procedure:

$$\text{Performance Score} = \left(((\sum_{1760}^{i=1} (|(y_i - \bar{x}_i)|/\overline{SD}_i))/1760) + ((\sum_{168}^{j=1} (|(y_j - \bar{x}_j)|/\overline{SD}_j))\ 168) \right)/2$$

where:

y_i = linear performance score of subject

$\bar{x}_i$ = mean linear performance

$\overline{SD}_i$ = standard deviation of mean linear performance score of professional golfers

y_j = angular performance score of subject

$\bar{x}_j$ = mean angular performance score of professional golfers

$\overline{SD}_j$ = standard deviation of mean angular performance of professional golfers

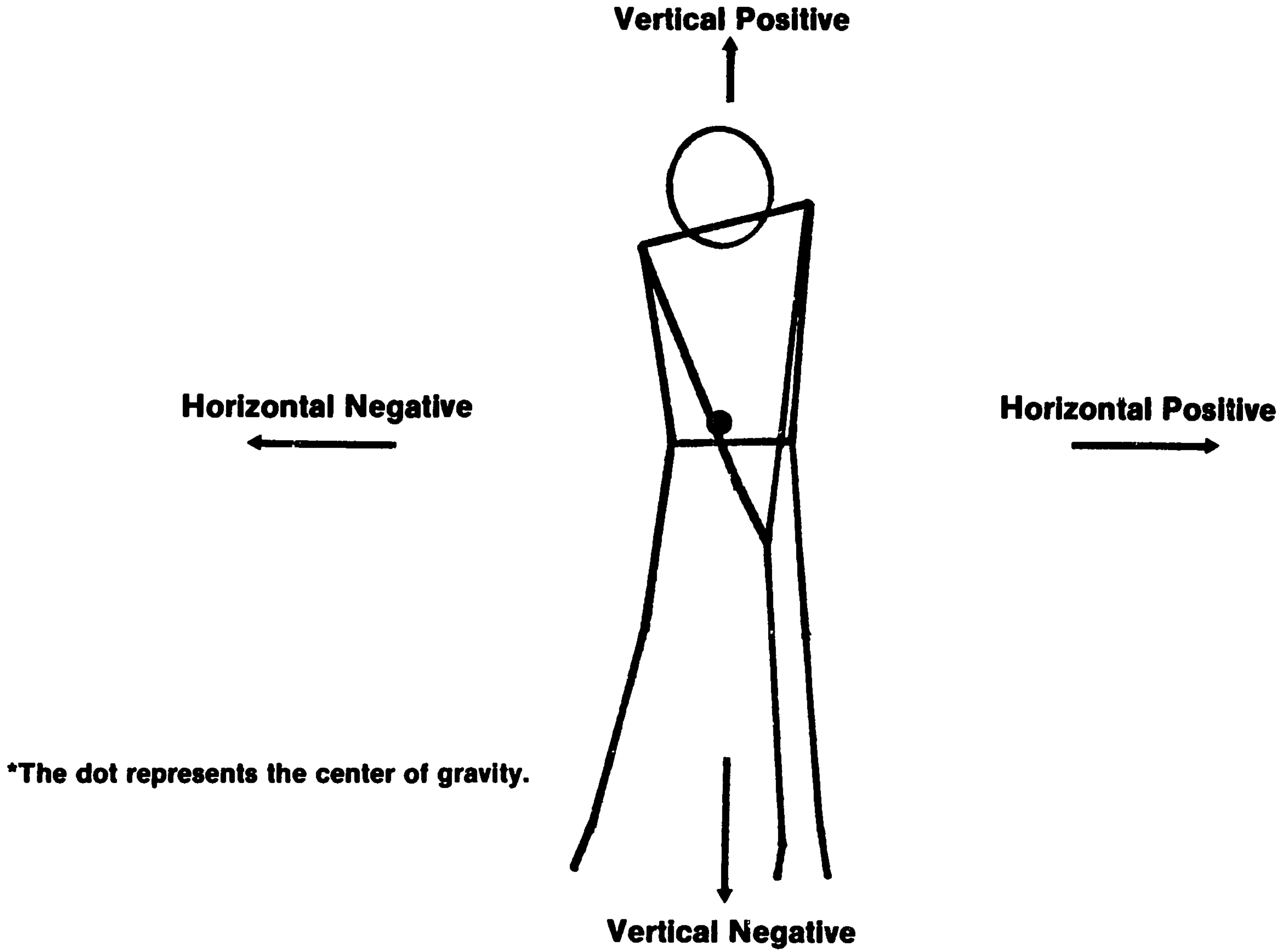

Figure 5. Horizontal and Vertical Movement Directions

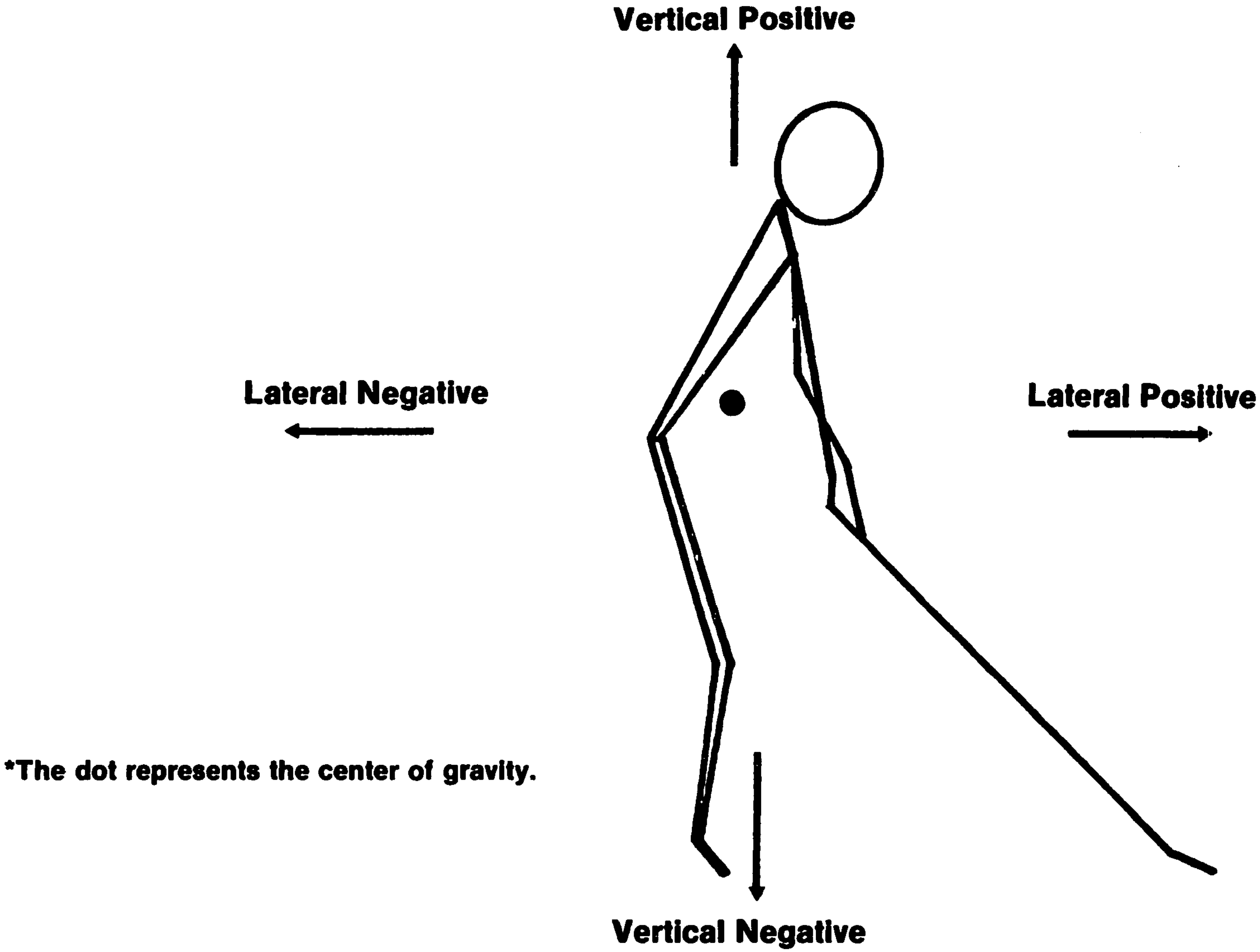

Figure 6. Lateral and Vertical Movement Directions

The performance scores of the professional golfers were determined from filmed results taken prior to the Heritage Golf Classic in 1982 and included the following golfers:

1. Tommy Aaron
2. Buddy Allin
3. Ben Crenshaw
4. Bruce Devlin
5. Danny Edwards
6. Al Geiberger
7. Lou Graham
8. John Mahaffey
9. Jodie Mudd
10. Lanny Wadkins

The same filming procedures used during data collection on the study subjects were employed during this collection process. Professional subjects were selected according to three criteria: (1) a subjective opinion by the investigator of the professional's golf swing technique, (2) the amount of money the professional had won on the P.G.A. tour, (3) the number of tournaments the professional had won on the P.G.A. tour, and (4) the availability of the professional on the filming day.

To perform the enormous number of calculations involved in this scoring system, a computer program was developed at the University of Kentucky Biomechanics Laboratory, under the direction of Dr. Ralph Mann.

Statistical Analyses

In all statistical analyses, comparisons of the data were made with the Student's *t* test. To determine within group changes (paired data) comparisons between pre- and posttest results were made. Changes were indicated by subtracting pretest scores from posttest scores. Analyses of the changes between groups (unpaired data) were conducted using the postest gain scores of the control and experimental groups. All analyses were performed using the computerized Statistical Analysis System (SAS).

CHAPTER FOUR

Data Analyses and Discussion

This chapter presents the results of data analyses comparing the golf swing and its improvement for two groups (10 in each group) of beginning golfers who learned the skill under two different teaching methods. One group, designated the control group, learned the golf swing using conventional methods of instruction while the other group, designated the experimental group, learned the golf swing using a kinesthetic feedback method of instruction.

Subjects for both the control and the experimental groups were randomly selected from beginning golf classes at Middle Tennessee State University. Golf swing performance scores for subjects in each group were measured prior to instruction (pretest) and ten weeks after instruction (posttest). A discussion of the data results of this study in reference to related research is also included in this chapter.

Data Analyses

The golf swing mechanics of the subjects in both the control and the experimental groups were analyzed through the biomechanical techiaques described in Chapter 3.

In order to compare the swing mechanics of the control group against the swing mechanics of the experimental group, a model golf swing needed to be developed. The model golf swing was determined by computing the means of 1,928 linear and angular golf swing performance score measurements of ten professional golfers in ten different positions. These data were analyzed and computed by the Statistical Analysis System (SAS), a computer program, processed at the University of Kentucky's biomechanics laboratory.

The formula used to average the 1,928 measurements for the professional golfers as well as the experimental and control groups is as follows:

$$\text{Performance Score} = \left(\left(\left(\sum_{1760}^{i=1} \left(\left| (y_i - \bar{x}_i) \right| / \overline{SD}_i \right) \right) / 1760 + \left(\left(\sum_{168}^{j=1} \left(\left| (y_j - \bar{x}_j) \right| / \overline{SD}_j \right) \right) 168 \right) \right) / 2$$

where:

y_i = Linear performance score of the subject

$\bar{x}_i$ = Mean linear performance

$\overline{SD}_i$ = Standard deviation of mean linear performance score of professional golfers

y_i = Angular performance score of the subject

$\bar{x}_j$ = Mean Angular performance score of professional golfers

$\overline{SD}_j$ = Standard deviation of mean angular performance of professional golfers

In order to determine the homogeneity of the means of the two groups before instruction began, a Student's _t_ test was computed for the two groups on the pretest performance score results. The _t_ value comparing the pretest performance scores of the control group with the pretest performance scores of the experimental group was found to be 1.44. Because the _t_ value did not reach the required 2.101 value that was needed for significance at the .05 level of confidence, it was concluded that there was no significant difference in the golf swing abilities between the two groups at the beginning of the instructional period.

Table 1 presents the professional golfers' group mean and standard deviation. In addition to this, the standard deviation from the mean of each professional golfer's swing is indicated.

Data presented in Table 2 (control group) and Table 4 (experimental group) indicate the standard deviation value for each individual on the pre- and posttest. Change scores are also recorded for each individual in standard deviations. Group means and standard deviations are also presented. All values given are the result of the comparison of each group to the model golf swing (mean) derived from the measurements taken of the ten professional golfers at ten different positions of the golf swing.

It becomes evident when comparing Table 1 (professional golfers) with Table 2 (control group) and Table 4

Table 1

The Golf Swing Linear and Angular Performance Score Mean and Standard Deviation for Ten Professional Golfers as Indicated by 1,928 Measurements

Individual Subject	Standard Deviation
P_1	.59
P_2	.77
P_3	.71
P_4	.91
P_5	.67
P_6	.75
P_7	.71
P_8	.63
P_9	.68
P_{10}	1.05

Group

Mean .74 Standard Deviation .13

P = Professional Golfer

Table 2

Linear and Angular Performance Score Means and Standard Deviations of Pretest, Posttest and Change as Indicated by 1,928 Measurements of Each Beginning Golfer

(Control Group)

Subject	Pretest	Posttest	Change
C1	1.30	1.01	-.29
C2	1.17	1.00	-.17
C3	1.03	.92	-.11
C4	1.06	.87	-.19
C5	1.24	.95	-.29
C6	1.21	1.01	-.20
C7	1.24	.88	-.36
C8	1.31	.92	-.39
C9	1.26	1.22	-.04
C10	1.16	.96	-.20
Mean of Subjects	1.198	.974	-.224

C=Control

(experimental group) that the swing mechanics of the professional golfers were more homogeneous in nature than those for the control and experimental groups. This was expected. In all statistical analyses comparisons of the data were made using the Student's t test. The formulas for these tests are included in Appendix I.

To determine within group changes between the pre- and posttest (paired data) for both the control and the experimental groups, the Student's t test revealed a significant improvement in the golf swing mechanics for both groups following the ten weeks of instruction (see Tables 3 and 5). The means, standard deviations and t values for these two groups are also presented. It can be seen that t values for both groups were significant at the .05 level of confidence.

Posttest analyses of the changes between the control and experimental groups (unpaired data) were conducted by using gain score techniques. The change score was determined for each individual in each group by subtracting the posttest performance score result from the pretest performance score result (see Tables 2 and 4). The analyses results are presented in Table 6.

Since it was determined that the conventionally taught group (control group) and the kinesthetically taught group (experimental group) both significantly improved their golf swing mechanics over the ten week instructional period, it

Table 3

Results of Paired t Test for the Control Group Between Pre- and Posttests

Test	N	Mean	SD	t Score: Pre/Post	Ho: Mean (Pre)= Mean (Post) Pre	Post
Pre*	10	1.198	.094		--	6.50**
Post*	10	.974	.101		6.50**	--

*Pre = Pretest; Post = Posttest

**Significant at the .05 level

Table 4

Linear and Angular Performance Score Means
and Standard Deviations of Pretest,
Posttest and Change as Indicated
by 1,928 Measurements of
Each Beginning Golfer

(Experimental Group)

Subject	Pretest	Posttest	Change
E1	1.29	1.00	-.29
E2	1.32	.96	-.36
E3	1.31	1.01	-.30
E4	1.37	.85	-.52
E5	1.02	.83	-.19
E6	1.06	.78	-.28
E7	1.37	1.11	-.26
E8	1.34	.95	-.39
E9	1.20	.98	-.22
E10	1.48	.91	-.57
Mean of Subjects	1.276	.938	-.338

E=Experimental

Table 5

Results of Paired t Test for the Experimental Group Between Pre- and Posttests

Test	N	Mean	SD	t Score:	Ho: Mean (Pre)= Mean (Post)	
				Pre/Post	Pre	Post
Pre*	10	1.276			--	8.67**
Post*	10	.938			8.67**	--

*Pre = Pretest; Post = Posttest

**Significant at the .05 level

Table 6

Means, Standard Deviations and Changes in Golf Swing Performance as Exhibited by the Control and the Experimental Groups After Ten Weeks of Instruction

	Changes--Pre- to Posttest	Changes--Pre- to Posttest
Subject	Control	Experimental
S1	-.29	-.29
S2	-.17	-.36
S3	-.11	-.30
S4	-.19	-.52
S5	-.29	-.19
S6	-.20	-.28
S7	-.36	-.26
S8	-.39	-.39
S9	-.04	-.22
S10	-.20	-.57
Mean of Subjects	-.224	-.338

was necessary to determine which group gained the most over time and determine if this difference was significant.

As can be seen by comparing Tables 2 and 4, the pretest mean of the control group (1.198) and the pretest mean of the experimental group (1.276) are not equal. Although the two groups were not significantly different in golf swing mechanics at the start of the instructional period, it can be seen that the control group was slightly better than the experimental group in golf swing mechanics. A _t_ test (Appendix I) for unpaired data was used to determine if the differences gained between the two groups was statistically significant over the ten week instructional period. Table 7 presents the results of this _t_ test between the control and experimental groups. Since a _t_ value of 2.17 resulted, it can be concluded that, at the .05 level of confidence, the gains made by the experimental group were significantly greater than the gains made by the control group.

This information also indicates that, although both the conventional method of instruction and the kinesthetic method of instruction were significantly good ways to improve golf swing mechanics, the kinesthetic method described in this text seems to be the better method. From these data results, the researcher rejected the null hypothesis.

Table 7

Results of *t* Test Between the Control and the Experimental Groups Using Gain Scores from Pre- to Posttest

Group	N	Mean	SD	*t* Score: Ho: Mean (C) = Mean (E)		
				C/E	C	E
C*	10	-.224	.107	C	--	2.17**
E*	10	-.338	.123	E	2.17**	--

*C = Control; E = Experimental

**Significant at the .05 level

Discussion

The findings of this investigation indicated that the kinesthetic instructional techniques used in this study were more effective in teaching the golf swing to beginners than conventional methods of instruction. Although both groups significantly improved their golf swing mechanics over the ten week instructional period, the group that learned the golf swing utilizing kinesthetic methods (experimental group) improved more than the group that learned the golf swing utilizing conventional methods (control group).

Even though there have been various studies investigating the kinesthetic method of learning golf, the results of most of these studies were very inconclusive as to the effectiveness of the technique. For example, Griffith,[1] Hanley,[2] and Pash[3] all indicated that the kinesthetic method of learning the golf swing was equally effective or superior to the conventional method of learning. Data analyses results in this study support these inferences.

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[1]Coleman Griffith, "An Experiment in Learning to Drive a Golf Ball," Athletic Journal, 11 (June 1939), 11-13.

[2]Mrs. Steward Hanley, "Sense of Feel in Golf," Journal of Health and Physical Education, 8 (June 1937).

[3]Kay Ladd Pash, "Improving Kinesthetic Perception," Thesis Univ. of Illinois, 1968.

Coady[4] and Rollo's[5] studies found the opposite results. In teaching beginning female students, these researchers found no significant difference between the effectiveness of the kinesthetic approach and the conventional approach. The inconsistencies in the results of these various kinesthetic approaches were possibly due to the variety of teaching methods used by each investigator. It is the writer's opinion that the effectiveness of the kinesthetic teaching method employed in this study was the result of the unique combination of various kinesthetic techniques which included (1) the use of a weighted golf club, (2) the use of swing drills, (3) the use of visual occlusion techniques, (4) the use of high repetition swinging, (5) the use of kinesthetic cues, (6) the use of knowledge of performance feedback information, (7) the use of selected visual techniques in order to establish a "reference of correctness," and (8) the absence of a golf ball during the early learning stages (7 weeks). To the writer's knowledge, none of the related studies combined all of the above.

In contrast with the findings of this study, most research reviewed indicated that the kinesthetic method of

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[4]Charlene Coady, "The Effects of Applying the Principles of Kinesthesis in Teaching Golf Skills to College Women," Thesis Indian Univ., 1950.

[5]Ethel Todd Rollo, "A Comparison of Two Methods of Teaching Selected Golf Strokes," Thesis Univ. of Iowa, 1951.

instruction was more valuable in the later stages of learning rather than the beginning stages.[6] Of the many studies reviewed, only two indicated that kinesthetic feedback information should be emphasized in the early stages of development.[7]

From this information, it seems reasonable to assume that the effectiveness of kinesthetic feedback information, as well as when it should be applied in the teaching process, might depend upon the type of motor skill being learned. Most research indicates that when learning a closed motor

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[6] P. M. Fitts, "Engineering and Equipment Design," Handbook of Experimental Psychology, S. S. Stevens Edition (New York: Wiley Publishers, 1951), p. 82; Edwin A. Fleishman and Simon Rich, "Role of Kinesthetic and Spatial-Visual Abilities in Perceptual Motor Leanring," Journal of Experimental Psychology, 66 (July 1963), 6-11; H. T. A. Whiting, Acquiring Ball Skill (Philadelphia: Lea and Febiger Publishers, 1969), pp. 56-57; R. A. Schmidt and C. A. Wrisberg, "Further Tests of the Adams Closed Loop Theory: Response Produced Feedback and Error Detection Mechanism," Journal of Motor Behavior, 3 (1973), 155-164; Robert Singer, Motor Learning and Performance (New York: Macmillan Publishing Co., Inc., 1975), p. 239; John N. Drowatzsky, Motor Learning: Principles and Practice (Minneapolis: Burgess Publishing Co., 1975), p. 192; John Dickinson, Proprioceptive Control of Human Movement (Princeton, New Jersey: Princeton Book Co. Publishers, 1976), p. 175; Sandra Hoth, "The Language of Motor Learning," Quest, 23 (January 1975), 72.

[7] Marjorie Phillips and Dean Summers, "Relation of Kinesthetic Perception to Motor Learning," Research Quarterly, 25 (Dec. 1954), 456-469; Richard A. Chew, "Verbal, Visual, and Kinesthetic Error Feedback in Learning of a Simple Motor Task," Research Quarterly, 47 (May 1976), 254-259.

skill kinesthetic feedback information should be emphasized.[8] Since the golf swing is classified as a closed motor skill, research has indicated that kinesthetic feedback information should be effective in the instructional process. This related research is also consistent with the findings of this study.

An important finding of this study indicates that the golf swing can be effectively learned without knowledge of results information (ball flight). Most contemporary golf instruction relies on ball flight results in the swing correction process. On the other hand, a paucity of research was found on the learning of the golf swing by emphasizing knowledge of performance information. However, Wallace and Hagler did find that knowledge of performance information was just as effective as knowledge of results information when learning a closed motor skill.[9] Newell's research also indicated that knowledge of results (ball flight) feedback information was insignificant as a

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[8]E. C. Poulton, "On Prediction of Skilled Movements," Psychological Bulletin, 54 (November 1957), 472; Drowatzsky, p. 93; Whiting, p. 10; R. G. Marteniuk, Information Processing in Motor Skills (New York: Holt, Rinehart and Winston Publishing Co., 1976), p. 102; A. M. Gentile, "A Working Model of Skill Acquisition with Application to Teaching," Quest, 17 (January 1972), 11; S. A. Wallace and R. W. Hagler, "Knowledge of Performance and the Learning of a Closed Motor Skill," Research Quarterly, 50 (May 1979), 265-271.

[9]Wallace and Hagler, pp. 269-271.

determiner of ensuing body response in the error correction process.[10] These findings seem to be consistent with the findings of this study. They are also in harmony with the opinions of many top golf instructors who have indicated that overemphasis and concentration on the golf ball and its ensuing ball flight may inhibit the learning of a mechanically correct swing.[11]

Most golf instructors recognize the importance of developing a "feel" for the proper movement pattern of the golf swing. It is hoped that the results of this investigation will prompt other researchers to promote and further investigate the kinesthetic method of teaching golf.

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[10] K. M. Newell, "Flight Feedback and Learning a Projectile Task," Journal of Motor Behavior, 5 (1973), 65-72.

[11] Bob Toski and Jim Flick, How to Become a Complete Golfer (Norwalk, Connecticut: Golf Digest and Tennis Publishing, Inc., 1978), p. 22; Eddie Merrins, Swing the Handle Not the Clubhead (Norwalk, Connecticut: Golf Digest Inc., 1973), p. 64; Ken Venturi, The Venturi Analysis (New York: Atheneum Publishers, Inc., 1981), p. 25.

CHAPTER FIVE

Summary, Conclusions and Recommendations

Summary

The purpose of this study was to make a biomechanical comparison of golf swing performance between two groups of beginning golfers receiving two different methods of golf instruction. Both groups that participated in this ten week study were compared to a model golf swing which represented the qualities of excellent golf swing mechanics. Twenty male subjects were randomly selected from two beginning golf classes at Middle Tennessee State University. The twenty subjects were randomly divided into two groups--a control group and an experimental group. Both groups participated in pretest filming (February 3, 1982) and post-test filming (April 26, 1982). Before any instruction began, the experimental group was told that the major learning goal was to develop a mechanically correct golf swing. In order to achieve this goal, each group member was taught using a kinesthetic feedback method of instruction. The control group was not given such a clearly defined learning objective and was taught using a conventional method of golf instruction.

In order to determine which golf swing instructional method was most effective, it was necessary to develop a model golf swing by which the two groups could be compared. This was accomplished by filming ten golf professionals on the P.G.A. tour who were thought to have excellent golf swing mechanics. The model swing was determined by taking the mean of the filmed results of these ten professionals' swings in what was thought to be the ten most critical positions in the golf swing.

Both the beginning golfers and the professional golfers' swings were filmed from two different angles: (1) directly in back of the performer and (2) to the side of the performer. This allowed the investigator to collect movement information in three movement directions: vertical, horizontal, and lateral. The cameras recorded information at 300 frames per second and the analyses of data were made on 1,760 performance scores consisting of linear displacement, velocity, and acceleration scores of nineteen body joints and segments, as well as the ball and the club, at the ten selected positions during the swing.

In addition, 168 performance score measurements were made on angular displacement, velocity, and acceleration for the shoulders and hips at each of the ten positions for both the ten professionals' swings and the students' swings. The results of both the professionals' swings and the students' swings were inserted into a formula that, when computed, indicated the number of standard deviations each golfer was away from the mean (the model golf swing).

After the model swing was determined, comparisons of the beginners' swings were made by using the Student's t test on the pretest and posttest results within and between groups. The t test analysis between the control and experimental groups before instruction indicated no significant difference in golf swing ability at the start of the instructional period. To determine within group changes (paired comparisons) between the pretest and posttest, the posttest results were subtracted from the pretest results. Paired t comparison analyses for both groups indicated significant improvement in golf swing mechanics at the .05 level of confidence following the ten-week instructional period.

In order to determine if the difference in gains between the control and the experimental groups were significant, a gain score analysis was performed. This comparison, tested at the .05 level of confidence, indicated that the experimental group (kinesthetic feedback method) made significantly greater gains than the control group (conventional instruction). Because of these data results, the researcher rejected the null hypothesis.

Conclusions

Data results prompted the researcher to make the following conclusions:

1. Both methods of teaching the golf swing to beginners were effective ways to learn the mechanics of a biomechanically correct golf swing.

2. Although both groups significantly improved their swing mechanics, the kinesthetic method of golf instruction proved to be a significantly better method of golf swing instruction.

3. It was not possible for the writer to determine which variable in this study contributed most to the significantly better gains in golf swing improvement made by the experimental group over the control group. It was thought that the unique combination of all the variables contributed to the significant results.

4. For best results, the utilization of a kinesthetic method of instruction seems superior to conventional methods.

The results of this study were consistent with the research which indicates that closed motor skills should be taught emphasizing kinesthetic feedback information.

Recommendations

Following are several points of interest and recommendations which developed as a direct result of this study:

1. It is recommended that in the early stages of development when learning the golf swing (a) it is important

to emphasize the proper mechanics of the skill and not the environmental outcome (ball flight) of that skill; (b) knowledge of performance (KP) feedback should be emphasized rather than knowledge of results (KR) feedback. In fact, this study indicated that the learner can effectively acquire this skill if provided with only movement execution information (the swing) in the absence of movement outcome (ball flight) information; (c) the emphasis when learning this type of skill should be on kinesthetic feedback information because visual information is not an integral part of the learning task. Golf swing error correction, based on visual feedback which the learner receives from the flight of the ball, is not considered to be important information in the golf swing correction process.

2. It is recommended that the kinesthetic method of golf instruction presented in this text be used to teach beginning golfers. This method should include: (a) the use of a weighted golf club; (b) the use of swing drills; (c) the use of kinesthetic cues; (d) the absence of a golf ball for the first eight weeks of instruction; (e) the use of knowledge of performance feedback information; (f) the use of visual occlusion techniques; (g) the use of limited visual techniques in order to establish a "reference of correctness;" and (h) the use of high repetition swinging.

3. It is recommended that, if this kinesthetic method of golf instruction is chosen, the instructor must be

knowledgeable enough to provide a clear "reference of correctness" to the student. It is also recommended that the instructor display sufficient enthusiasm to keep the class motivated.

4. After the eighth week of instruction, it is recommended that the golf ball be introduced in conjunction with the kinesthetic method of golf instruction. This would give the learner knowledge of performance feedback as well as knowledge of results information. This recommendation is made because the researcher does not believe that complete golf swing learning can occur without the ball. Also, the researcher does not believe that total non-visual learning will transfer into effective visual learning and execution.

5. It is recommended that other studies and movement skills be evaluated through the use of biomechanical analyses. Although these methods of evaluation are time consuming and expensive, they are the most scientific and logical way to evaluate movement execution information.

6. It is recommended that further research be conducted in order to determine which variable used in this study was most responsible for the significant improvement in the golf swing mechanics of the experimental group over the control group.

7. It is also recommended that a similar study be conducted on students and other golfers who have played golf

for a period of years in order to determine if the kinesthetic method of learning golf would be effective regardless of the skill level of the subjects.

APPENDIXES

APPENDIX A

FORMAT FOR THE KINESTHETIC GOLF INSTRUCTIONAL PROGRAM

Format of the Program

This program answers the four critical questions in the teaching-learning process. These four questions include the following:

1. "Why" is this material being taught (justification)?
2. "What" is being taught (content)?
3. "How" is this material being communicated (methodology)?
4. "When" is the information presented to the student (sequencing)?

First of all, the purpose of each swing drill is explained. This immediately reveals "why" a particular drill is important.

Second, both the instructor and the student want to know "what" is being taught. This information is covered under explanation of principles being taught.

Third, both the instructor and the student want to know "how" to perform the drill. This is explained under the section on "position" and is greatly aided by the augmented verbal feedback students receive from the instructor concerning the correctness of their response. The more correct the response, the less the students will depend on the instructor for directions and the more they will depend on their own kinesthetic sensations.

Finally, the sequencing of the program answers the question concerning "when" to teach these principles. The program should be followed in this exact order for maximum benefits. The kinesthetic cues that the instructor gives the students are given in order to make the students aware of what swing and body sensations to feel. In so doing, the students will "feel" the mechanics of a correct swing.

APPENDIX B

DESCRIPTION AND EXPLANATION OF THE KINESTHETIC INSTRUCTIONAL PROGRAM

Description and Explanation of the Kinesthetic Instructional Program

Before teaching the kinesthetic or "feel" method of golf, the instructor should thoroughly familiarize himself with the description and explanation of this program.

The purpose of this program is to teach students a mechanically correct golf swing. In order to focus on this objective, a ball is not used. In fact, it is hypothesized that the actual presence of the ball and the resulting ball flight inhibit golf swing learning in the early stages of development. Since the desired goal of this program is the development of a mechanically correct swing, the instructor must continually emphasize the correct technique. Information about swing performance is the type of feedback which should be given to the student.

Before introducing the mechanics of teaching this kinesthetic method, it is important that the students have a clear, conceptual image of what they are trying to accomplish. During the first two or three days in class the students should be presented with a "model of correctness." In this "model of correctness," the instructor should demonstrate the ten critical parts of the golf swing. This can be accomplished through physical demonstration of the ten positions by the instructor, through slides, pictures, high speed film, or video tape. As the instructor demonstrates the ten positions, he should tell the students what the body is doing while it is moving. A sample verbal description is included in the text.

The instructor should then have a short quiz to test the students' knowledge of the "model." Once the instructor feels that the students have a clear mental image of what they are supposed to try to imitate, he may proceed with teaching the training program.

The class should be organized so the students are facing the instructor in a series of four or five rows (see Appendix C). In order to insure safety, there should be at least ten feet of space on all four sides of each student. The students should come to class with a weighted golf club and a long beach towel. Any of the weighted devices on the market would be acceptable as long as the student could handle the weight. It is thought that a three and one-half ounce weighted headcover could be most effectively used by all concerned. The total weight of the club should be between eighteen and thirty ounces. Anything heavier than this would affect the technique of the participants' swings. Each club should also have a molded reminder grip to insure proper hand placement as the student is performing the drills.

The second and third class meetings should be devoted to demonstrating the swing drills to the students. If the students are not performing the drills correctly, they should be corrected. The instructor should insist that the swing drills be performed properly because it is these swing drills that are thought to automatically condition the correct swing. Throughout the entire learning process, the students must constantly be reminded that swing technique and correct form are the goals of the class.

By the fourth class meeting, students should know how to perform the drill without the instructor's help. The students now move from the conceptual stage to the training stage of development. The instructor should bring a stop-watch to class in order to time the duration of the swing drills. It is essential that the swing drills be performed in the sequence that they are presented in this text.

In a typical classroom situation, the instructor would first demonstrate the swing drill. The students would watch to see how it is performed while the instructor verbally gives the reasons why is is important for the swing. After the demonstration, the students are asked to do as many repetitions as they can in sixty seconds. While the students are performing the drills, the instructor is giving concurrent, verbal augmented feedback. This feedback is essentially of two types: (1)constructively critical and (2) positively reinforcing. Constructively critical feedback gives the students verbal cues as to the correctness of each swing. This type of feedback is also called knowledge of performance information. Since this type of feedback is given after the response, it is often called terminal feedback. Knowledge of performance feedback information should be sporadically given when the instructor sees that a student is not displaying the correct form when performing the drill. Positive reinforcing feedback is given in the terms of kinesthetic cues or "swing feels." All the students are told what body parts they are supposed to feel as they are performing the drills. In order to heighten the student's sensation for the proper "swing" and body mechanics, the student is asked to close his eyes while he performs during the last thirty seconds of the drill.

It is essential to this program that the instructor constantly give this verbal augmented feedback on the correctness of the student's responses. Also, the text that describes the kinesthetic cues by the instructor should be closely followed.

Since this program is a motor training program, there should be a minimum amount of rest between exercises. The demonstration by the instructor at the beginning of each drill should allow sufficient time for the student to rest. In using a specificity of training program like this, the students must be made aware of the fact that their improvement is directly related to the intensity of their training.

This being the case, it was thought that a "timed" program would allow some students to perform more repetitions than others in that given time limit. This makes the program adaptable to all physical ability levels. But, on the whole, the more repetitions performed in a minute's time, the more improvement will be noticed. The intensity of training principle should be emphasized to the students before training begins. The other principles of duration, frequency, and overload are also built into the program.

Although the program is designed to meet twice a week for ten weeks (20 class meetings), it can be adapted to a fifteen- or twenty-week program. It also could provide for class meetings three times a week instead of twice a week. In fact, it is thought that three class meetings per week might be more effective.

After the students are into the seventh or eighth week of training, they will enter the internalizing stage of development. By performing most of the drills with the eyes closed, the students will build up a kinesthetic feeling for the movement pattern. As training proceeds, they will continue to compare their sensory feedback information received from their own bodies to the "reference of correctness" being supplied by the instructor. Eventually, the students will come to rely less and less on external information from their instructor for golf swing corrections and more and more on their internal kinesthetic mechanisms.

The last stage of development is the playing stage. The students enter this stage after they have developed a habit pattern. This is the stage where the ball is presented to the students for the first time. The swing drills are still the major part of the class, but the ball is presented to the student at the end of the class. This occurs during the eighth week of training. The students are asked to hit ten to twenty balls with their eyes closed while mentally concentrating on making a correct swing. It is during this playing stage that the student should be able to transfer his "swing feels" into consistent ball flight results.

This entire program is dependent upon the quality of instruction and the ability of the instructor to provide a good "reference of correctness." If the instructor is not competent to demonstrate and verbalize a good "reference of correctness," the students will not be able to make correct sensory comparisons. Also, if the instructor cannot motivate the students to internalize these "swing feelings," then little learning will occur. It is also important for the instructor to follow the text as it is written in order for kinesthetic learning to occur. Finally, if the instructor fails to correct a swing error through "knowledge of performance" feedback information, the quality of learning will diminish. For these reasons, this program should only be taught by a competent and knowledgeable golf instructor.

This entire program is based on swing performance and not outcome performance. In other words, the swing itself is more important than the environmental result of that performance. Movement outcome is also called knowledge of results (KR). In conventional golf learning, KR refers to ball flight. In this program, the presence of the ball and its eventual flight are secondary to the learning of a correct swing.

APPENDIX C

CLASS FORMATION FOR TEACHING THE KINESTHETIC GOLF INSTRUCTIONAL PROGRAM

Instructor's Preparation for Swing Drills

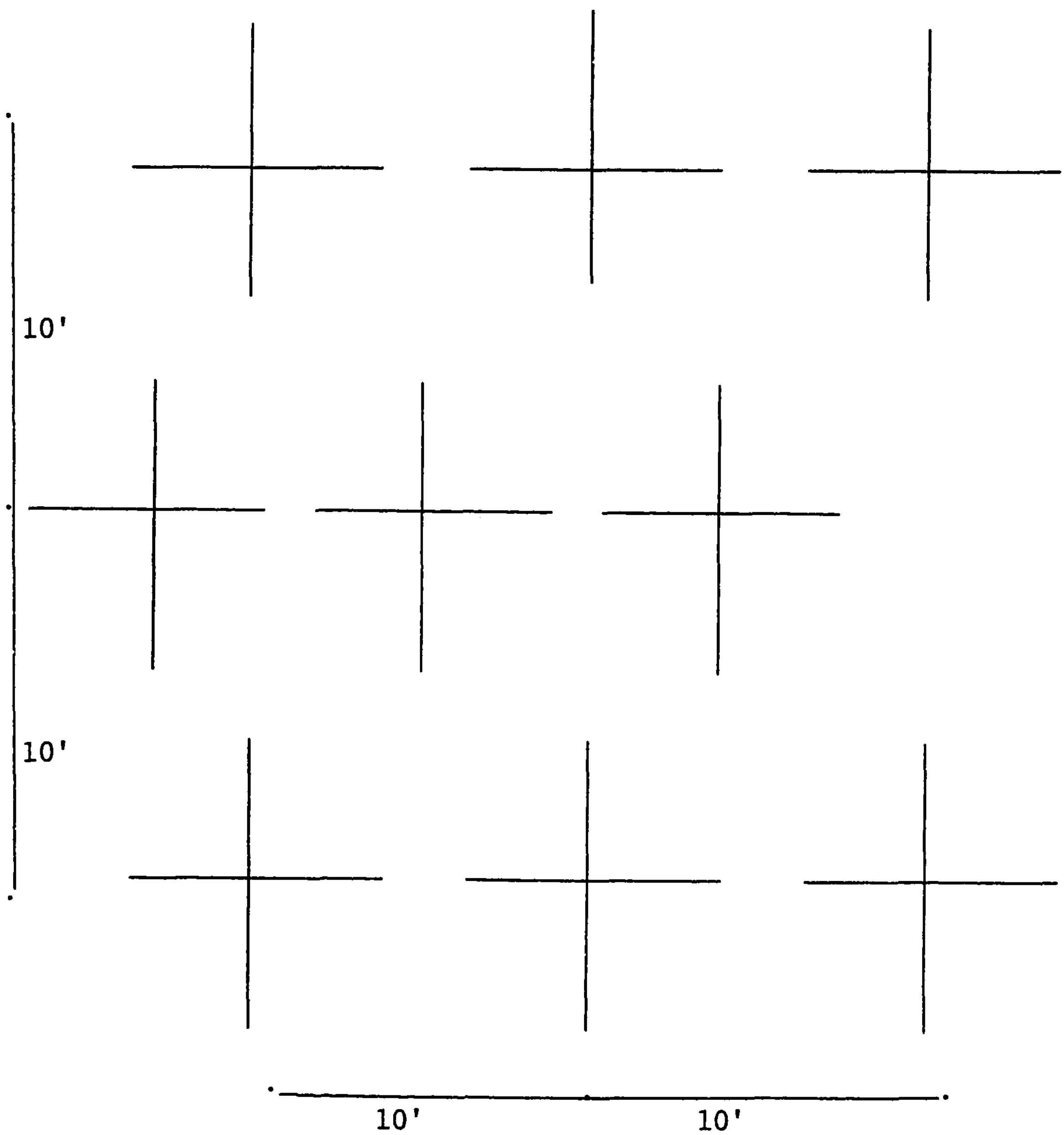
Before proceeding to demonstrate the drills, have the students take places according to the diagram on the next page. Each student should have a tape crossed on the floor to mark the imaginary ball position. (Some may have to reposition their crosses after checking space.)

Spacing: Make sure the students in the second, fourth, sixth rows, etc. are standing between, not directly behind, those in the rows in front of them to assure clearance and sightlines. Have students extend their clubs full length left and right and leave a minimum of two feet between clubheads. More space between clubheads is desirable if room permits.

The instructor should explain and demonstrate each drill from a position in front of the class. He should go through each drill's procedure and purpose in the manner that is normal and comfortable to his teaching style. This manual should be used as a guide, not a rigid instruction teaching sheet.

The instructor should do several repetitions as a demonstration at the front of the class. Then, as the students go through the drill, the instructor can walk through the group making corrections as necessary before returning to the front for the next demonstration. He should make sure the students understand that it is necessary to perform the drill correctly if they expect it to improve their golf swing.

Class Positioning Diagram



The diagram shows dimensions for the <u>minimum</u> space requirements for each student. The easiest means to achieve this spacing for swing exercises is to have the students take positions as shown. Have them extend their clubs left and right, making sure they allow at least two feet between the extended clubheads.

In addition to spacing, ncte in particular the sight lines to the instructor and the positioning of left-handed players at the end to the instructor's left to allow space for their swings.

The instructor should repeat his demonstration of each drill with two or three swings during the second and third classes to help implant the correct procedure in the students' minds. A minimum of repetitions are specified for the first and second classes. This allows time for adequate demonstration and correction within the hour. These repetitions in the first two classes should be practiced while the students form a semi-circle around the instructor, then return to their positions for executions of the drills. By the third class period, students should understand the drills to the extent that they can remain in the arranged position for execution of the drills. Indication of what drill and repetition number should suffice beginning with the third class period.

As students practice each drill, the kinesthetic cues suggested in the manual to reemphasize the purpose of the drill should be used. The instructor should encourage self-checking for the correct technique while encouraging each student to sense the "feelings" that each drill fosters.

When using the commentary, the instructor should encourage the students to seek the "feel" of the motion. By doing this, he will provide the students with their own goals which they can strive toward at their own rate. By doing this, the instructor has not put an arbitrary standard that the student must meet or fail; rather he has given the student incentive to work toward a reasonable goal.

APPENDIX D

EXPLANATION AND DESCRIPTION OF THE MODEL GOLF SWING AND REFERENCE OF CORRECTNESS

Explanation and Description of the Model Golf Swing and Reference of Correctness

Before any actual swinging of the golf club begins, the students have to be presented with a "reference of correctness." The "reference of correctness" includes the ten positions of the golf swing the investigator found to be most critical to efficient performance.

At least two, and possibly three, days should be spent on studying the model. It is important for the students to know what the body parts are doing when the club gets to each of these ten positions. The "model of correctness" is based on the investigator's findings of what constitutes an efficient swing. This model was developed by filming ten P.G.A. tour professionals with high speed film (300 frames per second). These professionals were filmed from two different angles: (1) from directly behind the performer looking down the target line and (2) to the side of the performer. These two positions are listed in Figures 5 and 6 in the text.

The movement of nineteen body joints, in addition to the clubhead and the shaft, were analyzed in each of these ten positions for each professional. The camera angles allowed the investigator to analyze the movement in three directions: (1) the vertical, (2) the horizontal, and (3) the lateral. This is also descriptively displayed in

Figures 5 and 6 in the text. One thousand nine hundred twenty-eight measurements were taken of each professional's swing. Both linear and angular movement was looked at with these nineteen body joints in the ten most critical positions of the golf swing. The model swing was established by taking the mean of the golf professionals' swings in each of the ten positions analyzed.

It is important for the students to be able to see the "model of correctness" before any actual in-class swinging occurs. This can be accomplished by use of almost any visual medium which might include: (1) slides, (2) handout drawings, (3) video tape, (4) still pictures, (5) 16 mm film, or (6) demonstration by the instructor. The students should generally become familiar with the movement that is occurring in each of the ten positions of the swing. This is not done to make the students "position" conscious but to help the students internalize the entire movement pattern. As the class is being shown the correct positions, the instructor should be describing the movement. The students should be made aware of the sequential nature of movement of the body joints that occurs in the efficient golf swing. It is thought that through this visualization process the student will be able to conceptualize and internalize what a good golf swing looks like. In order to evaluate conceptual learning, a test should be given on the third or fourth day of class.

The model should be presented with the use of an overhead projector. After the model is presented graphically, the instructor should demonstrate the positions by swinging the club in slow motion. This adds further reinforcement to the students' internalization process. Once the students understand the model of correctness, they should be asked to perform a few swings while trying to duplicate the model.

On the following pages, a stick figure model golfer is presented with a description of the movement of the body parts from two different positions (front and back). The stick figure on the left side of the page represents the mean of the golf professionals' swings in that particular position. The picture on the right side of the page represents the instructor demonstrating the "reference of correctness" in that particular position. When describing the model, the instructor should follow the description presented within this text.

Position #1 (P1): The Address (Front View)

1. Target arm and clubshaft form a straight line down to the ball.

2. The imaginary ball position is in front of the target heel.

3. The trail arm is relaxed and closer to the golfer's side than the target arm.

4. The head is positioned behind the imaginary ball position.

5. The knees are slightly bent.

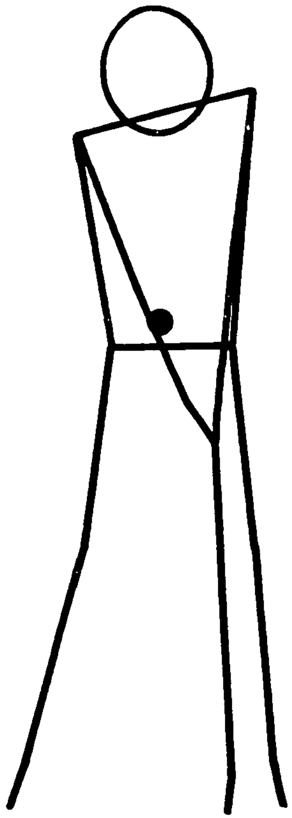
6. The foot stance is a little wider than shoulder width and parallel to the target line.

7. The target shoulder is higher than the trail shoulder.

8. The weight is evenly distributed between the feet and supported evenly between the ball and heel of each foot.

The address position

(P1)



· Dot represents center of gravity

The Reference of Correctness

Front View

Position #1 (P1): The Address (Back View)

1. Knees slightly bent.

2. The weight is evenly distributed between the ball and heel of each foot.

3. Posture--the back is kept straight as the model bends forward from the hips. This is called the athletic position or spine angle.

4. Arms hang relaxed and are in a vertical position.

5. The back of the upper arms are held close to the chest.

6. The trail side arm is held close to the side.

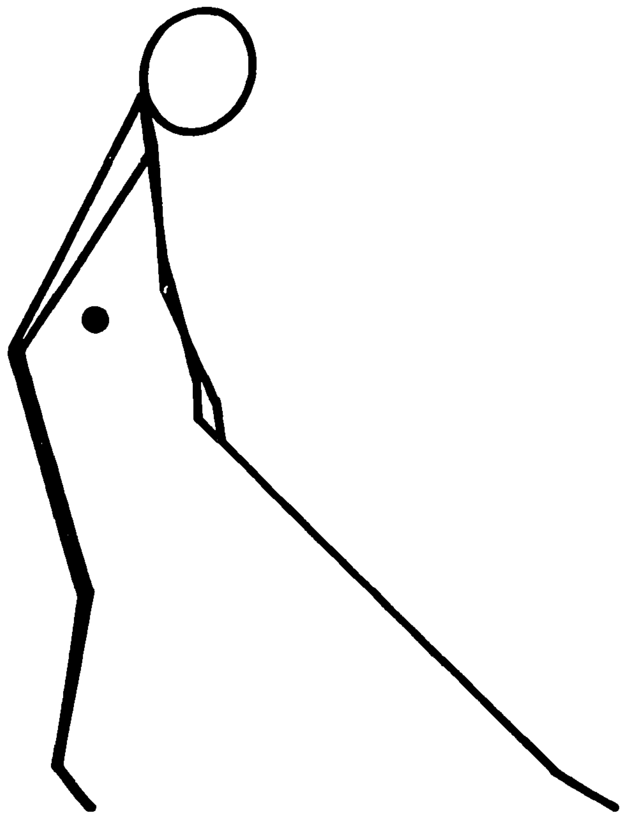
7. The shoulders and hips are parallel to the target line. The trail shoulder and hip are lower than the target shoulder and hip.

8. The stance is square and parallel to the target line.

The address position

(P1)

The Model Golf Swing



• Dot represents the center of gravity

The Reference of Correctness

Back View

Position #2 (P2): The Horizontal #1 Position (Front View)

1. The club is swung back until the shaft is horizontal or parallel with the ground.

2. This movement is caused by a one-piece turning of the shoulders.

3. The wrists have not cocked yet.

4. The target arm is controlling the movement.

5. The trail arm is folding into the side of the body.

6. The head remains steady as the body begins turning around it.

7. The arms and club are swung back until the club-shaft is horizontal to the ground. The wrists and hands should not pick the club up.

8. When the shaft is horizontal to the ground, the clubface will be pointing outward towards an imaginary ball. The toe of the club points up to the sky at this point.

9. The trail hand is resting on the side of the club-shaft at this point in the swing almost as if the golfer were going to shake hands with somebody standing directly to the side of him.

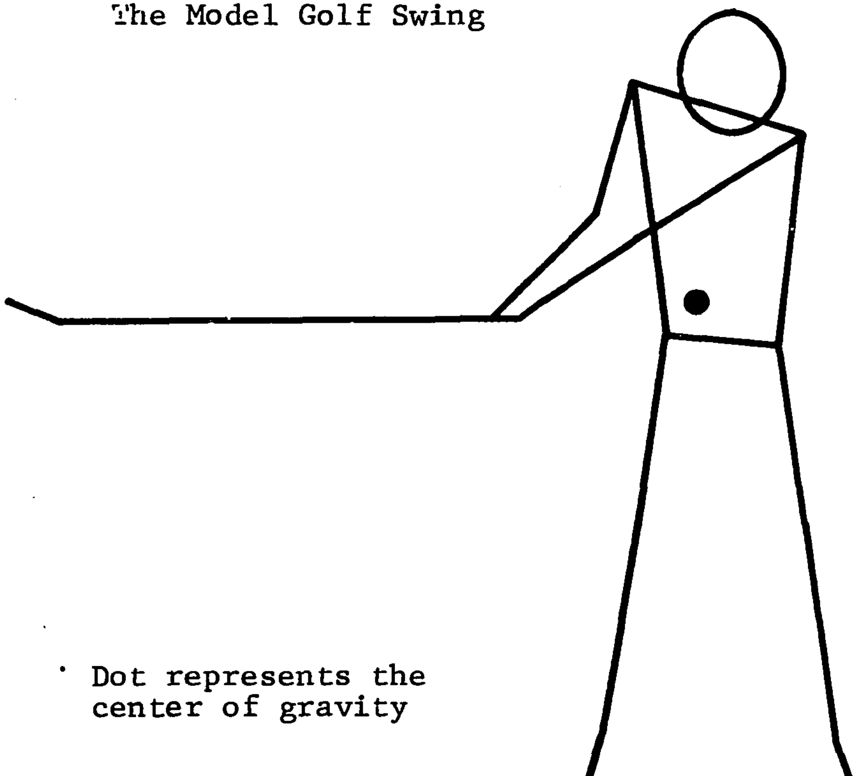
10. The hips are just starting to turn.

11. The target knee is just starting to be pulled backward.

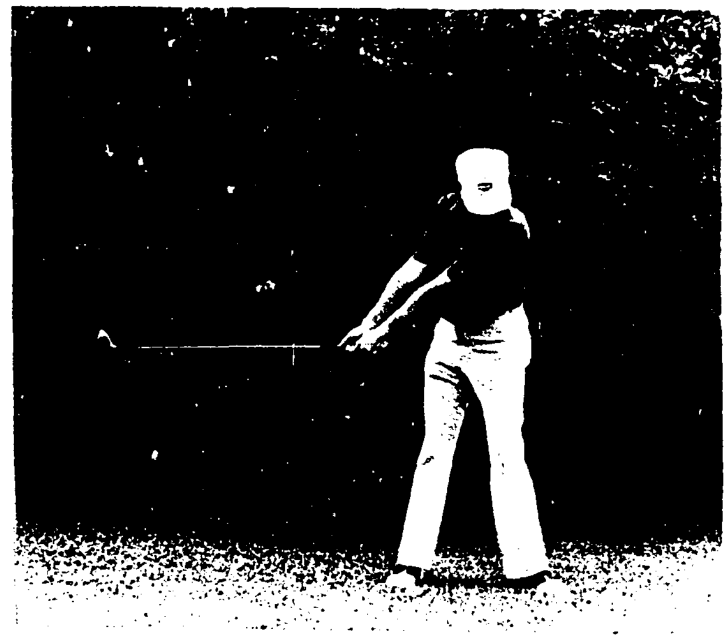
The horizontal #1 position

(P2)

The Model Golf Swing



The Reference of Correctness



• Dot represents the center of gravity

Front View

Position #2 (P2): The Horizontal #1 Position (Back View)

1. The club is swung back until the shaft is horizontal to the ground.

2. The wrists have not cocked yet.

3. The shoulders are turning and providing most of the impetus for the movement.

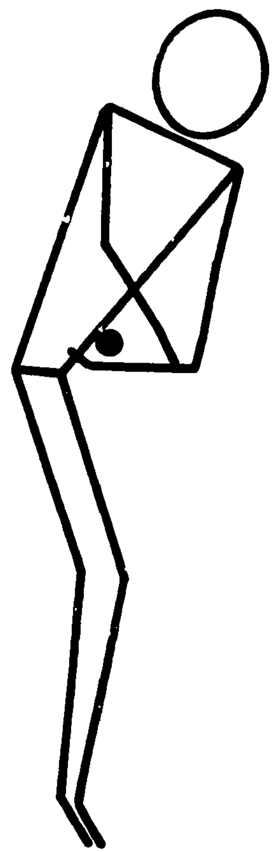
4. At the horizontal #1 position the club should be pointed directly behind the golfer.

5. The trail elbow folding to the trail side.

The horizontal #1 position

(P2)

The Model Golf Swing



• Dot represents the center of gravity

The Reference of Correctness

Back View

Position #3 (P3): The Vertical #1 Position (Front View)

1. When the target arm is parallel with the ground, the clubshaft should be pointing upward (vertically).

2. The clubshaft is pointed to the sky at this point as the target arm and clubshaft form a right angle.

3. The shoulders keep turning and dominating the backswing movement.

4. The wrists are starting to cock upward.

5. The hips are starting to turn as the target knee is being pulled back behind the ball.

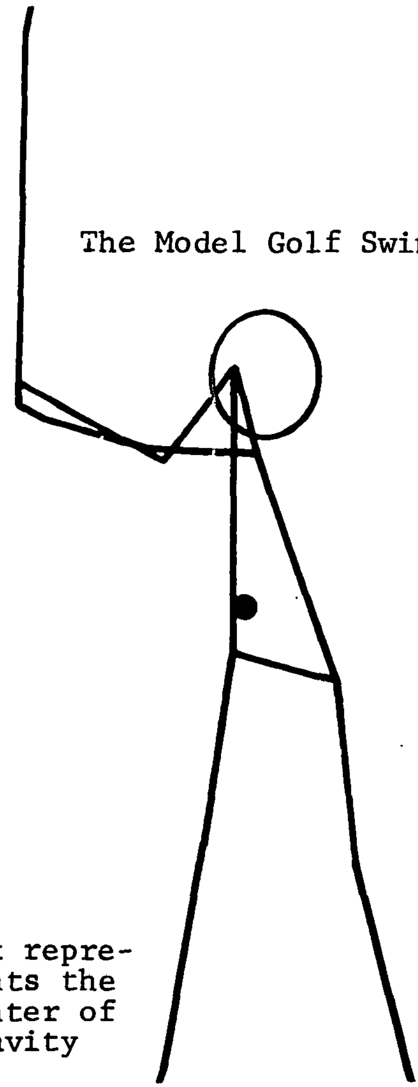
6. The trail arm is relaxing and folding to the body.

7. The head is remaining in a fixed position.

8. The entire body is beginning to rotate.

The vertical #1 position
(P3)

The Model Golf Swing



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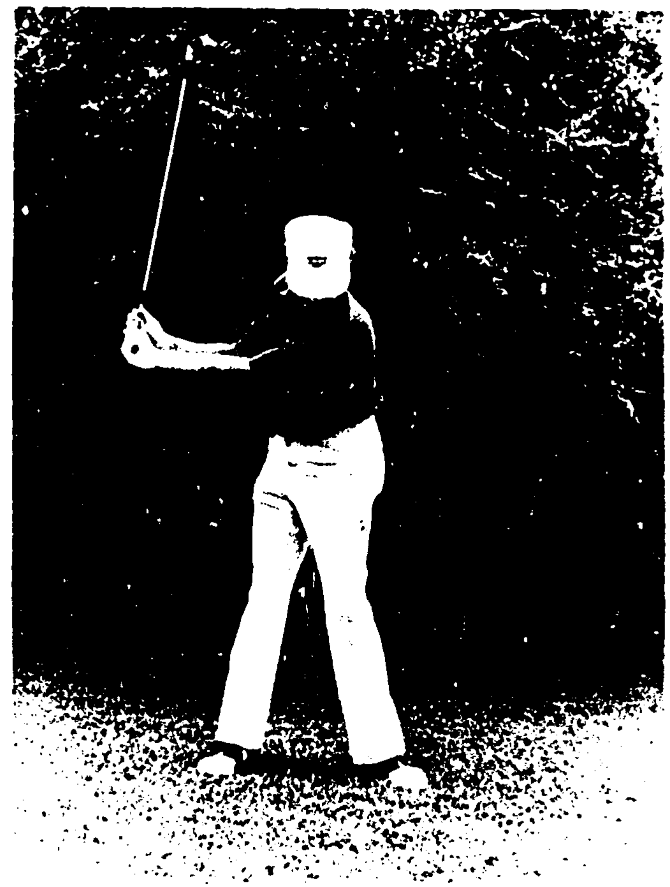
The Reference of Correctness



Front View

Position #3 (P3): The Vertical #1 Position (Back View)

1. The club and shaft are working upward toward the sky.

2. The wrists are cocking upward and not hinging backward.

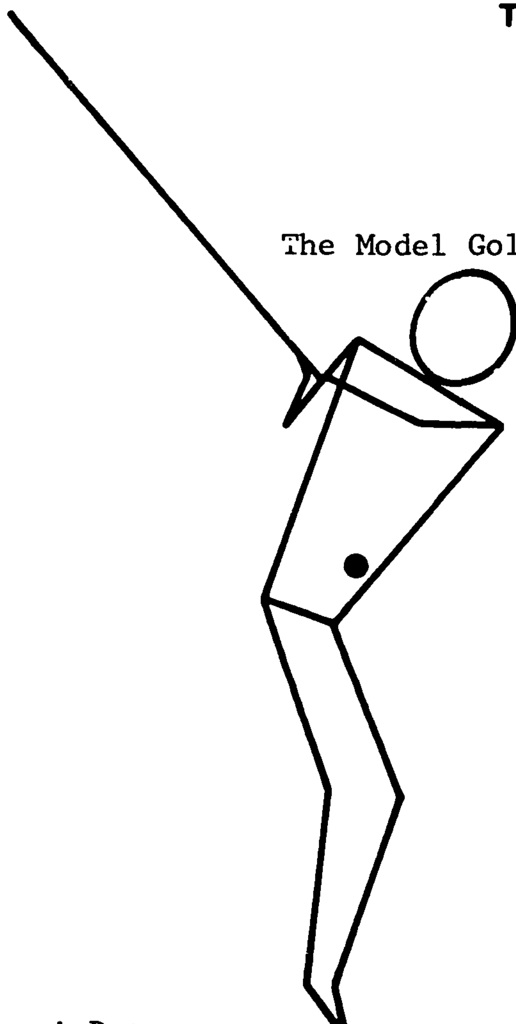
3. The shoulders and hips are turning.

The vertical #1 position

(P3)

The Reference of Correctness

The Model Golf Swing



• Dot represents the center of gravity

Back View

Position #4 (P4): The Top of the Swing (Front View)

1. The clubshaft is parallel with the ground.

2. The target arm is straight.

3. The target wrist is straight and fully cocked.

4. The clubshaft is slightly above the top of the head.

5. The shoulders have turned at least 90 degrees.

6. The shoulders have coiled to a very tight position on top until the back is facing the target.

7. The target shoulder has turned until it is pointed behind the imaginary ball position.

8. The hips have rotated about 45 degrees.

9. The target knee is pointing behind the ball.

10. The trail leg is bent and in a braced position. The weight is supported by the inside of this foot.

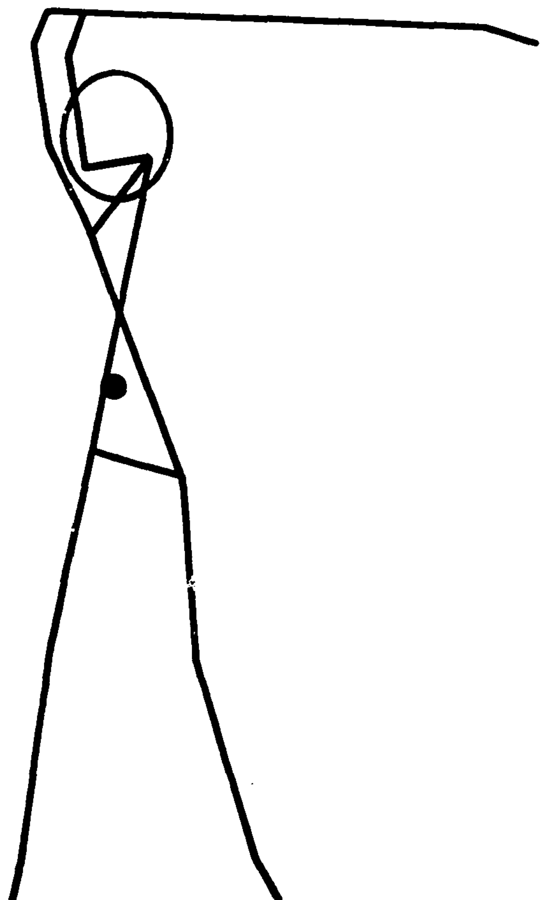
11. The target heel is being pulled about an inch off the ground.

12. The head is still in the same position it was when the golfer started.

Position at the top of the swing

(P4)

The Model Golf Swing



·Dot represents the center of gravity

The Reference of Correctness

Front View

Position #4 (P4): The Top of the Swing (Back View)

1. The clubshaft is parallel with the ground and pointed down the target line.

2. The clubshaft is positioned slightly above the head and directly over the trail shoulder.

3. The hands are in a high position.

4. The trail elbow is bent and pointed down at the ground.

5. The target arm is straight.

6. The hips have rotated to the trail side.

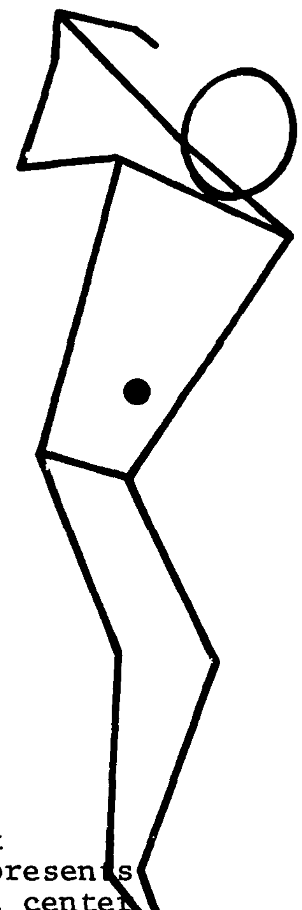
7. The target wrist is flat or straight.

8. The wrists are fully cocked.

Position at the top of the swing

(P4)

The Model Golf Swing



•Dot represents the center of gravity

The Reference of Correctness

Back View

Position #5 (P5): The Vertical #2 Position (Front View)

1. At this point in the downswing the clubshaft is perpendicular or vertical to the ground and the target arm is horizontal or parallel to the ground.

2. The target knee starts the downswing.

3. The wrists stay in a cocked position or are even cocking more as the golfer reaches this position.

4. The knees are leading the downswing movement as the weight is starting to transfer toward the target foot.

5. The trail elbow is coming back to the side.

6. The target arm swings straight down. This arm is being pulled down vertically by the movement of the legs.

7. The knees stay bent.

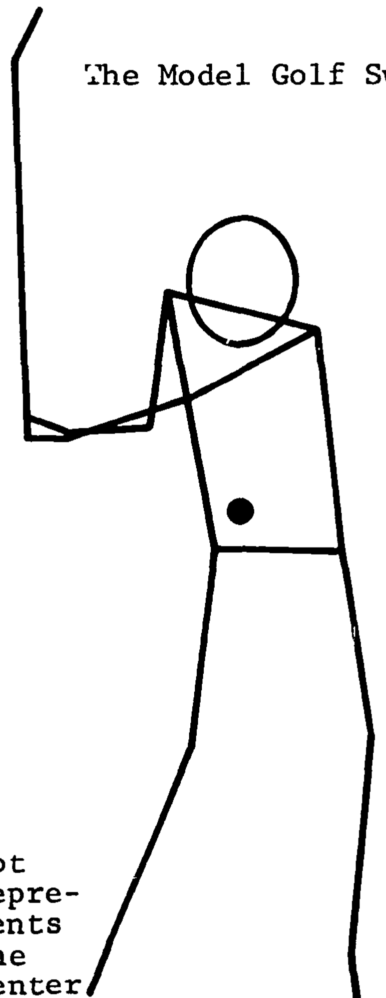
8. The shoulders stay back as the arms swing downward.

9. The head remains steady and behind the ball.

The vertical #2 position

(P5)

The Model Golf Swing



Dot represents the center of gravity

The Reference of Correctness

Front View

Position #5 (P5): The Vertical #2 Position (Back View)

1. The clubshaft is still pointed upward in the vertical position as the knees and legs are pulling the arms to the body.

2. The wrists remain in a cocked position or even cock a little more as the downswing begins.

3. The knees remain bent on the downswing.

4. The trail elbow comes in close to the trail side.

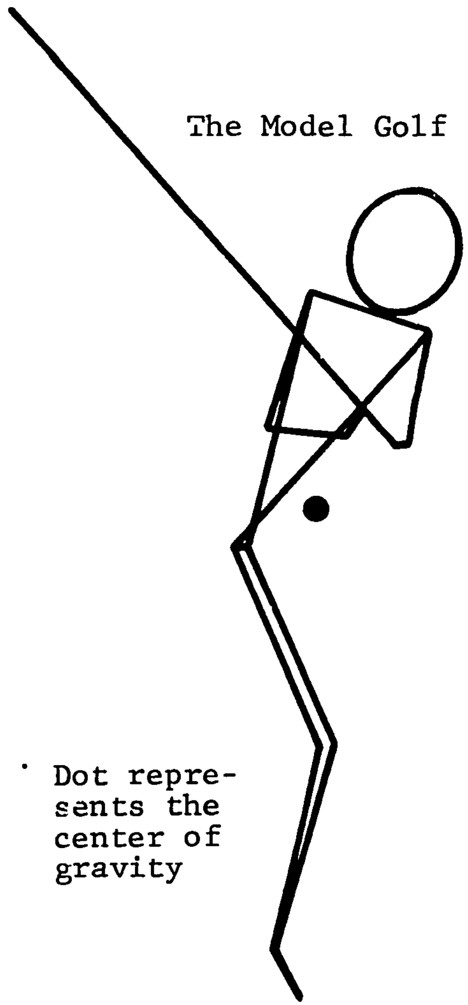
5. The downswing is started with the legs.

6. The clubshaft is being pulled down inside the target line by the target arm and target leg.

The vertical #2 position

(P5)

The Model Golf Swing



• Dot represents the center of gravity

The Reference of Correctness

Back View

Position #6 (P6): The Horizontal #2 Position (Front View)

1. When the target arm is perpendicular to the ground in the downswing, the clubshaft should be horizontal to the ground.

2. The target knee leads the downswing movement. This causes the knees and hips to shift laterally toward the target. This movement is called a lateral start, slide, or shift.

3. The weight is gradually being transferred to the target leg.

4. The trail leg and knee are starting to provide some force at this point.

5. The trail elbow is very close to the side as the wrists remain in a cocked position.

6. The knees are still bent.

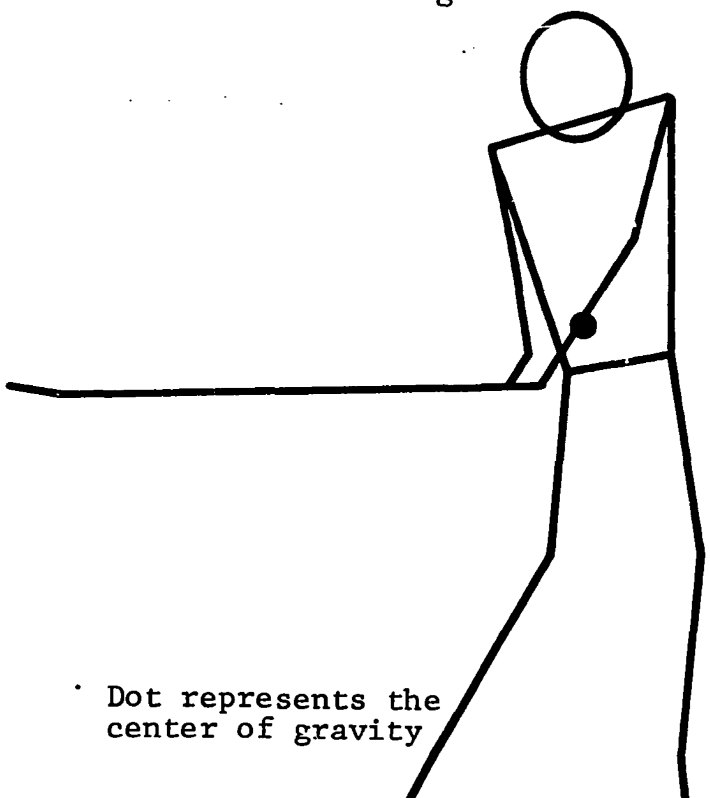
7. The head is still in the same position as it was at the starting point. It remains behind the ball.

8. The shoulders are starting to unwind at this point.

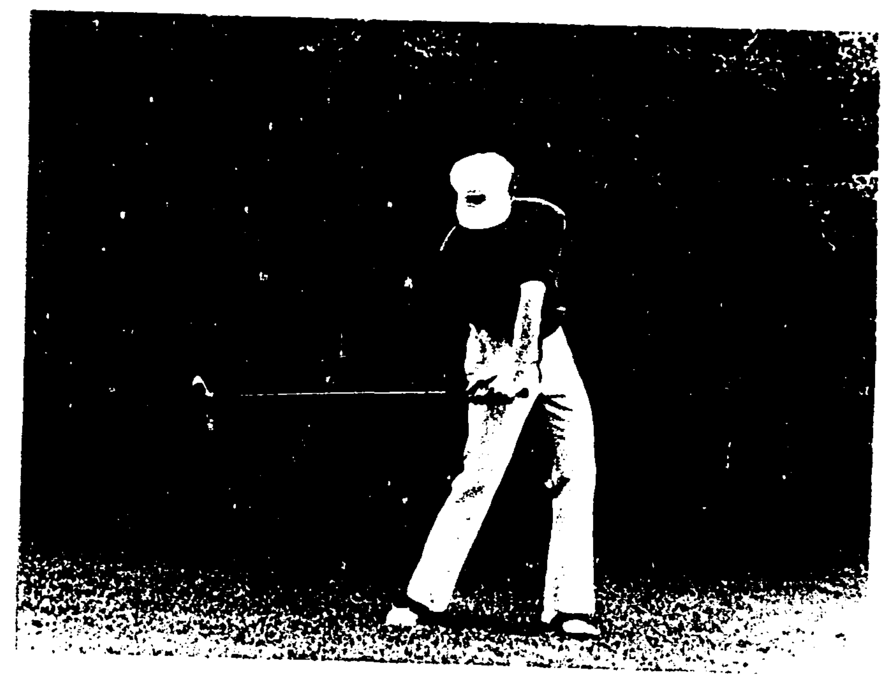
The horizontal #2 position

(P6)

The Model Golf Swing



The Reference of Correctness



• Dot represents the center of gravity

Front View

Position #6 (P6): The Horizontal #2 Position (Back View)

1. The trail elbow is very close to the trail hip at this point.

2. The trail arm is completely relaxed and broken down.

3. The clubshaft is approaching from inside the target line and below the trail shoulder.

4. The wrists remain in a cocked position.

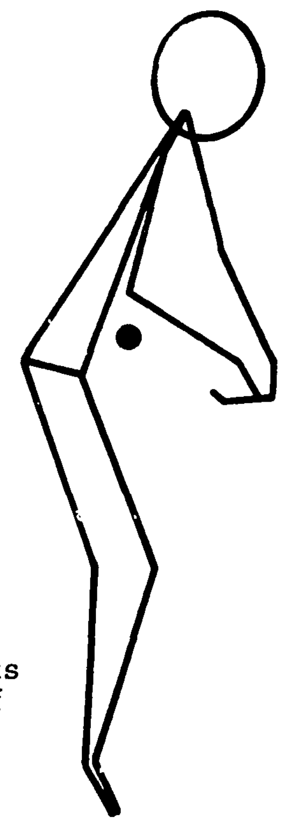
5. The hips are starting to turn to the target side as the weight is being transferred to the target leg.

The horizontal #2 position

(P6)

The Reference of Correctness

The Model Golf Swing



• Dot represents the center of gravity

Back View

Position #7 (P7): The Impact Position (Front View)

1. At this point, both the target arm and the clubshaft are again lined up like they were at the address position (perpendicular to the ground).

2. The head is still behind the ball.

3. The knees are still bent and the weight has shifted to the target leg.

4. The trail elbow is relaxed and close to the side. This gives the impression that the target arm is in control of the swing.

5. The target wrist is straight or slightly flexed.

6. The trail knee is starting to drive towards the ball position.

7. The target knee is still bent and bowing out at the target.

8. The trail shoulder is moving under the chin.

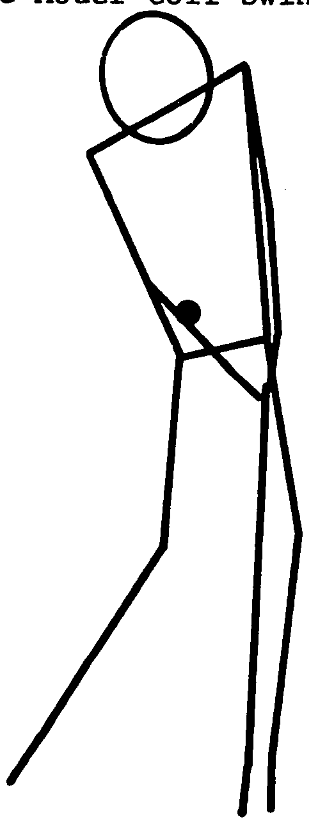
9. The target shoulder is moving vertically upward. The shoulders are still parallel to the target at this point.

10. The hips are starting to turn to the target side to clear for the arm swing.

11. Although most of the weight is off the trail foot, the trail heel is only slightly off the ground at this point.

The impact
(P7)

The Model Golf Swing



• Dot represents the center of gravity

The Reference of Correctness

Front View

Position #7 (P7): The Impact Position (Back View)

1. The trail elbow is relaxed and close to the trail side. The trail arm is in closer to the side than the target arm.

2. The head is in back of the ball position.

3. The knees are bent and the weight is being transferred to the target leg.

4. The shoulders are still square to the target line.

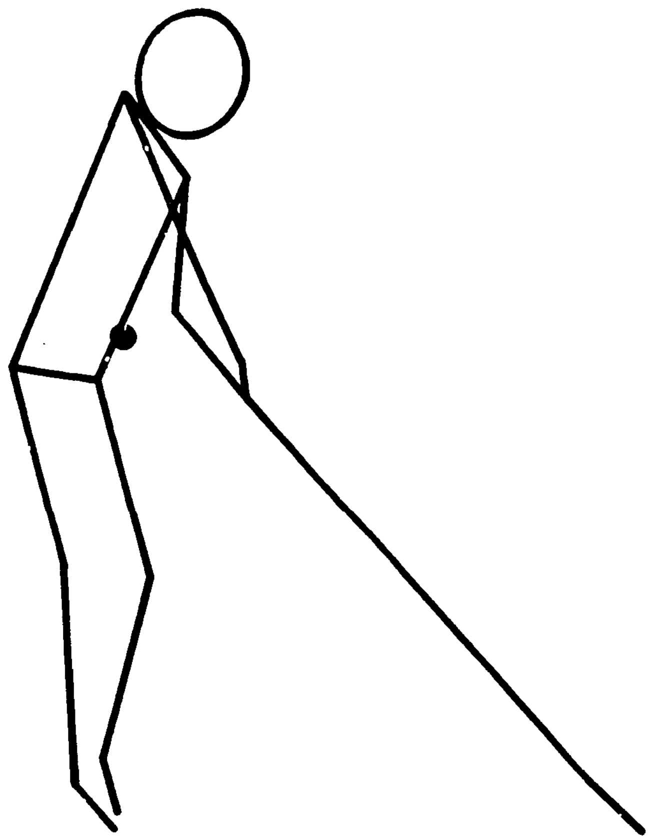
5. The hips have opened up slightly to clear the way for the arm swing.

6. The target shoulder is working upward as the trail shoulder is working downward.

The impact

(P7)

The Model Golf Swing



• Dot represents the
center of gravity

The Reference of Correctness

Back View

Position #8 (P8): The Horizontal #3 Position (Front View)

1. After impact, the club moves into the horizontal position for the third time. Both the arms and the club are horizontal to the ground at this point.

2. Both arms are straightening. The trail arm appears to be a little straighter than the target arm.

3. The head is still back behind the ball position but is starting to rotate to allow for a full high finish.

4. The weight has been transferred to the target leg. Most of this weight is being supported by the outside of the target foot.

5. The trail heel is starting to come off the ground.

6. The trail knee is driving at the target.

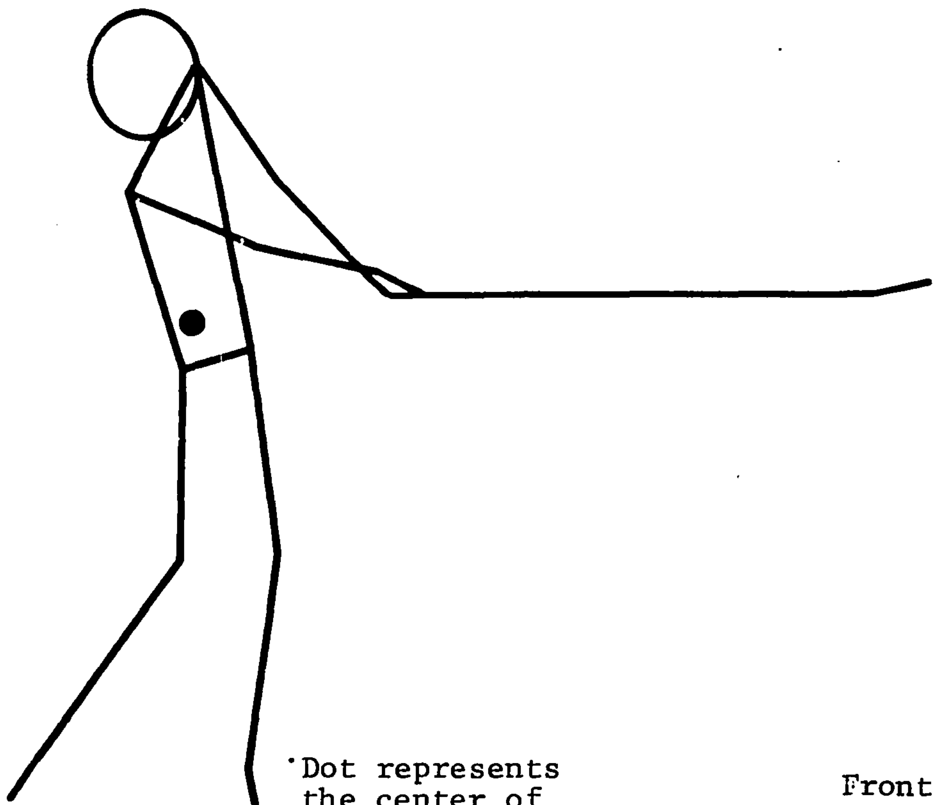
7. The knees are remaining bent.

8. The hips are continuing to turn out of the way.

9. The trail arm and hand are rotating and climbing over and on top of the target hand and arm. The arms and hands appear to have crossed over until the target palm is facing upward and the trail palm is facing downward.

The horizontal #3 position
(P8)

The Model Golf Swing



·Dot represents
the center of
gravity

The Reference of Correctness

Front View

<u>Position #8 (P8): The Horizontal #3 Position (Back View)</u>

1. Both arms are straightening and extending at the target.

2. The trail hand has pronated over the target hand.

3. The weight is predominantly on the target leg.

4. The head is still back behind the ball.

5. The hips are turning out of the way.

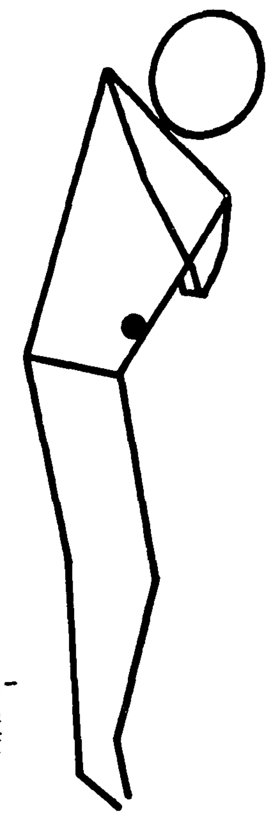
6. The knees are still bent.

The horizontal #3 position

(P8)

The Reference of Correctness

The Model Golf Swing



• Dot represents the center of gravity

Back View

Position #9 (P9): The Vertical #3 Position (Front View)

1. The clubshaft is perpendicular or vertical to the ground for the third time. At this point, the trail arm is just a little past the horizontal position.

2. The wrists and hands are starting to release upward to prepare for the follow-through. As this occurs, the club continues to work upward.

3. The head is starting to come up and starting to rotate to the target.

4. The body is starting to release and face the target.

5. Almost all the weight is off the trail foot as this foot is being pulled off the ground and up on its toe.

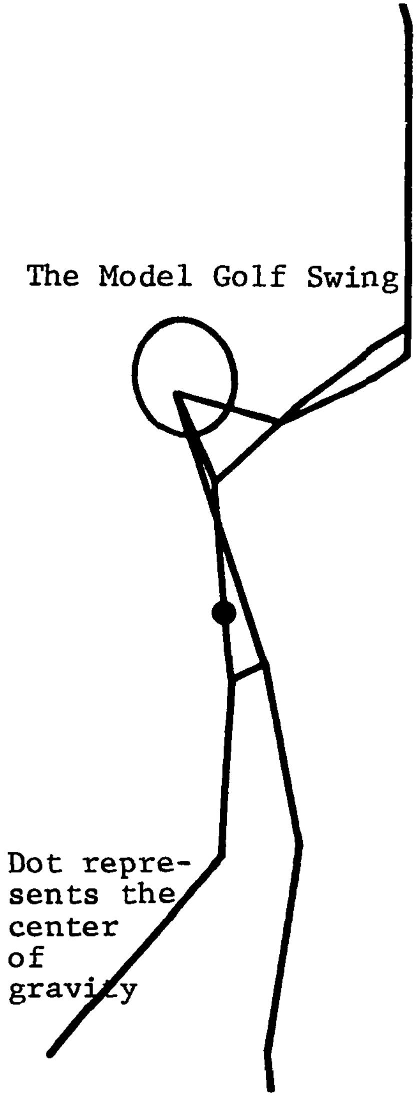
6. The trail knee is pointing at the target.

7. The hips have nearly cleared to the target side completely.

The vertical #3 position

(P9)

The Model Golf Swing



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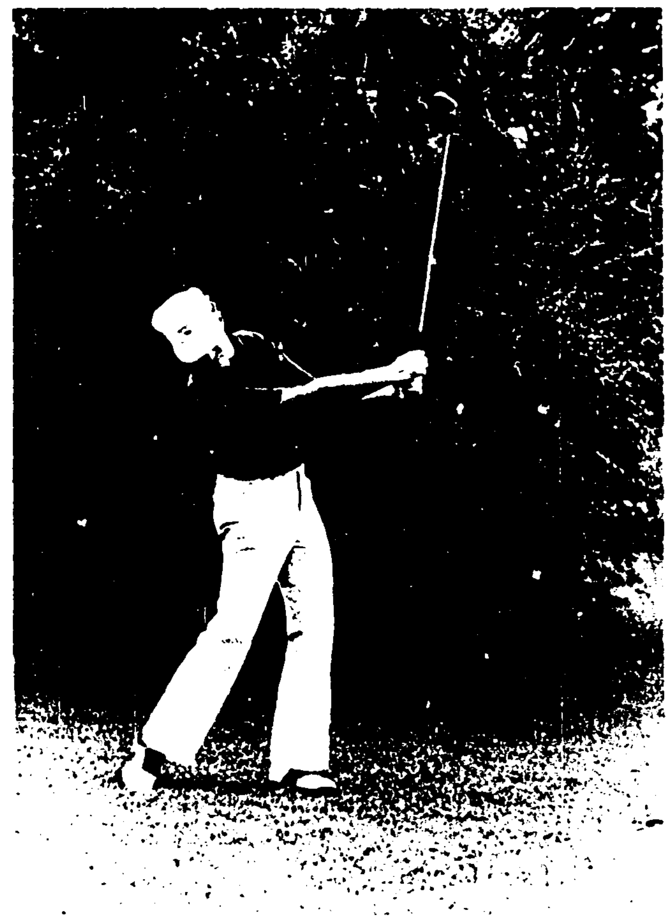


Front View

Position #9 (P9): The Vertical #3 Position (Back View)

1. The arms and club are extending outward and upward toward the target.

2. The arms are being swung at the target.

3. The hips have nearly cleared completely.

4. The head is starting to come up.

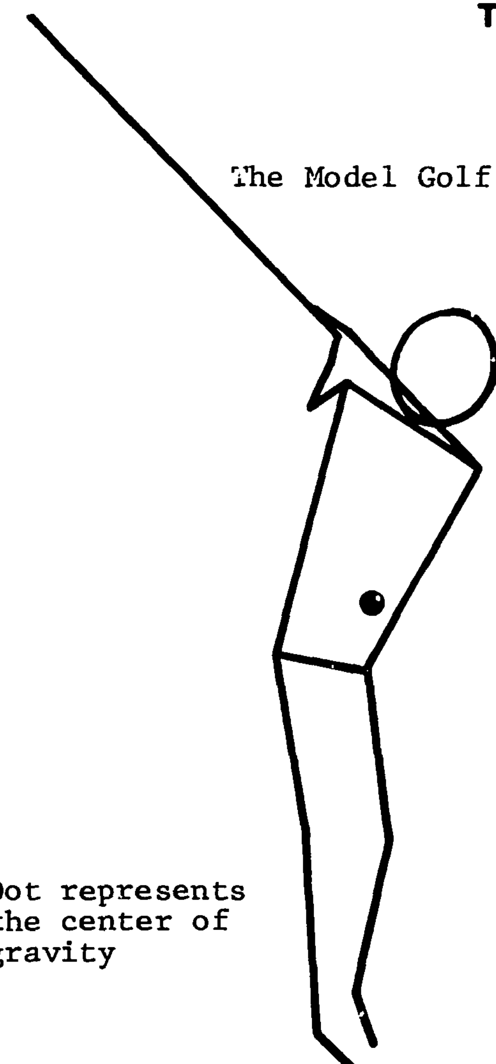
5. The weight is on the outside of the target foot.

6. The knees are still bent.

The vertical #3 position

(P9)

The Model Golf Swing



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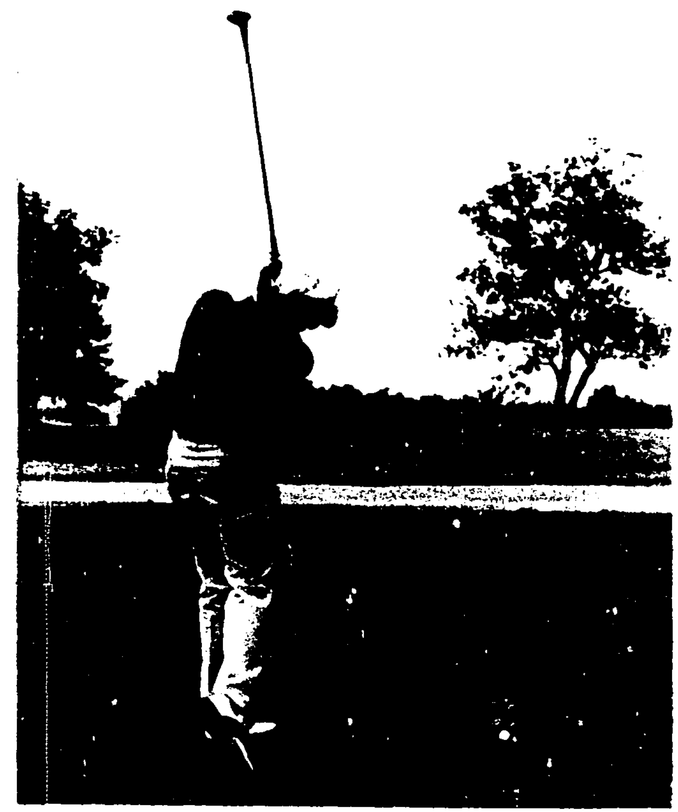
The Reference of Correctness



Back View

Position #10 (P10): The Finish (Front View)

1. The hands are high and behind the head.

2. The elbows are relaxed. The target elbow is bent and facing down to the ground.

3. The body is facing the target with a slight arch in the lower back.

4. The head is up and looking down the target line.

5. The hips have rotated completely around until the stomach is facing the target.

6. The weight is predominantly on the outside of the target leg.

7. The trail knee is bent and is pointing at the target.

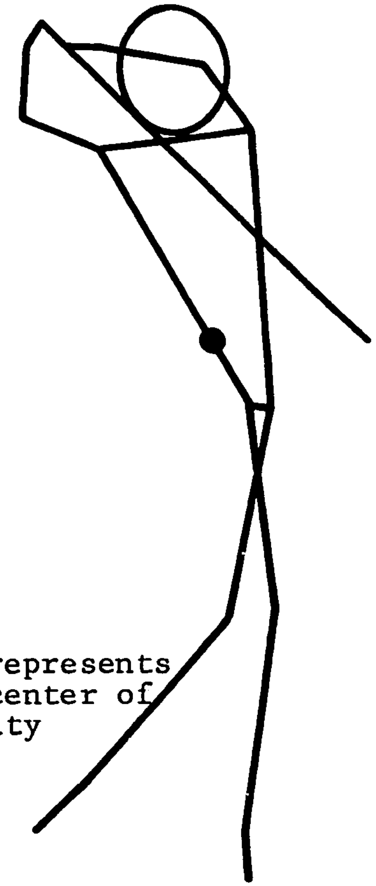
8. The golfer has shifted his weight to the target leg until the trail heel has been pulled completely off the ground and the golfer is resting only on the trail toe.

9. The golfer is in a balanced position because the head has now been allowed to move toward the target.

The finish

(P10)

The Model Golf Swing



• Dot represents the center of gravity

The Reference of Correctness

Front View

Position #10 (P10): The Finish (Back View)

1. The hands are high behind the head.

2. The elbows are relaxed with the target elbow pointing down toward the ground.

3. The stomach, chest, head, and trail knee are all facing the target.

4. The majority of the weight is being supported by the outside of the target leg.

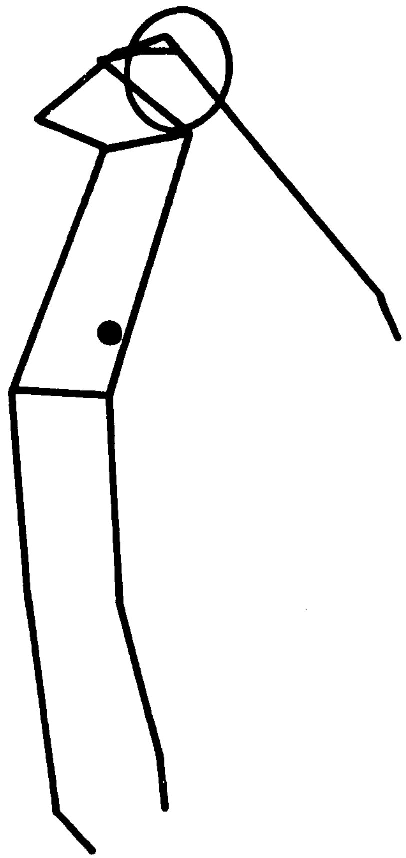
5. The trail heel has been lifted completely off the ground and the weight is being balanced by the trail toe which is in the vertical position.

6. The hips have rotated completely until they are facing the target.

The finish

(P10)

The Model Golf Swing



• Dot represents the center of gravity

The Reference of Correctness

Back View

APPENDIX E

LIST OF GOLF DRILLS

Golf Drills

1. Golf Grip Drill
2. P.P.A.S.S. Drill
3. General Motion Drill
4. Target Side Coiling Drill
5. Turning Drill with Towel
6. Turning Drill with club hooked behind the shoulders
7. One Piece Backswing and Extension Drill
8. Position at the Top Drill
9. Footwork and Knee Action Drill
10. Center Drill
11. Pre-set Turning Drill
12. Target Wrist/Trail Hand Drill
13. Target Arm Swoosh Drill
14. Feet Together Drill
15. Cross Legs Drill
16. Trail Foot/Target Toe Drill
17. Target Foot/Trail Toe Drill
18. Target Arm Drill
19. Trail Arm Drill
20. Double Overlap Drill
21. Feet Together/Weight Shift Drill
22. Knee Swing Drill
23. Trail Arm Swoosh Drill

24. Lever Drill
25. Post Impact Extension Drill
26. Split Grip Release Drill
27. Cross Handed Drill
28. Inside Path Drill
29. Angle and Release Drill
30. Full Swing Finish Drill

APPENDIX F

DESCRIPTION OF GOLF DRILLS AND HOW THEY ARE USED IN THE KINESTHETIC GOLF INSTRUCTIONAL PROGRAM

Golf Drills

The golf drills described in this section are those used by the instructor when teaching the experimental group. This golf drill program is designed so that another instructor could take the information in this text and teach a golf class using the kinesthetic method. For this reason, each drill is broken down into six areas: (1) the purpose of the drill is included; (2) the principle or fundamentals being taught are described; (3) the technique of performing the drill is included; (4) the number of repetitions or time limit for each drill is included; (5) terminal knowledge of performance feedback indicating the quality of the student's last swing is used; and (5) kinesthetic cues are used to help the students obtain a feeling for the movement pattern.

Definitions of Terms Used in This Teaching Manual

Target side--that part of the body closest to the target when swinging a golf club.

Trail side--that part of the body furthest away from the target when swinging a golf club.

Knowledge of performance feedback information--verbal feedback given by the instructor indicating the correctness of the student's swing.

Kinesthetic cues--verbal cues by the instructor which encourage the student to try to "feel" the body parts that are moving when swinging the golf club.

Drill #1: The Golf Grip Drill

The grip controls the clubface. Therefore, before a student can perform any of the swing drills, a correct grip must be learned. If the student does not have a correct grip, body movement will be affected by the way the club is held. If the student is allowed to swing with a poor grip, the motion developed will also be poor. It is suggested that all students learn with a pre-formed reminder grip. This grip automatically guides the hands on the club properly.

Some checkpoints for the grip (for a right-handed golfer) are:

1. Both palms face one another when they are put on the club.

2. The back of the target side hand should be lined up with the clubface.

3. The left thumb should be directly on top of the shaft or slightly to the right of it.

4. The left hand grip is a combination finger-palm grip. The club runs diagonally across the third digits of the fingers and underneath the meaty pad of the left hand.

5. The student should apply light grip pressure to the club with the last three fingers of the left hand.

6. The "V" formed between the left forefinger and left thumb should point to the right eye.

7. The right hand grip is primarily in the fingers.

8. The lifeline of the right hand should fit snugly on the left thumb.

9. The grip pressure is very light with the right hand.

10. The thumb of the right hand rests on the left side of the shaft so that the "V" formed between the right forefinger and thumb points to the chin.

11. The right hand grip is primarily in the finger tips and not the palm.

12. The little finger of the right hand should overlap the knuckles of the left hand so that the student only has three fingers of the right hand on the club.

13. The grip should feel very unified and close together. In order to do this, the students should make sure they hold on to the club with the left hand at the top of the swing. They should also make sure that the lifeline of the right hand stays snugly on the left thumb at the top of the swing.

Drill #2: The P.P.A.S.S. Drill

P.P.A.S.S. represents position, posture, alignment, stance, and set-up. Before doing any swing drills, it is important to get the body in the proper position to swing the club. Swing efficiency and correct swinging motion are dependent upon the correct body positioning at the beginning of the swing (address). Since all motion in the golf swing takes place from a static position, this motion will be affected by the position created at the starting point. This starting point is called the athletic position in the text. All swing drills should be performed from the athletic position.

Some of the more important points in the athletic position are:

1. The feet should be approximately shoulder width apart. If the stance is too wide, body motion is restricted. If the feet are too close together, balance is affected.

2. The weight should be evenly distributed and slightly favoring the heels.

3. Knees should be only slightly flexed and stay flexed throughout the swing.

4. The posture. The back should be straight as the student tilts forward from the hips. The student should feel like his head is coming forward and his buttocks are protruding. The student should be constantly reminded to

stay in this posture or athletic position throughout the entire swinging process. It is a common error for the student to come out of his posture while making the swing.

5. The right arm or trail arm should be a little closer to the body than the left (target) arm.

6. The shoulders should be square (parallel) to the target line with the target shoulder (left) tilted slightly higher than the trail shoulder.

7. The head should be positioned behind the ball at the address.

8. The student should always address an imaginary ball positioned off the target side heel.

Drill #3: General Motion Drill

Purposes:

This drill encourages the golfer to establish maximum body motion and body rotation. It forces the golfer to turn his upper body behind the ball on the backswing. Because neither a club nor a ball is being used with this drill, the golfer will eliminate arm and shoulder tension and establish freedom of motion.

Principles Taught:

1. Shoulder Turn
2. Hip Turn
3. Footwork
4. Knee Action

5. High Swing Plane
6. Arm Freedom
7. General Motion

Position:

Without the club, assume the address position. Simulate the golf swing by swinging your hands high over your trail shoulder on your backswing and high over your target shoulder at the finish. Emphasize body motion, body turn, high hands and good footwork. From the starting position, the swing should be continuous. There should be no stopping after each swing. Continuous motion.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	ten repetitions (last four with eyes closed)
Classes 3-20:	continuous swinging for one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel the target heel raise on the backswing and trail heel rise on the finish?

-Can you feel target knee move on the rear on the backswing and the trail knee move toward the target on the finish?

-Can you feel the hands and arms swing over the trail shoulder on the backswing and over the target shoulder at the finish?

-Can you feel the back face toward the target on the backswing and the stomach face toward the target at the finish?

-Can you feel the hips rotate to the trail side on the backswing and to the target side on the forward swing?

-Can you feel the weight shift to the trail leg on the backswing then shift to the target leg on the forward swing?

-Can you feel your arms swing back and forth as your shoulders turn?

-Can you feel your arms extend or straighten out after the impact area?

Feedback:

Continually supply terminal feedback as to the quality of the student's last swing (knowledge of performance).

Drill #4: Target Side Coiling Drill

Purposes:

To lengthen the swing arc by stretching the target side muscles. This drill gives the student the feeling of establishing a tight coil in the target side muscles.

Principles Taught:

1. Tight shoulder coil
2. Swing Radius
3. Arc Length

Position:

Without a club, assume the address position. Extend your arms and hook the back of your trail hand underneath and in front of your target hand. As you swing your arms away from the target, resist with the back of the target hand until you reach the top of the swing. Hold for a count of two. Swing down and through to the target, finishing with both arms extended as high as possible. Go back to address position and start over.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	ten repetitions (last four with eyes closed)
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Are you feeling those target side muscles stretch and coil?

-Are you feeling the target arm staying straight on the backswing?

-Can you feel the shoulders turn?

-Can you feel the trail side work under on the downswing?

-Can you feel your arms extend to your target?

-Do you feel a tight coiling sensation at the top of the swing?

Feedback:

Continually supply terminal feedback as to the quality of the student's last swing (knowledge of performance).

Drill #5: Turning Drill with Towel

Purpose:

This drill trains the golfer to lead with the target arm with the correct trail side coil and turn.

Principles Taught:

1. Shoulder Turn and Coil
2. Target Side Lead on Downswing
3. Correct Swingplane
4. Correct Trail Elbow Position at the Top of the Swing

Position:

Tie a knot in the end of a large bath towel. Assume the address position. Grasp the end of the towel with the hands ten inches apart. The target hand should face down with the palm facing the floor and the trail hand should be positioned with the palm facing up to the sky. Extend the target arm in front of you and tuck the trail arm and elbow to your side. Swing the arms and shoulders away from the target, keeping the towel taut. Hold this position at the top of the backswing for a count of two. As the downswing begins, release the trail hand. Continue forward with the target arm and feel yourself flinging the towel forcefully out toward the target to a high finish. Go back to the address position and repeat.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	ten repetitions (last four with eyes closed)
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel the stretching in your target side shoulder?

-Can you feel the turn in your shoulders?

-Are you keeping the target arm extended?

-Are you keeping your trail arm folded in?

-Do you feel like you are swinging your left arm down the target line?

Feedback:

Continually supply terminal feedback as to the quality of the student's last swing (knowledge of performance).

Drill #6: Turning Drill with the Club Hooked Behind the Shoulders

Purposes:

To train the body to turn behind the ball with the shoulders on the backswing. To train the shoulders to turn on a horizontal plane. To teach footwork and knee action as it is coordinated with the shoulder turn into one rhythmical sequence. To train the golfer to turn the body without swinging the arms.

Principles Taught:

1. Shoulder and Hip Turn (body rotation)
2. Footwork
3. Knee Action
4. Steady Center

Position:

Assume the address position. Put the club across your back in the crook of your elbows, or put the club on your shoulders. Bend forward from the waist. Make a full shoulder and hip rotation away from the target. Be sure to transfer the weight to a slightly flexed trail leg. On the backswing the target side heel should come slightly off the ground to allow the weight to transfer to the trail leg. The student should feel the turning of the shoulders behind the ball so that the butt end of the club is pointing to an imaginary spot outside and behind the imaginary ball position. This gives the student the feeling that the shoulders are turning horizontally on the backswing. The student should also feel that the target knee is moving behind the ball on the backswing as the target heel rises off the ground. While doing this, the golfer's trail knee should be driving toward the target on the forward swing as the trail heel is rising off the ground. As this body rotation is occurring, the knees should stay flexed. Finally, the head should be kept in the same spot as the body rotates around the head.

Go back to the address position and repeat.

<u>Repetitions/Time</u>:

Class 1:	five repetitions
Class 2:	ten repetitions (last four with eyes closed)
Classes 3-20:	one minute (last 30 seconds with eyes closed)

<u>Kinesthetic Cues</u>:

-Can you feel the body rotating behind an imaginary ball position on the backswing?

-As you rotate the body, is the head staying centered?

-Are the shoulders turning horizontally on the backswing?

-Can you feel the footwork and knee action through the swing?

-Can you feel the trail leg remaining flexed and acting as a brace on the backswing?

<u>Feedback</u>:

Continually supply terminal feedback as to the quality of the student's last swing (knowledge of performance).

Drill #7: One Piece Backswing and Extension Drill

Purposes:

To train the student to create a swinging motion away from the ball. To teach the student to develop a one piece backswing and a wide arc after impact. To train the student not to pick the club up with the hands and wrists.

Principles Taught:

1. Arc Width
2. Arm Swing
3. Shoulder Turn
4. One Piece Backswing
5. Clubface Positioning on Backswing

Position:

Assume the address position. Swing the club back until it is parallel to the ground. The two arms and the club-shaft should form the letter "Y" at this point. The club-face should be pointing out at the imaginary ball at this point as the toe of the club is pointing up to the sky. The wrists and hands have been isolated and have done very little. Most of the movement of the club has been caused by the arms swinging and shoulders turning.

On the downswing, simply let the arms swing at the target. After the impact area is reached, the golfer should feel that the forearms are rotating, causing the clubface to turn over. When the club reaches the parallel position after impact, the "Y" position with the arms and clubshaft should be reestablished. At the finish, or horizontal position, the arms are both straight as the club-face has rotated until it is pointing to the ground.

Go back to the address position and repeat.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	ten repetitions
Classes 3-20:	thirty seconds (eyes open)

Kinesthetic Cues:

-Can you feel your arms initiating the backswing?

-Can you feel your target shoulder turning around?

-Do your hands feel like they are in a cast as you go back? The hands and wrists do not break.

-Can you feel your "Y" staying together (the two arms and the clubshaft)?

-Can you feel the club sweeping away on the backswing?

-Can you feel your arms extending back and forth?

-Can you feel your arms extending forward while keeping your "Y" together?

-Can you feel your backswing swingpath come inside your target line?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #8: Position at the Top Drill

Purpose:

To help the golfer "feel" the correct position at the top of the swing. This allows the golfer to feel a "tight" coil of the shoulders at the top of the swing. The golfer should "feel an on line position and an in plane position at the top of the swing.

Principles Taught:

1. Shoulder Coil
2. Club Positioning
3. Length of Arc
4. Swingplane

Position:

Assume the address position. Swing to the top of the swing and stop for five seconds; try to achieve a tight coil with the target shoulder and arm. Also, the student should feel the "setting" of the club in position at the top of the swing. The arms should feel like they are being pulled down to the inside and in close to the body on the downswing. The student should continue to swing to the finish.

Return to the address position and repeat.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	five repetitions
Classes 3-20:	fifteen repetitions (last seven with the eyes closed)

Kinesthetic Cues:

Swing to the top of the swing and hold; count one - two - three - four - five. Swing arms down to the inside.

-Can you feel a tight coil with your shoulders at the top?

-Can you feel a straight target arm at the top?

-Do you feel your trail elbow pointed down to the ground at the top?

-Can you feel your arms come in close to the body on the downswing?

-Does it feel like you are holding a tray of glasses at the top? Is your trail hand underneath the club at the top?

-Can you feel your shoulder coil tighten up; can you feel those target side muscles stretch?

-Can you feel a straight or flat target wrist at the top?

-Does it feel like you are sticking the club in the air at the top with a minimum of wrist break; can you set the club in a solid position?

-Dos it feel like you are only swinging three-quarters of the way back? (Try not to drop the club on top! Stick it in the air!)

-Does it feel "solid" at the top?

-Have you turned your shoulders behind the ball?

-Do you feel the plane of the swing?

-Is the clubshaft above the right shoulder?

-Do you feel like a spring or a coil?

-Is your back facing the target at the top?

-Is your club on line at the top?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #9: Footwork and Knee Action Drill

Purposes:

To help the golfer establish dynamic balance and maximum swing motion early in the developmental process. To train the golfer about the importance of footwork and knee action and how the swing is built on these two fundamentals.

Principles Taught:

1. Footwork
2. Knee Action
3. Dynamic Balance
4. Weight Shift

Position:

Assume the address position. From this position take full swings concentrating on footwork and knee action. On the backswing think of the target knee going behind an imaginary ball. As this occurs, the target heel should raise about an inch off the ground. The small amount of weight that is still on the target leg at this point will be on the instep.

The knee action and footwork will cause the weight to shift or transfer to the rear or trail leg. As the arm swing reaches the top, the weight of the body should be supported by the trail leg. Ninety percent of the weight should be on the inside of the trail leg and heel. The trail leg should be only slightly flexed. It should now be acting as a brace for the entire backswing turning motion.

The downswing starts with the target knee moving toward the target. The forward movement of the target knee is immediately followed by the trail knee. The trail knee should move past the imaginary ball position on the downswing. This will pull the trail heel all the way off the ground and will put the trail foot in a vertical position. At this point (the finish) in the swing, the majority of the weight should be resting on the outside of the target foot. As a reminder, the student's legs should stay bent all the way through the entire motion.

After each swing, go back to the address position and repeat.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	five repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel the target knee move behind the imaginary ball on the backswing and the trail knee move in front of the imaginary ball on the forward swing?

-Can you feel the target heel up on the backswing and the trail heel go up on the forward swing?

-Can you feel the knees staying flexed throughout the whole swing?

-Can you feel the weight moving to the inside of the trail foot on the backswing and to the outside of the target foot on the forward swing?

-Can you feel the trail leg staying bent on the backswing?

-Can you feel your upper body coiling over the braced trail leg?

-Can you feel the push off the inside of the trail foot on the downswing?

-Are you coming all the way up on your rear foot on the forward swing?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #10: Center Drill

Purpose:

To get the golfer to identify with the feeling of keeping the head steady as the body rotates around it.

Principles Taught:

1. Steady Center
2. Balance
3. Body Rotation
4. Consistent Swing Arc

Position:

(1) If drills are performed outside, each student should assume the address position and turn his back to the sun as he swings. Watch the shadow made by the head as the swing is made. There should be no up and down or back and forth movement of the head as the swing is made. If there is no shadow, follow instructions for (2).

(2) If drills are performed inside, each student should have a partner. Your partner should hold your head

as you make continuous swings. Use a towel instead of a club in this drill so as not to injure your partner. The towel should be held and the movement performed exactly like the towel turning drill shown previously.

Swing once and go back to the address position and repeat.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	ten repetitions
Classes 3-20:	one minute (with partners)

Kinesthetic Cues:

-Can you feel a steady center as your body pivots around your head?

-Can you feel the body turn?

-Can you feel the head staying back behind the ball as the arms and legs are moving toward the target on the downswing?

-Can you feel your balance?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #11: Pre-set Turning Drill

Purposes:

This drill helps the golfer feel the correct swing plane for a particular body build. It also forces the golfer to get the feeling of turning the trail side out of the way on the backswing. It makes the trail arm fold and break down on the backswing. With this folding, a lot of trail side tension is eliminated. And, finally, since the wrists are already pre-cocked, this drill forces the wrists to cock upward properly.

Principles Taught:

1. Upward Cocking of the Wrists
2. Relaxation and Folding of the Trail Side Arm on the Backswing
3. Swingplane
4. Body Turn
5. Target-arm Clubshaft Angle on the Downswing
6. Late Release

Position:

Assume the address position. Pre-set the wrists at the starting position so that: (1) the clubshaft is parallel to the target line and parallel to the ground; (2) the face of the club points out towards an imaginary ball as the toe of the club points upward toward the sky; (3) the trail elbow is relaxed and tucked close to the side; and (4) the back of the target hand is facing out toward an imaginary ball.

From this starting pre-set position, swing the arms back to the top and through to the finish position. Try to maintain this pre-set position as long as you can into the downswing.

After one swing, return to the address position and start over.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	two repetitions
Classes 3-20:	one minute (last 30 seconds with the eyes closed)

Kinesthetic Cues:

-Can you feel the trail arm and side fold and relax as the body turns to the rear?

-Can you feel the trail shoulder and hip turn to the rear on the backswing?

-Can you feel the plane of the swing?

-Can you feel the target shoulder turn away from the ball on the backswing?

-Can you feel the hands leading the clubhead into the impact area on the downswing?

-Does it feel like your wrists are staying cocked on the downswing?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #12: Target Wrist/Trail Hand Drill

Purposes:

This drill helps the student identify the "feeling" of swinging the target arm while turning the body. It helps the student feel the body turn and the coiling and uncoiling of the shoulders. As this coiling and uncoiling take place, the student should feel the trail arm staying in close to the body far into the downswing. This drill helps the student identify with the target side lead and the target side pulling on the downswing. This drill also builds strength in the target arm.

Principles Taught:

1. Target Side Lead
2. Soft or Relaxed Trail Arm Throughout the Swing
3. Shoulder Coil
4. Target Side-pulling

Position:

Assume the address position. With the club in the target hand and the target arm extended, grasp the target wrist with your trail hand. To insure good control, put your right index finger around the butt of the club. Make complete swings holding the club this way.

After one swing, go back to the address position and start over.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	ten repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel the soft trail arm position during the swing?

-Can you feel the stretch in the target side arm and shoulder area?

-Can you feel the shoulders coil and uncoil?

-Can you sense the target arm lead on the downswing?

-Can you feel your upper body coil against the resistance of the lower body?

-Can you feel the target arm pulling on the downswing?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #13: Target Arm Swoosh Drill

Purposes:

This drill helps the student get a sense of target arm pace and clubhead speed. It also gives the student a sense of lightness in the arms and creates an accelerating effect through the impact area. It helps the student retain the target-arm-clubshaft angle on the downswing. The "swooshing" sound of clubshaft through the impact area gives the student an indication of the amount of target arm control, release, and clubhead speed.

Principles:

1. Target Arm Pace or Tempo
2. Arm Freedom
3. Eliminate Arm Tension
4. Retention of Target-arm-clubshaft Angle
5. Late Release
6. Target Arm Control
7. Clubhead Speed

Position:

Assume the address position. Hold the club upside down and grip the clubhead at the hosel with your target hand. The trail hand should be put behind your back. Take full swings this way trying to create a "swooshing" sound at the bottom of the swing.

Take one swing and then go back to the address position and repeat.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	ten repetitions
Classes 3-20:	one minute (last 30 seconds with the eyes closed)

Kinesthetic Cues:

-Can you feel your target arm accelerate to the finish position?

-Can you sense the lightness in your target arm?

-Can you feel your target arm and hand rotate through the impact area?

-Can you hear the "swooshing" sound at the bottom of the swing?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #14: Feet Together Drill

Purposes:

This drill helps the golfer feel the arms swinging and the body following. It also promotes the golfer's balance.

It reduces excessive shoulder action as well as arm tension in the swing.

Principles Taught:

1. Arm Swing and Arm Freedom
2. Balance
3. Footwork
4. Timing
5. Body Turn
6. Steady Center
7. Eliminates Early Rotation of the Body on the Downswing

Position:

Assume the address position. Put your feet as close together as possible. Make normal swings from this position.

After each swing go back to the address position and repeat.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	ten repetitions
Classes 3-20:	one minute (last 30 seconds with the eyes closed)

Kinesthetic Cues:

-Can you feel the freedom in your arms?

-Are you maintaining your balance?

-Can you maintain a steady tempo?

-Can you feel the center remaining steady throughout the swing?

-Can you feel your arms release on the follow-through?

-Can you feel your trail side shoulder work down and under your chin on the downswing?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #15: Cross Legs Drill

Purposes:

Helps the golfer feel the arm swing as he attempts to maintain his balance. This drill prevents the golfer from overusing the trail shoulder and hand.

Principles Taught:

1. Arm Swing
2. Balance
3. Tempo
4. Release
5. Steady Center

Position:

Assume address position. Cross the target foot in front of trail foot.

After each swing, go back to the address position and start over.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	five repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel the body center remain steady?

-Can you feel the arms swinging?

-Can you sense the forearms rotating naturally after the impact point?

-Can you feel the trail side shoulder work under the chin?

-Is the body retaining its balance?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #16: Trail Foot-Target Toe Drill

Purposes:

This drill gives the student the feeling that the trail leg is supporting the backswing. It also gives the feeling that the arms are swinging and the body is following. It tends to help the golfer stay behind the ball with the upper body. This drill gives the feeling that the target arm is rotating left after the impact. It further helps eliminate excessive leg drive on the downswing while giving the student a feeling of target arm control.

Principles Taught:

1. Arm Swing
2. Arm Freedom
3. Arm Pace
4. Trail Leg Support
5. Weight Shift
6. Keeps Center Point Behind Ball
7. Eliminates Premature Rotation of the Bcdy on the Downswing
8. Inside to Inside Swingpath
9. Tempo
10. Balance
11. Slows Down Excessive Leg Action
12. Target Arm Extension

Position:

Assume the address position. Put your feet twelve inches apart. Withdraw your target foot about twelve inches behind your trail heel. Put all of your weight on your trail foot and position your target foot so it is resting on its toe. Take a normal swing from this position taking your trail hand off at impact.

After one swing, go back to the address position and repeat.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	five repetitions
Classes 3-20:	one minute (last 30 seconds with the eyes closed)

Kinesthetic Cues:

-Are you turning your shoulders behind the ball on the backswing?

-Are you feeling the weight shift to your trail leg?

-Can you feel the trail leg act as a support?

-Do you sense that you are keeping your head and upper body behind the ball through the impact area?

-Do you sense the tempo of the swing?

-Do you feel a little off balance when you lose that tempo?

-Can you feel the target arm extend and swing back to the inside after the impact area?

-Can you feel the target arm pace the swing?

-Can you feel the target arm and hand rotate through the impact area?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #17: Target Foot/Trail Toe Drill

Purposes:

This drill permits the golfer to turn his shoulders fully and freely. It also allows the trail side to turn out of the way on the backswing. This drill gives the golfer the sensation of swinging the arms and hands down from inside the target line on the downswing. It also helps stop any premature rotation of the body on the downswing. It helps the golfer slow down his legs and encourages him to feel his arm swing. It forces the golfer to approach the ball from an inside path which is the most critical aspect of consistent shot-making.

Principles Taught:

1. Arm Swing
2. Arm Pace
3. Inside Path on the Downswing
4. Allows Trail Side to Turn Out of the Way on the Backswing
5. Decreases Premature Body Rotation (spinning) on the Downswing
6. Increases Arm and Hand Rotation on the Forward Swing

7. Slows Down Lower Body and Legs

8. Helps Tempo and Balance

Position:

Assume the address position. Put 95% of your weight on your target foot, withdrawing the trail foot a few inches behind the target heel and in line with the imaginary ball. It should appear that the trail foot is resting upon its toe and directly behind the target foot. As you swing from this position, you should feel you are going back a little inside your target line and coming down from inside your target line.

After one swing, go back to the address position and repeat.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	five repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel your trail shoulder and hip turn behind you?

-Can you feel your arms swinging the club back in one plane and rerouting to a flatter plane coming down?

-Does it feel like you are swinging inside to outside?

-Can you feel your trail elbow come in close to your side on the downswing?

-Can you feel the forearm rotation in the impact area?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #18: Target Arm Drill

Purposes:

This drill gives the student a sense of target arm pace and control during the swing. It helps create target side lead on the downswing by giving the student a pulling sensation. It also helps the student identify with target arm rotation after impact. It insures target arm extension after impact. And, finally, this drill develops target arm strength.

Principles Taught:

1. Target Arm and Side Lead
2. Target Arm Pace
3. Target Arm Rotation
4. Target Arm Extension
5. Target Arm Strength
6. Target Arm-Clubshaft Angle on the Downswing

Position:

Assume the address position. Grip the club with your target hand only. Put the trail hand behind your back. Take a regular swing from this position. Now swing continuously.

Note: Those having difficulty with this procedure should grip the club with both hands to the top of the backswing, then release the trail hand and swing with target arm. Anyone not able to do this should choke up on the shaft and perform as instructed. If still unable to complete this drill, choke up further and try half-swings.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	ten repetitions
Classes 3-20:	ninety seconds (last 45 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel the club going back as if the target arm and the club are one piece?

-Can you feel the target arm move first, with the body following on the backswing?

-Can you feel the pulling sensation on the downswing as the target arm rotates through the impact area?

-Are you maintaining a flat wrist position on your target side through the target area?

-Are you extending that target arm to a high finish position?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #19: Trail Arm Drill

Purposes:

This drill was designed to strengthen and train the trail arm muscles during the swing. It helps the golfer eliminate trail arm, shoulder, and hand tension during the swing. It promotes the proper hinging action of the trail wrist and elbow. Furthermore, this drill helps the golfer develop acceleration in the swing.

Principles Taught:

1. Hinging of Trail Arm
2. Relaxation of Trail Arm
3. Tempo
4. Gradual Acceleration of Trail Arm on Forward Swing
5. Position at the Top
6. Clubshaft Angle Retention on Downswing (late release)
7. Correct Trail Arm Use
8. Inside-outside Path

Position:

Assume the address position. Grip the club with the trail hand. The target hand should be behind the back. Take swings from this position insuring that the shoulders and hips turn fully on the backswing. Also, make sure that your trail elbow is pointing down toward the ground at the top of the swing. The club should be firmly "set" in three-quarters position at the top of the swing.

On the downswing, try to get the trail elbow immediately close to the trail side. Keep extending the trail arm at the target after the impact point until a full finish is reached.

After one repetition, go back to the address position and repeat.

Repetitions/Time:

Class 1:	five repetitions
Class 2:	ten repetitions
Classes 3-20:	ninety seconds (last 45 seconds with eyes closed)

Kinesthetic Cues:

-Can you keep the club parallel to the ground at the top of the backswing with your back facing the target?

-Is the club solidly "set" at the top of the swing?

-Can you keep the grip pressure light to allow the arm to rotate freely?

-Can you feel your trail arm fold on the backswing as your shoulders are turning?

-Is your trail elbow pointed toward the ground at the top of the swing?

-Do you feel the clubhead lag behind, then catch up as you swing through to the finish?

-Can you feel the trail elbow come into the body on the downswing?

-Can you feel the trail arm extend toward the target after impact?

-Can you feel the arm rotate on the forward swing?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #20: Double Overlap Drill

Purposes:

This drill trains the target arm to control the swing. It helps create a "quiet" and "firm" hands position at the top of the swing. It reduces looseness at the top of the swing as it strengthens the target arm.

Principles Taught:

1. Target Arm Control
2. Target Arm Pace
3. Target Arm Release

4. Firmness of the Hands at the Top of the Swing
5. Target Arm-Clubshaft Angle Retention on the Downswing

Position:

Assume the address position. Completely overlap the trail hand on top of the target hand. From this position, make full swings.

After one repetition, go back to the address position and repeat the drill.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	ten repetitions
Classes 3-20	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel the target arm rotation through the impact area?

-Can you feel a pulling sensation from your target arm on the downswing?

-Can you feel your hands stay firm at the top of the swing?

-Can you feel how high and free the finish is?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #21: Feet Together/Weight Shift Drill

Purposes:

This drill helps the student feel the proper weight shift with the lower body on the downswing. It helps the student get the idea that the weight must transfer to the target leg before the arm swing starts down.

Principles Taught:

1. Dynamic Balance
2. Weight Shift
3. Target Knee Action
4. Lower Body Lead on Downswing

Position:

Assume the address position with the feet together. Swing to the top of the backswing. Before the arms reach the top of the backswing, you should already be stepping forward with the target foot. This is done almost as if you were stepping into a pitched baseball with the target leg. You should be careful not to stride too far with the target leg because this would not allow the weight to transfer. Also, you should be sure that the target leg is firmly planted before starting down with the arm swing. The arms will feel like a couple of spokes of a wheel as they will be forced to finish high.

After one repetition, you should go back to the address position and start over.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	eight repetitions
Classes 3-20:	one minute (last 30 seconds with the eyes closed)

Kinesthetic Cues:

-Can you feel the shoulder turn on the backswing?

-Can you feel the shift or slide of the hips on the downswing?

-After the target foot has been planted on the downswing, can you feel the arms swing downward?

-Can you feel centrifugal (momentum) force build up in the arms and transfer to the clubhead on the downswing?

-Do you sense your arms following the legs on the downswing?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #22: Knee Swing Drill

Purposes:

This drill helps the student feel the correct horizontal shoulder turn on the backswing and the forward swing. It also forces the student to develop a tight shoulder coil at the top of the swing. It automatically causes the student to swing his arms and not his body.

Principles Taught:

1. Arm Swing and Arm Freedom
2. Level Shoulder Turn
3. Shoulder Coil
4. Forearm Release
5. Swingplane
6. Hand Action

Position:

Assume your address position with your towel in hand. Fold your towel and put it on the floor. Kneel down on the towel with the club extended as if you were going to hit an imaginary ball. Make sure the club is at least two inches above the ground when addressing the imaginary ball because the tendency here is to hit the ground or floor with the club. Make one swing at a time, trying to concentrate on a level shoulder turn, arm freedom, and releasing the forearms through the impact area.

Take one swing and go back to the starting position.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	eight repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel the shoulders turn on a level or horizontal plane on the backswing?

-Can you feel the club come low and inside the target line on the backswing?

-Can you feel a tight shoulder coil at the top of the swing? Is the target arm straight?

-Can you feel the arms swing freely through the impact area?

-Can you feel the forearm rotation after the impact area?

-Can you feel the arms extend toward the target after impact?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #23: Trail Arm Swoosh Drill

Purposes:

This drill is designed to train the trail arm to swing correctly. It helps eliminate trail arm tension while promoting proper hinging of the trail wrist and elbow. It also helps the golfer feel the development of maximum arm speed with the trail arm.

Principles Taught:

1. Trail Arm Hinging
2. Tempo
3. Swing Acceleration
4. Trail Arm Positioning at the Top
5. Trail Arm Lightness
6. Clubhead Speed
7. Club Positioning at the Top
8. Inside-Outside Path
9. Clubhead Lag and Angle Retention

Position:

Assume the address position. Put the target hand and arm behind the back. Grip the club upside down with the trail hand. Make arm swings from this position, trying to make a loud swoosh at the impact area. On the backswing, make sure that you are allowing your trail arm to fold until the trail elbow is pointing down at the ground.

The club should be in a solid three-quarters position at the top. You should feel like you are sticking the club in the air with very little wrist cocking on the backswing.

On the downswing, try to get the trail elbow immediately close to the trail side. After impact keep extending the trail arm at the target until a high and full finish is reached.

Go back to the address position and repeat.

<u>Repetitions/Time</u>:

Class 1:	five repetitions
Class 2:	ten repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed)

<u>Kinesthetic Cues</u>:

-Are you folding the trail elbow on the backswing?

-Is the trail elbow pointed down toward the ground at the top of the swing?

-Do you keep turning the body on the backswing? (Don't quit turning.)

-Is the club in a "solid" three-quarters position at the top?

-Can you feel the gradual acceleration of the trail arm and clubhead into the impact area?

-Is the trail elbow coming close to the body on the downswing?

-Can you feel the clubhead speed at the bottom?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #25: Post Impact Extension Drill

Purposes:

This drill helps the student develop the feeling of swinging through the ball and not at the ball. It trains the student to extend and straighten the arms after impact. It helps insure a wide swing arc and a flat-bottomed swing. It encourages the student to feel the release of the forearms after impact.

Principles Taught:

1. Width of Arc
2. Arm Extension
3. Forearm Rotation
4. Hand and Clubhead Release

Position:

The starting position for this drill is a little different than the address position for the other drills. At the start, both arms should be straight with the club parallel to the ground and pointing at the target. The trail hand should be rotated completely on top of the target hand. The head should be positioned behind the ball and looking over the trail shoulder. The trail side and leg should be released only slightly with the trail heel off the ground. Hold this position for a count of three trying to extend the arms as far as they will go. From this position, take a full backswing and swing through to the finish.

Go back to the starting position and repeat.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	five repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed).

Kinesthetic Cues:

-Do you feel that you are staying behind the ball with your head and shoulders as the arms straighten and release?

-Is the head staying back as the arms are extending?

-Can you feel the forearms rotate after impact?

-Can you feel both arms straighten after impact?

Feedback:

Continually provide feedback as to the quality of the student's last swing (knowledge of performance).

Drill #26: Split Grip Release Drill

Purposes:

This drill trains the student to rotate the forearms and release the clubhead after the impact. It forces the trail arm to fold on the backswing and gives the student a general feeling for the clubhead all the way through the swing. It also trains the student to approach the ball from an inside path on the downswing.

Principles Taught:

1. Trail Arm Hinging
2. Inside Approach
3. Forearm Release
4. Clubface Rotation
5. Clubface Positioning

Position:

Assume the address position. Slide the trail hand down the shaft four to five inches below the target hand. Take a normal swing allowing the trail arm to fold on the backswing.

On the downswing, try to feel the trail hand turn completely over the target hand until the clubface points down toward the ground.

After one repetition, go back to the starting position and repeat.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	ten repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel your arm swing the clubhead?

-Can you feel your trail arm fold on the backswing?

-Can you feel your arms release and your trail hand rotate over your target hand at the bottom of the swing?

-Can you feel the clubface turn over after impact?

-Can you feel your right arm cross over your left?

Feedback:

Continually provide feedback as to the quality of the student's last swing (knowledge of performance).

Drill #27: Cross Handed Drill

Purposes:

This drill helps the student build the sensation of target arm control and target side lead. It also gives the golfer the feeling of keeping the trail arm soft and passive all the way through the impact area.

Principles Taught:

1. Target Side Lead and Control
2. Target Wrist Control
3. Target Side Pulling
4. Trail Side Folding and Tucking on the Downswing

Position:

Assume a normal address position. The hands should be placed on the club so that the target hand is positioned below the trail hand. From this position you should make full swings while concentrating on the target arm and wrist control.

After one repetition, go back and repeat.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	five repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel your trail side folding on the backswing?

-Can you feel the target arm pulling on the downswing?

-Does it feel like the target wrist is flat at the impact area?

-Do you feel the trail elbow came close to the body at the start of the swing and stayed that way through most of the swing?

-On the downswing, can you feel the soft and relaxed trail elbow come in close to the body?

-Can you feel the target wrist staying firm through the impact area?

Feedback:

Continually supply feedback as to the quality of the student's last swing (knowledge of performance).

Drill #28: Inside Path Drill

Purpose:

This drill gives the student the feeling of approaching the imaginary ball with the arms swinging down from inside the target line. It gives the golfer the feeling of swinging inside to outside.

Principles Taught:

1. Correct Downswing Plane
2. Inside Approach
3. Trail Arm Getting Into the Side on the Downswing

Position:

The student should take a normal address position. From this position, you should feel like you are swinging the club straight back on the target line.

On the downswing you should feel like you are swinging the club down from far inside the target line. You should feel like you are swinging directly to right field on the downswing. The feeling here should be "inside" on the backswing and "outside" on the downswing.

After one swing, go back to the address position and repeat.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	five repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel the club go straight back on the backswing?

-Can you feel your arms drop to the inside on the downswing?

-Does it feel like you are swinging toward right field on the downswing?

-Can you feel your trail elbow getting close to the side on the downswing?

-Are you swinging inside to outside?

Feedback:

Continually provide feedback as to the quality of the student's last swing (knowledge of performance).

Drill #29: Angle and Release Drill

Purpose:

This drill trains the golfer to retain the target arm-clubshaft angle as the arms are released through the impact area.

Principles Taught:

1. Target Arm-Clubshaft Angle Retention on the Downswing
2. Release and Rotation of Forearms Through the Impact Area
3. Vertical Positioning of the Clubshaft on the Backswing and the Forward Swing

Position:

Start with your target arm parallel to the ground while the club is in the vertical position. From this position, swing through until the trail arm is parallel to the ground and the club is again in the vertical position.

Go back to the starting position and repeat.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	five repetitions
Classes 3-20:	one minute (last 30 seconds with eyes closed)

Kinesthetic Cues:

-Can you feel the wrists retain their cocked position far into the impact area?

-Can you feel the forearms rotate and turn over through the impact area?

-Can you feel the arms extend as the club works up to the vertical position?

-Can you feel the release?

Feedback:

Continually give feedback information as to the quality of the student's last swing (knowledge of performance).

Drill #30: Full Swing Finish Drill

Purposes:

This drill was designed to help the student develop a full motion swing insuring a ballistic movement. Also, this drill helps the golfer establish good balance habits.

Principles Taught:

1. Balance
2. Motion
3. Arm Swing
4. Centrifugal Release
5. Correct Finish

Position:

The beginning point for this drill is the finish position. At the finish position, the hands are high and they are positioned behind the head. The target knee is slightly flexed as the majority of the weight is supported by the target leg. The belt buckle is facing the target, and most of the weight is off the trail leg. The trail foot is in a vertical position (being balanced by the toe). The majority of the weight is on the outside of the target foot. You should face the target with a very slight bend in the lower back. The elbows remain in a relaxed position.

From this starting position, count to three and then take a complete swing. Each time you finish a swing you should hold for a count of three before swinging again.

Repetitions/Time:

Class 1:	three repetitions
Class 2:	five repetitions
Classes 3-20:	one minute (last 30 seconds with the eyes closed)

Kinesthetic Cues:

-Do you feel balanced at the finish?

-Are your hands high behind your head?

-Are your elbows relaxed?

-Are you facing your target?

-Can you feel your weight on the outside of your target foot?

-Is your target leg bent?

-Is your trail knee facing your target and are you off your trail heel?

-Can you feel a slight arch in your back?

Feedback:

Continually provide feedback as to the quality of the student's last swing (knowledge of performance).

APPENDIX G

EXPERIMENTAL GROUP (KINESTHETIC GOLF INSTRUCTION) DAILY LESSON PLANS

Daily Lesson Plans

Monday, February 8

Meeting Place: Classroom

Topics Covered:

I. Explanation of the Training. Aspect of the Golf Learning Program.

   A. Emphasized golf swing performance and not ball flight results.

   B. Explained the training principles of overload, intensity, duration, and frequency.

   C. Explained to the class why a weighted club was being used while swinging.

      1. To strengthen the golf muscles--specificity of training.

      2. To give the students a better sensitivity or "feel" for the movement pattern of the golf swing and the muscles being used in that swing.

   D. Explained to the class why a golf ball was not being used.

      1. It is thought that the golf ball inhibits the learning of a correct swing in the early stages of development.

      2. The absence of a golf ball forces the student to concentrate on the swing and not the results (ball flight) of that swing.

E. Explained why the swing drills were being used.

1. To automatically ingrain a habit pattern and force the muscles and body parts to work in a coordinated manner.
2. To insure the correct form.

F. Explained to the class why the swing drills were to be performed correctly.

1. To insure proper form.
2. Emphasized to the students that if the drill is performed incorrectly their normal swing will also be incorrect.

G. Emphasized to the students the importance of intensity of training.

1. Each individual's golf swing development is directly related to the number of swing repetitions that are <u>correctly</u> performed within the given time limit (1 min.).
2. Progress is directly related to intensity of training.

II. Explanation of Kinesthetic or the "Feel" Method of Learning the Swing.

A. Explained to the students the reason why half of the swing drills are performed with the eyes closed.

1. In order to heighten the kinesthetic sensitivity for the movement pattern of the golf swing.

2. In order to enable the students to quickly learn the mechanics of a correct golf swing.

B. Explained the reason for the use of kinesthetic cues.

C. Explained the "reference of correctness" to the students.

1. In order to make sensory (kinesthetic swing comparisons.

2. In order to imitate the instructor's swing.

3. In order to use mental practice and internalize the swing feelings.

Wednesday, February 10, and Monday, February 15

Meeting Place: Classroom

Topic Covered: The Model of Correctness

1. Described the ten most critical parts of the golf swing.
2. Explained body movement in each position.
3. Demonstrated these positions to the students.
4. Used an overhead projector to show the model of correctness.
5. Described the movement that occurs as the model gets in each position.
6. Encouraged students to internalize these critical points.
7. Question-answer period on the model.

Wednesday, February 17

Meeting Place: Gymnastics Area

Class Formation: Three or four rows. Ten feet of space on all sides of each student (see Appendix F). Instructor faces students.

Topics Covered: "The Statics" or the Pre-Swing Fundamentals

Grip

Posture and Position

Alignment and Aim

Stance

Set Up

I. Grip

The class used pre-formed molded grips throughout the training period. It was thought that the pre-molded grip would force the students to hold the club properly and give them a kinesthetic feeling for the correct grip throughout the entire training period. A verbal description of the grip is included in Appendix F which describes the golf drills.

Since the grip directly controls the clubface, it was thought that the correct grip was extremely important in order to insure proper movement. Each student was checked by the instructor to see if he had a correct grip.

II. Posture and Position (see Appendix F)

A. Athletic position of spine angle formed at address.

B. The importance of establishing the correct posture and retaining that mosture all the way through the swinging motion was emphasized. Maintaining the proper posture allowed the student to get into the correct body positions throughout the swing.

C. The amount and duration of knee flexion was discussed.

III. Alignment and Aim (see Appendix F)

A. Align the body.

1. Align the shoulders until they are parallel to the imaginary target.

2. Align the feet, knees and hips until they are parallel to an imaginary target.

B. Aim the clubface at the imaginary target.

IV. Stance and Set-up (see Appendix F)

A. Target and trail arm position.

B. Head position.

C. Weight distribution.

D. Muscular tension.

E. Stance.

1. Type of stance

2. Width of stance

V. Imaginary Ball Positioning

A. With a piece of white adhesive tape, an "X" was placed on the floor or the ground where the imaginary ball was thought to be.

B. Position the imaginary ball off the target heel. All the swing drills were performed from this initial target heel position.

C. Distance from the imaginary ball. The students determined their distance from the imaginary by:

1. Their body build--a short and heavy-set person was told to stand further away from the ball while a tall person was told to stand closer to the ball.

2. The amount of bend from the hips. A heavy-set person was told to bend more from the hips to free up the arms while a thinner and taller person was told to stand up straighter in order to achieve arm freedom.

3. Their natural arm hang. The students were told to bend forward from their hips keeping their backs straight. They were also told to bend their knees slightly and allow their arms to hang down vertically. The ball position was determined from this vertical arm hang position.

4. Upper arm placement. The students were told that the imaginary ball was in the correct position when the back of the upper arms (the triceps) slightly touched the chest.

VI. The Importance of Assuming a Proper Grip, Set-up, Posture, Alignment, and Ball Positioning

A. If the club and body are positioned correctly at the start of the swing, the student was told that he had a better chance of making a correct motion.

B. If the club and body were incorrectly positioned at the start of the swing, the entire swinging process would be composed of swing compensations to make up for poor initial positioning.

VII. Individual Help and Error Corrections

Monday, February 22, and Wednesday, February 24

Meeting Place: Gymnastics Area

Class Formation: Three or four rows. Ten feet of space on all sides of each student. Instructor faced the students.

Topics Covered:

1. Review of the "statics."
   a. grip
   b. posture and position
   c. alignment and aim
   d. stance
   e. set-up
2. Demonstration of each swing drill by the instructor. Two repetitions only. As the instructor demonstrated each swing drill, he described the reason the swing drill was important for improved swing technique.
3. After the instructor demonstrated the swing drill, the students were asked to perform the drill. At this time, the instructor made corrections on any student who was not performing the drill correctly. Once the instructor felt that the entire class could perform the drill correctly, he went on to the next drill.

The first 15 drills were taught on Monday, February 22, and the last 15 drills were taught on Wednesday, February 24.

In performing all drills, swing performance was emphasized.

Each student performed every drill at least five times by February 24.

On the dates listed below the kinesthetic instructional method was followed exactly as it is described in Appendix F.

Monday, March 1	Monday, March 29
Wednesday, March 3	Wednesday, March 31
Monday, March 8	Monday, April 5
Wednesday, March 10	Wednesday, April 7
Monday, March 15	
Wednesday, March 17	

Meeting Place: Outside

Class Formation: Three or four rows. Ten feet of space on all sides of each student. Instructor faces students as he demonstrates the drill.

Class Objective: Develop an efficient golf swing by feeling the swing.

Swing Objective: Aim and swing the club along the target line.

Topic Covered: Development of a correct golf swing through the use of swing drills and kinesthetic training techniques.

Procedures Followed:

1. All swing drills were performed exactly as presented in Appendix F. Constant emphasis was placed on swing performance.

2. Once the class was in formation, the instructor started with Drill #3 (The General Motion Drill).

3. The instructor demonstrated each drill before the students were allowed to perform the drill.

4. Each drill was timed by the instructor. Most drills lasted one minute. The last thirty seconds of each drill were performed with the eyes closed. The instructor informed the students when to close their eyes.

5. During the performance of each drill, the instructor gave terminal verbal augmented feedback as to the correctness of the student's previous swing. This was thought to be positively reinforcing and constructively critical.

6. The instructor followed the commentary which gave kinesthetic cues that described which "feelings" the students should try to recognize as they were swinging the club. The students were encouraged to get the "feeling or sensation" that each drill provided.

7. The students were reminded to try to remember how the swing model looked as they were swinging.

Meeting Place: Outside

Class Formation: Three or four rows. Ten feet of space on all sides of each student. The instructor faced the students as he demonstrated the drills.

I. Class Objectives: To develop an efficient golf swing by emphasizing kinesthetic cues and swing "feels" to the student. To emphasize the golf swing and not the results of that swing (ball flight).

II. Swing Objectives: Aim and swing the club along the target line.

III. Topics Covered: Swing drills and limited hitting with eyes closed.

IV. Procedures to be followed:

A. The same procedures as previous classes were used except that after the swing drills were completed the students were given ten balls each to hit with a seven iron. The students were asked to hit these balls with their eyes closed.

B. The emphasis was still on making a correct golf swing. The ball was made incidental to the whole process as the students were told to swing "through" the ball and not "to" the ball.

V. The ball was brought in during the ninth week of training in order:

A. To accustom the student to the ball position so that when he was retested (filmed) he would not focus all his attention on the new stimuli (the golf ball) and forget the importance of making a correct swing.

B. To give the student a "feeling" for the golf ball and how it reacts off the clubface.

C. To give the student a feeling for the set-up, posture, grip, stance, and alignment when the ball was present.

D. To give the student a "feeling" of how far away from the ball to stand when the ball was present.

On the dates listed below, the ball was introduced after the fifty-minute training period.

Monday, April 12

Wednesday, April 14

Monday, April 19

Wednesday, April 21

APPENDIX H

CONTROL GROUP (CONVENTIONAL GOLF INSTRUCTION) DAILY LESSON PLANS

The control group was taught the golf swing using conventional instructional methods. Conventional golf instruction is typically taught outside with a golf ball. The majority of this type of learning takes place through the student's sense of hearing and sight.

Conventional golf instruction makes swing corrections based on ball flight results. This is normally transmitted through verbal cues the student receives from the instructor. The instructor's demonstration of the skill was also a big part of each lesson. After the instructor demonstrated the skill, he described and explained the skill to be learned to the students. Once the students had seen the skill performed by the instructor, they tried to imitate and duplicate the instructor's swing and the fundamentals that were presented. Ball striking was an integral part of this method.

All error correction in conventional golf instruction was based on the flight of the golf ball. For example, if the ball flight was poor, the student relied on his instructor for advice on how to correct that swing error. The instructor gave the student three or four fundamentals that might help the student hit the ball better. This kind of instruction was based on negative feedback mechanisms. In other words, the student was very aware of the errors in his swing but not aware of how to correct those errors. At times, it seemed the student was concentrating on what he should be avoiding rather than concentrating on what he was trying to accomplish. Furthermore, if the ball flight was poor, both the instructor and the student assumed that the swing was also poor, and a swing correction was made. Although learning the golf swing was an important part of the conventional method, hitting the ball long and straight was also an important objective. Knowledge of results (ball flight) was emphasized as much as swing performance with this method.

Since each student in the control group hit at least seventy-five balls during each class period, it was still felt that the student should understand the impact factors or Ball Flight Laws that cause a golf ball to fly straight. These Ball Flight Laws were taught at the beginning of the semester. An understanding of the Ball Flight Laws was thought to help the student to make his own corrections.

During the ten week instructional period, the students in the control group were allowed to practice with all of their clubs. Both the iron club swings and the wood club swings were taught to the students. Since there are a variety of conventional methods that were found to be effective learning tools, a combination of these methods was used. At the beginning of each class, the fundamentals that were being emphasized that day were described and demonstrated. The students were expected to incorporate these new fundamentals into their swings each practice session. After a demonstration, the instructor walked up and down the line giving individual instruction as the students continued to hit balls. Error correction was based on feedback that the student received from the flight of the ball.

Daily Lesson Plan Examples

Thursday, February 4

Meeting Place: Classroom

Topics Presented:

(1) The game--history, values and how to play it.

(2) Parts of the golf course

(3) Terminology

(4) Reading the scorecard

(5) Understanding the equipment and when to use it

(6) Types of play

  (a) medal play

  (b) match play

(7) Understanding the different types of swings and when to use them

  (a) the driver swing--hit the ball on upswing

  (b) the iron swing--hit the ball on downswing

  (c) the chipping swing

(d) the pitching swing

(e) the sand wedge swing

(f) the putt

(8) Handicapping

Tuesday, February 9, and Thursday, February 11

Meeting Place: Classroom

Topics Presented:

(1) Basic rules

(2) Safety

(3) Etiquette

(4) Introduction to Ball Flight Laws or the impact factors that cause a golf ball to go straight

(a) importance of a swing path that is moving in the direction of the target at the point of impact

(b) importance of a face position that is facing the target line at the point of impact

(c) importance of hitting the golf ball in the center of the club face

(d) importance of generating maximum clubhead speed at the point of impact

(e) importance of approaching the ball from the correct angle of attack

(5) Summary and explanation of principles

(a) grip

(b) aim and alignment

(c) set-up and posture

(d) downswing plane

(e) width of arc

(f) length of arc

(g) target wrist position

(h) lever system

(i) timing

(j) release

(k) dynamic balance and footwork

(l) swing center

(m) body turn and body rotation

(n) target side control

(o) tempo

(p) rhythm

(q) body rotation

Tuesday, February 16, and Thursday, February 18

Meeting Place: Auxilary Gymnasium
Room 300 near the golf net

Class Formation: Sem-circle around the instructor

The Pre-Swing Principles

I. The Grip

A. Explanation and Description of the Three Types of Grips

1. The baseball grip
2. The interlocking grip
3. The overlapping grip

B. Discussion of Grip Pressure

C. Verbal Explanation and Demonstration of the Grip

1. Palms face one another
2. The V's formed when the thumbs and forefingers of the two hands should point toward the trail shoulder
3. Back of the target hand and the palm of the trail hand should face toward the target and be lined up with the clubface
4. Hands should be as close to one another as possible when put in the club
5. Target hand grip is a combination palm-finger grip
6. Trail hand grip is a finger grip
7. When placing the target hand on the club, the thumb of the target hand should be placed just to the right of the center of the grip

8. When placing the trail hand on the club, the lifeline of the trail hand should fit snugly on top of the target thumb

II. The Stance--Demonstration

A. Explanation and Description of the Three Types of Stances

1. The open stance--used for short shots, chip shots, and pitch shots
2. Square stance--used for wood shots and long and medium irons
3. Closed stance--not used any more

B. Stance Width

1. Narrow for shorter shots because less leg action is needed
2. Wider (about shoulder width apart) for longer shots because more leg action is needed

III. Ball Positioning--Demonstration

A. Explanation and Description of the Two Basic Ball Positions

B. Ball Positioning for Woods and Long Irons is Off the Target Heel

C. Ball Positioning for the Middle Irons, Short Irons, and Shorter Shots is Off the Middle of the Stance

IV. The Golf Posture--Demonstration

A. Explanation and Description of the Golf Posture and Why It Is Important to Stay in the Golf Posture for the Entire Swing

B. Description of the Athletic Position

1. Slight bend at the knees
2. Weight evenly distributed between the balls and heels of the feet
3. Bend forward from the waist (hips) keeping the back straight until an angle is formed at the spine
4. Importance of keeping the knees bent in the athletic position throughout the entire swinging motion
5. Arms should hand down vertically to the ground

V. Weight Distribution--Demonstration

A. Sixty Percent to Seventy Percent of the Weight Favors the Trail Foot for the Woods and Long Irons

B. Weight is Evenly Distributed for the Middle Irons

C. Weight Favors the Target Leg for the Short Irons and All Shorter Shots

VI. Head Positioning--Demonstration

A. The Head is Positioned Behind the Ball for the Woods and Long Irons

B. The Head is Positioned Over the Ball for Medium and Short Irons

C. The Head is Positioned in Front of the Ball for Chips and Pitches

VII. Arm Positioning--Demonstration

A. The Target Arm, Wrist and Clubshaft Form a Straight Line All the Way Down to the Ball at Address

B. The Hands are Positioned Off the Inside of the Target Leg

C. The Back of the Upper Arms are Resting Against the Chest

D. The Arms Should Be Hanging Down in a Vertical Position with the Trail Arm a Little Closer to the Body than the Target Arm

VIII. Determining the Distance from the Ball--Demonstration

A. Dependent on the Length of the Club and the Amount of Leg Action Needed

1. Stand very close for chips and pitches
2. Stand farther away for full swings

B. Determine Distance from the Ball By:

1. Bend at the knee

2. Bend forward from the hips keeping the back straight and the upper target arm into the chest
3. Let arms hand in a vertical position

IX. Body Alignment--Demonstration

A. Using a Square Stance, the Feet are Lined Up So They are Parallel with the Target Line
B. The Shoulders are Also Lined Up So they are Parallel with the Target Line
C. The Target Shoulder Is Much Higher than the Trail Shoulder

X. Clubface Aim--Demonstration

A. Rest the Club on Ground So It Is Not Resting on Its Toe or Heel
B. Aim the Clubface Where You Want the Ball to End Up
C. Align Your Body to the Clubface

XI. Muscular Tension--Demonstration

A. The Weight Should Be Felt on the Insides of the Feet at Address (stand slightly knockkneed to get this feeling)
B. A Small Amount of Pressure in the Lower Back Area
C. Pressure Can Be Felt on the Insides of the Legs

XII. Student Participation and Error Correction

XIII. Dates of Instruction:

On the dates listed below, conventional methods of golf instruction were used to teach the control group. The student hit at least seventy-five balls during each meeting as a part of the instruction.

Tuesday, February 23	Tuesday, March 30
Thursday, February 25	Thursday, April 1
Tuesday, March 2	Tuesday, April 6
Thursday, March 4	Thursday, April 8
Tuesday, March 9	Tuesday, April 13
Thursday, March 11	Thursday, April 15
Tuesday, March 16	Tuesday, April 20
Thursday, March 18	Thursday, April 22

APPENDIX I

$\underline{t}$ TEST FORMULAS USED FOR COMPARING PAIRED AND UNPAIRED DATA

$\underline{t}$ for unpaired observations ($N_1=N_2$) used to determine the homogeneity of the two groups before instruction and the change (gain) made as a result of instruction.

$S_d^{-2} = 2_s{}^2/N$

$$s^2 = \frac{\Sigma X_1{}^2 + \Sigma X_2{}^2}{2(N-1)}$$

$$\Sigma X_1{}^2 = \Sigma X_1{}^2 - (\Sigma X_1)^2/N$$

$$\Sigma X_1{}^2 = \Sigma X_2{}^2 - (\Sigma X_2)^2/N$$

where:

$S_{\bar{d}}^{2}$	= Variance of the mean
s^2	= Average variance of the samples
$S_{\bar{d}}$	= Standard deviation of the mean
N	= Number in each sample
$\Sigma X_1{}^2$	= Variance of sample 1 squared
$\Sigma X_2{}^2$	= Variance of sample 2 squared

+ for paired observations used to determine within group differences from pre- to posttest

$$S_{\bar{d}}^{2} = \frac{\Sigma(X_1-X_2)^2-[\Sigma(X_1-X_2)]^2/N}{N(N-1)}$$

where:

$S_{\bar{d}}^{-2}$	= Standard deviation of the mean
Σ	= Sum of
X_1	= Scores of group 1

X_2 = Scores of group 2

N = Number of subjects

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