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REACTION AND RESPONSE TIME OF FOOTBALL PLAYERS  
AS AFFECTED BY AN AUDIBLE CHANGE OF PLAY

BY

EDWARD PAUL FINN

A thesis submitted  
in partial fulfillment of the requirements  
for the degree Master of Science, Major  
in Physical Education, South Dakota  
State University

1968

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REACTION AND RESPONSE TIME OF FOOTBALL PLAYERS  
AS AFFECTED BY AN AUDIBLE CHANGE OF PLAY

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor

Date

Head, Physical Education Department

Date

2661-25

REACTION AND RESPONSE TIME OF FOOTBALL PLAYERS  
AS AFFECTED BY AN AUDIBLE CHANGE OF PLAY  
Abstract

EDWARD PAUL FINN

Under the supervision of Professor Ralph Ginn

The purpose of this study was to determine the effects of audible plays at the line of scrimmage on reaction and response time of college football players, in carrying out selected offensive assignments correctly.

The subjects included sixteen experienced football players from the 1967 freshman and varsity football teams at South Dakota State University.

A total of 240 reaction times and 240 response times were measured. Each subject was tested with eight audible and eight non-audible play sequences. Three practice trials were given before testing each individual. Errors were recorded, and the trials in which they occurred were repeated.

The response time and reaction time data obtained were analyzed by employing the paired  $t$  comparison, then determining the significance of the difference between the means at the .01 level of significance. Each subject acted as his own control.

As a result of the statistical analysis of the data obtained, the investigator found non-audible plays to be faster than audible plays, but not statistically significant at the .01 level. Audible plays were also found to produce a greater number of errors in performance.

## ACKNOWLEDGEMENTS

The writer wishes to express his most sincere appreciation to his advisor, Ralph Ginn, Associate Professor Glenn E. Robinson and Doctor W. Lee Tucker for their valuable guidance, supervision and assistance in the completion of this thesis.

The writer also expresses his gratitude to the members of the freshman and varsity football teams who gave of their time and effort in making this study possible.

EPF

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## CHAPTER I

### THE PROBLEM, LIMITATIONS, AND DEFINITIONS OF TERMS USED

In recent years, football coaches have been concerned, for various reasons, over the value of audible signals as an aid to offensive strategy. Two major factors causing this concern are the speed and the accuracy with which a player adjusts to an audible in a game situation. Often it is not the physically superior player who excels but the player who reacts the quickest and is able to gain the better angle, position, or leverage in accurately completing his offensive assignment.

The majority of football coaches will agree that quick reaction time and movement to a starting signal is a major football fundamental. According to "Bud" Wilkinson, "The most important single fundamental of offensive football regardless of the system of play is the starting count. We know of no other single fundamental of the game which will pay bigger dividends than the proper execution of the starting count."<sup>1</sup>

Speed and quickness are a definite advantage to any football team. A team must not only be quick, they must move together.

"Bobby" Dodd, head football coach at Georgia Tech, made the following

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<sup>1</sup>Charles Wilkinson, Oklahoma Split T Football (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1952), pp. 92-97.

statement:

Unless the functions of the individual team members of an offensive line are well coordinated and synchronized to the back-field movements, advancing the ball is an impossible job. . . . An aggressive and well synchronized offensive line can make ball carrying an easy task.<sup>2</sup>

It is the writer's opinion that the majority of coaches agree that they must employ all possible coaching techniques to insure the team's ability to move quickly and in unison in order to achieve peak efficiency.

Although there have been a number of studies investigating starting signals and various types of audible systems, little research has been completed in the area of the effect audibles have on an individual's speed and accuracy of movement.

The single most important drawback to the use of audibles is the lack of simplicity. Coaches constantly ask the question: Can we use audibles and not have broken assignments and a marked loss in performance time? This is an extremely important question in an area where there is very limited research reported.

## I. THE PROBLEM

Statement of the problem. The purpose of this investigation was to determine the effects of audible plays at the line of scrimmage on reaction and response time of college football players in carrying out selected offensive assignments correctly.

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<sup>2</sup>R. L. Dodd, Bobby Dodd On Football (New York: Prentice-Hall, Inc., 1954), p. 57.

Importance of the study. Football, perhaps more than any other area of athletics, places a person in situations where he must react quickly to different stimuli in order to be successful. The significance of quick response to auditory stimuli, as in the case of football starting signals, has been demonstrated by a number of studies. The ability to move quickly to a snap count is the offensive team's most decisive advantage, which compensates for the defensive team being able to use their hands. Can they afford to give up this advantage and still be successful?

It is hoped that the information procured from this investigation may add to and be of some benefit to the football coaching profession.

II. LIMITATIONS OF STUDY

1. The study was limited to sixteen members of the 1967 freshman and varsity football teams at South Dakota State University.
2. Thirty-two offensive plays from the South Dakota State University's football playbook were used in the training program.
3. A number audible system was employed.
4. A rhythmic cadence was used in the study.
5. The training program took place in an enclosed area.
6. Crowd noise and crowd motivation was not taken into consideration.
7. A wide tackle six-two defense was employed in the study.

### III. DEFINITION OF TERMS USED

Reaction Time. The time interval between the quarterbacks' auditory starting signal, which activates the reaction clock, and the instant the subject moves his hand from the reaction pad and stops the reaction clock.

Response Time. The reaction time plus the time interval it takes to complete his assignment by hitting the correct response termination grid, thus stopping the response clock.

Audible. A vocal means of changing a play at the line of scrimmage.

Audible Number System. A system involving the calling of two numbers at the line of scrimmage before the play is run. If the quarterback calls the same number of the play he called in the huddle, the play to be run is changed to the second number. As an example, if play 13 is called in the huddle and the quarterback calls 13, 22 at the line of scrimmage, then play 22 will be run. If he had called 17, 22 there would be no change.

Rhythmic Cadence. An even sequence or flow of sounds. (Ex. hut 1 --- hut 2 --- hut 3 --- hut 4).

Snap Count. The number chosen on which the football is centered.

Error. Off-sides, backfield in motion, or an incorrect response in carrying out the subjects' assignment by contacting the correct termination grid.

Hale Reaction Timer. A commercial instrument used in measuring reaction, performance or response time.

Short-Snap Count. The number on which the football is centered is either one or two in this study.

Long-Snap Count. The number on which the football is centered is either three or four in this study.

## CHAPTER II

### REVIEW OF THE LITERATURE

A survey of the literature revealed that very limited research in the area of audible signals has been reported. This chapter will review the literature that is directly or indirectly related to this study.

#### GENERAL STUDIES OF REACTION AND RESPONSE TIME

In a study by Burley, seventy-seven college male athletes and non-athletes were tested on index finger reaction time to a visual stimulus. Simple and complex signals were used as stimuli. He found that all individuals reacted more slowly to complex stimuli than to a simple stimulus. A greater variation in reaction times was scored by all individuals to the complex stimuli than to the more simple stimulus.<sup>1</sup>

In a comprehensive review of simple reaction time studies, completed by Teickner, the researchers were almost unanimous in reporting faster reaction times for audible stimuli when compared to other means of stimulation. The following statements summarized the representative views regarding simple reaction time:

1. There was a positive correlation between reaction times of visual and audible stimuli.

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<sup>1</sup>L. R. Burley, "The Study of Reaction Times of Physically Trained Men," Research Quarterly, 15:232-239, October, 1944.



2. Reaction time is a negatively accelerated decreasing function of intensity of stimulation up to some maximum intensity.
3. The optimum foreperiod of reaction time is 1.5-8.0 seconds depending on duration and intensity of warning signal, and stimulus; and the duration of muscular tension.
4. Reaction time is not related to length, direction, or speed of movement of responding body parts.
5. The reaction time is positively correlated to the duration or complexity of the response.<sup>2</sup>

According to Henry, when complications such as discrimination between several stimuli and/or choice between several possible movements are introduced, the required time increases and may be as long as .50 seconds. . . . He also hypothesized that with richer and more complicated patterns involved, a longer latent time for the more complicated circulation of neural impulses through the coordination centers is inevitable.<sup>3</sup>

#### PHYSIOLOGICAL FACTORS AFFECTING RESPONSE AND REACTION TIME

According to Thompson, Nagle, and Dobis, it is an accepted physiological fact that when an individual concentrates on the stimulus (starting signal), his reaction time is slower than it is when he concentrates on the response to that stimulus.

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<sup>2</sup>W. H. Teickner, "Recent Studies of Simple Reaction Time," Psychology Bulletin, 51:128-149, September, 1954.

<sup>3</sup>Franklin M. Henry, Donald E. Rodgers, "Increased Response For Complicated Movements and a 'Memory Drum' Theory of Neuromotor Reaction," Research Quarterly, 31:448-459 (October, 1960).

Applying this physiological principle to football, they make the following statement: "We assume that a player would be able to start (charge) faster when he is concentrating on the response (charge) rather than on the stimulus (starting signal)."<sup>4</sup>

Slater-Hammel studied the reaction time needed to release a hand switch after a visual stimulus. He observed that if the stimuli are too close together (50-500 millisec.), the reaction time may be delayed.<sup>5</sup>

Henry makes the following statement regarding measurement error, reliability, and intra-individual differences: "It is clear.... that in the case of reaction times, and movement times when they are as variable as reaction times, the major source of irreliability is variation in the response of the individual rather than in the error of measurement."<sup>6</sup>

A study by Vallerga measured net speed of arm movement made in response to sounds of forty-five, sixty-five, and eighty-five decibels. Thirty-six college men were tested after fifteen to twenty minutes of strenuous exercise. He postulated that a louder and stronger sensory inflow might cause greater excitation of the

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<sup>4</sup>C. W. Thompson, F. T. Nagel, and F. Dobis, "Football Starting Signals and Movement Times of High School and College Football Players," Research Quarterly, 29:222, May, 1958.

<sup>5</sup>A. T. Slater-Hammel, "A Psychological Refractory Period In Simple Paired Responses," Research Quarterly, 29:468-481, December, 1958.

<sup>6</sup>F. M. Henry, "Reliability, Measurement Error, and Intra-Individual Differences," Research Quarterly, 30:21-24, March, 1959.

pyramidal tracts and thus produce a more vigorous muscular response.<sup>7</sup>

"In general, the louder sounds produced faster arm movements and a stronger contraction of muscles."<sup>8</sup>

Cratty in his book has the following statement about performance "set":

Following the impingement of some event upon the attention of the organism, a specific readiness or "set" is produced. During this period, the human performer begins to adjust to the demands of the task, including self-instruction concerning his capabilities to perform the task, the amount or intensity of the impending task, as well as specific related to task performance.<sup>9</sup>

Henry and his co-workers suggest that the more complex the task the individual is "set" for, the longer will be the response time.<sup>10</sup>

#### REACTION AND RESPONSE TIME RELATED TO ATHLETIC ABILITY

The findings of Beise and Peasely indicated that fast reaction time is fundamental to skill in certain activities, but that training did not significantly improve reaction time. Arm reaction time for both groups was faster than leg reaction time, but subjects with

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<sup>7</sup>J. M. Vallerger, "Influence of Perceptual Stimulus Intensity on Speed of Movement and Force of Muscular Contraction," Research Quarterly, 29:93-101, March, 1958.

<sup>8</sup>Ibid.

<sup>9</sup>Bryant J. Cratty, Movement Behavior and Motor Learning (Philadelphia: Lea and Febiger Company, 1964), p. 153.

<sup>10</sup>Franklin Henry, "Increased Response Latency For Complicated Movements and a 'Memory Drum' Theory of Neuromotor Reaction," Research Quarterly, 31:448-457, October, 1960.

faster arm reaction times did not necessarily display faster leg reaction times.<sup>11</sup>

In research by Keller, it was concluded that there was a positive relationship between the ability to move quickly and success in athletics. He also stated that quickness was not needed equally for all sports. Quickness was needed most in team sports where a player was required to react to other players and rapidly changing conditions and less in individual sports.<sup>12</sup>

#### STUDIES RELATED TO FOOTBALL

Wilson in his comparison of quickness of reactions to rhythmic and non-rhythmic visual stimuli found that reaction times were faster with rhythmic signals. Movement time was found not to be related to the type of signal used. Individual differences in quickness of reaction and quickness of movement were almost completely independent.<sup>13</sup>

Thompson, Nagel, and Dobis related movement times of forty-three college and forty high school football players and letter-

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<sup>11</sup>D. Beise and V. Peasely, "Relation of Reaction Time, Speed, and Agility of Big Muscle Groups To Certain Sports Skills," Research Quarterly, 8:137-142, March, 1937.

<sup>12</sup>L. F. Keller, "The Relation of 'Quickness of Body Movement' to Success in Athletics," Research Quarterly, 13:146-155, May, 1942.

<sup>13</sup>D. J. Wilson, "Quickness of Reaction and Movement Related to Rhythmicity or Non-Rhythmicity of Signal Presentation," Research Quarterly, 30:101-109, March, 1959.

winners to rhythmic and non-rhythmic starting signals. Rhythmic signals were significantly faster at the one percent level of confidence. The chronoscope was started manually. Upon reaction to the signal, the subjects were required to take an eighteen inch step to depress a contact plate and stop the timer. Five trials were taken by each subject in the first half of the study. A correlation of 0.86 was obtained between the scores of three and five trials. With this in mind, only three trials were given during the second half of the test.<sup>14</sup>

Miles in studying the reaction time of football players to starting signals found that the rhythmic signals produced the faster reaction times of their respective groups. Off-sides were fewer for the non-rhythmic signals overall.<sup>15</sup>

#### FOOTBALL COACHES' POINT OF VIEW

Modern football coaches are the people who decide on the use of an audible signal system. The writer feels it is important to the reader to be familiar with the importance football coaches place on reaction and response time of football players.

The value that football coaches put on fast reactions receives scientific support from Karpovich. He states, "In sports and

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<sup>14</sup>Thompson, Nagel, Dobis, op. cit., pp. 222-230.

<sup>15</sup>W. R. Miles and B. C. Graves, "Effects of Signal Variation on Football Charging," Research Quarterly, 2:14-31, October, 1931.

games, in which movements of a participant are conditioned by signals, by movements of opponents, or by motion of a ball, reaction time is of great importance."<sup>16</sup>

In a survey conducted by Eaton, thirty-one football coaches in the New England area determined the criteria for good offensive players and teams. A team's ability to move together as a unit was rated very high. The criteria considered to be most important by those surveyed were individual and team speed of reaction, as well as a team's relative reaction speed.<sup>17</sup>

Former head football coach at Georgia "Tech," "Bobby" Dodd, believes that the team with overall speed has the advantage over the opponent. . . . makes this statement regarding the importance of the starting signal and fast reactions.<sup>18</sup>

The offensive individual or team that consistently gets off on the snap of the ball is certain to have a most definite advantage over the defense. Too many offensive men are defeated at this stage of the game without ever having had an opportunity to prove their blocking abilities. Getting the jump on the opponent often means the difference between success or failure on a particular maneuver. . . . if they can control the line of scrimmage, since the defense has to react after they see the ball move.<sup>19</sup>

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<sup>16</sup>Peter V. Karpovich, Physiology of Muscular Activity (Philadelphia: W. B. Saunders Company, 1959), p. 45.

<sup>17</sup>W. N. Eaton, "A Study to Examine the Criteria For Football Offense" (unpublished Master's Thesis, Springfield College, Springfield, Mass., 1961), p. 50.

<sup>18</sup>Dodd, op. cit., p. 37.

<sup>19</sup>Ibid.

Fuoss, assistant coach at Purdue, made the following statements concerning the importance of the starting signal as a fundamental of the game.

While football may be thought of as a game of strategy and deception, reduced to its basic components it is a game of movement and execution of fundamental skills. Other things being equal, proficiency in the fundamentals is the winning edge. . . . the major cause in blocking failure is slow starting or failure to get off on the count.<sup>20</sup>

Nelson, athletic director and head football coach at the University of Delaware, and a member of the National Football Hall of Fame, comments:

Without a doubt the most important item of a signal system is the takeoff signal. . . . Only a perfect takeoff will allow a play to be executed up to its capacity.<sup>21</sup>

A perfect takeoff is one that allows all eleven men to execute their assignments at the proper times and places, with the advantage they have of knowing when the ball will be snapped.<sup>22</sup>

"Bud" Wilkinson, considered as one of the deans of American football coaching, maintains that the signal which gives the most consistent reaction, keeps the players alert and produces the least off-sides is the best signal to use to start a team from scrimmage. If both players are of equal ability, the defensive man's privilege of using his hands should make him superior. The offensive player has only one weapon to offset this advantage: knowing the exact moment

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<sup>20</sup>Donald E. Fuoss, Champion Football Drills For Teaching Offensive and Defensive Fundamentals and Techniques (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964), p. 67.

<sup>21</sup>Dave M. Nelson, Football Principles and Play (New York: Ronald Press Company, 1962), p. 215.

<sup>22</sup>Ibid.

the ball is to be passed.<sup>23</sup> He sums up his feeling by stating, "While only a split second is involved in this reaction, enough time is gained to give the team operating out of a quick-striking offense a substantial advantage over the defense."<sup>24</sup>

#### SUMMARY

There is ample evidence in the literature concerning the relationship of reaction and response time to success in athletics. Football coaches in particular seem to be in agreement that, with all things being equal, the team that moves most quickly and in unison will be successful. The literature also tends to agree that the team that moves more quickly and more accurately will win.

The literature appears to be in agreement that the more complex the task, as in the case of audibles, the longer the reaction and response time. Crowd noise, changing defenses, and mental adjustment to the audible are some of the factors that make this task complex. Thus, the literature seems to agree that when the player is concentrating on these adjustments rather than on the starting count or stimulus, his reaction and response time will decrease.

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<sup>23</sup>Wilkinson, op. cit., p. 96.

<sup>24</sup>Ibid.



## CHAPTER III

### PROCEDURE FOR OBTAINING DATA

#### I. INTRODUCTION

The subjects, the training program, and the instruments for obtaining data are described in this chapter.

#### II. SUBJECTS

Subjects for the study were sixteen members of the 1967 freshman and varsity football teams at South Dakota State University. The subjects were selected according to their offensive positions. A full offensive team consisting of eleven players plus one extra center, guard, tackle, fullback and halfback were chosen. Only one quarterback was employed in the study, in order to reduce the variability in signal calling. The sixteen subjects were members of both the experimental and control group in the study. Each subject acted as his own control.

#### III. TRAINING PROGRAM

Letters were sent to the squad members explaining the study and asking for their assistance on a voluntary basis. After checking class schedules, times and dates for the training program were assigned. Training covered a period of five weeks and consisted of twelve training sessions followed by three days of testing. The

scheduled meeting days were Tuesday and Wednesday of the first three weeks, plus Monday of the final two weeks. The initial training session began on February 20, 1968, and the sessions continued until March 20, 1968.

The players were assigned a playbook, football spikes, and sweat suits. The playbook was a condensed duplicate of the original offensive playbook used by the South Dakota State University football team during the 1967 season. The condensed playbook copy contained thirty-two plays which were selected so as to give each position a variation in assignments.

Upon arriving at the training site, each subject went through a five-minute warm-up period which consisted of jogging, ball handling, and stretching exercises. These exercises were conducted to stretch the major muscle groups of the legs and to reduce the possibility of a pulled muscle because of tightness of the musculature of the legs.

Immediately following the warm-up period, the players lined up in their proper position opposite the dummy defense. The alternates stood behind the offensive team and alternated every other play.

Each session lasted thirty-five minutes and was broken down in the following manner:

1. The first five minutes of each session were spent with the general warm-up exercises.
2. In the following ten minutes, plays from the previous sessions were run from the line of scrimmage with no huddle between plays. Approximately twenty-five to thirty plays were run from this position against a 6-2 dummy defense. No audibles were used at this time.

3. In the next ten-minute period, the new plays were introduced for that day. Again, with no huddle, the play was run first at half speed then at full speed from the line of scrimmage. Three new plays were introduced each night, each one being executed eight times.
4. The last ten minutes were used to review all plays that had been introduced up to that time. The team huddled, the play was called along with the snap count, and the players broke from the huddle and went to their offensive positions. During this session, the quarterback had the option of using audibles. Between ten and twelve audibles were used during this period each session. The quarterback was instructed to vary the starting count between one and four.

The players were instructed to study their playbooks and to bring any questions to the attention of the investigator before the next training session.

For testing, the group was divided into two smaller groups, the interior linemen and the backs and ends. A test schedule was presented to the subjects as to their testing time and date. Only one subject could be tested at a time.

The plays for presentation were not selected randomly from the condensed playbook but were selected according to their variance in assignments for each subject. Plays chosen were assigned audible and non-audible for each player and these in turn were put into rank order and randomly selected for order of presentation.

The order of the snap count presentation was randomly selected in the same manner by assigning a snap count to each play when the plays were randomly selected for presentation. Following this procedure assured the audible and non-audible plays an equal opportunity of going on the same number of long and short snap counts for each subject.



The plays and snap counts were selected randomly for presentation by the track pill box method. A sample play sheet can be found in Appendix A.

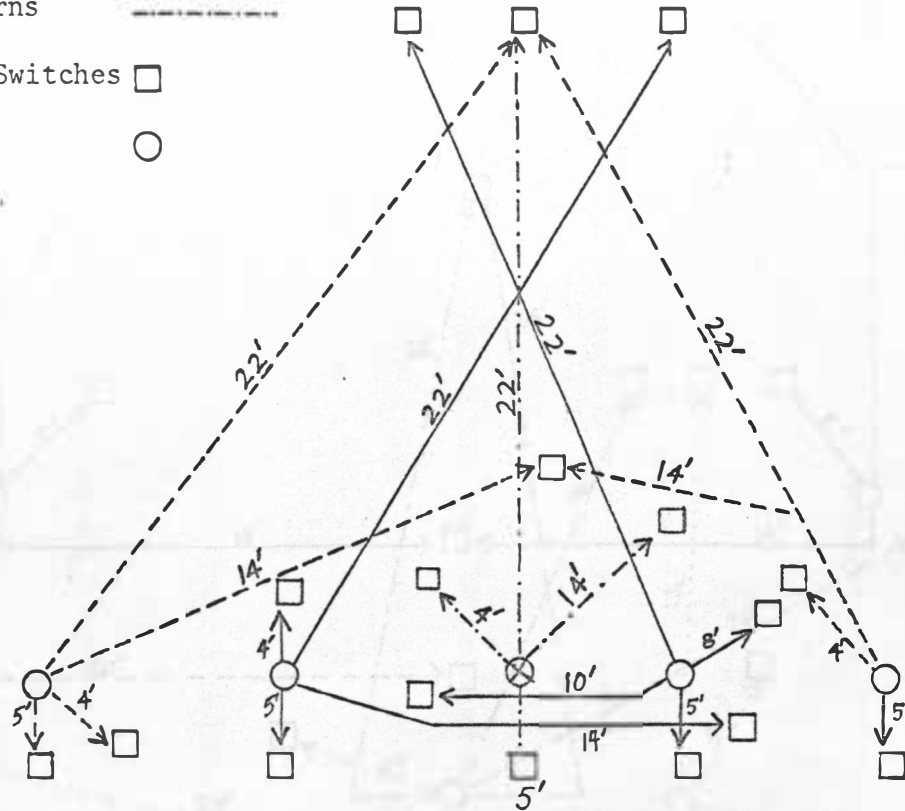
Before the post-test, the subjects were given a brief oral explanation relative to the role they would play in the study. Then each of the subjects was given three practice trials. Upon completion of his practice trials, the subject went to the spot designed as the huddle. The procedure for the audible, as well as the non-audible plays, progressed in the following manner: The play and the snap count were first given to the subject; the subject went to his position and assumed a three-point stance with his hand on the reaction switch pad; the quarterback went to the Hale Reaction Timer, and when the subject was ready, the quarterback began calling the signals and manually activated the time at the correct snap signal; on the verbal stimulus the subject reacted and completed his assignment, and the times were recorded in the appropriate box on the score sheet.

If the subject made an error in the execution of his assignment, a record was made of the infraction by placing a dot in the corner of the correct box of the scoring sheet. In case of an error the recorded times were disregarded, and the play was repeated at the end of his testing period.

There were four performance termination grids placed in areas where the subjects' assignment would end. Each subject ran sixteen plays, with four ending at each of the four termination grids. Two of each set of four plays were audible and two were non-audible so that







Play Patterns

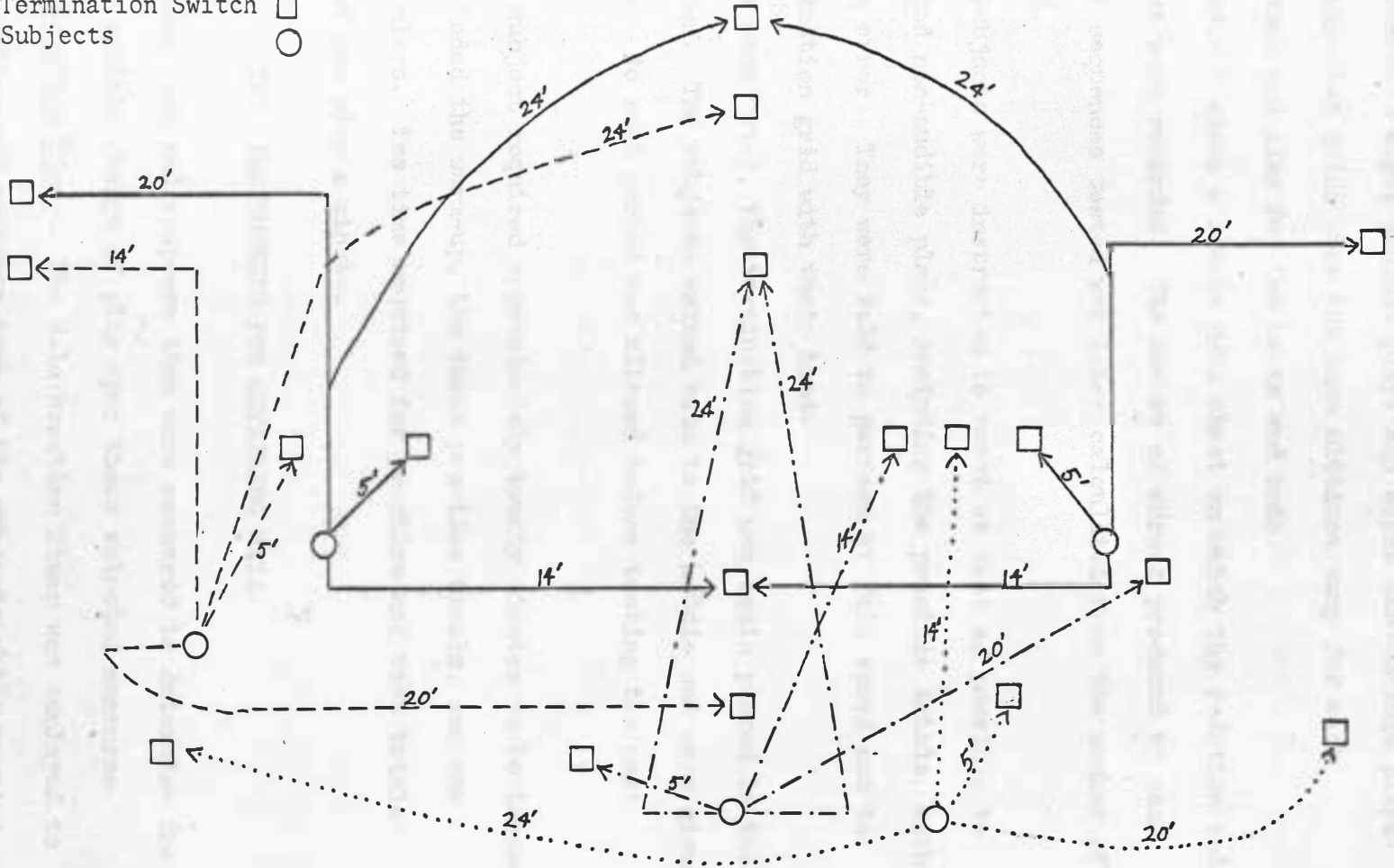
- Tackle Patterns      - - - - -
- Guard Patterns        —————
- Center Patterns        - · - · - ·
- Termination Switches □
- Subjects                ○



# Back And Ends

## Play Patterns

- Wingback Patterns 
- Fullback Patterns 
- Tailback Patterns 
- End Patterns 
- Termination Switch 
- Subjects 



each player executed eight audible plays and eight non-audible plays. The four termination grids were the same distance away for each interior lineman and also for the backs and ends.

Appendix A shows a sample data sheet on which the reaction and response times were recorded. The number of errors produced by each of the signal sequences tested was later calculated from the number of dots recorded.

The subjects were instructed to react as fast as possible to all audible and non-audible plays, including the practice trials, without making an error. They were told to perform at full speed and to hit the termination grid with their hand.

After each trial, the termination grid was again placed in the proper position. The subjects walked back to the huddle and were given the next play. No rest period was allowed before testing the next play.

Each subject required approximately twenty minutes to be tested. This time included the warm-up, the three practice trials, and the sixteen test plays. The time required for practice and test trials averaged about one play a minute.

#### IV. INSTRUMENTS FOR OBTAINING DATA

Reaction time and response time were measured to determine the effects of an audible change of play upon these selected measures.

Hale Reaction Timer. The Hale Reaction Timer was employed to measure the reaction and response time of the subjects while running



their correct play patterns. The times were accurately recorded to the nearest hundredth of a second.

Performance Termination Grid. This instrument was used in stopping the response clock on the Hale Reaction Timer.

Reaction Pad. This instrument was used for stopping the reaction clock on the Hale Reaction Timer when the subject made his initial move.

#### V. TESTING PERSONNEL

Three members of the physical education staff at South Dakota State University were employed as assistants in order to test the subjects accurately. The first assistant recorded the reaction time, response time, and errors, besides giving the quarterback the next predetermined play to be called and the snap count. The second assistant read the correct reaction and response times, accurate to the nearest one hundredth of a second, to the recorder. The third assistant, together with the investigator, observed errors of performance and placed the termination pads back in the proper position following each play.

The reaction clock was started manually by the quarterback on the predetermined snap count given in the huddle.

## CHAPTER IV

### ANALYSIS OF DATA

#### I. INTRODUCTION

Recognizing that quick movement with the snap of the ball on the part of players and teams is very important to offensive football success, the investigator compared the reaction time and response time of football players to an audible and a non-audible play sequence. The writer analyzed the reaction and response time of experienced football players to both the audible and non-audible play. In order to determine whether any significant difference was present between the reaction and response times, the investigator analyzed statistically the difference between the means for each of the four individual distances. The difference between the means of reaction and response times of audibles and non-audibles having a long-snap count and audibles and non-audibles having a short-snap count was also analyzed statistically in an effort to determine whether the selected measures were affected.

#### II. ANALYSIS OF DATA

The paired  $t$  comparison technique was employed by the investigator, as outlined by Steel and Torrie,<sup>1</sup> to compare the

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<sup>1</sup>Robert G. D. Steel and James H. Torrie, Principles and Procedures of Statistics (New York: McGraw-Hill Book Company, Inc., 1960), pp. 78-79.

following mean gain or loss difference between the reaction and response times for audible and non-audible plays. The .01 level of significance was chosen to denote the statistical significant difference between the audible and non-audible play sequence, but the .05 level of significance was also recorded. A statistical coefficient at or beyond the .01 level necessitated rejecting the null hypothesis. Seven degrees of freedom were used in the study when analyzing the scores of the interior linemen. A t value equal to or greater than 3.50 was necessary to reject the null hypothesis. To report the .05 level of significance the t value had to be equal to or greater than 2.36.

Six degrees of freedom were used in the investigation when analyzing the scores of the backs and ends. A t value equal to or greater than 3.71 was necessary for rejecting the null hypothesis. To report the .05 level of significance the t value had to be equal to or greater than 2.45.

Statistical procedures were also applied to the mean gain or loss difference between audible and non-audible plays having a long-snap count and audible and non-audible plays having a short-snap count. The .01 level of significance was chosen to show the statistical significant differences between the audible and non-audible plays having a long or short-snap count, but the .05 level of significance was also recorded.

The sixteen subjects were members of both the experimental and control group in the study. Each subject acted as his own control.

### III. FINDINGS

A total of 240 reaction times and 240 response times was measured in this study. Both the audible and non-audible plays had four respective distances each. Each of the component distances accounted for sixty reaction and sixty response times recorded. The raw data for audible and non-audible plays appear in Appendix C and Appendix D, respectively.

The data from this investigation were analyzed statistically and reported in this chapter.

### IV. RESPONSE TIMES

Backs and ends at four selected distances. In Table I is shown the t value for obtaining response time data of backs and ends, which were recorded for audible and non-audible play sequences. Also shown are the response times for each of the four component distances of the respective play sequences. There were no statistically significant differences; therefore the null hypothesis was not rejected.

Distance	Response Time	t-value	Significance
1	7.57	-1.56	0.12
2	8.28	-1.50	0.14
3	12.26	-1.22	0.23
4	13.10	-1.70	0.10

TABLE I  
SUMMARY OF  $t$  COMPARISON FOR RESPONSE TIME OF BACKS AND  
ENDS AT FOUR DIFFERENT DISTANCES

Distance	Mean Response Time		$\bar{d}$	$s_{\bar{d}}$	$t$
	Non-Audible	Audible			
1	6.61	6.22	.39	.0714	.78 NS
2	9.17	9.46	-.29	.0219	-1.87 NS
3	11.55	12.62	-1.07	.0806	-1.90 NS
4	14.68	14.74	-.06	.0608	-.15 NS

(NS) No statistical significance at the one-percent level.

Interior linemen at four selected distances. The  $t$  value of the data collected on response times of interior linemen was not statistically significant at the .01 or .05 level. The null hypothesis was not rejected. (Table II)

TABLE II  
SUMMARY OF  $t$  COMPARISON FOR RESPONSE TIME OF INTERIOR  
LINEMEN AT FOUR DIFFERENT DISTANCES

Distance	Mean Response Time		$\bar{d}$	$s_{\bar{d}}$	$t$
	Non-Audible	Audible			
1	6.36	7.92	-1.56	.1382	-1.41 NS
2	8.78	9.28	-.50	.0519	-1.25 NS
3	10.08	10.36	-.28	.0519	-.50 NS
4	12.60	13.10	-.50	.0700	-1.06 NS

(NS) No statistical significance at the one-percent level.

## V. REACTION TIMES

Backs and ends at four selected distances. The  $t$  value of the data collected on reaction times of backs and ends was not statistically significant at the .01 or .05 level, as shown in Table III. The null hypothesis was not rejected.

TABLE III  
SUMMARY OF  $t$  COMPARISON FOR REACTION TIME OF  
BACKS AND ENDS AT FOUR DIFFERENT DISTANCES

Distance	Mean Response Time		$\bar{d}$	$\frac{s}{d}$	$t$
	Non-Audible	Audible			
1	.82	.98	-.16	.0346	-.66 NS
2	.89	1.14	-.25	.0300	-1.20 NS
3	.80	1.46	-.66	.0656	-1.34 NS
4	.95	1.02	-.07	.0173	-.58 NS

(NS) No statistical significance at the one-percent level.

Interior linemen at four selected distances. Although the  $t$  value obtained on reaction times at all four distances showed non-audible plays to be faster, the difference was not statistically significant at the .01 or .05 level. The null hypothesis was not rejected. (Table IV)

TABLE IV

SUMMARY OF  $t$  COMPARISON FOR REACTION TIME OF INTERIOR  
LINEMEN AT FOUR DIFFERENT DISTANCES

Distance	Mean Response Time		$\bar{d}$	$s^2_d$	$t$
	Non-Audible	Audible			
1	1.15	1.75	-.60	.0374	-2.05 NS
2	1.36	1.47	-.11	.0200	-.70 NS
3	1.02	1.40	-.38	.0245	-1.92 NS
4	.74	.53	.21	.0223	1.17 NS

(NS) No statistical significance at the one-percent level.

In view of the results, the non-audible plays produced faster reaction and response times than the audible play sequence, but the difference was not statistically significant at the .01 or .05 level.

Next, the investigator sought to examine the effect of audible and non-audible plays run on a long-snap count and audible and non-audible plays run on a short-snap count to determine whether the difference was real or the result of chance.

#### VI. RESPONSE TIME

Interior linemen, backs and ends on short-snap counts. The  $t$  value of the response time data obtained on interior linemen, backs and ends for audibles and non-audible plays executed on a short-snap count was not statistically significant at the .01 or .05 level. The null hypothesis was not rejected. (Table V)

TABLE V

SUMMARY OF  $t$  COMPARISON FOR RESPONSE TIME OF SHORT-SNAP  
COUNTS OF BACKS, ENDS AND INTERIOR LINEMEN

Subjects	Mean Response Time		$\bar{d}$	$s_d$	t
	Non-Audible	Audible			
Interior Linemen	9.25	11.12	-1.87	.1109	-2.21 NS
Backs and Ends	11.13	10.42	-.71	.0877	-1.15 NS

(NS) No statistical significance at the one-percent level.

Interior linemen, backs and ends on long-snap counts. In Table VI is shown the  $t$  value for collecting response time data of interior linemen, backs, and ends, which were recorded for audible and non-audible play sequences run on a long-snap count. There was no statistical significance at the .01 or .05 level; thus the null hypothesis was not rejected.

TABLE IV

SUMMARY OF  $t$  COMPARISON FOR RESPONSE TIME OF LONG-SNAP  
COUNTS OF BACKS, ENDS AND INTERIOR LINEMEN

Subjects	Mean Response Time		$\bar{d}$	$s_d$	t
	Non-Audible	Audible			
Interior Linemen	9.65	10.06	-.41	.0500	-1.02 NS
Backs and Ends	10.61	10.22	.39	.0435	1.29 NS

(NS) No statistical significance at the one-percent level.



## VII. REACTION TIME

Interior linemen, backs and ends on short-snap counts. The  $t$  value collected on reaction time data for short-snap counts of audible and non-audible plays was not statistically significant at the .01 or .05 level. The null hypothesis was not rejected. (Table VII)

TABLE VII

SUMMARY OF  $t$  COMPARISON FOR REACTION TIME OF SHORT-SNAP COUNTS OF BACKS, ENDS AND INTERIOR LINEMEN

Subjects	Mean Response Time		$\bar{d}$	$s_{\bar{d}}$	$t$
	Non-Audible	Audible			
Interior Linemen	1.06	1.46	-.40	.053	-.94 NS
Backs and Ends	1.01	1.52	-.51	.0346	-2.11 NS

(NS) No statistical significance at the one-percent level.

Interior linemen, backs and ends on long-snap counts. The reaction time shows that the  $t$  value of the data obtained was not statistically significant at the .01 or .05 level. The null hypothesis was not rejected. (Table VIII)

TABLE VIII

SUMMARY OF  $t$  COMPARISON FOR REACTION TIMES OF LONG-SNAP  
COUNTS OF BACKS, ENDS AND INTERIOR LINEMEN

Subjects	Mean Response Time		$\bar{d}$	$s_{\bar{d}}$	t
	Non-Audible	Audible			
Interior Linemen	1.05	1.02	.03	.017	.213 NS
Backs and Ends	.69	.78	-.09	.050	-.26 NS

(NS) No statistical significance at the one-percent level.

The breakdown of the observed errors recorded while using audible and non-audible plays, along with the subjects' mean reaction and response times for audible and non-audible plays, appears in Appendix B. It is evident from the obtained scores that audible plays result in more errors than do non-audible plays.

#### IX. SUMMARY OF FINDINGS

The reaction and response time data collected in this investigation were analyzed by calculating a  $t$  value, then determining the significance of the difference between the means at the .01 level of significance.

The findings of the study are as follows:

1. Non-audible plays produced faster response plays at distance two, three, and four. The difference, however, was not statistically significant at the .01 level.
2. The response time of interior linemen was faster for non-audible plays than for audible plays at each of the four

individual distances. The difference was not statistically significant at the .01 level.

3. The reaction time was found to be quicker for non-audible plays than for audible plays of backs and ends at the four selected distances. The difference was not statistically significant at the .01 level.
4. Reaction times for interior linemen at distances one, two, and three showed non-audible plays to be faster, although the difference was not statistically significant at the .01 level.
5. Non-audible plays produced faster response times than audible plays that were executed on short-snap counts for both the interior linemen and the backs and ends. The difference, although being extremely close, was not statistically significant at the .01 level.
6. The response times of interior linemen were faster for non-audible plays than for audible plays having a long-snap count. The response times for both the audible and non-audible plays were less effected when performed on long-snap counts, than the audible and non-audible plays run on short-snap counts. However, the difference was not statistically significant at the .01 level.
7. Non-audible plays produced faster reaction times than audible plays that were executed on short-snap counts for both the interior linemen and the backs and ends. The difference, although being high, was not statistically significant at the .01 level.
8. The reaction times of both the interior linemen and the backs and ends did not show a statistically significant difference at the .01 level for plays run on a long-snap count.

#### X. DISCUSSION OF FINDINGS

Although no statistical significance for reaction and response time was noted the non-audible plays produced faster recorded times than did audible plays. It may also be interesting to note that when response times of audible plays for both groups, the interior linemen

and the backs and ends, were compared to all non-audible plays for both groups, there was a statistically significant difference at the .05 level. However, the fact that the reaction time was unaffected tends to agree with the literature regarding reaction time.

## CHAPTER V

## SUMMARY

## I. PROBLEM

The purpose of this investigation was to determine the effects of audible plays at the line of scrimmage on reaction and response time of college football players in carrying out selected offensive assignments correctly.

## II. DATA

This study, in which the reaction and response times of football players to an audible and a non-audible play were compared, was undertaken at South Dakota State University. The subjects included sixteen experienced football players from the 1967 freshman and varsity football teams at the University.

A total of 240 reaction times and 240 response times were measured. Each subject was tested with eight audible and eight non-audible play sequences. Three practice trials were given before testing each individual. Errors were recorded, and the trials in which they occurred were repeated.

The response time and reaction time data obtained were analyzed by employing the paired  $t$  comparison, then determining the significance of the difference between the means at the .01 level of significance.

### III. FINDINGS

The difference between reaction and response times for audible and non-audible plays was not statistically significant at the .01 level. There was no statistically significant difference between the reaction and response times of audible and non-audible plays run on long or short-snap count.

Finally, the non-audible plays produced thirteen fewer errors, than did the audible plays, which produced seventeen errors.

### IV. CONCLUSIONS

The following conclusions were drawn from this investigation:

1. That audible plays did not decrease reaction and response times significantly at the .01 level.
2. There was no significant difference between audible and non-audible plays run on short-snap counts or the audible and non-audible plays run on long-snap counts.
3. Audible plays produced more errors, seventeen than did non-audible, four.

### V. RECOMMENDATIONS FOR FURTHER STUDY

After completing this investigation, the author recommends further research in the following areas:

1. A study to determine variability of football players' reaction and response times to audible and non-audible plays which are called by different quarterbacks.

2. A study to determine the effect on reaction and response times of football players where the snap count is always the same or predetermined for all audible plays.
3. A study of different audible systems, such as words or numbers, to determine which system produces the fastest reaction and response times of players.

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APPENDIX  
 SERVICE RECORDS

NAME: \_\_\_\_\_  
 GRADE: \_\_\_\_\_  
 SERVICE NO.: \_\_\_\_\_

DATE	DESCRIPTION	STATUS	REMARKS	INITIALS
1	...	...	...	...
2	...	...	...	...
3	...	...	...	...
4	...	...	...	...
5	...	...	...	...
6	...	...	...	...
7	...	...	...	...
8	...	...	...	...
9	...	...	...	...
10	...	...	...	...
11	...	...	...	...
12	...	...	...	...
13	...	...	...	...
14	...	...	...	...
15	...	...	...	...
16	...	...	...	...
17	...	...	...	...
18	...	...	...	...
19	...	...	...	...
20	...	...	...	...

APPENDICES

## APPENDIX A

## Sample Data Form

Name \_\_\_\_\_

Position \_\_\_\_\_

Number \_\_\_\_\_

Plays	Count	Errors	Response Time	Reaction Time
1. T-20 Counter Pass	2			
2. Wing Left 16 Pass	3			
3. Wing Right 46	4			
4. Wing Right 58 -- Wing Right 19 Reverse	3			
5. Wing Right 19 Reverse -- Wing Right 76 Banana	3			
6. Wing Left 16 Pass	1			
7. Wing Left 50 Trap -- Wing Left 17 Fly	1			
8. Wing Right 19 Reverse -- Wing Right 46	1			
9. Wing Right 51 Trap	2			
10. Wing Left 50 Trap -- Wing Left 24 Hand-Off	4			
11. Wing Right 10 Reverse -- Wing Right 58	4			
12. Wing Left 18 Reverse -- Open Left 38 Pitch	2			
13. Open Left 38 Pitch	1			
14. Wing Left 24 Hand-Off	3			
15. Wing Right 51 Trap -- Wing Right 58	2			
16. T-24 Pass	4			

APPENDIX B

Name of Subject, Position Played, Mean Reaction  
and Response Times, and Total Errors

Subject Number	Name	Position	AUDIBLE			NON-AUDIBLE		
			Mean Response Time	Mean Reaction Time	Errors	Mean Response Time	Mean Reaction Time	Errors
1	James Langer	Tackle	1.40	.13		1.08	.08	
2	Bob Frazer	Tackle	1.36	.08	3	1.22	.13	
3	Tom Jones	Tackle	1.62	.23	1	1.37	.12	1
4	Chuck Stan	Guard	1.37	.20	2	1.26	.12	
5	Larry Rosenkrans	Guard	1.24	.17	1	1.25	.19	
6	Larry Kivioja	Guard	1.23	.12		1.12	.13	
7	Bob Kendall	Center	1.01	.12		1.06	.11	
8	Steve Plitt	Center	1.09	.19	2	1.10	.17	1
9	Gary Barnes	End	1.62	.24	4	1.55	.22	
10	Dave Schween	End	1.37	.19		1.53	.13	
11	Mike Langin	Fullback	1.43	.10	2	1.47	.09	1
12	Skys Stanic	Fullback	1.65	.16		1.42	.17	
13	Tim Keller	Wingback	1.67	.16	1	1.61	.11	
14	Barry Loos	Tailback	1.61	.13	1	1.39	.10	1
15	Dennis Pagel	Tailback	1.52	.19		1.40	.06	

APPENDIX C

Non-Audible and Audible Reaction Times in Hundredths of a Second

Subject Number	Audible Trials								Non-Audible Trials							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1	.37	.15	.29	.02	.04	.11	.03	.01	.07	.12	.03	.09	.09	.12	.08	.07
2	.07	.21	.11	.08	.01	.02	.05	.09	.14	.13	.09	.13	.03	.07	.05	.43
3	.77	.17	.31	.06	.02	.15	.11	.28	.04	.07	.30	.18	.01	.28	.05	.03
4	.12	.33	.09	.15	.22	.05	.37	.28	.18	.02	.26	.02	.19	.18	.08	.06
5	.16	.16	.15	.22	.28	.15	.20	.07	.09	.16	.12	.28	.26	.15	.26	.20
6	.10	.08	.03	.23	.15	.30	.01	.04	.25	.24	.16	.10	.13	.07	.11	.03
7	.01	.12	.07	.12	.17	.07	.23	.16	.07	.03	.08	.06	.14	.17	.17	.19
8	.23	.30	.06	.26	.25	.18	.20	.05	.11	.09	.21	1.7	.14	.23	.17	.21
9	.20	.32	.33	.14	.21	.17	.06	.46	.28	.24	.23	.10	.30	.06	.22	.34
10	.05	.18	.11	.41	.09	.25	.29	.30	.14	.12	.22	.15	.04	.14	.15	.06
11	.20	.23	.05	.13	.10	.20	.14	.04	.10	.19	.04	.14	.05	.08	.02	.22
12	.15	.23	.22	.20	.06	.21	.21	.18	.14	.22	.27	.13	.13	.10	.19	.22
13	.06	.27	.20	.11	.07	.09	.17	.21	.08	.06	.24	.03	.05	.11	.04	.12
14	.02	.07	.10	.06	.10	.11	.11	.03	.04	.02	.19	.04	.09	.19	.11	.10
15	.13	.05	.16	.04	.02	.03	1.02	.06	.05	.04	.04	.07	.05	.05	.08	.09

APPENDIX D

Non-Audible and Audible Response Times in Hundredths of a Second

Subject Number	Audible Trials								Non-Audible Trials							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1	1.58	1.05	.95	1.28	.165	1.70	1.32	1.66	.60	1.41	1.66	.63	.63	.60	1.35	1.76
2	1.34	1.10	1.06	1.50	1.75	.67	1.71	.77	1.10	.80	1.63	.77	1.31	1.41	1.74	1.02
3	2.09	.80	2.35	1.55	1.92	1.04	1.96	1.25	1.91	1.95	.93	.83	1.40	1.33	1.07	1.50
4	2.05	1.41	1.86	1.19	1.40	.68	1.01	1.35	1.19	.63	1.40	1.81	1.42	1.30	.70	1.65
5	1.30	.73	1.40	1.05	1.89	1.06	1.83	.68	1.98	1.36	1.23	.91	1.06	1.87	.61	1.00
6	1.78	.95	.90	1.05	1.28	1.15	1.03	1.69	1.09	1.06	1.00	1.29	1.02	1.74	.93	.86
7	1.10	.93	.84	1.20	.95	1.08	.72	1.23	.88	.81	1.35	1.02	1.20	1.20	1.10	.96
8	1.39	.86	1.12	.84	1.33	1.01	.96	1.19	.94	1.20	1.24	1.17	1.23	1.24	.86	.93
9	2.36	1.98	1.39	2.17	1.83	.79	.69	1.47	1.51	.88	.93	2.00	1.89	1.65	2.11	1.44
10	1.75	1.86	1.75	1.01	.53	1.29	1.70	1.30	1.92	1.26	1.31	1.86	1.81	.69	1.73	1.72
11	2.46	1.61	2.24	1.59	.58	1.63	1.54	.52	1.64	.68	1.60	2.24	1.41	.56	1.42	2.20
12	2.33	2.40	1.91	.66	1.60	1.37	.64	1.40	1.56	1.45	2.17	1.30	.55	1.31	.65	2.33
13	1.56	2.04	1.95	1.84	1.52	1.99	1.58	2.06	1.91	1.47	2.01	1.88	1.82	1.90	1.59	1.53
14	1.08	.83	1.92	1.93	1.14	1.48	.87	1.50	2.08	1.45	1.24	.77	1.05	2.24	1.50	.79
15	.93	1.95	2.11	1.43	1.07	.79	2.75	1.13	1.06	1.08	1.53	1.50	.81	.80	2.24	2.14