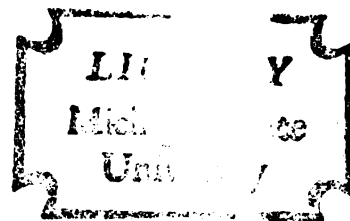


A CINEMATOGRAPHIC COMPARISON OF BLOCKING
PATTERNS IN EXPERIENCED AND INEXPERIENCED
HIGH SCHOOL LINEMEN

Thesis for the Degree of M. A.
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HIGH SCHOOL LINEMEN

By

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CHAPTER I

INTRODUCTION

The ability to move rapidly in many directions is an important characteristic of offensive football linemen. This ability to move forward, backward or to either side is believed to be facilitated by assuming a crouched position most commonly referred to as a three-point stance. However, in recent years, more coaches have preferred to teach the four-point offensive stance. Some of these coaches believe that linemen can move more quickly in a straight ahead direction from the four-point stance than from the three-point stance. Although coaches concede that each type of stance has its advantages, research is not supportive of either position. Fitch (1956) is the only investigator known to have directly compared the movement time of the three-point with the four-point stance. He found that the different stances did not affect the time required to complete the maneuvers tested.

Other investigators did not specifically compare the three-point stance to the four-point stance regarding reaction, movement, or response time from one position to another. Owens (1956), for example, studied the effects

of variations in foot spacing of the three-point stance on movement time, but he did not analyze the four-point stance. Kadatz (1965) analyzed the relationship between weight distribution and charging time, but he too only studied different types of three-point stances.

In several other studies, the response times of linemen were analyzed, but only from one type of stance. Most notably, speed of movement was related to success, fatigue, and type of shoes worn (Manolis 1955, Reading 1961, Krahenbuhl 1974). These factors were shown to have influenced the duration of response time.

Need for the Study

There was no available literature pertaining to any specific attempt to compare the reaction time and movement time of football linemen using a three-point stance to a four-point stance in a cinematographic investigation. While cinematography may have been used in analyzing similar problems, a search of the literature has failed to reveal any instance of a study using high-speed filming (100 fps) in conjunction with a sophisticated timing system. Advantages of this procedure are that a film provides a record that can be repeatedly and minutely examined; and timing lights provide an accurate method of measuring reaction and movement times.

In Fitch's study (1956), the three-point stance was

compared directly to the four-point stance in four different blocking patterns, but only movement time was analyzed. Therefore, this investigation proceeded on the premise that new insights could be gained by separately analyzing the linemen's reaction, movement, and response times. In addition, there was a need to structure a study that (1) compared the three-point to the four-point stance using the same subjects, (2) more closely simulated the actual football situation, and (3) included a comparison of experienced to inexperienced linemen.

Statement of Problem

The primary purpose of this experiment was to determine if the stance (either three or four-point) of offensive linemen influences their ability to move from a stationary position. Subproblems included the following questions: (1) What influence does experience in lineplay have on the ability to move from a stationary stance? and (2) Is the direction of movement (either forward, to the right or to the left) influenced by the type of stance used by the lineman?

Delimitations

The comparisons were limited to two stances, namely, a three-point stance with staggered footing spread shoulder-width apart and the center of gravity established over the center of the base; and a four-point stance with even footing

spread shoulder-width apart and the center of gravity toward the front of the base. These stance variations were selected because they are the most commonly used and because of their obvious contrasting styles.

The analysis was further restricted to three blocking patterns: (1) straight-ahead blocking; (2) pulling to the left and blocking; and (3) pulling to the right and blocking. In a game situation, linemen would incorporate these variations in nearly all of their blocking patterns.

The path that the linemen used to approach their target was prescribed so that the distance from stance to target was identical for all subjects. For the determination of left and right pulling patterns, a blocking sled was placed 15 feet from the center of the subject's original position. For the straight ahead movement pattern, the blocking sled was placed directly in front of the linemen at a distance of three feet.

The linemen were required to execute the same type of block whether moving forward, left or right. The lead block, with the face mask of his helmet striking the blocking sled as the initial contact point, was the standard block used in the study.

Research Hypotheses

Because of the lack of previous research dealing with comparison of the three-point to the four-point stance,

it was a difficult task, if not an impossible one, to accurately predict the outcomes of the experiment. However, on the basis of present evidence, it was hypothesized that:

1. There would be no significant differences in reaction, movement, and response times between the three-point and the four-point stance in moving in any one direction.
 - a. There would be no significant differences with the inexperienced group in reaction, movement, and response times between the three-point and the four-point stance in moving in any one direction.
 - b. Movement from the three-point as opposed to the four-point stance would be significantly faster with the experienced group in reaction, movement, and response times moving in any one direction.
2. Experienced linemen would have significantly faster reaction, movement, and response times than inexperienced linemen using either type of stance in moving forward, left or right.
3. Reaction times would be significantly faster with both groups from either stance when moving forward as opposed to moving to the left or right.
4. Reaction, movement, and response times would be significantly faster with both groups of experience when moving to the right as opposed to moving to the left.
 - a. Reaction, movement, and response times would be significantly faster with both groups when moving to the right as opposed to moving to the left from the three-point stance.
 - b. Reaction, movement, and response times would not be significantly different with both groups when moving to the right or left from the four-point stance.

Research Plan

The sample was taken from a finite population of high school football players. The players were the current and

prospective linemen who attended Port Huron Northern High School in Port Huron, Michigan. Port Huron Northern is a Class 'A' high school with an enrollment of 2000 students. The sample included 10 white male varsity linemen 16 or 17 years of age and 10 white male freshmen linemen 13 or 14 years of age.

The independent variables of this experiment were (1) the three-point and the four-point stances, (2) the three blocking patterns including movements forward, left and right, and (3) the experienced and the inexperienced groups.

The dependent variables were reaction time, movement time, and response time. Each particular time measured depended on which combination of stance, blocking pattern, and group was under consideration.

All of the testing was accomplished on Saturday, September 6, 1975. Filming began at 9:00 a.m. and continued until about 4:00 p.m. on the practice field at Port Huron Northern High School. Each lineman was filmed in two or three trials at 100 frames per second under each of the following conditions:

1. Three-point stance, with movement directly forward.
2. Three-point stance, with movement to the left.
3. Three-point stance, with movement to the right.
4. Four-point stance, with movement directly forward.
5. Four-point stance, with movement to the left.

6. Four-point stance, with movement to the right.

Linemen were given a verbal cue to begin their movement through a rhythmic signal of the quarterback. Upon this pre-arranged signal, a center hiked a ball to the quarterback. The linemen moved from their stance to a stationary blocking sled. Reaction and movement times were determined by timing lights that were placed in view of the camera.

Rationale

It seems logical that the more closely an experimental situation simulates game conditions, the more nearly the results will approximate what might actually take place in a game. In this study, the linemen dressed in the equipment that they would normally wear in a game. A quarterback used audible signals and a center hiked a football to the quarterback. The linemen used the pattern when pulling to the left and right (between the center and quarterback) which would be closely similar to the one most commonly used in a game condition. Furthermore, the entire study was filmed outside on a grass field.

An experienced group of varsity linemen was compared to an inexperienced group of freshman linemen. The experiment was conducted with the assumption that playing experience would influence the proficiency of the players in one of the blocking stances. The varsity linemen had more experience with a three-point than with a four-point stance. It was

thought that this previous training would positively influence the reaction, movement, and response times of the experienced group from the three-point stance. On the other hand, the group of freshman linemen had little experience with either stance. The writer speculated that because the inexperienced group had no extensive instruction in either blocking stance, they would be equally proficient from the three-point stance or the four-point stance.

The linemen were given two trials from both stances in each movement pattern. If they appeared to be offside or out of position, or if for some reason instrumentation failed, then an additional trial was awarded. Though all of the subjects had received some previous training in preparedness for the experiment, the novelty of the test situation may have elicited some hesitation in their movement. Two trials therefore provided a better chance of including the subject's best performance. The trial with the fastest response time was used for scoring purposes.

Assumptions

It was assumed that the linemen were able to keep their weight evenly distributed in the three-point stance and that they were able to keep their weight forward in the four-point stance. It was stressed repeatedly to the linemen that they were to assume a position with the same weight distribution during every trial, relative to the stance being used.

The test situation was not exactly identical to a game situation. The linemen were attacking a stationary sled and not a moving opponent. It is quite possible that the linemen would move to a set object more quickly than they would to a reacting defensive lineman. However, every effort was made to simulate game conditions as closely as possible.

The inexperienced group had received some previous education in blocking stances. Both the freshmen and varsity linemen were given three hours of training with the stances and blocking patterns used in the experiment prior to the day of testing. This helped to familiarize the subjects with the test situation. Therefore, the inexperienced group had in fact received some basic instruction before the investigation.

Limitations

The size and structure of the sample was a definite limitation. Only 20 subjects participated in the investigation and they were highly homogenous in race and background. Unfortunately, the high cost of filming necessitated a small sample size. Over 200 trials were filmed at 100 frames per second. Though the sample size was small, better quality of measurement may have been obtained than if there had been a large sample.

Reaction time, movement time, and response time varied depending on the physical ability of the subjects.

The disposition of the linemen, their attitudes, and their energy levels all could have had an effect on the dependent variables of time. The fact that one group was tested in the morning and the other group in the afternoon could have been a limiting factor. However, all of these factors were difficult to control.

Reaction time was determined from the moment the ball moved to the moment the lineman moved. However, the identical starting signal initiated both reaction time and the subject's movement. When the quarterback called the starting signal, the center hiked the ball to him and the lineman began movement to the blocking target. Thus, reaction time depended on how rapidly the center moved the ball. All measurements of reaction time in this investigation were made with this limitation.

Definitions

Several terms with non-conventional usage are defined below. They include:

1. Movement time--length of time from the initial response of the lineman to the initial contact on the blocking object by the lineman.
2. Reaction time--length of time from the stimulus (signal) to the response (movement) of the lineman.
3. Response time--the sum of reaction time and movement time (mrt); in this experiment, since the distance of the movement patterns is short, used interchangeably with quickness time.
4. Quickness time--in this experiment, since the distance of the movement patterns is short, defined as

the sum of reaction time and movement time (mrt); used interchangeably with response time.

5. Block--to bump an opponent out of the play.
6. Blocking categories--(1) a lineman charging straight ahead from a three-point stance; (2) a lineman moving to the left from a three-point stance; (3) a lineman moving to the right from a three-point stance; (4) a lineman charging straight ahead from a four-point stance; (5) a lineman moving to the left from a four-point stance; and (6) a lineman moving to the right from a four-point stance.
7. Blocking patterns (movement patterns)--straight ahead (forward) blocking; pulling (moving) to the left and blocking; pulling (moving) to the right and blocking.
8. Stance, four-point--a body position assumed when both feet and both hands are in contact with the ground.
9. Stance, three-point--a body position assumed when both feet and one hand are in contact with the ground.
10. Cinematographical analysis--study of movement through the use of motion pictures.
11. Lineman--a player who assumes a position in football within two feet of the horizontal plane of the ball before that ball is moved from the center to the quarterback.
12. Offensive lineman--a lineman on the team in possession of the ball.
13. Quarterback--an offensive player in football who takes the ball from the center to start the play; he normally calls signals and stands directly behind the center.
14. Center--an offensive player in football who initiates each play by moving the ball between his legs to another player situated behind him (usually the quarterback).
15. Staggered footing--a foot position taken by a lineman in his stance when the toes of one foot are touching the same horizontal line as the heel of the other foot.

16. Pulling--a lineman pivoting from his stance with a drop-step to the left or right and moving in a diagonally opposite direction from his original position.
17. Sled--a flat padded structure used by offensive football linemen to practice blocking.

CHAPTER II

REVIEW OF LITERATURE

The related literature pertaining to this study is divided into three general areas: (1) reaction time and movement time; (2) stance; and (3) cinematography. Each area includes a summary and is incorporated in the summary at the end of the chapter.

Reaction Time and Movement Time

Three types of signals are commonly used in experiments that pertain to reaction and movement time. They are called auditory, visual, and kinesthetic signals. It is believed that these signals have a varying effect on the speed of reaction time. An auditory signal is generally considered advantageous for inducing the fastest reaction times. Colgate (1968) analyzed 50 male physical education students at the State University of Iowa by testing their reaction time to three different stimuli. The students were asked to press a switch upon recognition of a light (visual), doorbell (auditory), or electroshock (kinesthetic). Colgate concluded that for both speed of reaction and speed of response, the group means were lower when the subjects

responded to an auditory stimulus than when they responded to a visual or kinesthetic stimulus. Kohfeld's study (1971) supported these findings. He reported that average reaction time to an auditory stimulus was about 40 milliseconds less than to a visual stimulus.

There is some debate as to whether the visual or kinesthetic stimulus is most advantageous. Colgate (1968) determined that there were no significant differences in reaction times in response to a visual or kinesthetic stimulus. However, others have indicated a preference for a kinesthetic stimulus rather than a visual stimulus. Jordan (1972) studied 36 students at Stanford University who had volunteered to participate in a fencing test. He concluded that kinesthetic reaction times were significantly faster than visual reaction times. Chernikoff and Taylor (1952), in a study of responses to a number of complex motor activities, concluded that a kinesthetic stimulus rather than a visual one seemed more beneficial since the kinesthetic route resulted in faster processing of information. Slater-Hammel (1955) studied groups of college students and concluded that reaction time to arm movement was significantly shorter than reaction time to a visual stimulus for all subjects.

The type of auditory signal can have a direct influence on reaction and movement times. In a study specifically related to football, Miles (1931) concluded that in anticipatory signals the players tended to start the charge

at the moment when the ball moved; whereas, in non-anticipatory signals, the linemen moved one-tenth of a second after the ball was moved. Wilson (1959) claimed that the study of Miles had a limitation because Miles did not use a statistical test to claim significance. Therefore, he also studied rhythmic and non-rhythmic signals. Wilson concluded that, when a series of rhythmic signals was presented, the average reaction time was six percent faster than when the signals were non-rhythmic. On the other hand, he concluded that the average movement time was not significantly influenced by the method of signal presentation. In contrast to these findings, Thompson (1958) found that rhythmic digit starting signals precipitated faster movement times than non-rhythmic starting signals. In summary, the type of auditory signal has a direct influence on reaction time, but there is debate concerning its influence on movement time.

The intensity of the auditory signal may have a relation to reaction time. Kohfeld (1969) studied reaction times to 30, 60 and 90-decibel starting signals. He concluded that the mean reaction time systematically decreased with a corresponding decrease in starting signal intensity. In other words, mean reaction time was shortest for the 30-decibel starting signal and longest for the 90-decibel starting signal.

The length of time between the preparatory warning

and the response signal is known as foreplay. The duration of the foreplay period has a direct bearing on the length of reaction time. In a simple reaction time task, Utter (1974) investigated 18 randomly selected college students and found that the shorter the amount of foreplay, the shorter the reaction time. Snodgrass (1969), in a similar study, concluded that any uncertainty caused by changes in foreperiod duration has a direct effect on reaction time. Simply stated then, the longer the span of the foreperiod, the longer the reaction time due to increased uncertainty in the time of stimulus occurrence.

The length of the reaction time period is influenced by several other factors. Remington (1969) determined that when subjects responded to the same stimulus as in an immediately preceding trial, reaction time to a repeated signal was faster than for a changed signal. Slater-Hammel (1960), in an analysis of transit reaction, concluded that the absolute error for performance with immediate knowledge of results was significantly smaller than that for performance without knowledge of results. In a study of the influence of motor and sensory sets on reaction latency, Henry (1960) demonstrated that a subject concentrating on the starting signal had faster reaction times than when he concentrated on necessary movements of the body in order to start. It was the opinion of Henry that an athlete would be quicker if he focused on the starting signal and let the movement take

care of itself. Atwell (1948) used 247 male high school students in 14-, 15-, 16-, and 17-year age groups as subjects for measuring the hand and body response to an auditory stimulus. He concluded that a slight difference exists between hand response time for each high school group with a tendency for more rapid response with increase in age.

Reaction time has been shown to have little, if any, influence on movement time. There have been numerous studies, of which only a few will be mentioned, which have indicated that there is no significant relationship between the ability to react rapidly and the ability to move rapidly. Henry (1952) measured hand reactions and movements and demonstrated that reaction time had no significant relationship with movement time. In an analysis related to fencing, Jordan (1972) noted that a low positive relationship existed between reaction time and movement time ($r=0.28$). Both Lotter (1960) and Smith (1961) concluded that the ability to move an arm or leg quickly had no significant relationship with reaction time for these movements. While there are no studies known comparing reaction time to movement time related to football, it is significant to note that when a lineman begins movement from his stance, usually a hand, arm or leg moves first.

Some factors may affect both reaction and movement time. Norrie (1967) analyzed the effects of practice on variability of reaction and movement times. He discovered that for simple and complex tasks, and for both reaction and

movement times, the intra-individual variability decreased with practice. Simon (1968) studied verbal commands of "right" or "left" which were presented to the subject's right or left ear. His results indicated that reaction time was faster for movements toward the side of the responding member, whereas movement time was faster when movements were directed toward the opposite arm of the responding member.

Several additional elements are known to influence movement time. Schmidt (1969) analyzed elements which increase movement time, e.g., greater distance or slower speed. He concluded that consistency of movement time tends to decrease when time of movement is increased. Kutton (1969) concluded that movement time was significantly affected by the index of movement difficulty, though non-significantly affected by the stimulus information. Grose (1969) studied 51 subjects who performed two coincident timing tasks that required a horizontal arm movement and a whole body movement. The progressive movement involved revealed no identifiable aspects that were related to a successful movement time. Moreover, measures of the subjects' rhythmic progressions were found to be unrelated to the success of a coincident timing task.

In summary, when responses are drawn from auditory, visual, and kinesthetic signals, the auditory signals produce the fastest reaction times, while reaction is more rapid when using kinesthetic signals than when using visual signals.

The probability of a fast reaction time is increased when (1) an auditory signal is given, (2) the intensity of the auditory signal is decreased to 30 decibels, (3) a repeated signal is given as the stimulus in a second trial, (4) the signal is anticipatory in nature, (5) there is immediate feedback of results, (6) the subject concentrates on the signal in contrast to body movement, (7) the stimulus is given from the same side as the direction of the movement, (8) the foreplay period is short, and (9) the subject has received considerable practice in responding to the stimulus. Moreover, reaction times are more consistent in a series of repeated tests.

Reaction time has no significant relation to movement time. However, some factors may affect both reaction and movement time. For example, these times are influenced by the direction an auditory signal is coming from and the amount of practice the subjects may have had before testing.

Movement time tends to be more consistent when (1) short rather than long distances are covered, (2) the subjects move the fastest, (3) the movement pattern is simple, and (4) the subjects have received considerable practice in responding to the stimulus. Movement time is not related to progressive movement or the subject's rhythmic progressions.

Stance

There have been few studies that have directly related

a lineman's stance to starting speed in different blocking patterns. Kadatz (1965) analyzed the weight distribution of 18 university football players from a three-point stance. He demonstrated that the more weight the linemen placed ahead of a line of gravity, the faster they were able to charge straight ahead. More significantly, Kadatz concluded that (1) linemen could pull in either direction equally as fast, and (2) no matter how much weight they placed ahead of a line of gravity, the linemen could also pull as fast as when they had their weight evenly distributed. Robinson (1949), on the other hand, studied backfield men and indicated that pulling to the left from a staggered three-point stance was considerably slower than pulling to the right from the same stance. Owens (1956) analyzed various placings of the hands and feet and their effect on movement time. Though his study was also restricted to the three-point stance, he discovered that the staggered-type stance was superior to the parallel-type stance.

Only one investigator is known to have directly compared the three-point stance to the four-point stance based on relation to starting speed (Fitch, 1956). Fitch concluded that both stances were influential in the maneuvers tested. However, the validity of Fitch's study may be questioned because the same subjects did not participate in both types of stances. Instead, he assumed an equal ability level existed within each group and, as each group performed from

only one type of stance, the results were compared between groups but not between individuals.

In the studies that related stance to starting speed, testing conditions did not simulate game conditions. The subjects did not wear a full set of equipment and they were not required to make contact with a blocking target (Kadatz 1965, Robinson 1949, Owens 1956, Fitch 1956). In addition, Fitch used physical education students as subjects rather than football players. Both Fitch and Owens (1956) tested their subjects on a gymnasium floor.

Fatigue and shoe type are two variables that could influence response times. Reading (1961) measured the effect of fatigue on the speed of linemen in an offensive charge over a distance of 36 inches. He concluded that speed of movement was significantly faster from one factor to another before or after a fatiguing exercise. The Harvard Step Test was used to exercise the subjects between trials. The type of shoes worn could possibly have an effect on response times. Krahenbuhl (1974), in an investigation of speed of movement with varying footwear conditions, found that movement time did not vary significantly when either football cleats or soccer shoes were compared on a natural grass surface. Bauer (1970) measured 24 subjects in a 30-yard sprint on natural grass and noted that when subjects wore low-cut shoes they were .048 seconds faster than when they wore high-top shoes. He conjectured that in forward speed

the low-cut shoes seem to afford a very small advantage to the runner.

Evidence concerning the importance of quickness for effective blocking in football is equivocal. However, fast response times are generally believed to be advantageous. Jones (1961), the veteran line coach of the University of Oklahoma Sooners, stated that "any player who wishes to develop into a starting lineman must constantly make an effort to improve his quickness." Fuoss (1964) declared that "a main cause of blocking failure is starting too slow or failing to make quick contact with the opponent." Rowen (1966) and Patrick (1959) both emphasize the importance of quick movement by all players on the line of scrimmage. In general athletic activities, Keller (1942) found a positive relationship between the ability to move the body quickly and success in athletic activities.

Several studies, on the other hand, have shown quickness to be negatively correlated with blocking effectiveness. Manolis (1955) related charging time to blocking performance and concluded that charging time failed to correlate significantly with ratings of blocking performance. Manolis stated that "accuracy of 'timing' movement is probably more important than speed of response in charging." This study has a limitation since Manolis tested for charging time during practice and rated the subject's performance in game situations. Rosenfield (1951) and Eibel (1952) both indicated that there

was no relationship between speed of charge and the amount of force exerted. Burpee (1936), in a general analysis of 46 subjects, found reaction time to be negatively related to successful participation in physical education activities.

In summary, few investigators have compared the stance of linemen to starting speed. Most of these studies have dealt with the three-point stance only. An exception was Fitch's study (1956), in which he compared the three-point to the four-point stance. Neither fatigue nor shoe type were found to have much effect on response time over a short distance.

It is generally believed that quickness is an important characteristic of offensive football linemen. Though a few studies have indicated that quickness is less important than other factors, the majority of research available is in support of quickness being an advantage to linemen.

Cinematography

The use of cinematography in analyzing sports activities has become increasingly popular, with the development of high-speed cameras. Scott (1973) stated that "the permanent record of a performance provides an ideal way to observe the performer and is necessary to have an accurate record of the passing of time." In addition, the precision and accuracy possible with high-speed photography increases the overall reliability of a study.

There has been only one known cinematographic study with a high-speed camera relating to football. Henrici (1967) analyzed the center snap in the punt. He found that 64 frames per second was fast enough for his purpose of studying the center's body and limb position.

High-speed photography has been used to analyze movement in other sports. For example, Wilson (1972) successfully timed the track starts of eight subjects with use of a high-speed camera and collected data from the pictures taken. Most important, she determined the time differential from a clock in the view of the camera, which is a more efficient method of measurement in cinematography than counting frames.

In short, the use of high-speed cameras in analyzing movements in sports helps to increase the reliability of studies. Advantages are (1) an accurate record of the passing of time, (2) more precision and accuracy in detecting actual movement, and (3) timing lights provide a more accurate method of measurement.

Summary

The first area of the review of literature pertained to reaction and movement time. Factors were discussed that influence the speed of reaction time. The probability of a fast reaction time is increased when (1) an auditory signal is given, (2) the intensity of the auditory signal is decreased to 30 decibels, (3) a repeated signal is given as

the stimulus in a second trial, (4) the signal is anticipatory in nature, (5) there is immediate feedback of results, (6) the subject concentrates on the signal in contrast to body movement, (7) the stimulus is given from the same side as the direction of movement, (8) the foreplay period is short, and (9) the subject has received considerable practice in responding to the stimulus. Reaction time has no significant relation to movement time. The probability of a fast movement time is increased when the stimulus is given from the opposite side as the direction of movement. Movement time tends to be more consistent when (1) short rather than long distances are covered, (2) the subjects move the fastest, (3) the movement pattern is simple, and (4) the subjects have received considerable practice in responding to the stimulus. Movement time is not related to progressive movement or the subject's rhythmic progressions.

The second section of the literature review dealt with studies pertaining to quickness and stance. Speed of the lineman and type of stance were important considerations. Though a few studies existed that questioned the meaningfulness of quickness in movement, the majority favored quickness as being a desirable asset for offensive football linemen. There has been a lack of research dealing with comparison of stances to quickness. The few studies available dealt with the three-point stance only with the exception of Fitch's study (1956). He compared the three-point to the four-point

stance and found no relationship between type of stance used and movement time. Neither fatigue nor shoe type were found to have much effect on response time over a short distance.

Cinematography for sports skills was the topic of section three. Because its use in analyzing sports activities has become most prominent only in the last decade, the number of studies has been limited and none were located that pertained specifically to the problems of this experiment. However, the advantages of cinematography over other methods were enumerated; they are (1) an accurate record of the passing of time, (2) more precision and accuracy in detecting actual movement, and (3) with the use of timing lights, a more efficient method of measurement.

CHAPTER III

RESEARCH PLAN

The primary purpose of this study was to determine if offensive football linemen were faster in moving from a three-point or a four-point stance. Variables of stance, experience, and direction of movement were compared. Sub-problems included the influence of experience on the ability to move from either stance and the influence of the type of stance used on the direction of movement. The methods used in the investigation of these problems are described in this chapter.

Subjects

The subjects included 10 high school varsity offensive linemen 16 or 17 years of age and 10 high school freshman offensive linemen 13 or 14 years of age. All of the subjects were white middle-class males, physically conditioned to play football. All were right side dominant and for the conditions of this experiment they were dressed in a complete set of football equipment and wore low-cut football shoes.

The subjects' prior experience with the two types of stances was an important factor in this investigation. While

the varsity linemen had two years of experience using both types of stances, they had considerably more practice time with the three-point than with the four-point stance. On the other hand, the group of freshmen had only three hours of experience, equally divided between both types of stances.

Sample

It was impossible in this experiment to select a representative sample from the population of all high school football offensive linemen in the world. Because of the limiting factors of availability of subjects and cost of filming, the sample for this study came entirely from Port Huron Northern High School (enrollment of 2000 students) in Port Huron, Michigan. The junior candidates for the offensive line of the varsity football team and the candidates for the offensive line of the freshman football team were asked if they would be interested in participating in the experiment. From each group, 10 linemen volunteered to be subjects. Therefore, it is clear that the sample was probably not typical of the whole population of high school offensive linemen.

The best estimate of variability depends on a large sample size. In this experiment, with the small sample size, the statistical significance of the data was restricted. On the other hand, a carefully tested small sample may permit the investigator to more precisely control the testing

situation and conduct a more thorough assessment and analysis. Furthermore, since the primary purpose of this study was to compare the within-group differences between the three-point and the four-point stances, a large sample size was not as desirable as it might be in an experiment where the variables of time were measured and the raw scores were projected to others in the population without comparison between factors. Nevertheless, the sample had severe limitations. Generalizations from this experiment could not be accurately applied to any other population; that is, all results were restricted to the specific population under investigation. Two factors greatly influenced the selection of the sample; namely, the sample was readily available and the cost of filming in color limited the number of subjects the investigator could film.

Independent Variables

The independent variables of this investigation included (1) the three-point and four-point stances, (2) the experienced and inexperienced groups, and (3) movements forward, left and right. For the primary purpose of the study, the variables of stance were compared under six conditions:

1. Forward movement with the experienced group.
2. Forward movement with the inexperienced group.
3. Movement to the left with the experienced group.
4. Movement to the left with the inexperienced group.
5. Movement to the right with the experienced group.

6. Movement to the right with the inexperienced group.

The second set of variables involved the influence of experience on the ability to move from a stance in a given direction. Levels of experience were studied under the following conditions:

1. Forward movement from a three-point stance.
2. Forward movement from a four-point stance.
3. Movement to the left from a three-point stance.
4. Movement to the left from a four-point stance.
5. Movement to the right from a three-point stance.
6. Movement to the right from a four-point stance.

The third comparison group to be analyzed was the direction of movement. Left, right, and forward directions were compared under the following conditions:

1. Three-point stance with the experienced group.
2. Three-point stance with the inexperienced group.
3. Four-point stance with the experienced group.
4. Four-point stance with the inexperienced group.

Precautions were taken to control stance and distance factors. Since the subjects differed in length of body and limbs, it was not possible to place the subjects in identical stances. However, consistency in weight distribution and hand and foot placing was stressed in directions to each subject throughout the practice sessions and the actual testing. With the right-handed three-point stance, there were

five guidelines to follow: (1) the tip of the subject's right foot touched the same horizontal line as the heel of his left foot, (2) the subject's right hand and head were equally as far forward, (3) the subjects were not leaning in any direction, (4) the center of their stances was lined up with a marker which was directly in front of the subjects' helmets, and (5) feet were spread shoulder-width apart. With the four-point stance, there were also five points of emphasis: (1) the tip of the subject's feet touched the same horizontal line, (2) the subject's hands and neck were equally as far forward, (3) the subjects were leaning forward, (4) the center of their stances was lined up with a marker which was directly in front of the subjects' helmets, and (5) feet were spread shoulder-width apart. Although these factors of stance could not be perfectly controlled, every effort was made to ensure as much consistency as possible from one sequence of testing to the next.

The subjects received training in blocking from the three and four-point stances prior to the day of testing. Both experienced and inexperienced groups had three hours of practice in moving from the two stances in three directions.

Research Design

A four-factor, three-way nested design was used to compare the various relationships. Factor A consisted of the three-point and the four-point stances, factor B consisted

of the experienced and the inexperienced groups of subjects; factor C consisted of forward, left, and right movements; and factor D consisted of replication of the subjects nested in factor B. These factors were analyzed in relation to the dependent variables of reaction time, movement time, and response time.

Conduct of Treatments

The supervisory personnel included Dr. Vern Seefeldt of Michigan State University and the investigator. Dr. Seefeldt was primarily responsible for the photographic situation, while the investigator was principally concerned with the performance of the subjects. He stressed in directions to each subject consistency in weight distribution and hand and foot placing. If the subjects failed to meet the specifications of stance, response to a signal or maximum effort, they were required to repeat the trial. A few of the subjects from each group, while waiting to be filmed, were responsible for assisting with equipment. They helped to move the timing lights and blocking sled to positions that had been predetermined in a pilot study. These subjects also changed the sequence number as each trial was recorded.

The center and quarterback of the varsity team participated in all of the sequences throughout the entire experiment. The center was responsible for hiking a ball to the quarterback and then moving forward several steps in a

customary blocking position. The quarterback called the starting signals, received the ball, and moved back from the line of scrimmage into a forward passing position.

Each series of stances and movements by the lineman was executed according to a procedure that was identical for all trials. When the subject was in an appropriate position, the investigator gave a ready signal at which time the quarterback moved behind the center and called the signal "set." Upon hearing the "set" command, the lineman moved into his stance by dropping from a crouched position on his feet to the three-point stance or by rising from his knees to the four-point stance. The quarterback used a rhythmic starting signal. After calling "set," he paused and called the signal "hut" which was the signal for the center to hike the ball to him and for the lineman to begin his movement toward the target.

The target of the lineman's movement was a flat padded surface on a blocking sled. The linemen used the face mask of their helmets to hit a clearly marked target area on the blocking surface. Correct positioning of the sled and timing lights in relation to the camera, football, center, and quarterback was necessary in order to gather the required data. In the test of movement time directly forward, the blocking sled was placed so that its surface was 36 inches from the face of the subject, when he was set in the appropriate blocking stance. For each lineman,

stance adjustments were conducted prior to the filmed trial to ensure consistency of the distance the lineman had to move to reach the target. Timing lights were placed behind the subject and the sequence numbers were placed on top of the timing lights. The camera on its tripod was placed approximately 20 feet away from, and opposite to, the right side of the subject. The football was placed on the ground slightly in front and to the left of the lineman. The quarterback and center were also situated to the left of the subject (see Figure 3-2).

For the lateral blocking patterns, the sled was placed to the left or right so that its blocking surface was exactly 15 feet from the center of the lineman's stance. The timing lights and sequence numbers were situated between the camera and the lineman to the left of the line of view. For both patterns, the camera was located within 25 feet of the most distant object and at an appropriate angle (determined in a pilot study) so that the subject and necessary paraphernalia could be clearly viewed. When the linemen were required to move to the right, the center and quarterback were placed to the right of the subject. The ball was placed in view of the camera on the side of the center and quarterback (see Figure 3-3).

The experiment took place on Saturday, September 6, 1975, at Port Huron Northern High School in Port Huron, Michigan and all of the testing was consummated on that day.

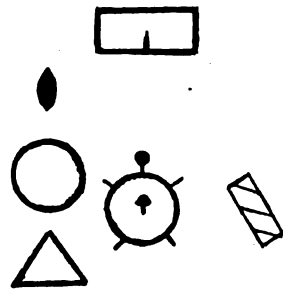
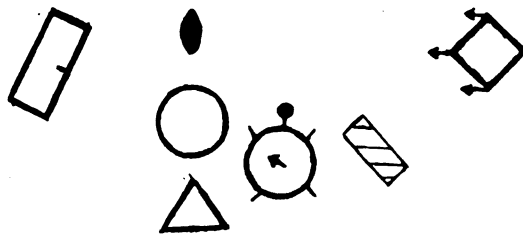


Figure 3-2.
Photographic situation for
recording the reaction and
movement times of subjects
when blocking in a forward
direction.

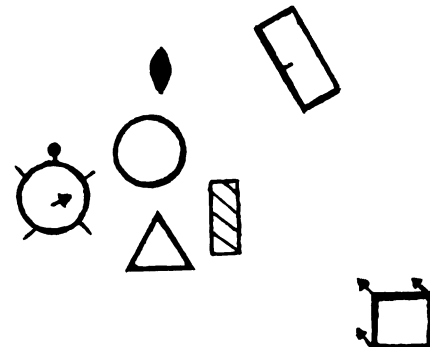
Key:

- lineman -
- center -
- quarterback -
- blocking sled -
- football -
- timing lights & sequence numbers -
- camera -



Left

Figure 3-3.
Photographic situation for
recording the reaction and
movement times of subjects
when blocking in a left or
right direction.



Right

The testing was done outside on a grass-covered field beginning at 9:00 a.m. and terminating at 4:00 p.m. The schedule of events is shown in Figure 3-4.

```

8:30 - 8:45 -- equipment set-up.
8:45 - 9:00 -- subjects warm-up.
9:00 - 9:45 -- inexperienced linemen, forward, 3 & 4 pt.
9:45 - 10:00 -- equipment change.
10:00 - 10:45 -- inexperienced linemen, right, 3 & 4 pt.
10:45 - 11:00 -- equipment change.
11:00 - 11:45 -- inexperienced linemen, left 3 & 4 pt.
11:45 - 12:00 -- equipment change.

12:45 - 1:00 -- subjects warm-up.
1:00 - 1:45 -- experienced linemen, forward, 3 & 4 pt.
1:45 - 2:00 -- equipment change.
2:00 - 2:45 -- experienced linemen, right, 3 & 4 pt.
2:45 - 3:00 -- equipment change.
3:00 - 3:45 -- experienced linemen, left, 3 & 4 pt.
3:45 - 4:00 -- collect equipment.

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Figure 3-4. Schedule of events for the photographic recording of the reaction and movement times of football linemen.

Dependent Variables

Reaction time, movement time, and response time were the dependent variables of this investigation. Reaction time was determined from the moment the ball moved to the moment the lineman moved. Movement time was determined from the time the lineman moved until he contacted the target on the blocking sled. Response time was determined by summing the reaction time performance. The preference for rhythmic over non-rhythmic starting signals has been discussed in the review of literature.

Data Collection

Instrumentation included a high-speed movie camera and timing lights. Stringent controls for calibration were built into the operating mechanisms of both pieces of equipment. Moreover, it was possible to count frames at various intervals and compare them with movement on the timing lights to determine if the camera speed was consistent with the movement of the lights.

It was essential to control factors that influenced camera performance. First, the camera was positioned so that its angle and distance from the subject and blocking sled were identical for both experienced and inexperienced groups in any particular blocking pattern. Second, the camera speed was set at 100 frames per second, which was fast enough to clearly determine when movement of the ball and subject occurred, and to identify, within one-hundredth of a second, specific frames of ball movement, subject movement, and contact with the blocking sled. Third, appropriate camera shutter and aperture setting adjustments were made to optimize prevailing light conditions.

A box of timing lights was placed in view of the camera, in order to properly measure the lineman's movement times. With this particular timing device, lights glowed to indicate numerical order. The box contained four rows of lights with 10 lights in each row corresponding to 10 digits. The lights on the top row represented seconds, the second

row represented tenths of a second, the third row represented hundredths of a second, and the fourth row represented thousandths of a second. Since the speed of the camera was set at 100 frames per second, it was possible to read only the top three rows of the timing lights. Caution was taken in positioning the lights to assure that the glare of the sun did not obscure their visibility. In the event that the lights in some of the sequences were not visible, the necessary information could still be calculated by counting the frames per second of those sequences where the lights were visible and then transferring that information to the film in which the lights were not visible. Sequence numbers were located on top of the timing lights so that the trials could be identified. Each trial in the experiment had a unique sequence number.

Actual scoring, recording, and collection of the data was done by viewing the film sequences with a frame-by-frame projector. Each sequence or trial contained three frames that were essential to the calculation of reaction and movement times; they were (1) the frame in which the ball first moved, (2) the frame in which the lineman first moved, and (3) the frame in which the lineman initially contacted the blocking sled. When viewing the film, if it was noticed that a lineman started his charge before the ball moved or if he was not set in his stance, then the lineman was counted as illegally in motion and that sequence was eliminated. Only once was a sequence actually eliminated because a lineman

started his charge before the ball moved. On the other hand, if the lineman moved during the same frame as the ball or if the ball moved before the lineman moved, then the sequence was considered a true representation of the lineman's ability. For each movement pattern and stance, the trial in which the lineman had the fastest response time was used for scoring.

Treatment of Data

The relationships of reaction time, movement time, and response time to the independent variables were each studied with a separate analysis of variance (ANOVA). The F-ratio was the statistic used to determine the significance of all main and interaction effects. Whenever significant values were obtained, the Scheffé test was used to locate the sources of significance. The level of significance for the analyses of variance was set at .20, while for the Scheffé test it was set at .25. With this high level of significance, there was a tendency to minimize the beta level. Thus, a greater probability existed of detecting significant differences in time between the various factors when in fact they may not have existed (type I error). On the other hand, if a low level of significance and a high beta level had been used, the probability of failing to detect significant differences when in fact they existed would have increased (type II error). In this study, it was more desirable to commit a type I error than a type II error. For example, if in reality

there was no difference between the three-point and the four-point stance, the consequences of a type I error would be to teach a particular stance when there was no difference between them anyway. But if a type II error was made, the consequences of failing to detect a real difference between the stances could result in erroneously teaching the less effective stance.

Pilot Study

A pilot study was conducted about a month before the actual experiment. A single lineman was filmed in two trials with each of the six blocking categories. The purpose of the study was to answer the following four questions: (1) Could the equipment and subject be situated so that a camera could record the required information? (2) Could stance factors be controlled? (3) What was the minimum speed of the camera necessary to clearly see movement and to read the row of timing lights that corresponded to one-hundredth of a second? and (4) Was the speed of the camera consistent in relation to the timing lights?

The questions posed in the pilot study were answered affirmatively; therefore, the experiment proceeded as outlined in this chapter. It was found that the equipment, subject, center, and quarterback could all be suitably positioned in relation to the camera in order to gain the desired data. The two stances and the various directions of movement could

be controlled within the limitations of the study. A camera speed of 100 frames per second was sufficient to gain the required data and was also convenient, since movement from one frame to the next coincided with the movement of one light on the third row of the timing lights. Finally, by counting frames and comparing them with movement on the timing lights, it was determined that camera speed was precisely consistent. When analyzing the film from the actual experiment, it was possible to use the same procedure at various intervals to check the consistency of the equipment.

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CHAPTER IV

RESULTS

The purpose of this investigation was to determine the effects of stance, experience, and direction on the ability of offensive linemen to move from a crouched position to a given blocking target. The results of tests for significant differences within stance, experience, or direction under various conditions in reaction time, movement time, and response time will be reported.

A planned progression of tests was utilized to compare the variables of stance, experience, and direction, and to detect if significant differences existed between them. The first procedure was to apply analyses of variance (ANOVA) to determine if significant differences existed within the general categories of stance, experience, and direction (see Table 1). Wherever significant differences were found within these variables in reaction time, movement time, and response time, the investigation proceeded with variance analyses for interactions between the factors of stance, experience, and direction. These variables were compared under the following conditions: (1) stance and direction (see Table 3); (2) stance and experience (see Table 5); (3) direction and experience (see Table 8); and (4) stance, experience, and

Table 1. Summary of variance analyses for differences in means within variables of stance, experience, and direction in reaction time, movement time, and response time.

	Source of Variance					
	Stance n=60, df=1		Experience n=60, df=1		Direction n=40, df=2	
Reaction Time	3-point	4-point	exp.	inexp.	left	right fwd.
	.094	.106	.078	.123	.108	.107 .086
	F-statistic=.339 (probability)		F-statistic=.005* (probability)		F-statistic=.167* (probability)	
Movement Time	3-point	4-point	exp.	inexp.	left	right fwd.
	.976	1.027	.923	1.080	1.322	1.252 .430
	F-statistic=.005* (probability)		F-statistic=.001* (probability)		F-statistic=<.0005* (probability)	
Response Time	3-point	4-point	exp.	inexp.	left	right fwd.
	1.070	1.134	1.001	1.204	1.431	1.360 .516
	F-statistic=<.0005* (probability)		F-statistic=<.0005* (probability)		F-statistic=<.0005* (probability)	

* significant at the .20 level.

direction (see Table 11). Each condition was tested for significance in reaction time, movement time, and response time. Finally, if these analyses of variance revealed significant differences between the independent variables in a particular type of time, then the Scheffé test was applied to determine the specific conditions of significance.

The Scheffé test was used to analyze comparisons of pairs of scores between variables within stance, experience, or direction under a specific condition of one or both of the other variables (see Table 2). For example, the three-point stance was compared to the four-point stance under various conditions of experience and/or direction. Comparisons were also made between variables of experience, and between variables of direction. These comparisons within stance, experience, and direction were made for reaction time, movement time, and response time. However, in movement and response times, scores were not included that involved comparisons between movement in a forward direction and left or right movement. Testing between these movements involved comparison of movement and response times based on distances between three and fifteen feet. Thus, these comparisons were eliminated.

Stance, Experience, and Direction (ANOVA)

Table 1 shows a summary of the variance analyses within the variables of stance, experience, and direction

Table 2. Summary of all main and interaction effects to be analyzed with the Scheffé test within stance (3,4), experience (E,I), and direction (L,R,F), in reaction time, movement time, and response time.

Comparison	Time	Conditions
3 - 4	reaction, movement, & response times	main effect; F; R; L; E; I; E,L; I,L; E,R; I,R; E,F; I,F.
E - I	reaction, movement, & response times	main effect; 3; 4; F. R; L; 3,F; 3,R; 3,L; 4,F; 4,R, 4,L.
L - R	reaction, movement, & response times	main effect; 3; 4; E; I; 3,E; 3,I; 4,E; 4,I.
F - L	reaction time	main effect; 3; 4; E; I; 3,E; 3,I; 4,E; 4,I.
F - R	reaction time	main effect; 3; 4; E; I; 3,E; 3,I; 4,E; 4,I.

in reaction time, movement time, and response time. The information in Table 1 includes comparisons of the group means for different conditions of stance, experience, and direction; and the statistical significance of factors within that particular variable.

Statistical analyses indicated that there were significant differences between the means of the three-point and the four-point stance in movement and response times. Under these conditions of time, movement from the three-point stance was found to be significantly faster than movement from the four-point stance. In reaction time, however, there was no significant difference between the two types of stances.

A comparison of the experienced group to the inexperienced group revealed that experienced linemen were significantly faster than inexperienced linemen in reaction time, movement time, and response time. The F-statistic probability of all of these differences was .005 or under.

Data on the comparisons of means within direction, presented in Table 1, indicated that reaction, movement, and response times were significantly fastest when the linemen moved forward, as compared to when they moved to the left or right. When comparing movements to the left or right, there was no significant difference in reaction time, whereas movement to the right was significantly faster than movement to the left in movement and response times.

Stance and Direction

The analyses of variance for stance and direction is presented in Table 3. With the level of significance for the study set at .20, significant differences between interaction effects of stance and direction existed in movement time only. The probability of the F-statistic was greater than .20 for reaction and response time and therefore differences in these times between interaction effects of stance and direction were not significant.

Reaction Time

Table 3 shows the mean scores for stance and direction in reaction time. Note that reaction time is lower from the three-point than the four-point stance in forward and right movements, but is higher in movement to the left. From the three-point stance, the order of movement times from fastest to slowest was in forward, to the right, and in a left direction. From the four-point stance, the order of movement times from fastest to slowest was to the left, forward, and in the right direction. However, none of these differences in reaction time were significant since the analysis of variance for stance and direction revealed an F-statistic (.224) greater than .20.

Movement Time

The results of the Scheffé test for movement time

Table 3. Summary of variance analyses for differences in the three-point and four-point stance within and between left, right, and forward factors of direction and for differences in direction of movement within and between three-point and four-point factors of stance.

Direction	REACTION TIME		MOVEMENT TIME		RESPONSE TIME	
	Stance		Stance		Stance	
	3-Point	4-Point	3-Point	4-Point	3-Point	4-Point
Left	.121	.096	1.270	1.375	1.391	1.470
Right	.090	.125	1.241	1.265	1.331	1.389
Forward	.073	.099	.416	.444	.490	.543
	n=40 degrees of freedom=2 mean square=.0106 F-statistic=1.560 F-statistic probability=.224		n=40 degrees of freedom=2 mean square=.0210 F-statistic=3.051 F-statistic probability=.060*		n=40 degrees of freedom=2 mean square=.0019 F-statistic=.4422 F-statistic probability=.646	

*Significant at .20 level.

in stance and direction are shown in Table 4. The information in this table includes comparisons (in pairs of scores) within stance or direction under a specific condition of the other; and the Scheffé value for stance and direction in movement time.

The statistical analyses indicated that significant differences existed in two out of three cases within variables of stance. Movement from a three-point stance was significantly faster than from a four-point stance in forward movement and movement to the left. Movement to the right, however, resulted in no significant difference between the three-point and the four-point stance.

A comparison of within-direction means in movement time revealed that movement to the right was faster than movement to the left. This relationship was significant with the four-point stance, but not with the three-point stance.

Response Time

The analysis of variance comparing interaction effects between stance and direction in response time revealed that no significant differences existed (see Table 3). The probability of the F-statistic was .646. However, moderate differences existed between the means. Movement from the three-point as opposed to the four-point stance elicited faster response times in left, right, and forward movements.

Table 4. Summary of the Scheffé test(s) for differences in means between the three-point and four-point stance within left, right, and forward factors of direction and for differences in means between left and right directions of movement within factors of stance in movement time.

M O V E M E N T T I M E				
D i r e c t i o n				
Stance	Left	Right	Forward	
3	1.270	1.241	.416	
4	1.375	1.265	.444	

Comparison & Condition	Means	Diff. (Ψ)	Scheffé Value	Significance
three-point to four-point stance in left direction	1.270-1.375	$\Psi=.105$	.070	1.05>.070**
three-point to four-point stance in right direction	1.241-1.265	$\Psi=.024$	.070	.024<.070
three-point to four-point stance in forward direction	.416- .444	$\Psi=.028$	.070	.028<.070
movement from right to left in three-point stance	1.241-1.270	$\Psi=.029$	.070	.029<.070
movement from right to left in four-point stance	1.265-1.375	$\Psi=.110$	.070	.110>.070**

** Significant at the .025 level.

Also, movement was faster to the right than to the left with both the three-point and the four-point stance. On the basis of the ANOVA test, however, it was assumed that neither stance provided an advantage in the directional maneuvers.

Stance and Experience

Table 5 shows a summary of the analyses of variance for stance and experience in reaction time, movement time, and response time. The probability of the F-statistics revealed that significant differences existed between the interaction effects of stance and experience in movement time (.140) and response time (.059), but not in reaction time (.859).

Reaction Time

The means of the three-point stance were lower than the means of the four-point stance with both experienced and inexperienced groups. Moreover, the means of the experienced group were lower with both stances than the means of the inexperienced group. However, the analysis of variance (see Table 5) for reaction time in comparison of interactions between stance and experience indicated that none of these differences were significant at the .20 level.

Movement Time

The analysis of variance indicated that significant

differences existed in movement time as it was influenced by stance and experience factors. Application of the Scheffé test determined which pairs of relationships within factors of stance and experience were significantly different. A summary of these tests on the factors of stance and experience is shown in Table 6.

The results of the Scheffé tests for the influence of stance on the factors of experience, between groups of linemen with experience and without, revealed that the experienced group was significantly faster than the inexperienced group in all comparisons made between them with both stances. Note that the differences of the means in movement time were far above the minimum value (Scheffé) needed to claim significance (see Table 6).

Data on within-stance differences between the three-point and the four-point with the influence of experience are also presented in Table 6. The inexperienced linemen were significantly faster from the three-point than from the four-point stance. On the other hand, there were no significant differences between means in movement time from the three-point or the four-point stance with the experienced group.

Response Time

A summary of the mean values obtained in comparison of stance to experience is shown in Table 5. The analysis

Table 5. Summary of variance analyses for differences in the three-point and four-point stance within and between levels of experience and for differences in levels of experience within and between three-point and four-point factors of stance.

Years of Experience	REACTION TIME		MOVEMENT TIME		RESPONSE TIME	
	3-Point	4-Point	3-Point	4-Point	3-Point	4-Point
2	.073	.082	.910	.937	.983	1.019
0	.116	.130	1.042	1.118	1.158	1.249
	n=60		n=60		n=60	
	degrees of freedom=1 mean square=.0001 F-statistic=.0324 F-statistic probability=.859		degrees of freedom=1 mean square=.0183 F-statistic=2.380 F-statistic probability=.140*		degrees of freedom=1 mean square=.0216 F-statistic=4.073 F-statistic probability=.059*	

*Significant at the .20 level.

Table 6. Summary of the Scheffé test(s) for differences in means between experienced (2 years) and inexperienced (0 years) groups within factors of stance and for differences in means between the three-point and four-point stance within levels of experience in movement time.

Stance	M O V E M E N T T I M E		E x p e r i e n c e	
	2 Years		0 Years	
3	.910		1.042	
4	.937		1.118	

Comparison & Condition	Means	Diff. (Ψ)	Scheffé Value	Significance
experienced to inexperienced group in three-point stance	.910-1.042	$\Psi=.132$	.049	.132>.049*
experienced to inexperienced group in four-point stance	.937-1.118	$\Psi=.181$	.049	.181>.049*
three-point to four-point stance with experienced group	.910- .937	$\Psi=.027$	.049	.027<.049
three-point to four-point stance with inexperienced group	1.042-1.118	$\Psi=.076$	.049	.076>.049*

*Significant at the .025 level.

of variance revealed that significant differences existed in response time at the .20 level. The Scheffé test was then used to detect the source of differences for specific pairs of comparisons between the factors within stance and experience (see Table 7).

The statistical analyses indicated that differences were evident in the identical comparisons within stance and experience in response time. A summary of these relationships follow: (1) the response times of the experienced group were significantly superior to the inexperienced group from both types of stance; (2) the experienced group did not differ significantly in response times from the three-point or the four-point stance; and (3) the inexperienced linemen were significantly faster from the three-point as opposed to the four-point stance in response times.

Experience and Direction

The variance analyses between the interactions of experience and direction revealed probability levels of .122, .520, and .165 for reaction time, movement time, and response time, respectively. Therefore, based on the .200 level of significance set for the study, differences existed in reaction time and response time, but not in movement time. Table 8 shows a summary of the analyses of variance for the influence of experience on direction and direction on experience.

Table 7. Summary of the Scheffé test(s) for differences in means between experienced (2 years) and inexperienced (0 years) groups within factors of stance and for differences in means between the three-point and four-point stance within levels of experience in response time.

R E S P O N S E T I M E				
E x p e r i e n c e				
Stance	2 Years		0 Years	
3	.983			1.158
4	1.019			1.249

Comparison & Condition	Means	Diff. (Ψ)	Scheffé Value	Significance
experienced to inexperienced in three-point stance	.983-1.158	Ψ=.175	.039	.175>.039*
experienced to inexperienced group in four-point stance	1.019-1.249	Ψ=.230	.039	.230>.039*
three-point to four-point stance with experienced group	.983-1.019	Ψ=.036	.039	.036<.039
three-point to four-point stance with inexperienced group	1.158-1.249	Ψ=.091	.039	.091>.039*

*Significant at the .025 level.

Table 8. Summary of variance analyses for differences in levels of experience (either 0 or 2 years) within and between left, right, and forward factors of direction and for differences in direction of movement within and between levels of experience.

Direction	REACTION TIME		MOVEMENT TIME		RESPONSE TIME	
	2 Years	0 Years	2 Years	0 Years	2 Years	0 Years
Left	.095	.122	1.236	1.409	1.331	1.531
Right	.069	.146	1.169	1.337	1.238	1.482
Forward	.070	.103	.365	.495	.435	.598
	n=40		n=40		n=40	
	degrees of freedom=2 mean square=.0073 F-statistic=2.232 F-statistic probability=.122*		degrees of freedom=2 mean square=.0056 F-statistic=.6661 F-statistic probability=.520		degrees of freedom=2 mean square=.0162 F-statistic=1.895 F-statistic probability=.165*	

*Significant at the .20 level.

Reaction Time

The analysis of variance indicated that significant differences existed in reaction time as it was influenced by direction and experience factors. Application of the Scheffé test identified the pairs of relationships within factors of direction and experience that were significantly different. A summary of these findings is shown in Table 9.

No significant differences existed within directions of movement with either level of experience. The experienced group had lower values of reaction time in forward and right movements compared with movement to the left, but the differences were not significant. The experienced group was faster in movement to the right as opposed to forward movement. The inexperienced group was fastest in reaction time when moving forward, slightly slower when moving to the left, and slowest when moving to the right. However, these differences were not statistically significant. Thus, the tests indicated that within each group of experience, direction had no influence on reaction time.

The influence of direction on experience was also tested. The experienced group was significantly faster in reaction time when moving to the right than the inexperienced group. However, in left and forward movements, there were no significant differences between the experienced and the inexperienced groups.

Table 9. Summary of the Scheffé test(s) for differences in means between experienced (2 years) and inexperienced (0 years) linemen within left, right, and forward factors of direction and for differences in means between directions of movement within levels of experience in reaction time.

R E A C T I O N T I M E				
D i r e c t i o n				
Experience	Left	Right	Forward	
2 years	.095	.069	.070	
0 years	.122	.146	.103	

Comparison & Condition	Means	Diff. (Ψ)	Scheffé Value	Signif.
experienced to inexperienced group with left movement	.095-.122	Ψ=.027	.049	.027<.049
experienced to inexperienced group with right movement	.069-.146	Ψ=.077	.049	.077>.049*
experienced to inexperienced group with forward movement	.070-.103	Ψ=.033	.049	.033<.049
left to right movement with experienced group	.095-.069	Ψ=.026	.049	.026<.049
left to right movement with inexperienced group	.122-.146	Ψ=.024	.049	.024<.049
forward to right movement with experienced group	.070-.069	Ψ=.001	.049	.001<.049
forward to right movement with inexperienced group	.103-.146	Ψ=.043	.049	.043<.049
forward to left movement with experienced group	.070-.095	Ψ=.025	.049	.025<.049
forward to left movement with inexperienced group	.103-.122	Ψ=.019	.049	.019<.049

*Significant at the .025 level.

Movement Time

The probability of the F-statistic for comparisons between interactions of experience and direction in movement time was .520 (see Table 8). With the level of significance set at .20, all differences in movement time for experience and direction were insignificant. Nevertheless, note that the experienced group was moderately faster than the inexperienced group for all directional comparisons. Moreover, both groups had lower mean times when moving to the right as opposed to moving to the left.

Response Time

Table 10 shows a summary of the Scheffé test for the influences of experience on direction and direction on experience in response time. Significant differences between factors of experience and direction existed in response time and, though these differences were insignificant in movement time, similarities existed between all comparisons made in response and movement times.

A comparison of experience within direction of movement indicated that significant differences existed. In forward, left, and right movement the experienced linemen had significantly lower mean response times than the inexperienced linemen.

The findings revealed that comparisons between left and right movements within levels of experience were

Table 10. Summary of the Scheffé test(s) for differences in means between experienced (2 years) and inexperienced (0 years) linemen within left, right, and forward factors of direction and for differences in means between directions of movement within levels of experience in response time.

Experience	R E S P O N S E T I M E			
	D i r e c t i o n			
	Left	Right	Forward	
2 Years	1.331	1.238	.435	
0 Years	1.531	1.482	.598	

Comparison & Condition	Means	Diff. (Ψ)	Scheffé Value	Significance
experienced to inexperienced group with left movement	1.331-1.531	Ψ=.200	.079	.200>.079*
experienced to inexperienced group with right movement	1.238-1.482	Ψ=.244	.079	.244>.079*
experienced to inexperienced group with forward movement	.435- .598	Ψ=.163	.079	.163>.079*
right to left movement with experienced group	1.238-1.331	Ψ=.093	.079	.093>.079*
right to left movement with inexperienced group	1.482-1.531	Ψ=.049	.079	.049<.079

*Significant at the .025 level.

significantly different for the experienced subjects, but not for the inexperienced subjects. The experienced group was significantly faster in moving to the right than to the left, while there was no significant difference between left or right movement with the inexperienced group.

Stance, Experience, and Direction

The variance analyses within factors of stance, experience, and direction revealed probability levels of .481, .300, and .122 for reaction time, movement time, and response time, respectively. Thus, significant differences existed in response time, but not in reaction time and movement time. Table 11 shows a summary of the analyses of variance for interactions within stance, experience, and direction based on varying conditions of the other two variables.

Reaction Time

Comparisons of interactions between stance, experience, and direction in reaction time were not significantly different as indicated by the analysis of variance (.481). Nevertheless, there was evidence of many important relationships (see Table 11). For example, note that the experienced group was moderately faster than the inexperienced group in all directions from both the three-point and the four-point stance. With both experienced and inexperienced groups, reaction time in movement to the left was moderately faster from the

Table 11. Summary of variance analyses for interactions within and between factors of stance (three-point and four-point), experience (0 years or 2 years), and direction (left, right, or forward).

	Three-Point Stance		Four-Point Stance		F-Statistic Probability
	Experience		Experience		
	2	0	2	0	
REACTION TIME					
Left	.098	.144	.092	.099	.481
Right	.052	.128	.086	.163	
Forward	.069	.077	.070	.129	
MOVEMENT TIME					
Left	1.209	1.331	1.262	1.487	.300
Right	1.154	1.328	1.184	1.345	
Forward	.366	.467	.364	.523	
RESPONSE TIME					
Left	1.307	1.475	1.354	1.586	.122*
Right	1.206	1.456	1.270	1.508	
Forward	.435	.544	.434	.652	

*Significant at the .20 level.

four-point than from the three-point stance. On the other hand, with both levels of experience, reaction time was moderately lower from the three-point than the four-point stance when moving forward or to the right. In comparison of left to right movement, the inexperienced group from a four-point stance was faster in moving to the left than moving to the right. However, the experienced subjects from both types of stances were faster in movement to the right as opposed to movement to the left.

Several additional insignificant interactions in reaction time are worthy of mention. They involve differences between forward movement and movement to the left or right under various conditions of stance and experience. With the experienced linemen in a three-point stance, forward movement was moderately faster than movement to the left, but movement to the right was moderately faster than movement in a forward direction. With the inexperienced linemen in a three-point stance and the experienced linemen in a four-point stance, lower values of reaction time existed in forward movement than in left or right movements. Finally, with the inexperienced subjects in a four-point stance, the order of reaction times were in left, forward, and right movements, respectively.

Movement Time

The results of the analysis of variance for stance, experience, and direction in movement time indicated that any

differences between means were not significant (see Table 11). Results revealed, however, that the experienced linemen were moderately faster than the inexperienced linemen in all directions from both the three-point and the four-point stance in movement time. In five out of six cases under conditions of experience and direction, movement from the three-point stance was faster than movement from the four-point stance. An exception was that the experienced subjects, in a forward pattern, were faster from a four-point as opposed to a three-point stance. In addition, both inexperienced and experienced groups were moderately faster moving to the right than to the left from both types of stances.

Response Time

The results of the Scheffé test for interactions within factors of stance, experience, and direction in response time based on conditions of the other two variables are presented in Table 12, Table 13, and Table 14, respectively. The study of the pertinent interactions of stance, experience, and direction was limited to 16 pairs of comparisons, based on the following conditions: (1) between factors of experience within specific conditions of stance and direction; (2) between factors of stance within specific conditions of experience and direction; and (3) between factors of direction within specific conditions of experience and stance.

Table 12. Summary of the Scheffé test(s) for differences in means between experienced (2 years) and inexperienced (0 years) groups within left, right, and forward directions of movement; and within the three-point or the four-point stance in response time.

Experience	Three-Point Stance			Four-Point Stance		
	Direction			Direction		
	Left	Right	Forward	Left	Right	Forward
2	1.307	1.206	.435	1.354	1.270	.434
0	1.475	1.456	.544	1.586	1.508	.652

Comparison & Condition		Means	Diff. (Ψ)	Scheffé Value	Significance	
experienced to inexperienced group with left movement from the three-point stance		1.307-1.475	$\Psi=.168$	.115	.168>.115*	
experienced to inexperienced group with right movement from the three-point stance		1.206-1.456	$\Psi=.250$	.115	.250>.115*	
experienced to inexperienced group with forward movement from the three-point stance		.435- .544	$\Psi= .109$	.115	.109<.115	
experienced to inexperienced group with left movement from the four-point stance		1.354-1.586	$\Psi=.232$	.115	.232>.115*	
experienced to inexperienced group with right movement from the four-point stance		1.270-1.508	$\Psi=.238$	.115	.238>.115*	
experienced to inexperienced group with forward movement from the four-point stance		.434- .652	$\Psi=.218$	.115	.218>.115*	

*Significant at the .025 level.

Table 13. Summary of the Scheffé test(s) for differences in means between the three-point and the four-point stance within levels of experience; and within left, right, and forward factors of direction in response time.

Experience	Three-Point Stance			Four-Point Stance		
	Direction			Direction		
	Left	Right	Forward	Left	Right	Forward
2	1.307	1.206	.435	1.354	1.270	.434
0	1.475	1.456	.544	1.586	1.508	.652

Comparison & Condition			Means	Diff. (Ψ)	Scheffé Value	Significance
three-point to four-point stance with the experienced group moving to the left			1.307-1.354	$\Psi=.047$	.115	.047<.115
three-point to four-point stance with the experienced group moving to the right			1.206-1.270	$\Psi=.064$	.115	.064<.115
three-point to four-point stance with experienced group moving forward			.435- .434	$\Psi=.001$	.115	.001<.115
three-point to four-point stance with the inexperienced group moving to the left			1.475-1.586	$\Psi=.111$	.115	.111<.115
three-point to four-point stance with inexperienced group moving to the right			1.456-1.508	$\Psi=.052$	.115	.052<.115
three-point to four-point stance with inexperienced group moving forward			.544- .652	$\Psi=.108$	.115	.108<.115

*Significant at the .025 level.

Table 14. Summary of the Scheffé test(s) for differences in means between left and right directions of movement within levels of experience; and within factors of stance in response time.

Experience	Three-Point Stance			Four-Point Stance		
	Direction			Direction		
	Left	Right	Forward	Left	Right	Forward
2	1.307	1.206	.435	1.354	1.270	.434
0	1.475	1.456	.544	1.586	1.508	.652

Comparison & Condition			Means	Diff. (Ψ)	Scheffé Value	Significance
right to left movement with experienced group from a three-point stance			1.206-1.307	$\Psi=.101$	.115	.101<.115
right to left movement with experienced group from a four-point stance			1.270-1.354	$\Psi=.084$	.115	.084<.115
right to left movement with inexperienced group from a three-point stance			1.456-1.475	$\Psi=.121$	.115	.121>.115*
right to left movement with inexperienced group from a four-point stance			1.508-1.586	$\Psi=.078$	.115	.078<.115

*Significant at the .025 level.

Two out of three comparisons between factors of experience showed significant differences in response time (see Table 12). From both the three-point and the four-point stance, the experienced subjects were significantly faster on the average than the inexperienced subjects when moving forward. On the other hand, in movement from the three-point stance, there was no significant difference in moving forward between the experienced and the inexperienced subjects.

Experience and direction were analyzed within factors of stance (see Table 13). When the three-point stance was compared to the four-point stance in any direction with either group of experience, no significant differences were found between the stances. Though the three-point stance was a moderately faster starting position than the four-point stance in five out of six comparisons, these differences were not statistically significant.

Statistical analyses of factors within direction indicated that no significant differences existed in response time (see Table 14). The response times of both groups of experience from both stances were similar in movement to the right and movement to the left. Movements in a forward direction were not compared to left or right movements in response time.

Summary of Results and Discussion

A brief summary of all interactions analyzed in this study is shown in Table 15. A discussion of these interactions within the factors of stance, experience, and direction for reaction time, movement time, and response time will be reported.

Stance

The comparisons were limited to two types of stance. One stance was a three-point with staggered footing spread shoulder-width apart and the center of gravity established over the center of the base. The other stance was a four-point with even footing spread shoulder-width apart and the center of gravity toward the front of the base. There were three hypotheses in this experiment relating to stance; they were (1) there would be no significant differences in reaction, movement, and response times between the three-point and the four-point stance in moving in any one direction, (2) there would be no significant differences with the inexperienced group in reaction, movement, and response times between the three-point and the four-point stance in moving in any one direction, and (3) movement from the three-point as opposed to the four-point stance would be significantly faster with the experienced group in reaction, movement, and response times moving in any one direction.

Table 15. Summary of all main and interaction effects within stance (3,4), experience (E,I), and direction (L,R,F) in reaction time, movement time, and response time.

	Reaction Time	Movement Time	Response Time
Stance (***)	3-4	**3-4	**3-4
	3-4, F	*3-4, F	3-4, F
	3-4, R	*3-4, R	3-4, R
	4-3, L	3-4, L	3-4, L
	3-4, E	3-4, E	3-4, E
	3-4, I	*3-4, I	*3-4, I
	4-3, E, L	3-4, E, L	3-4, E, L
	4-3, I, L	3-4, I, L	3-4, I, L
	3-4, E, R	3-4, E, R	3-4, E, R
	3-4, I, R	3-4, I, R	3-4, I, R
	3-4, E, F	4-3, E, F	4-3, E, F
	3-4, I, F	3-4, I, F	3-4, I, F
Experience (***)	**E-I	**E-I	**E-I
	E-I, 3	*E-I, 3	*E-I, 3
	E-I, 4	*E-I, 4	*E-I, 4
	E-I, F	E-I, F	*E-I, F
	*E-I, R	E-I, R	*E-I, R
	E-I, L	E-I, L	*E-I, L
	E-I, 3, F	E-I, 3, F	*E-I, 3, F
	E-I, 3, R	E-I, 3, R	*E-I, 3, R
	E-I, 3, L	E-I, 3, L	*E-I, 3, L
	E-I, 4, F	E-I, 4, F	*E-I, 4, F
	E-I, 4, R	E-I, 4, R	*E-I, 4, R
	E-I, 4, L	E-I, 4, L	E-I, 4, L
Direction (***)	**F- ^L _R	**R-L	**R-L
	F-R, 3	R-L, 3	R-L, 3
	F-L, 3	*R-L, 4	R-L, 4
	R-L, 4	R-L, E	*R-L, E
	L-R, 4	R-L, I	R-L, I
	R-L, E	R-L, 3, E	R-L, 3, E
	L-R, I	R-L, 3, I	R-L, 3, I
	R-L, 3, E	R-L, 4, E	R-L, 4, E
	R-L, 3, I	R-L, 4, I	R-L, 4, I
	R-L, 4, E		
	L-R, 4, I		
	F-L, 3, I		
	R-F, 3, E		
	F-L, 3, E		
	F-R, 4, I		
	L-F, 4, I		
	F-R, 4, E		
	F-L, 4, E		

*Significant at the .25 level.

**Significant at the .20 level (main effect).

***faster factor listed first for each pair of comparisons.

Reaction Time

There were no significant differences between the three-point and the four-point stance in reaction time (see Table 15). The hypothesis was therefore accepted for the inexperienced group, but rejected for the experienced group. Though there were no significant differences, there were moderate differences in the magnitude of the values between the two stances. In both forward and right movement, reaction time from a three-point stance was faster than from a four-point stance with both levels of experience. On the other hand, in movement to the left, reaction time was faster from a four-point stance than from a three-point stance with both levels of experience. Because the subjects were right side dominant and used a right-handed three-point stance, these results in comparisons between the three-point and the four-point stance were anticipated in left and right movements. Also, because the experienced linemen were trained extensively in the three-point stance, it had been anticipated that reaction time for them in forward movement would be more favorable from the three-point as opposed to the four-point stance.

Movement and Response Time

The three-point stance was found to be a significantly faster starting position than the four-point stance in movement and response time (see Table 15). Thus, the hypothesis

that there would be no significant differences between the stances was rejected. This evidence refutes Fitch's (1956) finding that the two types of stances equally affected the maneuvers tested.

The three-point stance resulted in significantly faster movement than the four-point stance with the inexperienced linemen in movement and response times. Thus, the hypothesis that there would be no significant differences between the stances was rejected. It had been expected that the inexperienced linemen would be equally as fast from both types of stance. Apparently they adapted better to the three-point than the four-point stance. The experienced linemen were also faster from the three-point as opposed to the four-point stance, but not significantly so. Thus, the hypothesis that the experienced linemen would be significantly faster from the three-point than the four-point stance was rejected. This moderate difference was less than expected, since the experienced linemen had previous training in the three-point stance.

It was hypothesized that there would be no significant differences between the three-point and the four-point stance in moving in any one direction. In movement to the right, this hypothesis was supported. However, the three-point stance was significantly superior to the four-point stance in forward and left movement. In these directions, the hypothesis of no differences between stances was rejected.

This result also refutes the finding of Kadatz (1965) who concluded that a starting position with weight ahead of a line of gravity was conducive to faster movement times than a starting position with weight even with a line of gravity in a forward direction. However, this condition was evident with the inexperienced group only. The experienced linemen, in a forward direction, were slightly faster from the four-point than the three-point stance in movement and response times. Therefore, with the experienced group, the finding of Kadatz (1965) was supported. The writer speculates that, on the basis of this evidence, the three-point may possibly be a less difficult stance to learn than the four-point stance. In addition, there were no significant differences between the three-point and the four-point stance within levels of experience and left or right directions of movement (see Table 15).

Experience

The subjects were equally divided between two levels of high school experience: (1) freshman linemen with no previous training and (2) varsity linemen with two years of training. It was hypothesized that experienced linemen would have significantly faster reaction, movement, and response times than inexperienced linemen using either type of stance in moving forward, left or right.

Reaction Time

The experienced subjects were faster than the inexperienced subjects under all conditions of stance and direction (see Table 15). Nevertheless, the hypothesis that experienced linemen would be significantly faster in reaction time than inexperienced linemen was supported in only a few comparisons. The main effect between experienced and inexperienced groups was significant, as well as the interaction in levels of experience with movement to the right. However, only moderate differences were evident in other interactions between levels of experience in stance and direction. In these cases, the hypothesis of significant differences between groups was rejected.

The results of comparison of within-experience factors in reaction time were supported by Atwell (1948) and Norrie (1967). Atwell concluded that reaction time involved a more rapid response in 16- and 17-year age groups than in 14- and 15-year age groups. Norrie's investigation revealed that intra-individual variability decreased with practice. In this study, the experienced linemen had much more practice than the inexperienced linemen with both stances.

Movement and Response Times

The main effect of experience resulted in the experienced subjects being significantly faster than the inexperienced subjects in both movement and response times (see Table 15). The experienced linemen were significantly

faster than the inexperienced linemen with both the three-point and the four-point stance in movement and response times. Other significant differences existed in response time only. The experienced group was significantly faster than the inexperienced group under all conditions of stance and direction in response time with one exception (four-point stance in a forward direction). In all of these cases the hypothesis of significant differences between levels of experience was supported. The writer speculates that these differences existed because of the greater physical maturity of the experienced group and their greater amount of practice as opposed to the inexperienced group. Also, the experienced group of juniors included subjects proven in the skills of lineplay. Some of the less skillful members of the inexperienced group may never reach a level of skill that will permit them to participate as varsity linemen during their junior year.

There were no significant differences in many interactions between levels of experience. However, moderate differences in favor of the experienced group were evident in all of these cases. In movement time, under all other conditions of stance and direction not previously discussed, the experienced linemen were moderately faster than the inexperienced linemen. In response time, with the three-point stance moving forward, the experienced group was moderately faster than the inexperienced group. For these

comparisons, the hypothesis of significant differences in levels of experience was rejected.

Direction

The linemen were analyzed moving in three different directions; they were: (1) forward over a distance of three feet; (2) to the left over a distance of 15 feet; and (3) to the right over a distance of 15 feet. It was hypothesized that reaction times would be significantly faster when moving forward as opposed to moving to the left or right with both levels of experience and from either type of stance. It was also hypothesized that reaction, movement, and response times would be significantly faster with both groups of experience when moving to the right as opposed to moving to the left. Finally, it was hypothesized that reaction, movement, and response times would be significantly faster when moving to the right as opposed to moving to the left from the three-point stance; whereas there would be no significant differences between left and right movement from the four-point stance.

Reaction Time

The main effect of direction revealed that reaction time in a forward movement was significantly faster than in movement to the left or right (see Table 15). This result supported the writer's research hypothesis. The writer

speculated that since forward movement was less complex than left or right movement, reaction time would be faster. Quite possibly, in relation to Henry's (1960) theory, the linemen in forward movement could more easily focus on the starting signal and be able to concentrate less on necessary movements of the body than in left or right movement.

Interactions in direction under varying conditions of stance and experience indicated that no significant differences existed in reaction time between forward and left or right movements. In these specific cases, the hypothesis that reaction time in forward movement was significantly faster than in left or right movement was rejected. Only moderate differences existed in the cases when forward movement was faster than left or right movement in reaction time.

Slower values of reaction time in the forward pattern as opposed to the left or right pattern existed under two conditions. With the experienced group in a three-point stance, reaction time was faster for right movement than for forward movement. This probably resulted from the experienced groups' extensive background with the three-point stance and their right side dominance. The other exception was that with the inexperienced group from a four-point stance, reaction time was faster in left movement than in forward movement. There is no logical explanation for this occurrence. However, none of these differences were statistically significant.

There were no significant differences between left and right movements in reaction time. Thus, the hypothesis that movement to the right would result in significantly faster reaction time than movement to the left was rejected. This hypothesis was also rejected for movements from the three-point stance. On the other hand, it was hypothesized that reaction time would not be significantly different with both groups when moving to the right or left from the four-point stance. Therefore, the hypothesis was accepted for the four-point stance.

Movement and Response Times

The main effect of direction indicated that in both movement and response times, movement to the right was significantly faster than movement to the left. Thus, the hypothesis was supported for the main effect. However, note that in all interactions, movement to the right was faster than movement to the left (see Table 15), but there were few cases of significant differences. Only moderate differences existed between right and left movements from the three-point stance, in both movement and response times. Therefore, the hypothesis that there would be significant differences in these comparisons was rejected. It was also hypothesized that there would be no differences in right and left movement in movement and response times from a four-point stance. In movement time, the hypothesis was rejected, since movement

to the right as opposed to movement to the left was significantly faster from the four-point stance. On the other hand, the hypothesis was supported in response time, since there was no significant difference between right and left movement from the four-point stance. In addition, in response time with the experienced group of linemen, right movement was significantly faster than left movement supporting the hypothesis. This was the only case in which the level of experience had an influence on the difference between right and left movement.

Other investigators have analyzed differences in time between left and right movements. Kadatz (1965) found no significant differences in response time between left and right movement from various types of three-point stances. In the majority of the comparisons, Kadatz' results support the writer's findings. On the other hand, Robinson (1949) concluded that movement to the right was faster than movement to the left from a three-point stance. The investigator found similar results, but they were not statistically significant. Yet movement to the right was found to be significantly faster than movement to the left from the four-point stance in movement time. Perhaps because of the influence of the experienced subjects with their extensive training in the three-point stance, there was increased variability when moving from the four-point stance within these directions of movement.

CHAPTER V

SUMMARY

There is general agreement among investigators that the ability to move rapidly in many directions is an important characteristic of offensive football linemen (Fitch 1956, Fuoss 1964, Jones 1961, Kadatz 1965, Miles 1931, Owens 1956, Reading 1961, Robinson 1961, Thompson 1958, Wilson 1959). The opinion of football coaches suggests that the ability to move rapidly is facilitated by starting from either a three-point or a four-point stance. Only one study was available to the investigator in which a three-point stance was compared to a four-point stance based on movement time (Fitch 1956). The writer's investigation proceeded on the premise that new insights could be gained about a lineman's ability to move from the two types of stance by analyzing reaction, movement, and response times; by employing cinematographic techniques for measurement; and by studying the influence of experience and direction on the stances.

Specific types of stances and directions of movement were stipulated for the experiment. Two types of stances were analyzed: (1) a three-point stance with staggered footing spread shoulder-width apart and the center of gravity

established over the center of the base; and (2) a four-point stance with even footing spread shoulder-width apart and the center of gravity toward the front of the base. Three directions of movement were analyzed: (1) forward movement over a distance of three feet; (2) movement to the left over a distance of 15 feet; and (3) movement to the right over a distance of 15 feet.

The subjects included in this investigation were offensive football linemen from Port Huron Northern High School in Port Huron, Michigan. Ten varsity linemen 16 or 17 years of age and ten freshman linemen 13 or 14 years of age volunteered to participate in the experiment. While the varsity linemen had two years of experience using both types of stance, they had considerably more practice with the three-point than the four-point stance. On the other hand, the group of freshmen had only three hours of experience, equally divided between both types of stance.

The purpose of this study was to determine whether there was a time advantage in using a three-point starting stance as opposed to a four-point stance when moving from a stationary position to a given blocking target. Subproblems included the influence of direction and experience on the ability to move from either type of stance.

Treatments were conducted on the practice field at Port Huron Northern High School. Each trial or sequence was initiated by a center and quarterback. The center hiked a

ball to the quarterback and moved forward into a customary blocking position. Concurrently, the quarterback called a rhythmic starting signal, received the ball, and moved back to a forward passing position. When given the rhythmic signal, the lineman moved to his target which consisted of a flat padded surface on a blocking sled.

Procedures to collect data included use of a high-speed movie camera and timing lights. Actual scoring and recording of the data was done by viewing the film sequences with a frame-by-frame projector. Each sequence contained three frames that were essential to the calculation of reaction and movement times; they were: (1) the frame in which the ball first moved; (2) the frame in which the lineman first moved; and (3) the frame in which the lineman initially contacted the surface of the blocking sled. For each movement pattern and stance, the trial in which the lineman had the fastest response time was used for scoring.

The results, based on analyses of variance (ANOVA) and Scheffé tests of one factor of stance, experience, or direction in comparison to a second factor within that variable dependent on conditions specific to the other two variables, were as follows:

1. Between-stance differences in reaction time under specific conditions of experience and direction:

There were no significant differences between the three-point and the four-point stance in reaction time with either

level of experience in any direction. Thus, the hypothesis was supported with the inexperienced group of subjects. On the other hand, the hypothesis that the experienced group would be significantly faster from the three-point as opposed to the four-point stance was rejected.

2. Between-stance differences in movement and response times under specific conditions of experience and direction: The main effect indicated that the three-point stance was a significantly faster starting position than the four-point stance in movement and response time. Thus, the hypothesis that there would be no significant differences between the stances was rejected.

It was hypothesized that there would be no significant differences between the three-point and the four-point stance in moving in any one direction. In movement to the right, this hypothesis was supported. However, the three-point stance was significantly superior to the four-point stance in movements forward and to the left. In these directions, the hypothesis of no differences between the stances was rejected.

The three-point stance was found to be a significantly faster starting position than the four-point stance in movement and response times with the inexperienced linemen. Thus, the hypothesis that the inexperienced linemen would not be significantly faster from either stance was rejected. Nevertheless, when analyzing these differences under specific

conditions of direction, there were no significant differences between the three-point and the four-point stance in forward, left, or right movements with the inexperienced group. In these cases, the hypothesis was supported.

It was hypothesized that the experienced linemen would be significantly faster from the three-point as opposed to the four-point stance. Since the experienced group was not significantly faster from either stance in any direction, this hypothesis was rejected for movement and response times.

3. Between-levels of experience differences in reaction time under specific conditions of stance and direction: The experienced subjects were faster than the inexperienced subjects under all conditions of stance and direction. Nevertheless, the hypothesis that experienced linemen would be significantly faster in reaction time than inexperienced linemen was supported in only a few comparisons. The main effect between experienced and inexperienced groups was significant, as well as the interaction in levels of experience with movement to the right. However, only moderate differences were evident in other interactions between levels of experience in stance and direction. In these cases, the hypothesis of significant differences between groups was rejected.

4. Between-levels of experience differences in movement and response times under specific conditions of stance and direction: The experienced linemen were faster

than the inexperienced linemen under all conditions of stance and direction in both movement and response times. Many comparisons were significant. The experienced linemen were significantly faster than the inexperienced linemen with movement from both the three-point and the four-point stances in movement and response times. Other significant differences existed in response time only. The experienced group was significantly faster than the inexperienced group under all conditions of stance and direction in response time with one exception (the four-point stance in a left direction). In all of these comparisons between levels of experience the hypothesis of significant differences was supported.

The hypothesis of significant differences between levels of experience was rejected with some comparisons. In movement time, under conditions of direction, and stance and direction, there were no significant differences between the experienced linemen and the inexperienced linemen. In response time, with the four-point stance in left movement, there was also no significant difference between the two levels of experience.

5. Between-directions of movement differences in reaction time under specific conditions of stance and experience: The main effect of direction revealed that reaction time in a forward movement was significantly faster than in movement to the left or right. This result supported the

writer's hypothesis. However, interactions in direction under specific conditions of stance and experience indicated that no significant differences existed in reaction time between forward and left or right movements. In these comparisons, the hypothesis that reaction time would be significantly faster in a forward direction than in a left or right direction was rejected.

There were no significant differences between left and right movements in reaction time under any condition of stance and experience. The hypothesis that there would be significant differences in favor of movement to the right from the three-point stance was rejected; whereas the hypothesis was accepted that there would be no significant differences between right and left movements from a four-point stance.

6. Between-directions of movement differences in movement and response times under specific conditions of stance and experience: The main effect of direction indicated that in both movement and response times, movement to the right was significantly faster than movement to the left. This result supported the main hypothesis. Movement to the right as compared to movement to the left was significantly faster from the four-point stance in movement time. The hypothesis that there would be no significant differences between left and right movements from the four-point stance was rejected in this comparison. However, there were no

significant differences between right and left movement from the four-point stance in response time and thus the hypothesis was accepted in this comparison.

The experienced group was significantly faster in movement to the right as opposed to movement to the left in response time, while the inexperienced group was not significantly different in either direction. The hypothesis that both groups of experience would be significantly faster when moving to the right than to the left was therefore supported with the experienced group, but rejected with the inexperienced group in response time. On the other hand, there were no significant differences with both groups of experience in movement time between right and left movements. Thus, the hypothesis that movement to the right would be significantly faster than movement to the left was rejected.

There were no significant differences between movement to the right and movement to the left in other conditions of stance and experience. With the three-point stance in movement and response times, there were no significant differences between right and left movement. In all comparisons in movement and response times between right and left movement that involved conditions of stance and experience, no significant differences were noted. Therefore, for all cases of no significant differences between right and left movements, the hypothesis was rejected in the comparisons with the three-point stance, but accepted in the comparisons with the four-point stance.

Conclusions

Several conclusions were made based on the results of this investigation. They include the following:

1. There were no significant differences between the three-point and the four-point stance in reaction time with either the experienced or the inexperienced group in either the forward, left, or right direction.
2. The inexperienced linemen were significantly faster from the three-point as opposed to the four-point stance with the main effect of direction in movement and response times; whereas the experienced linemen were not significantly different from either stance with the main effect of direction in movement and response times.
3. The three-point as opposed to the four-point stance was a significantly faster starting position in movement time for movements to the right and forward; whereas there were no significant differences in response time between the stances for right and forward movement.
4. There were no significant differences between the three-point and the four-point stance with experienced and inexperienced groups with movement to the left in either movement or response time.
5. The main effect between levels of experience in reaction, movement, and response times indicated that the experienced linemen were significantly faster than the inexperienced linemen.
6. The experienced group was significantly faster than the inexperienced group in response time under all conditions of stance and direction with one exception (the four-point stance in a left direction).
7. There were no significant differences between the experienced group and the inexperienced group in reaction and movement time in any interaction between the levels of experience when factors of stance and direction were included in the condition of the comparison.
8. The main effect between directions of movement in reaction time revealed that forward movement was significantly faster than left or right movement.

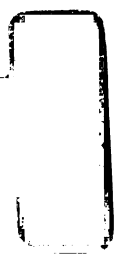
9. There were no significant differences between forward and left or right movement in reaction time in any interaction between the directions of movement when factors of stance and/or experience were included in the condition of the comparison.
10. The main effect between right and left movements in movement and response times indicated that movement to the right was significantly faster than movement to the left; whereas in reaction time, there was no significant difference between movement to the right or left.
11. Movement to the right was significantly faster than movement to the left from a four-point stance in movement time; whereas there was no significant difference between the directions of left and right in reaction and response times from the four-point stance.
12. There were no significant differences between right and left movement from the three-point stance in reaction, movement, or response time.
13. There were no significant differences between right and left movement with the inexperienced group in both movement and response times with the main effect of stance; whereas the experienced group was significantly faster in moving to the right than left in response time, but not significantly different in either direction in movement time.
14. There were no significant differences between right and left movements in reaction, movement, or response time in any interaction between the directions of movement when factors of stance and experience were included in the condition of the comparison.

Recommendations

It is recommended that:

1. This study be continued with the analysis of different types of three-point and four-point stances; while the stances used in this study were selected for their common use, there are many variations of the three-point and four-point stance that involve different weight distributions and different placings of the hands and feet.

2. This study be continued with the analysis of offensive linemen differentiated on the basis of size. It is quite possible that smaller linemen would differ from large linemen in their preference and effectiveness in type of stance.
3. This study be continued by comparing offensive linemen with experience in both the three-point and the four-point stance in order to detect if equal amounts of exposure to both stances would influence their ability to move from them.
4. This study be continued with the analysis of differences between the three-point and the four-point stance in relation to the pattern of the center of gravity as the linemen move from either stance to a blocking target.



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