

THE RELATIONSHIP OF LATERAL DOMINANCE
TO THE LEARNING OF A COMPLEX
MOTOR SKILL

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THESIS



ABSTRACT

THE RELATIONSHIP OF LATERAL DOMINANCE TO THE LEARNING OF A COMPLEX MOTOR SKILL

By

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Statement of the Problem

The purpose of this study was to investigate the relationship of lateral dominance to the learning of a complex motor skill.

Methodology

Fourteen females, who were enrolled in a beginning lacrosse activity class in the Woman's Physical Education Department at Michigan State University during the spring of 1969, served as subjects for this study.

All subjects were tested for hand and eye dominance and grouped according to the characteristics they displayed:

Left-hand -- left-eye,
Left-hand -- right-eye,
Right-hand -- right-eye,
Right-hand -- left-eye.

A pre-test for throwing ability was administered to all subjects. Each subject threw a ball at a target from a distance of ten yards. Ten trials were allowed.

After the pre-test a training program was conducted for six weeks. This program included the use of various passing and shooting drills which required the overhand throw.

At the conclusion of the training period, a post-test for throwing ability was given. Scores were collected in the same manner as in the pre-test procedure. Test results were analyzed using the Kruskal-Wallis one-way analysis of variance by ranks statistical technique.

Conclusions

There were no significant results indicated for differences between groups in throwing ability or in pre-test and post-test scores.

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John Patrick Cooke Jr.

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DEDICATION

I would like to dedicate this thesis to my wife,
Sally. Without her hard work, this year would never
have been possible.

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I would like to acknowledge the kind assistance of the ladies who participated as subjects for this study. Their patience and kind understanding was extremely valuable. I would also like to express appreciation to Miss Hallock for her assistance in the completion of this study. Particularly, I would like to express my sincere gratitude to Dr. Dorothy Popejoy for her patience, understanding, and counsel in the completion of this study.

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CHAPTER I

THE PROBLEM AND DEFINITION OF
TERMS USED

Statement of the Problem

Since many games and sports require the manipulation of various types of objects and implements involving the arms and legs, the phenomenon of preferred laterality is an area of real concern in physical education. At the present time, the relationship of lateral dominance to motor ability has not been clearly established. If evidence can be presented establishing a clear cut connection between lateral dominance characteristics and motor ability, physical educators, psychologists, and physiologists could utilize this information in combined types of study in this area.

Purpose of the Study

The purpose of this study was to investigate the relationship of hand-eye dominance in the learning of a complex motor skill in lacrosse.

Importance and Need for the Study

The game of lacrosse is the only game that enjoys a truly American heritage. From the time of the American

Indian lacrosse has grown to the point where today it is ranked as the fastest growing sport in America. Lacrosse not only presents a vigorous and challenging activity to the athlete and the student, but it also remains an exciting spectacle for the spectator.

If it is possible to establish that there is a direct and measurable connection between certain dominance combinations and superior motor achievement, the physical educator in the classroom could utilize this information to improve upon or realign teaching methods currently in use. This would be particularly helpful when attempting to teach skills to the left-handed individual. Slow learners could be easily identified through screening and individualized instruction could be implemented within the physical education program to insure a successful experience for each student involved.

The selection of player personnel in lacrosse is a problem which every coach must face, as it is in any other type of athletic competition. Prediction formulae and/or other means for predicting athletic ability and performance have been developed through the years with minimal success. If a relationship of dominance characteristics of any given individual and his athletic ability were established, the problem of player selection for the coach would be reduced considerably.

Nature and Scope of the Study

Fourteen subjects participated in this study. They ranged in age from eighteen to twenty-two years old. All subjects were female students who were enrolled in a lacrosse activity class in the Woman's Physical Education Department of Michigan State University during the spring of 1969. The subjects were grouped according to hand- and eye-dominance combinations into four preference groups: left hand - right eye; left hand - left eye; right hand - right eye; right hand - left eye.

The subjects participated in a training program for six weeks which included training in skill and accuracy in the overhand throw.

A pre-test and post-test were administered to compare the achievement of each group. Each subject was allowed ten throws at a target placed in front of a regulation lacrosse goal which was divided into areas of different point values. Results of the tests were compared with non-parametric statistics.

Limitations of the Study

Limitations of the study included the following:

1. The methods used for the determination of dominance characteristics were somewhat dated, and

more recent inexpensive techniques were not available.

2. The effect of having a male teacher instructing a female activity cannot be determined.
3. To insure the presence of left-handed individuals within the population, eight subjects were requested to enroll in the activity.
4. As the training program progressed, subjects from all dominance groups withdrew from the class, which severely limited the number of subjects within each dominance group.

Definition of Terms

1. Dominance.--A preference for one hand, one eye, or one foot over the other in any given activity.
2. Dextrality.--Pure right-sided dominance.
3. Sinistrality.--Pure left-sided dominance.
4. Homolaterality.--Dominance on the same side of the hand, eye, and foot.
5. Contralaterality.--A quality of mixed dominance of hand, eye, and foot.
6. Overhand throwing motion.--A term to describe the action of each subject as she threw a ball at a target.

The crosse was held at the throat in the dominant hand in a vertical position, with the pocket of the crosse facing the target. The throwing motion was initiated by stepping forward on the opposite foot. Action of the hands and arms was a combined, coordinated pushing and pulling motion. To initiate the pushing motion, the upper hand and arm were extended at the elbow and shoulder simultaneously. To initiate the pulling motion, the lower hand and arm were drawn from a position of extension from the body to a position in which the lower hand on the crosse finally rested in the approximate area of the opposite axilla.

CHAPTER II

RELATED LITERATURE

Since the purpose of this study was to investigate the relationship of lateral dominance to motor ability, literature pertaining to hand dominance, eye dominance, and motor learning was reviewed.

Dominance

The phenomena of dominance, preferred laterality, or handedness appears to be one of the mysteries of human development. Walters stated, "Although we are constructed bi laterally we function unilaterally and have a preference for one hand, one leg, and one eye."¹

Theories of Dominance Development

Early theories mentioned by Blau,² Hildreth,³ and Way⁴ centered around developmental ideas and related to three major areas: anatomical factors, hereditary factors, and social influence factors.

The early anatomical theories were concerned with cerebral dominance within the fetus. One such theory reasoned that the fetus would develop a dominant brain hemisphere prior to birth. In this case if the left

brain was dominant the child would be born with right-sided dominance. If the right brain was dominant the child would be born with a left-sided dominance.⁵

Another anatomical theory, which was supported, maintained that the blood flow to one side of the brain was greater than the blood flow to the other side of the brain. The brain hemisphere which received the greatest amount of blood would become the dominant side.⁶

This theory was disproved by Cunningham⁷ in 1902. He found no significant difference in size between left and right carotid arteries.

Blau⁸ in agreeing with Cunningham, stated that the physiological differences between the dominant and non-dominant sides as concerned with the brain and sensory organs were undetectable.

Other anatomical theories were concerned with the center of gravity of the body as determined by the placement of the viscera.⁹ Blau¹⁰ indicated that this theory could not be supported with any credible evidence.

A fifth possible theory indicated that the route of the subclavian artery influenced the determination of the preferred hand. In this situation the blood pressure exerted by the right-side artery was greater, thus causing a greater incidence of right-handedness within the population.¹¹ Blau¹² indicated that this theory could not be supported by any evidence either.

The last theory was developed by Jones,¹³ who stated that the length of the bones on the right side of a right-handed person was greater than the same bone on the opposite side. This theory was invalidated by Beeley¹⁴ in 1918.

Hildreth¹⁵ indicated that all efforts to identify a structural reason which would account for lateral dominance have failed.

Blau¹⁶ agreed and stated that congenital theories had little significance.

Both Blau¹⁷ and Hildreth¹⁸ indicated that there were theorists who held that handedness was determined by heredity. Blau¹⁹ found no consistent evidence that handedness followed familial tendencies. He further stated that in studies conducted with twins, and in families with one or both parents being left-handed, there was no definite correlation between biological symmetry and lateral preference.

Social Theories of Dominance Development

The theory of social influence as a cause of determining handedness seemed to receive the strongest support from most authors. In this situation, handedness was determined by direct or indirect pressure placed on the child by society. Hildreth²⁰ pointed out this connection when she stated that social convention had

strong connections with laterality by establishing rules pertaining to how certain activities were to be done. In further support of this statement she also stated that right handedness was a cultural and social convention to which most people found it expedient to conform.

Blau²¹ agreed when he stated that learning and education could be factors in choosing the preferred side.

Oxendine,²² Palmer,²³ and Provins²⁴ all indicated that early training and activity were important factors in the determination of dominance.

Blau²⁵ indicated that the preferred hand was sometimes the result of imitation by the child of the parent, training of the child by parents and educators, and other influential factors placed on the child by social pressure. He also mentioned injury to a limb which forced the child into a pattern of preference as a factor in the determination of dominance.

Blau²⁶ and Hildreth²⁷ both agreed that at birth the child had no preference for one side over the other and that there were both right and left dominant potentialities.

Hildreth²⁸ stated that up to age three the child had little need in daily activity for specialized dexterity. She further stated that consistent sidedness really occurred only when the child learned motor coordination.

Cratty²⁹ indicated that by age seven the child indicated a preference for one side which remained unchanged throughout life.

Hildreth³⁰ indicated that infant studies found that right-handedness was shown at an earlier age than left-handedness. She also indicated that from ages three to seven there was a marked increase in the number of right-handed children with a decrease in ambilaterality.

Frequency of Dominance Types
Within the Population

Blau,³¹ Oxendine,³² and Rife³³ estimated that the percentage of right-handed people within the population ranged from 70 to 98 per cent, depending upon the author being read.

Hildreth³⁴ found further that females outnumbered males within this group. Her findings were supported by other investigators,³⁵ who indicated a relationship of dominance incidence with regards to age, sex, and culture.

Between the pure right-handed and the pure left-handed groups was a group which was considered to be ambidextrous. Hildreth³⁶ and Oxendine³⁷ defined ambidexterity as the equal ability of both hands in similar functional tasks, or a non-preference of one hand over the other.

Hildreth³⁸ felt that the truly ambidextrous person was non-existent. Schlaefer³⁹ reported only .021 per cent of 17,074 school children as showing ambidexterity.

Blau⁴⁰ maintained a more conservative point of view by stating that all people are ambidextrous when considering the activities which brought both sides into play. He further stated:

Laterality has significance only in terms of a particular activity. Separated from the activity it has no meaning but taken together it shows a preference of one side over the other coupled with a degree of superior skill. A consistent right-left pattern for different activities and forms of laterality in one person are rare, and a mixed design more common.⁴¹

Hildreth⁴² found that tests indicated the average two-handed person was never effective in tool using. In support of this she cited evidence which indicated that an inconsistent hand preference, and efforts to change the dominant hand in habitual skills, caused motor difficulties and social adjustment difficulties.

She also stated that those individuals who have not achieved manual dominance were less effective or possibly handicapped in motor performance. She cited five studies in which the authors indicated numerous difficulties in individuals who were unable to express a consistent dominant side.

The remaining dominance group consisted of those individuals who exhibited a left-handed preference in activity. Hildreth⁴³ indicated that this trait was more common when skills other than writing and eating were observed. Burt⁴⁴ indicated that the difference between

hands was not so much connected with strength as it was connected with speed and skill in an activity requiring dexterity.

Downey,⁴⁵ in 1928, found that the percentage of left-handed individuals was small. Blau,⁴⁶ Hildreth,⁴⁷ Oxendine,⁴⁸ and Rife⁴⁹ indicated that the left-hand population comprised from two to thirty per cent of the population. The accepted, conservative estimate ranged from two to eight per cent.

Regarding this group Hildreth stated, "the left-handed individual tends to be a slow learner in the motor realm; he is clumsy, awkward in sports and motor performance."⁵⁰

Blau⁵¹ found in his study that the percentage of left-handed individuals was more frequent in the following groups:

1. Males more than females
2. Mental defectives
3. Delinquents and defectives
4. Psychopaths, epileptics, neurotics, psychotics
5. Stutterers
6. Children with reading difficulties

He qualified his findings by saying that only the rate of incidence (of left-handed persons) was higher. There were right-hand dominant people in these groups.

Palmer⁵² indicated similar findings in his study done in 1964.

Characteristics and Classification of Dominance

Hand Dominance

Hildreth commented on the difficulty of determining dominance when she stated, "Laterality is a complex feature of human structure and development."⁵³ Irwin⁵⁴ further established this difficulty when he found that dominance does not approximate a normal distribution.

Palmer⁵⁵ indicated that true dominance was difficult to establish because of the influence of opposite-sided tendencies in the performance of any activity. This has caused many individuals to be incorrectly classified into a particular dominance group.

Blau⁵⁶ indicated difficulty in testing methods as one reason for inconsistency in hand-dominance determination.

Eye Dominance

Blau⁵⁷ indicated that the phenomena of ocular dominance was first recognized by Humphrey in 1861. Since that time many investigations regarding ocular dominance were undertaken in an effort to determine its distribution within the population, and to explore any means by which ocular dominance could be determined.

According to Hoerr and Olsen in Blakiston's New Gould Medical Dictionary, the dominant eye was defined

as, "That eye which is unconsciously and preferentially chosen to guide decisions and actions."⁵⁸ More specifically the dominant eye would be that eye unconsciously utilized by the individual in situations in which a binocular view was not possible or was undesirable.

Miles explained ocular dominance by stating, "Ocular dominance tends to clear the visual field by giving the right of way to the image to the dominant eye."⁵⁹

Crider⁶⁰ found that there were three types of eye dominance into which subjects could be classified. He also found more people who were correctly classified as being impartial eyed than were in the group classified as being left-eye dominant. The right-eye dominant group was again found to contain the largest percentage of the population.

Way⁶¹ substantiated these figures by indicating that 61.9 per cent of a sample of 410 subjects preferred the right-eye. She also indicated that, of those in her sample who exhibited a pure-sided preference, fifty-three per cent indicated the right-hand, right-eye combination.

No exact figures were indicated for the size of the left-eye dominant population. Hildreth⁶² and Oxendine⁶³ agreed that left-eye dominance was more

common than left-hand dominance. They were supported by the work of Sinclair and Smith.⁶⁴

Hildreth⁶⁵ indicated that eyedness could not be influenced by training. She also indicated that other investigators in this area could not support any theories pertaining to how the dominant eye was determined.

Crider⁶⁶ indicated that there appeared to be no significant difference between the sexes in relation to which eye was dominant. This was in opposition to the findings that more males exhibited left-handedness than females.

Techniques of Dominance Determination

Hand Dominance

Many techniques have been utilized as testing or screening methods to assist investigators in determining the hand dominance of test subjects. Among those more commonly used were the questionnaire and those techniques which utilized a skill or dexterity test.

Hildreth⁶⁷ indicated that the determination of the dominant hand was a problem for statistical analysis. She supported this stand by indicating the complexity of clearly establishing the dominant hand. In her examples she mentioned many activities which were often done with the left-hand by individuals who were classified as being

right-handed. She felt that through statistics a consistent measurement of hand preference could be established.

Oxendine⁶⁸ stated that tests requiring both fine and gross dexterity and skill would be helpful in the determination of dominance. Along with the task performance he supported the use of a questionnaire as a screening device.

Crovitz and Hull both used the questionnaire technique as a method of dominance determination. Crovitz⁶⁹ developed his test for use in screening large groups. Hull⁷⁰ initially tested her subjects using a questionnaire and a performance test. She rearranged the test questions after an initial test and retested the same group, which established a high reliability for her technique.

Blau⁷¹ called the questionnaire technique notoriously unreliable, and later mentioned Hull's test as being of limited value. However, in his section relating to testing methods, he listed Hull's test as the suggested method for determining hand dominance with the comment that it was sufficient for practical purposes. Oxendine⁷² cited other methods utilized by other investigators which required timing and stimulus machinery.

Eye Dominance

Eye dominance determination was another area in which there was considerable investigation, particularly in the area of psychology. One of the most important criteria for the determination of eye dominance was that the subject should not be aware of the test purpose. This unconscious sighting was an essential element in preventing the subject from becoming confused during testing.

Miles⁷³ was the first author who indicated the need for unconscious sighting by the subject. His testing method utilized a tapered cone which the subject used to sight a visual target. He found that by having the subject keep both eyes open while looking through the large end of the cone toward the small end of the cone, the testee was forced to sight the test object with only one eye. By repeating the tests with various visual targets, Miles was able to determine the preferred eye with extremely high consistency. In this case, the preferred eye was considered to be the dominant eye.

Cuff⁷⁴ substantiated this consistency using a similar type of cone. He found a reliability coefficient of 0.97 for measurement consistency.

Other tests utilized the fingers and pencils as sighting objects. Crovitz⁷⁵ maintained that this type of test was useful only as a screening device. To

detect real dominance with consistency, a more differentiated test must be developed.

Crider⁷⁶ developed one of the best test batteries concerning eye-dominance determination. These particular items were developed over a period of ten years using thousands of subjects. The battery had a reported reliability of 0.98 to 0.99. Crider also reported that sex, handedness, intelligence, or visual acuity did not influence test results. Further investigation into testing methodology failed to disclose other methods of equal consistency or ease of administration.

Dominance and Motor Learning

In the area of physical education, early studies pertaining to dominance were done by Vogel⁷⁷ and Irwin⁷⁸ in 1939. Neither of these authors was able to establish a clear relationship between dominance and skill.

Roth investigated the effects of hand and eye dominance as factors in motor ability. He indicated that of the four hand-eye dominance combinations possible, the left-hand right-eye group proved to be superior in motor ability. Of the other groups, the right-hand, right-eye group was rated second; the right-hand, left-eye group was third; and the left-hand, left-eye group was rated fourth.

After Roth there appeared to be a lapse of fifteen years before Sinclair and Smith⁷⁹ investigated the relationship of laterality in swimming and dominance. These authors found no relationship of hand, eye, and foot dominance to the preferred side for breathing in swimming.

In 1958 Way⁸⁰ investigated the relationship of lateral dominance to scores on motor ability and selected skills tests. She found no significant differences between motor ability mean scores of laterality groups which were determined by hand-eye preference. In her conclusions she stated that motor ability seemed to be related to foot ambidexterity since combinations of preference, including foot ambidexterity, resulted in higher motor ability scores.

Starting in the 1960's, studies in the area of dominance and its relationship to physical education and athletic activities increased. In 1961, Frasek⁸¹ investigated dominance as measured by the factors of balance dexterity and strength. She considered her results as indicating an inconsistency in preferred dominance when measuring different traits.

Ries⁸² found no relationship to accuracy in fencing and pure dominance. Her results indicated that mixed dominance gave higher results on the accuracy test.

Mancini⁸³ found that right-handed subjects reacted faster to the right and left-handed subjects to the left when testing their ability to move laterally.

Adams⁸⁴ found that individuals with pure dominance were superior in more batting categories than those individuals with crossed dominance. He concluded that there was some connection between dominance and batting ability.

Poindexter⁸⁵ found that pure dominant individuals were consistently better in the performance of a perceptual motor task than mixed dominance groups.

Robinson⁸⁶ came to a similar conclusion in his study when he found that laterally dominant subjects were better in reaction time tests.

Sander,⁸⁷ in her study, found a difference in ability of crossed and unilateral hand and foot groups to increase the ability of the non-preferred arm.

Oxendine⁸⁸ indicated that the left-hand dominant individual found difficulty in the learning and performance of motor skills. He indicated that this could be due to the fact that most skills are taught by right-handed teachers who have difficulty transposing the skill to the opposite hand.

Fitts⁸⁹ theorized that the number of skills that a man could learn were limitless. The major limitations dealing with skill achievement in any one individual

were directly concerned with individual physiological makeup. Of particular concern were the muscular and nervous systems.

Waterland's remarks concerning skilled movement provided further insight into the complexity of the problem:

Skilled movement is composed of three inter-related components; willed movement that may be cortically directed; reflexes that are evoked in association with the purposive act; and the sensory inputs from the external and internal environment.⁹⁰

In discussing the potential limits of skill achievement, Fitts⁹¹ felt that such limits existed. He further stated that there were indications that performance approached these limits so slowly that it was seldom possible to establish when any given individual had reached his limit in any given activity. Equally important was the type of activity being performed. Two main factors appeared to restrict the skill achievement of any given individual. The first factor was the aging process. Because of age and subsequent physiological changes, the ultimate level of skill achievement possible was lowered. Secondly, motivation, which was initially strong, often times became reduced to the point where the effort required to improve in skill ceased.

FOOTNOTES--CHAPTER II

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⁶⁷Hildreth, op. cit., p. 204.

⁶⁸Oxendine, op. cit., p. 309.

⁶⁹Herbert F. Crovitz and Karl Zenner, "A Group Test for Assessing Hand and Eye Dominance," American Journal of Psychology, LXXV (June, 1962), 270-276.

⁷⁰Catherine J. Hull, "Study of Laterality Test Items," Journal of Experimental Education, IV (1936), 287-290.

⁷¹Blau, op. cit., p. 12.

⁷²Oxendine, op. cit., p. 309.

⁷³Miles, op. cit., p. 125.

⁷⁴Noel B. Cuff, "A Study of Eyedness and Handedness," Journal of Experimental Psychology, XIV (1931), 164-175.

⁷⁵Crovitz, op. cit., p. 276.

⁷⁶Crider, op. cit., p. 187.

⁷⁷O. H. Vogel, "The Relationship of Dominance to Acts of Skill," Research Quarterly, VI (1935), 15-18.

⁷⁸Leslie W. Irwin, "A Study of the Relationship of Dominance to the Performance of Physical Education Activities," Research Quarterly, II (1938), 93-119.

⁷⁹Sinclair and Smith, op. cit.

⁸⁰Way, op. cit.

⁸¹Judith Frasek, "An Investigation of Dominance as Measured by the Factors of Balance, Dexterity, and Strength" (unpublished Master's thesis, Smith College, 1961).

⁸²Susan Carol Ries, "Dominance, Discrimination and Accuracy in Fencing" (unpublished Master's thesis, University of California, Los Angeles, 1962).

⁸³V. H. Mancini, "Study of the Relationship of Hand Dominance to Performance Time" (unpublished Master's thesis, Springfield College, 1964).

⁸⁴Gary L. Adams, "Effects of Eye Dominance on Baseball Batting" (unpublished Master's thesis, University of California, Riverside, 1964).

⁸⁵M. Coleen Poindexter, "Unilateral and Crossed Lateral Hand Eye Dominance and Performance on a Perceptual Motor Task" (unpublished Master's thesis, University of California, Berkley, 1965).

⁸⁶Edwin N. Robinson, "A Comparison of Laterally Dominant to Crossed Dominant Individuals in Tests of Reaction Time and Hand Eye Coordination" (unpublished Master's thesis, University of California, Santa Barbara, 1965).

⁸⁷Carolyn M. Sander, "Development in Kinesthetic Awareness in the Non Preferred Arm of College Women" (unpublished Master's thesis, University of Washington, Seattle, 1967).

⁸⁸Oxendine, op. cit.

⁸⁹Paul M. Fitts and Michael I. Posner, Human Performance (Belmont, California: Brooks Cole Publishing Co., 1967), p. 18.

⁹⁰Joan C. Waterland, "The Supportive Framework for Willed Movement," American Journal of Physical Medicine, XLVI (1967), 266.

⁹¹Fitts, op. cit.

CHAPTER III

METHODOLOGY

Since the purpose of this study was to investigate the relationship of lateral dominance to motor ability, the experimental method was used to investigate the problem.

Source of the Data

This study was undertaken during the spring term of 1969. Fourteen members of a woman's lacrosse activity class, offered by the Woman's Physical Education Department at Michigan State University, participated as subjects in the study. The subjects ranged from eighteen to twenty-two years of age.

Testing Procedure

For the purpose of categorizing them in hand-eye dominance groups all subjects were first administered a test questionnaire, and an eye-dominance test battery.

By means of the hand-eye dominance tests, all subjects were divided into four groups according to the combination of dominance characteristics they displayed. The four groups were designated as follows: left

hand - left eye; left hand - right eye; right hand - left eye; right hand - right eye.

Since all subjects were unfamiliar with lacrosse and associated skills, two ten-minute training periods were given to the subjects during the first and second class periods to assure a meaningful measurement of their skill. Subjects were then tested for their ability to throw a lacrosse ball at a target which represented a lacrosse goal.

After a six-week training program the subjects were retested with the same procedures and target.

Description of Tests

Determination of Hand Dominance

The questionnaire technique, developed by Hull,¹ was used to establish hand dominance (see Appendix B).

The questionnaire was a series of forty questions in which the subject was asked to indicate which hand she preferred to use to perform various common activities. If the subject could perform the skill equally well with either hand, she indicated this also.

The dominant hand was determined from the questionnaire by totaling the hand preferences the subject indicated the most number of times.

Determination of Eye Dominance

Eye dominance was determined through the use of a test battery developed by Crider² (see Appendix A).

The series utilized the phenomena of unconscious sighting by the subject to determine which eye was dominant. The test items were comprised of seven objects which the subject held in her hand. She was then instructed to keep both eyes open while attempting to sight various objects as she looked through the test items. By restricting the view of the subject as she attempted to sight the test objects, she unconsciously sighted with one eye. By tabulating which eye was used for the sighting of the test objects, the dominant eye was determined.

Motor Ability Testing

To measure the improvement made by each group in learning a complex motor skill, a throwing test for accuracy was administered prior to and immediately after the training program. A target was tied securely to one of the permanent lacrosse goals on the lacrosse field. The target was divided into two areas, the center area and the outer area (see Figure 1). Two restraining lines were placed in front of the target. Ten yards from the goal mouth a line ten yards long was marked on the grass using a flakey white asbestos marking material. A second

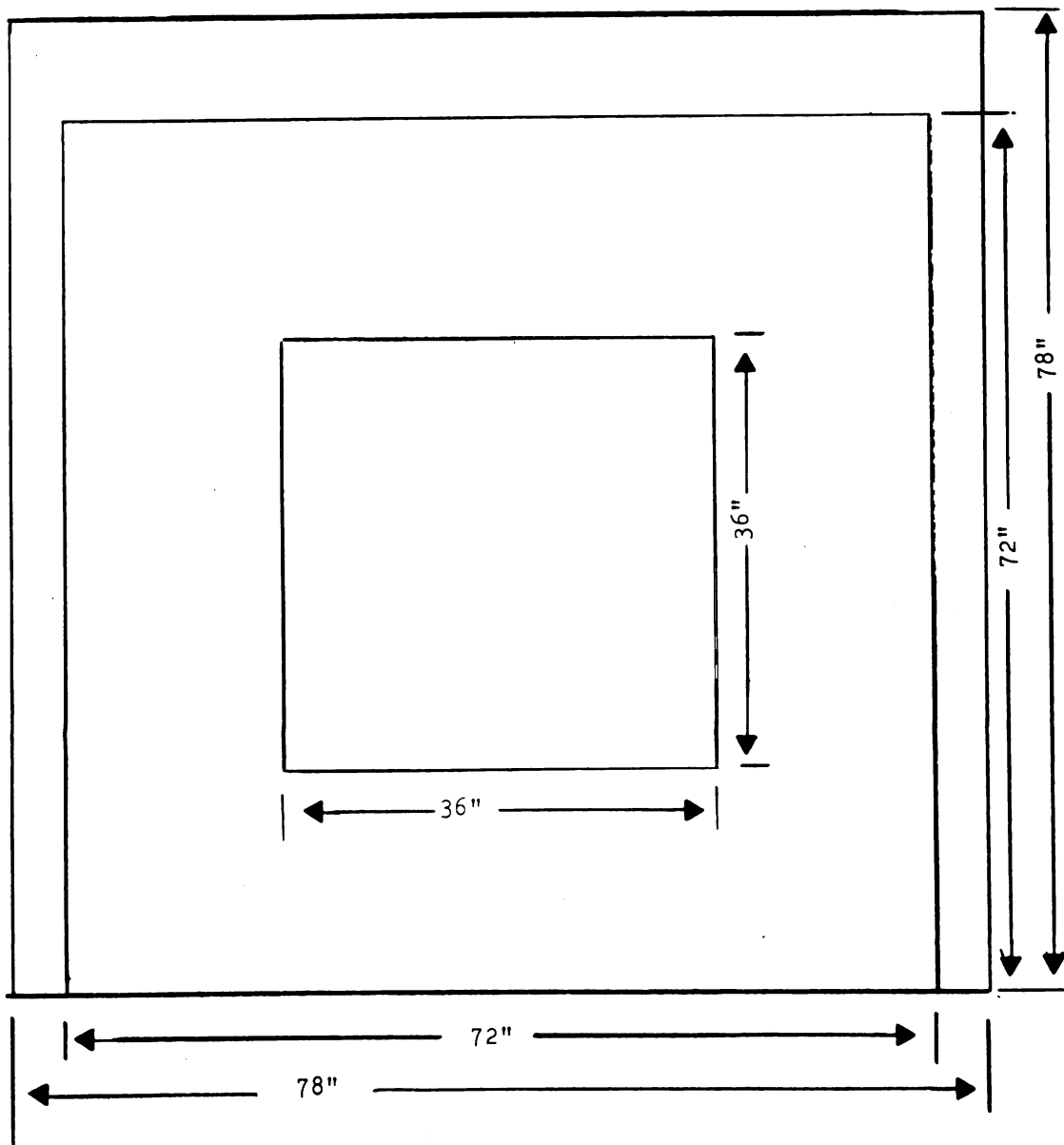


Figure 1.--Modified lacrosse goal target.

line, which was five yards long, was drawn perpendicular to the first. If this line was extended it would divide the goal into two equal halves.

Each subject was given instruction on the approach to the target. The left-handed subjects were instructed to throw from the right-hand side of the restraining lines and the right-handed subjects were instructed to throw from the left-hand side of the restraining lines. The following instructions were given to each subject in exactly the same way,

Throw the ball at the target. You must stay within this area (indicating the right-hand or left-hand restraining area depending on the dominant hand of the subject). Run or trot to the target. Do not step over any of the lines. You do not want to hit the middle of the target.

The subject was then told to pick up a regulation woman's lacrosse ball with her crosse and carry out the instructions. Replacement balls were immediately available. This permitted the subjects to recover from their throw, pick up a new ball, trot to the target and throw again in a very short period of time.

Each subject took ten shots at the goal from her respective restraining area. Successful or unsuccessful throws were determined and recorded. If the subject missed the target completely, or struck the center area or target backing material in such a manner that it would be a miss in a game situation, she was rated unsuccessful

in her throw. If the subject struck the outer area or the marginal line it was considered a successful throw.

No reinforcement was given to any of the subjects by verbal or other means.

Target Construction

The target was constructed in two parts, the backing portion and the target portion (see Figure 1).

The backing portion of the target was constructed of one-half inch thick fiberboard material. It was mounted on a frame of two- by four-inch planks and heavily braced. This portion of the target measured seventy-eight inches by seventy-eight inches. The bottom edge rested on the ground.

The target portion was constructed of one-half inch thick exterior type plywood. It was centered on the backing material by measuring three inches from two sides and six inches from the top of the backing material. The fourth edge of the target rested on the ground and coincided with the edge of the backing material which rested on the ground.

The center area of the target, or the unsuccessful area, measured three feet by three feet. It was located exactly in the middle of the target area. This area was bordered by a continuous red line three-eighths of an inch wide.

The outer most area, or the successful area, was located exactly eighteen inches from the center area boundary. The edge of this boundary coincided with the extreme edge of the plywood material. This was also outlined with the same red color with a line three-eighths of an inch wide.

With the exception of the red boundary markings, the entire target and backing materials were painted with vinyl acrylic exterior latex house paint in the tone of Harvard Gray. This color was chosen because it presented a neutral background.

Training Program

After the pre-test all subjects were involved in a treatment program to teach them the skills of lacrosse and the rules of the game. At the beginning of each class all subjects took part in various and different drills which involved throwing and catching. Continued and repeated instruction was carried out involving the group and specific individuals, depending upon the situation. These drills and activities required between ten and fifteen minutes per class session at each class meeting. The drills varied slightly from day to day depending upon the conditions. In essence, the overhand throwing action was stressed and demonstrated repeatedly. In practice game situations, verbal reinforcement was continuous.

Method of Statistical Analysis

The Kruskal-Wallis one-way analysis of variance by ranks statistical technique was used to determine if there was any significant difference between dominance groups in their ability to throw a lacrosse ball at a target. The same technique was used to determine if there was any significant changes in the pre-test and post-test scores of the groups before and after the training program.

FOOTNOTES--CHAPTER III

¹Catherine J. Hull, "Study of Laterality Test Items," Journal of Experimental Education, IV (1936), 289-290.

²Blake Crider, "A Battery of Tests for the Dominant Eye," Journal of General Psychology, XXXI (October, 1944), 179-190.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

Data from a six-weeks training program for fourteen women enrolled in a lacrosse activity class are presented to indicate what effect a training program had on four differently classified hand-eye dominance groups in learning a complex motor skill. The data were grouped according to hand-eye dominance combinations: left hand - left eye, left hand - right eye, right hand - left eye, and treated statistically with non-parametric statistics.

Test Results

The pre-test and post-test scores for each individual are presented in Table 1. They were divided into successful and unsuccessful trials. Since the unsuccessful trials represented a complete miss or an obvious save by the goalie in a game situation, the analysis was only concerned with the successful scores.

The figures in the space beside each subject represent the number of successful trials for that subject in ten attempts. The total number of successes for each individual in each group were tabulated and ranked. The individual with the lowest number of successes received

TABLE 1.--Successful and unsuccessful scores before and after a training program
by dominance groups.

Subject	Before			After		
	Unsuccessful	Successful	Success Rank	Unsuccessful	Successful	Success Rank
Group I						
1	4	6	10.5	6	4	3.5
2	5	5	8	6	4	3.5
Rank Total			18.5			7.0
Group II						
3	5	5	8	10		1
4	6	4	4.5	2	8	13.5
Rank Total			12.5			14.5
Group III						
5	5	5	8	3	7	11
6	3	7	12	2	8	13.5
7	4	6	10.5	4	6	8
8	1	9	14	5	5	5.5
9	9	1	1	8	2	2
Rank Total			45.5			40.0
Group IV						
10	6	4	4.5	4	6	8
11	6	4	4.5	5	5	5.5
12	2	8	13	3	7	11
13	8	2	2	3	7	11
14	6	4	4.5	4	6	8
Rank Total			28.5			43.5

Group I = Left hand - right eye dominance combination; Group II = Left hand - left eye dominance combination; Group III = Right hand - right eye dominance combination; Group IV = Right hand - left eye dominance combination.

a rank of one. Each succeeding subject was ranked in ascending order. In the case of ties at any given rank by two or more subjects, each subject involved received the average score for that rank.

Analysis of the scores of the pre-test data indicated that the right-hand - right-eye dominance combination group scored a rank total of 45.5; the right-hand - left-eye dominance group scored 28.5; the left-hand - right-eye dominance group scored 18.5; and the left-hand - left-eye dominance group scored 12.5.

The post-test scores indicated that the right-hand - left-eye dominance group scored a rank total of 43.5; the right-hand - right-eye dominance group scored 40.0; the left-hand - left-eye dominance group scored 14.5; and the left-hand - right-eye dominance group scored 7.0.

Statistical Analysis

The results were analyzed by comparing rank totals of the number of successes of each group with two other groups. In this manner both right-handed groups were compared singly and together against both left-handed groups singly and together.

The null hypothesis was that there would be no significant difference between groups in their ability to throw accurately at a target, and that there would

be no significant change in group scores before and after participation in a training program. In this experiment the level of confidence was set at .05.

Analysis of the results indicated that there was no significant difference between groups in their ability to throw for accuracy, or in their ability in throwing before and after participation in a training program.

CHAPTER V

SUMMARY, CONCLUSIONS, AND
RECOMMENDATIONS

This study was conducted to determine if any significant difference existed in the ability of different dominance groups to throw lacrosse balls at a target.

Summary

Fourteen females who were enrolled in a beginning lacrosse class offered by the Woman's Physical Education Department at Michigan State University in the spring of 1969 served as subjects for this study. All subjects were tested for hand and eye dominance and were grouped according to dominance characteristics; left hand - left eye; left hand - right eye; right hand - right eye; right hand - left eye.

A brief pre-training program was initiated involving throwing skills in order to insure meaningful results on the pre-test scores. The pre-test for each subject consisted of ten trials in which she was to throw a lacrosse ball at a target from a distance of ten yards. Hits were considered successful or unsuccessful,

depending on the area struck, and were recorded after each trial.

All subjects took part in a training program for six weeks which involved various drills utilizing the overhand throw.

After six weeks all subjects were re-tested using the same target and procedures that were used in the pre-testing period. All of the pre-test and post-test data were then analyzed using non-parametric statistics.

Conclusions

The following conclusion was made:

1. The training program utilized in this study had no significant effect on the ability of any subject to throw a lacrosse ball for accuracy.

Recommendations

It is recommended that a similar study be made with larger samples and greater control.

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APPENDICES

APPENDIX A

DIRECTIONS FOR AND ITEMS USED IN
CRIDER'S EYE DOMINANCE TESTS

APPENDIX A

DIRECTIONS FOR AND ITEMS USED IN CRIDER'S¹ EYE DOMINANCE TESTS

Sit at a table facing each other squarely. The room should be well lighted. Tests should be out of sight of the testee. After use each test should be returned so that it is out of sight. On the table should be a score sheet and a pencil. If the examinee wears glasses, tests should be given once with and once without. No mention that the tests are to determine the dominant eye should be made.

1. We have here some simple tests for discovering your best eye. It will take about five minutes to go through them. You must listen carefully to the instructions which I shall give you with each test so that you can do the tests exactly as I tell you.

2. In these tests you must always keep both eyes open. Never close one eye to take a test because this will throw the results off.

3. Be sure to look at my nose first and then bring the test up so you can see my nose through it. Be sure to keep both eyes opened.

¹Blake Crider, "A Battery of Tests for the Dominant Eye," Journal of General Psychology, XXXI (1944), 170-190.



Figure A-1.--Ring test.

The ring is constructed of a wooden curtain ring 60 mm. in diameter. A wood screw 60 mm. in length is attached to serve as a handle.

Demonstrate and say:

4. I want you to take the handle of this ring in one hand and look at my nose through the ring. Look at my nose first, then hold the ring at arms length and look at my nose through it. Be sure to keep both eyes open.

Place ring in front of examinee directly in the mid-plane of the body with the handle toward him. As soon as the examiner can note the eye used by the examinee he says:

5. That's fine; now put the ring down.

(Ring Test--Cont.)

As soon as the examinee puts the ring down the examiner says:

6. Do this again for me, but this time hold the ring in the other hand. Look at my nose first, then bring the ring up and look at my nose through it. Keep both eyes open.

Immediately the sighting eye is observed the examiner says:

7. That's fine.
and takes the ring.

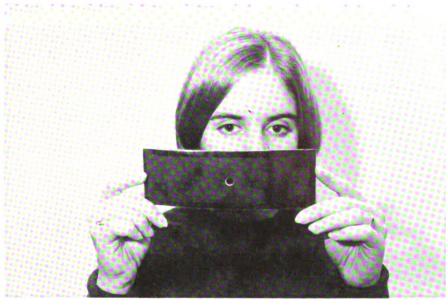


Figure A-2.--Card test.

Three cards are made measuring 7.6 cm. by 23 cm. One is covered with black paper, one with blue paper, and one with green paper. In the center of the green card is a round red spot, on the black a gold spot, and on the blue a red spot. The spots are the size of the unsharpened end of a pencil. Three other cards of the same colors are made. These measure 6.0 cm. by 17.5 cm. In the center of these cards there is a round hole through which a round pencil will fit snugly.

The examiner takes the black card with the hole in the center and holds it momentarily about six or eight inches in front of his eyes and says at the same time:

(Card Test--Cont.)

8. Hold this card in both hands and look through this hole.

He then hands the card to the examinee. The examiner then picks up the black card with the spot on it and holds it in front of his face just below the eyes so the spot is about even with his nose:

9. Now I want you to look at the spot on this card. Look at the spot first then bring your card up in front of your face about six or eight inches in front of your eyes as I did. Keep both eyes open and look at the spot through the hole.

The examiner should determine quickly the eye used for sighting the spot. The minute the observation is made the examiner says:

10. Put your card down and do the same thing with this card.

The examiner hands him the blue card and takes the other blue card.

11. Look at this spot through the hole in your card and be sure to keep both eyes open.

The directions are repeated for the third card. The score is not counted on the first card since this is used to get the examinee adjusted to the test.



Figure A-3.--Box test.

A box 5 cm. by 7 cm. by 12 cm. was made out of cardboard. The ends of the box were left open. A white pipe cleaner, 6 cm. long, was inserted at one end. At the other end a black pipe cleaner of the same length was inserted. The distance between the two pipe cleaners was 9.6 cm.

The examiner holds the box about six or eight inches in front of his eyes without definitely aligning it with either eye. At the same time he says to the examinee:

12. I want you to hold this box in your two hands as I am doing. Hold it about six or eight inches in front of your face so that you can line up the black string with the white string. Keep both eyes open while you do this.

(Box Test--Cont.)

The examiner then hands the box to the examinee. The instant the sighting eye is observed the examiner says:

13. That's fine; now put the box down.

As soon as the box is placed on the table the examinee turns it around so the other end is toward the examinee and at the same time says:

14. Now I want you to do the same thing for me again--try to align the two strings. Keep both eyes open.

Make the observation as soon as possible and say:

15. That's fine; hand me the box now.



Figure A-4.--Cone test.

The cone is similar to the one used by Miles² except that it is longer. From the forehead to the end of the cone the distance is 9 cm. The small opening is 1.5 cm. in diameter. The large opening is 25.5 cm. long.

The examiner holds the tube over his own eyes as he gives the directions:

16. I want you to look at my nose through this tube. First, look at my nose and then bring this tube up to your eyes as I am doing so you can see my nose through the end of the tube. Be sure to keep both eyes open.

²W. L. Miles, "Ocular Dominance Demonstrated by Unconscious Sighting," Journal of Experimental Psychology, XII (1929), 113-126.

(Cone Test--Cont.)

The examiner hands the tube to the examinee and repeats briefly the directions. The examiner notes quickly which eye the examinee uses for sighting and then says:

17. That's fine; put your tube on the table.

Then the examiner says:

18. I want you to do this once more for me. Look at my nose, bring the tube up to your eyes and look at my nose through it. Be sure to keep both eyes open.



Figure A-5.--Opthoscope

A 6 cm. by 7 cm. mirror was covered on both sides with cardboard. In the center of the cardboard on each side a round hole was cut so as to expose the mirror. A 6.5 cm. by 2.0 cm. tube was inserted in each hole and fastened securely. The total length between the ends of the tubes was approximately 14.0 cm.

The examiner holds the opthoscope by its sides (the mirror) and demonstrates the test while he gives the directions:

20. I want you to hold this tube in both hands and bring it up to about six inches away from your eyes. Keep both eyes open. Look in the tube and find an eye.

(Opthoscope--Cont.)

He hands the opthoscope to the examinee and makes the observation of the sighting eye as soon as possible and then says:

21. That's fine, now look in the other end of the tube and see if you can find an eye. Be sure to keep both eyes open.



Figure A-6.--Spot test.

A 6.5 cm. by 7.5 cm. mirror had all the silver removed except for a round piece about the size of a twenty-five cent piece.

The examiner holds the test about six inches from his face while he says:

22. I want you to hold this test in both hands about six inches in front of your face so that you can see your nose in the mirror. Keep both eyes open.

As soon as the sighting eye is observed the examiner says:

23. That's fine. Let's see if you can do the same thing again.



Figure A-7.--Mirror test.

A round mirror 6.0 cm. in diameter was obtained. A nickel was held to the surface so that a circle of that size was scratched on the mirror, in such a way that the circle was located in the middle of the mirror.

The examiner holds the test in both hands about six inches in front of his face as he says:

24. Hold this mirror about six inches in front of your face. I want to see if you can get your nose in the ring. Be sure to keep both eyes open.

The examiner takes the test the moment he can serve [sic] the sighting eye.

APPENDIX B

HULL'S QUESTIONNAIRE USED IN THE
DETERMINATION OF HAND DOMINANCE

APPENDIX B

HULL'S¹ QUESTIONNAIRE USED IN THE DETERMINATION OF HAND DOMINANCE

This is a test to determine which side you prefer to use in various activities.

In the following questions, encircle the letter R if you perform the activity with the right hand, L if you perform it with the left, and the letter E if you can perform it easily with either hand. In all of these activities, your hands should be empty when you begin to perform them.

- | | |
|---|-------|
| 1. With which foot do you kick a ball? | R L E |
| 2. When you cross your legs, which one is
on top? | R L E |
| 3. When hopping on one foot, on which foot
do you put your weight? | R L E |
| 4. Which hand holds a hammer when hammering? | R L E |
| 5. Which hand uses a can opener? | R L E |
| 6. Which hand holds the scissors (shears)
while cutting? | R L E |

¹Catherine J. Hull, "Study of Laterality Test Items," Journal of Experimental Education, IV (1936), 289-290.

7. Which eye remains open when you sight with one eye through a small hole in a piece of paper? R L E
8. Which hand distributes cards when dealing them? R L E
9. Which hand holds the handkerchief when you blow your nose? R L E
10. Which hand waves goodbye? R L E
11. Which hand spins a top? R L E
12. Which hand strikes a match? R L E
13. Which hand winds a watch? R L E
14. Which hand holds a tooth brush? R L E
15. Which hand takes money from a purse? R L E
16. Which hand holds the knife in sharpening a pencil? R L E
17. Which hand directs the thread through the eye of a needle? R L E
18. Which hand holds the spoon when stirring in a bowl? R L E
19. Which hand holds the comb when you comb your hair? R L E
20. Which hand turns the pages in a book? R L E
21. Which hand takes the cork from a bottle of ink? R L E
22. With which hand do you write? R L E

- | | |
|--|-------|
| 23. With which hand do you use an eraser on paper? | R L E |
| 24. Which hand cuts with the knife when eating? | R L E |
| 25. Which hand uses a salt shaker? | R L E |
| 26. With which hand do you bounce a rubber ball on the floor? | R L E |
| 27. Which hand is on top when you applaud? | R L E |
| 28. With which hand do you draw a sketch or a picture? | R L E |
| 29. Which hand turns on the water faucet when you hold no glass in either hand? | R L E |
| 30. With which hand do you pick up a penny from the floor? | R L E |
| 31. Which hand uses an eraser on the blackboard? | R L E |
| 32. Which hand throws a ball? | R L E |
| 33. Which hand is at the top of the handle when you sweep the floor with a straight broom? | R L E |
| 34. Which hand holds a tennis racquet? | R L E |
| 35. Which hand is at the top when you rake? | R L E |
| 36. From which shoulder do you swing a bat? | R L E |
| 37. Which hand is at the top end of the handle when you shovel? | R L E |
| 38. Which hand pushes the light switch on the wall? | R L E |
| 39. Which hand puts the key in the door key hole? | R L E |
| 40. Which hand turns the knob in opening a door? | R L E |

APPENDIX C

RAW SCORE DATA SHEET FOR SUCCESSFUL (S)
AND UNSUCCESSFUL (U) TRIALS

TABLE C-1.--Tally of successful and unsuccessful scores before and after a training program by dominance groups.

Sub- ject	Dominance	Pre-test Trials										Post-test Trials									
		1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
1	LH-RE	U	S	S	U	S	S	S	U	S	U	U	U	U	S	U	U	S	S	S	
2	LH-RE	U	U	U	U	U	S	S	S	S	S	S	U	S	U	U	U	S	U	S	U
3	LH-LE	U	S	U	S	U	S	S	S	U	U	U	U	U	U	U	U	U	U	U	U
4	LH-LE	U	S	U	S	U	U	S	S	U	U	U	S	U	S	S	S	S	S	S	S
5	RH-RE	U	U	S	U	U	S	S	S	U	S	S	U	S	S	U	S	U	S	S	S
6	RH-RE	S	S	S	U	U	S	U	S	S	S	S	S	S	U	U	S	S	S	S	S
7	RH-RE	U	U	S	U	S	S	U	S	S	S	U	U	S	S	S	U	S	U	S	S
8	RH-RE	U	S	S	S	S	S	S	S	S	S	S	S	U	S	U	S	S	U	U	U
9	RH-RE	U	S	U	U	S	U	U	S	S	U	U	U	U	S	U	U	U	U	U	S
10	RH-LE	U	U	U	U	S	S	U	U	S	S	U	U	U	U	S	S	S	S	S	S
11	RH-LE	S	U	S	U	U	U	S	S	U	U	S	U	S	U	U	U	S	S	U	S
12	RH-LE	S	U	S	S	S	S	S	S	S	U	S	S	S	U	S	S	S	U	U	S
13	RH-LE	U	U	S	U	S	S	U	U	U	S	S	U	S	S	S	S	S	U	S	U
14	RH-LE	U	U	U	S	S	S	S	U	S	U	U	S	S	S	U	U	U	S	S	S

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