A STUDY OF THE LITERATURE PERTAINING TO KINESTHESIA AND MOVEMENT WITH SPECIAL EMPHASIS ON THE APPLICATION OF THESE TO THE TEACHING OF SPORT SKILLS

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by

Sylvia Wilson

Submitted as an Honors Paper
in the
Department of Physical Education

The Woman's College of the University of North Carolina
Greensboro, North Carolina
1956

CORRECTION

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REFILMED
TO ASSURE LEGIBILITY OR TO
CORRECT A POSSIBLE ERROR

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INTRODUCTION

Kinesthesia can be briefly defined as the "muscle sense". However, this does not reveal the many and varied aspects encompassed by this sense sometimes labelled the "sixth sense".

Wiebe (72) says that the functions of kinesthesia -- co-ordination, skill development, posture, body control, balance, and pressure discrimination -- are all important in teaching physical education (72, p. 222).

Stevens (82) states that kinesthesia is important in that one must be aware of the movement for a successful performance of any action. Through kinesthesis, she believes

> "it is possible to bring movements into consciousness and, thus realized, we are able to control and make adjustments" (82, p.2).

Ensign (78), working along similar lines, believes that

> "if there is an awareness of the body during the learning stages of a skill, the acquisition of it will probably take place more rapidly and upon firmer roots. Movement that is conspicuously recognized, analyzed, and directed, is understood" (78, p. 63).

Scott (59) believes that kinesthetic awareness and perception may be the connection between past experience and present learning (59, p. 334).

From the literature that was reviewed, the writer would summarize that kinesthesia is responsible for:

1. Perception of own bodily movement, whether active or passive
2. Awareness of the position of the body parts and of the whole body
3. Ability to recognize, assume, and hold a specified position and/or force
4. Determination and distinction of weight and pressure
5. Awareness of the body in relation to its surroundings
6. Co-ordination of movement
7. Partial aid in maintenance of balance

Individuals are always experiencing the use of this sense, whether they recognize it specifically or not. The comments: "I can do that without looking;" "I can find it easily in the dark;" "She can measure anything without a ruler;" "She can knit as fast as lightning, and still read a book at the same time;" "The second I threw the ball, I could feel it was going into the basket;" are all indications that the human organism is experiencing the different facets of kinesthetic sensitivity.

It has been only recently that kinesthesia has been recognized as a special sense with possible important applications to the field of teaching physical education. More and more people in the physical education profession are basing their hopes on the belief that an increased awareness of the body and its actions -- the "feel" of a movement -- can be used in postural work, in improving motor ability, in explaining individual differences, in motivating, in learning and improving skills, and in applying knowledge to other skills (59, p. 324).

The purpose of this study is to survey and summarize the available literature concerning the different aspects of kinesthesia.

The writer organized the material into sections on the early research proving the presence of kinesthesia, the presently accepted nervous structures controlling kinesthesia, the testing that has been done concerning kinesthesia, the theories pertaining to kinesthesia and its numerous facets, and the rhythmical and effort theories of movement.

The literature pertaining to the testing has been grouped in relation to the test emphasis and purpose. A check list type chart of the tests used by various researchers can be found in the Appendix. A brief description of these tests is also included.

The writer has made no attempt to draw any conclusive statements from this survey, but merely presents the available pertinent material concerning kinesthesia and movement.

EARLY RESEARCH

Charles Bell was the first individual to venture this theory of the "muscle sense", as he termed it. He declared his belief in 1844 without having any actual knowledge of the function of the nervous structure necessary for kinesthesia -- his was a purely theoretical idea (26, p. 3).

Since that time, many experiments have been made substantiating Bell's theory of the presence of the muscle sense. A summary of some early experimentations follows.

Anatomical and Physiological Proof

The first consideration of these early researchers was to find sensory nerve endings in the muscle. The nerves coming from the muscles were traced, and it was found that not all of them went to the motor roots. All of the sensory root fibers did not go to the skin, so it followed, by assumption, that these sensory nerves went to the muscles (26, p. 2).

In another experiment, the motor fibers to a muscle group were cut. These motor fibers consequently degenerated, but some healthy nerve fibers still remained. Since some of these healthy fibers had a medullary sheathe, they could not be sympathetic ganglia. The only other alternative was to accept the presence of sensory nerve fibers (26, pp.2-3).

These nerve fibers were followed to the muscle spindle, the Pacinian corpuscles, and the Gogli corpuscles (26, p. 4).

The next problem was to determine the source and result of the stimulation of these nerves. The nerve end-organs listed above were found to be adequately stimulated by purely mechanical means. Stimulation of either the muscle or its nerve was found to produce a reflex action in a muscle. This meant that sensory stimuli were coming from the muscle itself to begin the reflex circuit (26, pp. 4-5).

Sherrington produced the condition known as decerebrated rigidity -- strong action of the extensor muscles. He then cut a motor nerve going to a flexor muscle, stimulated the central ending, and found that all the other flexor muscles in that group contracted reflexly, while the extensor muscles relaxed. This showed that stimulation of a muscle caused a relaxation of the antagonists of that muscle, which could only be caused by nerve innervation (26, p. 5).

Though these experiments indicate the presence of sensory nerve innervation and spinal reflex control, they do not prove that sensory impulses from the muscles reach the conscious centers (26, p. 5).

Psychological Proof

Psychological evidence is necessary to complete the proof that there is some conscious awareness of kinesthetic factors.

A great deal of discussion among these early researchers centered on whether conscious awareness of kinesthetic actions was really dependent on cutaneous sensitivity or on the actual muscle sense.

Duchenne applied electrical stimuli to bare muscles. The conscious awareness of the stimulation was diffuse and the amount of awareness depended on the strength of the stimulus (26, p. 6).

Goldscheider did experiments using anaesthetized skin and the results were similar to those of Duchenne. In this experiment, an anaesthetic would deaden the nerves to the skin so that just those nerves believed within the interior of the part being tested would be capable of reacting to the stimulation. He found that pressure produced a dull, diffuse feeling that did seem to come from within the muscle (26, p. 7).

Bernard totally anaesthetized the hind feet of a frog by cutting the sensory roots of the spinal cord going to this area. An extreme loss of co-ordination resulted. Then Bernard produced cutaneous insensibility in another frog by removing the skin. The co-ordination remained normal after this operation. This showed positively that, in the frog at least, the sensory nerves of the kinesthetic system must be in the interior (26, p. 8).

This same result has been found true in humans, though not to such a great extent. Cutaneous anaesthesia caused inaccuracy in the perception of different positions, but this was not similar to the total loss due to complete anaesthesia of the appendage (26, p. 8).

Gley and Mariller tested a blindfolded subject who had lost all sensibility in the upper half of his body. The subject was completely unaware of any passive movement that the testers caused him to do. This subject was able to do movements for himself, though they were done slowly and with difficulty. Habitual movements could be done without the subject looking, but any other movement required visual assistance. This subject was unable to tell an object's weight, or to differentiate between the consistency of objects -- such as wax, wood, rubber, paper -- by feeling them. The testers tied the forearms of the subject to a table and the subject was then told to flex his arms. When the subject believed that he had folded his arms, he had actually only barely moved them. When asked to explain his belief, the subject replied that he thought the movement had been accomplished because of the time that had elapsed (26, p. 9).

Cremer tested a blindfolded subject whose left arm was totally anaesthetized. When the good arm was put into motion by a tester, and the subject asked to copy the movement with the left arm, the movement was started, but was of short duration. When the same movement was done for both arms simultaneously, and the subject asked to repeat, the left arm always traveled a shorter distance than the right. If the subject's attention was centered on the right arm during this experiment, the normal arm made a much bigger movement than that made by the left. If the attention was directed toward the left arm, however, an equal movement was made by both arms (26, p. 10).

Goldscheider discovered that the least perceptible movement recognized by a normal subject was very similar to that recognized by one with anaesthetized skin, but three or four times greater than that felt by a subject with an anaesthetized joint (26, p. 11).

Weber found that weights were perceived and differentiated better when they were raised, rather than when they were simply held (26, p. 11).

It has thus definitely been found that cutaneous anaesthetization has no pronounced effect on the execution or perception of a movement, and none on weight perception (26, p. 11).

These early research tests proved by anatomical, physiological, and psychological means, the presence of a muscular sense with both spinal and cerebral control.

ACCEPTED STRUCTURAL BASIS

Since the time of these early experimentations, a great deal of research has been done, and a summary follows of the now well determined and generally accepted nervous mechanisms involved in kinesthesia. The kinesthetic sense is considered a part of the nervous system, for it has its own sensory receptors, nerve pathways in the spinal cord to the brain, and connections with motor nerves.

There are four types of sensory receptors discussed by authorities: the muscle spindle, the Gogli tendon organ, the Pacinian corpuscle, and the free nerve ending.

The muscle spindles occur mostly in between the fleshy part of the muscle fibers, and contain both motor and sensory nerves (5, p. 323). The spindles are of two types: (1) the annulospiral type, consisting of the ends of the larger nerve fibers that spiral around the muscle fiber; (2) the flowerspray type, made up of the ends of smaller nerve fibers that spray out like tree branches on the muscle fiber. These spindles are stimulated only when the muscle is stretched -- therefore, they are called stretch afferents. The annulospiral type, because of the greater diameter of its fibers, is able to conduct impulses faster than the flowerspray ending type. When the muscles are in tonic contraction, these two receptors send out about fifteen impulses per second. When the muscle is stretched, the receptors can send out a high of 500 impulses per second (20, pp. 256-259).

The Gogli tendon organs are the afferent nerve fibers that end at the junction of the muscle fiber with its tendon. These receptors are stimulated by either stretching or contraction of the tendon. These receptors have a higher threshhold value than that of the muscle spindles. They are also smaller in diameter, and therefore conduct the impulses more slowly (20, pp. 256-259).

With these two, the muscle spindles and the Gogli tendon organs, the higher areas of the nervous system can determine whether a muscle is stretched or contracted. To illustrate, stimuli from the muscle spindle and the Gogli tendon organ indicate a stretched muscle; stimuli from just the Gogli tendon organ indicates a contracted muscle (20, p. 258).

The Pacinian corpuscles are the sensory receptors located in the fascia of the muscle and tendons, the lining of various organs, and in the fat tissue under the skin. These corpuscles are especially responsible for feelings of deep pressure. The fibers of these corpuscles are smaller than either the muscle spindle or the Gogli tendon fibers, with a resultant decrease in the possible number of impulses per second that can be conducted (20, pp. 256-259). The corpuscles are stimulated by pressure of either stretching or contracting musculature (5, p. 323).

The free nerve endings are found in the deep tissues and in the blood vessels immediate to the muscle. They are responsible for the sensation of pain. These are difficult to place as they are smaller than the others and give out such weak impulses that they cannot be recorded (20, p. 258).

The sensory impulses are carried from one or more of these sensory receptors along the afferent nerves and go, via the medial part of the posterior root, to the spinal cord. Some of these nerves end in the gray matter of the cord and synapse there with a motor nerve, producing a simple reflex action. Other nerves carrying these sensory impulses go to the posterior column of the spinal cord. Those impulses from above the mid-thorax line go up the tract of Cuneatus to the nucleus of Cuneatus in the medulla oblongata; those from below the mid-thorax line ascend the tract of Gracilis to the nucleus of Gracilis also situated in the medulla. At either nucleus, the nerve synapses with the second neurone (78, pp. 52-53). The axone of this second neurone goes ventrally and crosses over at the sensory decussation (85, p. 1). The impulses next go to the thalamus, via the leminiscus, where the axone synapses with the third neurone. The third neurone takes the impulses to the cortex of the cerebellum (78, p. 53).

> "The area where the afferent fibers deposit body sensibility extends back of this sulcus (Rolando) to the posterior central convolution" (78, p. 57).

The association areas of the brain -- those large and relatively unspecialized areas -- receive all the impulses and then discriminate, sending out appropriate impulses to the motor area of the cortex which is anterior to the central sulcus (fissure of Rolando) (78, pp. 57-59) and

> "in the ascending frontal convolution and the immediately contiguous portions of the first, second, and third frontal convolutions" (78, p. 56).

This area is divided into units corresponding to the body parts. The size of the area is dependent upon the complexity of the movement required (78, p. 56).

It can be seen that

> "the continuity of these sense organs with the contracting muscle ensures in the best possible way that the organs should be affected by the slightest change of tension of the muscle, and should transmit information of the state of tension to the central nervous system" (23, p. 601).

The receptors are stimulated by both active and passive movement. Passive movements are recognized mainly by stimulation of the joint and ligament receptors. The movement is felt as covering so much distance at a certain speed. The amount of perception varies with the joints involved, some having a lower threshhold than others. Experimentation shows that the movement is perceived better when the joints are pushed together, rather than when being pulled away from each other. Active movements are sensed by a variety of receptors. These judge the space covered by, and the force of, a movement (23, p. 600).

The motor impulses produced as a result of the sensory stimuli travel along the motor nerves to the muscle fibers.

The muscles contract in response, producing a co-ordinated movement by smoothing out the reflex acts or the jerky contraction of individual muscle groups (20, pp. 332-333).

Injury to the kinesthetic pathways can cause extreme disturbances to motor co-ordination. This is called voluntary ataxia -- inability to co-ordinate the muscles under voluntary control. The break in the system causes different results in different parts of the body; those parts producing more precise movements being the most disturbed (20, pp. 332-333).

TESTING

Tests for Kinesthesia

The number of actually useful tests for measuring kinesthetic factors has been rather limited. Scott, Wiebe, Stevens, and Cumbee have given numerous tests which were purported to measure kinesthesia, but only a few have been found to be reliable and valid. A more detailed account of these studies follows.

Scott has done the most recent research on tests of kinesthesia; she tried to determine which tests were reliable and valid (59, p. 324). The battery was originally composed of twenty-five tests, but nine did not meet her standards, leaving sixteen. From the results of these sixteen tests, Scott answered some common questions (59, p. 328).

1. There does seem to be some relationship between an individual's control of muscular contraction of both arms, while no relationship was found between control of the arms and legs, showing that voluntary control of muscular contraction is specific. However, she does state that the ease in which a person adapts is general enough to affect the accomplishment of a number of activities (59, pp. 329-330).
2. Balance was found to have a relatively high positive correlation with other tests of kines-

thetic factors, indicating that balance is a part of kinesthesia (59, p. 330).

3. The ability to assume and name a position of the body or a part of the body was not found to be a general factor acting throughout the whole body. Scott believes that this ability may be specific for each part, and may possibly be due to the influence of past experience on the action of each part (59, p. 331).
4. The tests for recognizing hand and arm position and movement were not found to be related to manipulative skill ability (59, p. 332).
5. Spacial orientation ability did not make movements easier and was not related to tests involving spacial perception (59, pp. 332-333). When movement was kept within short distances, however, kinesthesia was found to be especially important in maintaining body orientation (59, p. 328).
6. There is a strong possibility that learning a new skill can be made easier by kinesthetic cues while still achieving similar results (59, pp. 333-334). The "learning rate is related to accomplishment level." (p. 334).

Scott concluded from her testing that there is little positive relationship between present tests. No single test was successful by itself, but a small battery proved to be fairly valid in relation to the criteria used. Scott therefore feels that kinesthesia must be specific (59, p. 324).

All of the balance tests were found to correlate positively with other tests of kinesthesia, indicating that a balance test should be included in a test battery. This may be due to nerve mechanisms for balance being similar to those in other tests; or, that the acuity of the inner ear may parallel the doings of the proprioceptive nerve endings (59, p. 337).

Arm swinging tests were also found to correlate consistently. These tests depend on the ability of the individual to recognize kinesthetic cues, and then to accomplish accurate movements (59, p. 337).

After all this testing, Scott still believes that

> "an attempt at definition and identity, which is essential as a starting point in measurement, is impossible because the facts are lacking" (59, p. 324).

It is her belief that past experience is very important in learning and adjusting to new things. She feels that kinesthetic awareness and perception may be the connection between past experience and present learning (59, p. 334).

Scott thinks that kinesthetic information should be applied practically. She thinks that this can lead to better awareness of how motor activities are learned, how individual differences show up in motor learning, how this can improve the learning process, and how an individual's capacity for perception can be increased (59, pp. 337-338).

Scott's suggestions for further study include:

1. Analysis of the components giving rise to the kinesthetic sense
2. Finding reliable and valid test items for these components
3. Showing the relationship between the kinesthetic sense and motor learning
4. Finding a test battery that will recognize individual differences (59, p. 338).

Wiebe believes that kinesthesia is an important factor in motor educability and in static and dynamic posture. He believes that it is a or the factor in a refined skill (72, p. 223).

Wiebe reviewed the tests of other researchers, and chose fifteen tests that had been found to have fairly good reliability co-efficients. He gave this group of tests, plus six of his own, to fifteen athletes and fifteen non-athletes. The athletes were found to have higher results on these tests than the non-athletes. Wiebe concluded from his testing that there is probably not one general kinesthetic factor, but numerous specific factors (72, p. 227).

By conscious consideration of the kinesthetic feeling of a movement, Stevens believes that individuals can learn, adjust, and improve a skill. She thinks that there is a need to evaluate the effectiveness of teaching motor activities by using the kinesthetic sense, as she believes that greater economy of effort and motion can be achieved by this method (82, pp. 2-3).

Stevens used numerous tests to evaluate the kinesthesis of college women. Her tests included: the ability to assume specified arm and leg position; the ability to recognize the amount of force applied; the ability to recognize arm positions in a swinging movement; the ability to maintain a steady rhythm; and the ability to accurately handle equipment (82, pp. 29-68).

Physical education majors were found to show a significantly higher score than non-majors on these tests. Stevens considers that this may possibly be due to the training of the major students. According to Miss Stevens, when the motor training of different individuals is the same, it seems that they all have the same amount of kinesthetic sensitivity (82, p. 94). This is in contrast to the findings of Fisher (see pp. 19-20), and Roloff (see pp. 23-24).

From the results of the tests, Stevens selected items for four batteries, ranging from six items to three. In this way, at least one battery would be suitable for the equipment, facilities, time, and personnel, conditions of a particular situation. The batteries containing more items naturally give a better total picture than those with fewer tests

(82, pp. 74-77).

Suggestions for further study include:

1. Analyzing kinesthetic factors
2. Finding the reliabilities of the batteries
3. Comparing the kinesthetic sensitivity of two groups other than physical education majors selected on the basis of motor ability scores (82, p. 94).

Cumbee was interested in analyzing the different aspects of co-ordination and grouping the types of tests together (34, pp. 412-416) into such categories as

> "the ability to balance objects and maintain body balance, the ability to time movements of the body, and the ability to move rapidly with the moving parts changing directions" (34, p. 414).

It was found that the variable factors involving

> "balancing objects, tempo, two-handed agility, speed of change of direction of the arms and hands, (and) body balance" (34, p. 420)

did tend to group (34, p. 420).

Cumbee also suggests that ability to balance objects may have a lot of influence in sports (34, p. 419).

Tests for Relating Kinesthesia to Skill and Motor Ability Tests

A handful of testers have been interested in relating kinesthesia to the skill and motor ability of subjects. Fisher, Henry, Mumby, Kerr and Weinland, Hart, and Chernikoff and Taylor did work in this area.

Fisher studied the importance of kinesthesia in certain motor movements. She gave a variety of tests, using repetition of pulley pressures, path walking, balancing, target pointing, accuracy in throwing, and the Young battery, consisting of the total T-score results of the balance stick, leg raising, and arm raising tests.

Fisher found the tests to be reliable. The balance crosswise and lengthwise had a significant relationship to general motor capacity, while the path test and the Young battery had low but significant correlations. The balance crosswise test seemed to be the only tests of the Young battery that had a significant positive relationship with kinesthetic criteria. The Workshop battery and the Young battery, though they both are supposed to measure kinesthesia, had no correlation with each other (79).

Fisher concluded that

> "correlations of the balance tests, Young battery, and Workshop battery with general motor ability and motor capacity are for the most part low but positive (79, p. 21).

Henry reviewed the previous work done in this area and suggested that the low or negative results of attempts to correlate kinesthesia with a sport skill may be due to the fact that the tests, while good for evaluating the muscle sense, are not necessarily also good for a sport skill (42, p. 176).

Henry believes that most individuals are not well aware of their kinesthetic sense and that the body has the ability to make movements and adjustments without there being conscious awareness of the change (42, p. 177). He tries to prove that

> "accurate kinesthetic adjustment is possible in the absence of the perceptual discrimination" (42, p. 177).

His subjects, blindfolded, had to apply an equal pressure in response to the force of an uneven cam, and to hold the position constant against a changing force. Henry's subjects were better in maintaining a constant position than in keeping a constant pressure in response to the uneven cam (42, p. 185).

Mumby tried to find the relationship, if any, between kinesthetic sensitivity and balance and wrestling ability. He feels that kinesthesia is very important in wrestling, as the forces are constantly changing, and a successful wrestler must be able to recognize these continually varying forces (52, p. 328).

Mumby used Henry's tests, balance tests, and skin sensitivity to pressure tests, with two groups of wrestlers, one group composed of good wrestlers, one of intermediate wrestlers (52, p. 329). He found no significant relationship between the test for constant position and wrestling ability, but did find a significant relationship in the constant pressure test against a dynamic and changing force with wrestling ability. The better wrestlers were found to have a higher degree of balance ability and balance learning ability. The acuity in recognizing skin pressure variations had no significant relationship (52, p. 334).

Kerr and Weinland wanted to find out if

> "tests of muscular perceptivity...should indicate in some degree, fitness for occupations requiring muscular skill" (46, p. 551).

They tried dynamometer tests calling for a repetition of force. Their results showed that athletes-in-training remained closer to the perfect score than athletes-out-of-training, while non-athletes were found to have the poorest scores. It was interesting to note that the scores of the athletes-out-of-training were closer to the non-athlete's scores than to those of the athletes-in-training. Kerr and Weinland also tested some manual workers and compared their co-ordination with that of the students. The manual workers were found to have better right hand control, while the students were better in foot pressure.

They conclude that

> "if muscular perceptivity is involved in skilled muscular work and can be tested, as our results indicate, it would be possible to devise and try out trade tests" (46, p. 557).

Hart tested six factors which were considered necessary for success in archery. These six were: arm and shoulder girdle strength, motor ability, steadiness, kinesthesia, hand-eye dominance, and activity preference.

No significant relationship was found between the archery scores and the results of the motor ability, kinesthetic, static or dynamic steadiness tests. There was a low but significant relationship found between kinesthesia and strength tests (80, pp. 2087-2088).

Chernikoff and Taylor made a study on reaction time following kinesthetic stimulation. This response was found to be shorter than that following either auditory or tactual stimulation (33, p. 5). The researchers suggest that there may be

> "a dual mechanism of control...wherein the volitional processes serve the function of intermittently issuing "orders" and the non-voluntary, lower centers execute these orders without additional voluntary guidance" (33, p. 8).

Tests for Relating Kinesthesia To Learning and Teaching

The studies of Bowdlear, Roloff, Coady, Walter, Luttgens, and Honzik, who have attempted to find the relationship between kinesthesia and learning and the position of kinesthesis in teaching, are summarized below.

Bowdlear made an early study of the influence of a kinesthetic emphasis in teaching the upstart on the parallel bars. Though his results were not conclusive, he believed that the kinesthetic sense could be developed if properly taught and practiced (30, pp. 100-105).

Roloff made an intensive study of the relation of kinesthesia to learning tennis, bowling, or fundamental skills. A variety of tests suggested by different authors were first used, and then eight of these were selected, after being tested for validity, for use in this study. These eight tests were given to a total of 200 students enrolled in skills clinic, tennis, and bowling classes (57, pp. 15-18). The scores on these kinesthetic tests were correlated with motor ability scores; Roloff found a positive relationship between the Scott Motor Ability test and these kinesthesia tests (57, p. 49).

Roloff changed the usual emphasis in her experimental classes to that of "feeling". Students were asked to "feel" the movements while watching demonstrations, movies, and while actually doing the skill. Activities were often done blindfolded. More demonstrations and other visual aids were given than are normally found in such a class (57, p. 21).

Results showed that it was possible to increase the amount of kinesthetic sensitivity, but any gain depended on the individual. No significant improvement was found in either the tennis, bowling, or skills clinic classes due to this method of teaching (57, pp. 47-49).

Roloff still suggests a possible plan for teaching with a similar emphasis. Her plan includes:

1. Observing the movement
2. Trying the movement
3. Observing, using mental practice
4. Practicing the movement
5. Practicing with closed eyes
6. Discussing the movement briefly to gain under-

standing and insight

7. Practicing the movement (57, p. 64).

Coady compared the abilities of two beginning golf classes. One was taught with special emphasis on "feel" while first practicing and later when "grooving" the movement, while the other class followed the more usual pattern. No significant difference was found between the two groups (76).

Walters made a study on the perceptual approach to teaching bowling as compared with the so-called traditional approach (70, p. 14). Her experimental group held their first lesson in the dark, bowling at phosphorescent pins after seeing a movie depicting correct form. Tennis balls were used at first instead of the regular bowling ball. If swing faults appeared in the experimental classes, the students bowled in front of a mirror or bowled with softballs (70, p. 15).

Results indicated that

> "the experimental group had fewer plateaus in their learning curves than the control group," (70, p. 17),

but that there was no significant difference in the final results (70, p. 17).

Luttgens attempted to relate kinesthesia with habitual posture and posture improvement. In her review of literature, she states that good posture was believed to be attained by a process of "feeling" the proper balance -- a conscious voluntary action at first, developing into a habit as the response is chosen which "feels" best (81, p. 11).

A variety of tests were used in the Luttgens' study. A very low, if any, relationship was found between kinesthesia, as tested, and posture or posture improvement (81, pp. 24-37).

Luttgens feels that more research needs to be done on closely related topics. She suggests:

1. Using two groups; one, a control, taught by regular body mechanics methods; one, an experimental group, emphasizing the training of the kinesthetic sense
2. Attempting to discover if general kinesthetic training is of any value in improving posture
3. Validating the kinesthetic tests (81, p. 31).

Honzik showed that kinesthetic sensitivity does not aid rats in learning a skill. Honzik does state, however, that kinesthesia is probably important in making the new habit or skill a smooth movement (43, p. 373).

Tests for the Untrustworthiness of Kinesthesia

Barlow checked and confirmed F. M. Alexander's theory that the kinesthetic sense is sometimes untrustworthy. In the test, subjects were studied in the act of sitting down. This movement causes the head to be thrown back slightly. When the subjects were asked about their head position, their kinesthetic sense led them to believe the opposite of what they were doing or thought they were doing (28, p. 365).

Tests for Relating Kinesthesia to Balance

The relationship of the semicircular canals to the kinesthetic sense has been studied by Bass, H. G. Seashore, Espenschade et al., and Worchel.

The muscle sense receptors work with the semi-circular canals of the inner ear, the sense of sight, and the sense of touch on the soles of the feet to produce and maintain balance (29, p. 42). Though one of these factors may be destroyed, the other three are usually capable of keeping the body in balance. For example, it is common knowledge that standing on one foot while keeping the eyes closed makes the kinesthetic awareness become more pronounced.

Balance is usually divided into two sections -- static balance, meaning that one body position is held in equilibrium; and dynamic balance, signifying that the body is kept in equilibrium while the parts are moving. Dynamic balance, in a sense, is the changing from one position of static balance to another (29, p. 33).

Bass gave tests to determine the factors involved in balance, and also developed tests for measuring balance ability.

A "stepping-stone" test was given for dynamic balance. This test, believed to be controlled mostly by kinesthesia and vision, proved to be reliable and it also had a high correlation with rhythm and general motor ability scores (29, pp. 35-38). For static balance, Bass employed a balance stick test. The best correlation score with the rhythmic rating and general motor ability rating was .50, done with the eyes open; and .37, done with the eyes closed (29, pp. 38-41). The Carl E. Seashore test was given and this proved to have a very low correlation with the balance tests and with a rhythmic rating (29, p. 41).

From her results, Bass concludes that the semicircular canals do not seem to do as much in these tests as was expected (29, p. 50) and that

> "other factors function most when the eyes are closed" (29, p. 50).

H. G. Seashore developed a beam-walking test and attempted to measure the development of balance in children with it. The subjects were required to take ten steps along the Springfield Beam-walking Board which had been regulated for age and foot size (60, p. 248).

Results showed a typical curve by age, though there was a wide range in individual differences in each age group. This would indicate that activity based on age grouping may result in widely divergent skills in the same class. Height and weight, when considered with age, were also found to relate to balance (60, pp. 254-255).

Seashore also found that physical education majors scored better than non-majors on this test which was found to be a reasonably reliable one (60, pp. 257-258).

Espenschade, Dable, and Schoendube used the Seashore beam tests to see if balance ability was disturbed during the adolescent years (36, pp. 271-272).

Their results showed that boys, at puberty, did decrease in the amount of yearly gain in motor ability. As dynamic balance is so important in physical education activities, this could be of especial importance for teachers. The tests were given a year later and proved to be reliable (36, pp. 272-274).

Worchel blindfolded deaf subjects and vestibularly insensitive subjects and had them traverse a triangle for his study on spacial orientation (73, p. 6).

He believes that the vestibularly deficient group relied more on kinesthetic cues for performance than the others, compensating for their lack of labyrinthe control (73, p. 9). Results also showed that

> "kinesthesis plus visual imagery (is) important in directional orientation involving short distances.... The longer the distance, the more important becomes the ability to visualize spacial relationships" (73, p. 9).

THEORETICAL BELIEFS

Skill

The beliefs of Morehouse and Miller, R. H. Seashore, and Affleck, in regard to a definition and possible implications of skill, have been summarized below.

Morehouse and Miller state that skill is

> "acquired mainly through a refinement of the co-ordination of different muscle groups" (19, p. 234).

This co-ordination is achieved by the motor impulses arriving

> "from the central nervous system...in such numbers and with such timing as to bring about the correct sequence of integrated events" (19, p. 234),

and is limited only by the central nervous system.

R. H. Seashore believes that steadiness, speed, and strength are the main variables of any motor activity, and that skill in any one activity is based specifically on one or possibly two of these three variables (61, pp. 86-89).

Precision of movement may depend on sensory receptors, sense organs, threshhold values of the nervous system, the type of nerve fibers and muscle fibers, the quality of reciprocal innervation, and the reflex actions; speed may depend on all of these plus the length of the refractory period, the relation of the muscles to the skeletal framework, and the efficiency of the bodily systems; strength seems to depend on the size and amount of muscle cells

(61, pp. 87-89).

Affleck describes correct timing of a motor skill as a combination of

"sequence, synchronization, and rhythm" (27, p. 69). These three are defined as follows: sequence refers to the application of greater or lesser strength at the appropriate moment; synchronization refers to the different parts working together to achieve a total picture, whether it be an individual skill or a team play; and rhythm refers to the correctly spaced time intervals present during a movement with appropriately placed accents (27, pp. 69-73).

Development of Kinesthesia

Most writers seem to agree that kinesthesia is developed by an accumulation of sensations.

Bowen, as stated in Luttgen's thesis, believes there is no muscular sense for an unperformed activity. Sensitivity is achieved by practice, for the synapses develop, letting the nerve impulses travel across them better, and only then establishing a definite pathway (81, p. 5).

Starling believes that muscular control is increased step by step and that learning is achieved by experiencing the combination of muscular movement and sensory impressions (22, pp. 601-602). As he states it,

> "we receive from our limbs impressions grouped in certain patterns, each pattern being associated with a given limb position. These we correlated in infancy

> by vision, touch etc.. When, in later life, the same kinesthetic groups of sensations are repeated, we correctly interpret them in terms of known limb positions" (23, p. 257).

Bastian believes that

> "To perform a voluntary act is to consent to doing that particular movement, the movement itself being at the same time mentally prefigured by certain revival sensations..." (78, p. 60).

Scott suggests that kinesthetic awareness and perception may be the connection between past experience and present learning and adjusting (59, p. 334).

In the study by Luttgens, it is stated that kinesthesia can be developed by:

1. Thinking about it
2. Recognizing the difference between tension and no tension
3. Stimulating the muscles and related parts by active training
4. Putting the body in unusual position and having the student feel the body changes (81, pp. 12-13).

Importance of Kinesthesia in Learning a Skill

Several writers have stated their views on the application of kinesthesia to learning a skill.

Wells states that the cerebral motor area receives sensations from visual and kinesthetic stimuli. By remembering former sensations and realizing the present sensations, the correctness of a movement can be judged, and a correct sequence of movements can be learned by repetition of this process. After learning the sequence well, the nervous pathways are shifted to the area in front of the motor area, and the movement becomes almost completely dependent on proprioceptive stimuli (25, pp. 46-47).

According to Morehouse and Miller,

> "learning of skills involves familiarity with the objects to be used and a co-ordination of the body movements which are required in handling an object" (19, p. 239).

When a skill is first being learned, constant attention should be given to the movement parts making up the whole, and to the adjustment of the strength and extent of the movement. Later, only proprioceptive stimuli are needed for the sequence of movements (19, p. 243).

Roloff cautions that every motor skill has its own special network and that individuals can only learn in proportion to the amount of perception and reproduction possible for them (57, p. 3).

When a new skill is being learned, Todd believes there is a visual image in each person's mind and the muscles contract in order to produce this image (24, p. 33). It is suggested that students experiment and try out different body positions and feel the interrelationships of body parts (24, pp. 175-179) when different movements are produced. By doing this, students can become able to correctly judge the force, distance, and time length of an accurate movement and also be able to recognize the correct feel of the movement. This movement, by repetition, can then become automatic (24, pp. 27-40).

Stevens believes that by bringing movements under conscious control, they can be learned, adjusted, and improved, due to activation of muscular action by voluntary thought (82, p. 2).

Shaw states in Newsweek that when an action was mentally reviewed, the muscles responsible for the action still contracted. It was also reported that the muscles contracted more strongly to "lift" heavy imaginary weights than light imaginary weights (62, pp. 30-31).

Ensign believes that

> "if there is an awareness of the body during the learning stages of a skill, the acquisition of it will probably take place more rapidly and upon firmer roots. Movement that is conspicuously recognized, analyzed, and directed, is understood" (78, p. 63).

Metheny believes that a new skill is learned by: (1) experiencing it and getting the feel of it; (2) practicing it, so the same feeling can be reproduced when desired (16, p. 59).

Howland, who has done postural work, believes that individuals can learn to bring their kinesthetic sensitivity into consciousness, and then the

> "kinesthetic cues under such circumstances assist greatly in effective learning or conditioning of the desired act" (9, p. 32).

Lee and Wagner suggest that for postural training, the teacher should strive to develop an awareness of the difference between relaxation of musculature, by using mirror work -- so the correct movement can be correlated with the feel, and by shutting the eyes and feeling the positions of muscles and joints. Good form should be emphasized throughout the learning process, so that the correct movement can be felt and the performer recognize it as such (15, pp. 61, 155).

Ragsdale states that the learning process must be thoughtful and active for good results. The student should see a model and then try to copy it. The results of this action should be considered in relation to the desired "finished" skill and any errors should be analyzed and corrected (57, p. 13).

Lee places a great emphasis on balance. She believes that balance is obtained by keeping a right angle relationship between an imaginary axis from the top of the skull to the zenith and any imaginary horizontal lines drawn through the joints (14, pp. 49-50). Postural faults can be corrected by using a pattern-image in which attention is focused on one part of the body and it is kept at right angles to the imaginary spinal line (14, pp. 73-74).

Skills demonstrate co-ordinated balance (14, pp. 43-44). When learning a new skill, Lee believes the mind should review the whole movement before actually doing it, so that the muscles will be ready to act correctly. After these mental directions have been given, the body should relax and let the muscles carry out the desired action (14, pp. 89, 96).

Hanley has emphasized the kinesthetic approach in her teaching of golf for quite a few years. She believes that along with the basic fundamentals, students should be impressed and encouraged to think through the golf swing and recognize the right movements by the use of the muscle sense. A realization of the position of the body parts and muscles moving these parts in a definite rhythm must be established; then the individual can repeat it, and be able to recognize and stop any movements deviating from the proper path (40, pp. 366-367, 390), for

> "a grooved swing is nothing more than a repetition of physical movements following closely a mental pattern that has been developed by trial and error method" (40, p. 366)

until a nervous pathway has been firmly established (40, p. 367).

Hicks and Griffin also emphasize kinesthesia in their teaching of golf. They believe that too much stress has been placed on visual analysis of parts of the swing rather than on a recognition of the swing as a total motion. (8, p. 157). They consider that

> "Control in golf indicates the ability to recognize through the medium of the hands what one is doing with the clubhead, and in turn, the ability to duplicate the correct pattern of swing in striking the ball" (8, p. 158).

Tommy Armour suggests in his book, How to Play Your Best Golf All the Time, that his readers keep a club handy so that when a new action is described, they can

> "translate the type and the illustrations into a language...(their) muscles can read and remember" (2, p. 5).

Only by doing the action and thinking about it, will the movement stay with the player so it can be repeated when needed (2, pp. 5-6). The muscles need a chance to study, too; or, as Armour puts it,

> "let your muscles and your brains learn together" (2, p. 6).

Recognition and Correction of Errors

Authors also agree that kinesthesia can be important in correction of errors by a process of individual awareness and recognition of the difference between correct and incorrect methods.

Jones reflects this vein of thought when he says that

> "if a person can be made aware of his muscular movements as a whole, and learn to distinguish their general, overall, pattern he can make constructive changes and corrections on the basis of knowledge rather than of trial and error" (45, p. 31).

He suggests that awareness of the body as a whole should be emphasized first, and then the movement should be broken down to more specific factors (45, p. 31).

Metheny emphasizes that muscular sensitivity must be developed, for

> "unless the individual senses or feels the rightness or wrongness of a movement, he has no basis for correcting it or for trying to establish it as an habitual pattern" (16, p. 96).

Riedman believes that only by feeling the correct and incorrect motion can individuals direct their actions so they will become skillful (57, p. 63).

Gertrude Hawley outlines her process of re-education in postural work as:

1. Knowing what is desireable
2. Leaving out all extraneous movements
3. Constantly using the correct movements and suppressing the incorrect

Since

> "the adjustments to awaken the proper feeling for the position requires the utmost concentration of the attention in order that new brain paths may be substituted for the old ones" (7, p. 89),

the corrected position may often feel strange and unbalanced to the learner until the central nervous system is re-educated and the new position becomes established as a habit (7).

THEORIES OF MOVEMENT

A rather intensive summary is drawn of the rhythmical approach to movement, and of the awareness of movement program.

Rhythmic Analysis of Movement

Glassow believes that a movement is perceived by hearing it, seeing, and sensing it through the muscles. When a skill is being learned, the student should watch the movement and then try and copy it with the correct timing, so that a muscular feeling for the movement will be achieved. Since the mind tells the muscles what to do, a clear picture of the desired movement is needed so clear directions can be given (6, pp. 57-60).

Glassow's emphasis is on rhythm. To achieve this clear picture of the movement, she believes that the individual parts of the skill should be recognized for their rhythmical pattern and then put back together to produce the whole movement. The elements in this rhythmic analysis consist of recognizing the time intervals in a series; the units of time in relation to each other, as long or short; and the relative intensities of the parts. For example, the front crawl can be analyzed as follows:

```
arms  -- L     L
legs  -- sss   sss   (pp. 69-71).
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Some skills are easier to analyze than others. Those skills involving many variables make a set analysis difficult. Uneven rhythms can be related to an even rhythm by means of recognizing the underlying beat. By feeling this beat, skills in which different body parts do different actions can be more easily learned (6, pp. 65-71).

> "In reproducing the rhythmic units of a muscular movement, the placing of the accent is most important, because it represents the proper application of force" (6, p. 63).

To illustrate, when throwing a ball, the backward movement is relatively weak, while the forward motion is strong. If the emphasis were reversed, the desired result could not possibly be achieved (6, p. 63).

By looking for the rhythm in different movements, awareness of the rhythm in sport skills can be developed. By using this technique of rhythmical analysis, learning skills in correct form should proceed more rapidly, and skills all ready learned should be improved, according to Glassow (6, p. 69).

When actually doing the skill in question, Glassow states that the whole movement should be visualized before any action is initiated. This should produce a flowing quality to the movement when it is performed which would have been broken by any attempt at conscious control while the movement was in process (6, pp. 65-67).

Ensign feels there is a definite need for the awareness of movement to be included in the physical education programs. She feels that in most situations, physical education is not really educating the body, for most individuals are not aware of the capabilities of their bodies, nor aware that they can feel what their bodies are doing (78, pp. 1-2).

Psychologists believe that children use kinesthesia dominantly in their body movements, but as they grow older this changes to visual dominance. The potential for kinesthetic sensitivity is still present and can be recalled when needed. In fact,

> "by developing the muscle sense, the body control can be brought to a point at least one-fourth better than that learned by a normal seeing individual" (78, p. 77).

Skilled movements are a product of muscular contractions and their quality of contraction (78, pp. 62-64). H'Doubler classifies movement into four categories depending on the quality of the movement. There are:

1. Swinging movements -- rhythmic pendulum action
2. Percussive movements -- quick, violent action
3. Sustained movements -- even, steady action
4. Collapsing movements -- gravitational action

(78, pp. 66-68).

These qualities of movement are the foundations for the fundamental body actions. Ensign considers the fundamental movements to include:

1. Walking, running, leaping, hopping, jumping
2. Crawling, rolling, cartwheeling, climbing, swinging
3. Sitting, standing, kneeling, squatting
4. Throwing, striking, pushing, pulling, holding, catching (78, pp. 70-71).

Young children should be well grounded in these fundamental movements so they will have this as a foundation for the progressively more complicated skills taught in junior high, high school, and college. By adapting the fundamentals slightly, they can be applied to the different skills (78, pp. 87-88).

When a skill is being learned, the kinesthetic sense brings the movement under conscious control. Every movement causes certain stimuli to travel to the brain where the feeling for this movement is stored away for possible recall. By repetition of the movement, the actions become accurate and a habit is formed. Any change in a movement can be recognized, for the set of stimuli is then different from the original sequence (78, p. 73).

Ensign emphasizes the rhythmical approach to movement, for she believes that

> "kinesthesia is the basis of rhythmical perception" (78, p. 79).

Every movement has its own rhythmic pattern, and it is the awareness of this rhythm that determines the correct feel of a movement (78, p. 82).

> "Even much more advanced skills...can be analyzed for their rhythmic patterns. But in order to make this analysis, there must be the awareness of the kinesthetic impressions of the movement" (78, p. 84).

Rhythm is important in learning a new skill because it ties the different body movements together into a total co-ordinated movement. It seems possible that a skilled body action could be achieved more rapidly by analyzing the movement and practicing it rhythmically. After a period of no practice of a skill, it is the rhythm of the movement that is best remembered (78, pp. 85-86), so it seems that an original emphasis should increase the learning rate.

Ensign suggests units for teaching movement according to her theory. The introductory unit includes discussion of the importance of the body, the usual lack of awareness of the body, the possibility of developing this awareness, and the value of body control (78, p. 90).

Unit two uses exercises for different parts of the body to increase awareness of the body positions through the kinesthetic sense. The instructor is urged to emphasize the feel of the positions and to insist on accuracy in the performance of the movement (78, pp. 91-96).

The ability to recognize and control movement qualities is the topic of the third unit. Exercises are given for feeling the qualities of swinging, sustained, percussive, and collapsing movement. They are first recognized separately and then combined, for the qualities of movement will actually be almost always combined in some manner (78, pp. 96-100).

Unit four takes up rhythm and the rhythmical analysis of movement. A chart of underlying beats is used to represent the movement.

> "Knowing the rhythm, which binds the movement into a unified whole, makes it possible to repeat the action the same way when desired" (78, p. 106).

The fifth unit considers the fundamental body movements and their basic relationships to skills. Ensign suggests that the parts of a skill should be broken down until the feel of each is recognized, and then the parts should be built up again to form the total movement. The movement qualities and the rhythmic analysis should be added to complete the total co-ordinated skill (78, pp. 106-108).

The final unit summarizes Ensign's belief that the best method of instruction

> "is to approach the teaching through consciously training the body by the use of the kinesthetic sense" (78, p. 114).

Evans and Battis believe that through rhythmic activities, a child

> "learns to move and to use his body efficiently" (4, p. 16).

They state that a program of rhythms tends to lessen the self-consciousness of the children and to increase their self-confidence (4, p. 16).

Ellis is a proponent of the rhythmic approach to kinesthetic teaching. The golf swing

> "requires a sense of rhythm and a sense of feel that can only be developed by long hours of patient practice" (35, p. 108).

The feel of the club and the swing were emphasized in her beginning golf classes. Swinging to waltz music was suggested as an excellent method of perfecting the timing needed for a good golf swing. The swing can be broken down as follows:

Part of swing	Count
Back..................	1
Top...................	2
Pause.................	3
Down..................	4
Contact...............	5
Follow through.........	6

(35, p. 108).

Effort Analysis of Movement

Rudolf Laban has had a great influence on the English interest in movement. He has applied his theory to education, to industry, and to the stage.

His theory of movement is based on effort, for

> "actions in all kinds of human activities,...consist of movement sequences in which a definite effort of the moving person under-lies each movement" (11, p. 8).

Every movement is distinctive in itself, for it consists of a set combination of weight, space, or time elements. The weight of a movement is either light or strong, fluent or bound. Space is used either flexibly or directly, while timing is considered as being either quick or sustained. These three elements are the basis for building movement (13, pp. 7-17).

The three elements can be combined into eight different movement types. These are given the following names: slashing, pressing, wringing, punching, sliding, flicking, dabbing, and floating (12, pp. 7-17).

An essential characteristic of an action is the flow of the movement. This flow is either one of two types: free or bound. Free flow is a feeling of continual motion, while bound flow contains a feeling of hesitation, for the body is ready to stop its movement. Flow has a very definite relationship to the kinesthetic sense (87).

An observer of a group performing a particular action can recognize:

1. Well established rhythms
2. The best patterns, and those that could be improved
3. The uninterrupted flow of movement (13, pp. 43-53).

This approach to movement should be in every school curriculum because it is possible to:

1. Develop and keep spontaneity

As a child grows and ages, he tends to become more stereotyped and inhibited, and loses his natural spontaneity in movement. By starting this program in the first school years, this enjoyment of movement can be maintained.

2. Develop creativity

Children, by experimenting and exploring with the body and its relationships to the surroundings, can develop the ability to invent new possibilities of movement.

3. Recognize the value of movement

An awareness of the movement feel and an analysis of its effort elements can be developed. This can be used for later vocational aspects as well as for individual self-knowledge (11, p. 12; and 87).

A progression of movement categories appropriate to the individual or group can be organized to achieve the maximum development of these three objectives. A sample progression follows:

<u>Theme</u>	<u>How achieved</u>
Awareness of the body	Playing with different body parts and the entire plastic body Alternating usual limb actions with unusual ones Repeating specific actions at a definite speed, so the feel of that movement is recognized and developed

Theme	How Achieved
Awareness of weight, time, and space	Realizing that the body parts can be moved in either a sustained or quick, strong or light, manner Realizing the difference between the wideness of movements
Awareness of combinations of movements, and transitional movement elements	Doing movements in sequence so a definite pattern is formed Recognizing transitional efforts between the main efforts in performing a pattern
Awareness of the group	Making antiphonal movements with a partner or group Using group formations and movements

(11, pp. 29-44).

Betty Meredith-Jones is a prominent exponent of the Laban theory. She aims to make each individual aware of the possibilities and limitations of his own body; and to awaken in each one, a feeling for the real joy of freedom which comes through movement.

She concentrates her teaching on feeling experiences, regardless of the age group or activity. She does this by emphasizing the word "feel", as, "feel that stretch from the center of your body;" or by giving a visual image, as, "carve a crescent moon."

Bodily sensitivity is developed and increased by emphasizing and using the four basic factors of movement -- weight, space, time, and flow. By contrasting the extremes in each category, the harmony of having the element felt equally throughout the whole body can be achieved. After sensitivity to the extremes has been achieved, then recognition of the sliding scale between the increasing and decreasing shades of these elements can be felt. Intermediary movements should also be recognized as such, and students should be able to change from one type of movement to another without a pause or break (87).

People have their own individual combination of these basic elements of movement. Certain individuals are therefore fitted for such positions and jobs requiring a similar combination. Two or more ways may be used for performing a movement, but the one that is the best for the individual determines the choice (13, pp. 7-17). Some people emphasize one element more than another, and this is evident in their actions. This is satisfactory if there is a contrasting effort to maintain a suitable balance of the movement elements. Any onesidedness tends to become exaggerated with constant use; and tension develops as a result, prohibiting other movement qualities (87). Any such overemphasis of certain elements

> "can be remedied only by a person who has experienced the full range of human effort-capacity" (11, p. 52).

Meredith-Jones realizes the difficulty of learning a co-ordinated skill. She feels, however, that movement is basic to all skills, and skill in movement is a prerequisite for skill in sports. She believes that an analysis of just the rhythm of the movement itself is not enough, but that each person should be aware of his own individual rhythm and be able to adapt it to the rhythm needed for the movement.

Learning takes place best when the movement is experienced and felt. Sport skills can be first taught by just using the movement involved and not theequipment, if the students are at home with themselves and do not need the security found from holding on to something. After the whole movement has been recognized, then attention can be given to more localized areas, if necessary. Students eventually feel when the movement is right and then they strive to repeat this feeling. By continual repetition, this movement becomes a co-ordinated skill (87).

This theory of Laban is important for the whole person because movement itself is so basic to life. Pioneers in this movement program are opening up new channels for their beliefs by bringing this theory, in an applicable form, to dance, sport, recreation, corrective, and therapy personnel, as well as to individuals in industry and drama. All these fields are now recognizing this theory's contribution toward individual self-knowledge and improvement (87).

The Ministry of Education in England states as its belief that movement should be considered as a whole. Joint or part by part analysis leads only to stilted jerky movements, because it eliminates the aspect of flow. It is suggested that movements be described according to the elements of strength, time, path of the movement, and flow. For example, a tennis serve would be described as

> "vigorous, quick, twisting, and freely flowing"

(18, p. 13).

This English approach also uses descriptive words or phrases to put across the type of movement desired. Running, for example, can be done either slowly and strongly, quickly and lightly, or accelerating and swerving (18, p. 16).

Vollmer uses a different approach to movement analysis of a sport skill. She suggests that it might be possible

> "to approach the understanding of the particular skill or skills...from the analysis of the fault itself" (83, p. 2).

This

> "might be helpful in determining the cause of the frequency of the fault or in arriving at the exact point of departure from skillful performance" (83, p. 2).

IN SUMMARY

Kinesthesia seems to be a rising influence in the field of physical education. Though testing still shows only a modicum of proof of the importance of kinesthesia, more and more professional physical educators are becoming interested in this phase of emphasis.

The present available literature leads to a number of suggestions for further research. These include:

1. Validating the various kinesthetic test batteries
2. Comparing the learning rate of blind and non-blind subjects in acquiring a sport skill
3. Teaching an experimental group by using rhythmical analysis techniques
4. Teaching an experimental sport skills group by using Laban's theory of movement as suggested by Meredith-Jones
5. Teaching an experimental group using a kinesthetic emphasis
6. Teaching an experimental group by using a kinesthetic emphasis along with mental practice
7. Analyzing a sport skill by the use of Laban's eight elements of movement
8. Studying kinesthesia as found in literature, music, and art

By using the various positive influential factors reported in this paper, it seems that a sport skill could be best taught by including the following procedures in the lesson plans:

1. Developing awareness of the body parts and combination of bodily movements concerned with the total skill
2. Using the numerous types of visual aids, emphasizing that the students "feel" the action as it is shown
3. Using blindfold techniques
4. Using descriptive phraseology
5. Practicing the skill without equipment and then with the equipment
6. Using mental as well as physical practice of the skill

The writer feels that this study has broadened her scope of the field of physical education and will lead to an increased kinesthetic emphasis in her teaching methods.

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D. Miscellaneous

87. Personal conference with Miss Betty Meredith-Jones

Tests of the Different Researchers

Test	Researchers								
	Scott	Wiebe	Stevens	Roloff	Luttgens	Phillips Summers	Hart	Bass	Fisher
Rt. arm, 90 to side		x	x		x				
Lt. arm, 90 to side			x						
Rt. arm, 90 fwd.			x			x			
Lt. arm, 90 fwd.			x			x			
Both arms 90 to side	x	x		x			x		
Both arms 45 to side					x				
Both arms 90 fwd.					x				
Lt. arm, 80 to side			x						
Rt. arm, 80 to side			x						
Rt. arm 130			x			x			
Lt. arm 130			x			x			
Rt. arm, 90 - 40						x			
Lt. arm, 90 - 40						x			
Rt. arm, 180 - 75						x			
Lt. arm, 180 - 75						x			
Rt. arm, 120 - 25						x			
Lt. arm, 120- 25						x			
Rt. arm, 55			x						
Lt. arm, 55			x						
Rt. arm, 135			x						
Lt. arm, 135			x						

Test	Researchers								
	Scott	Wiebe	Stevens	Roloff	Luttgens	Phillips Summers	Hart	Bass	Fisher
Lower part of rt. arm, 60			x						
Lower part of lt. arm, 60			x						
Rt. leg, 25 or 20	x	x	x	x					
Lt. leg, 25			x						
Rt. hip, 60			x						
Lt. hip, 60			x						
Rt. hip, 90	x								
Knee bend 90	x				x				
Rt. leg, 45					x				
Pull 45 down and fwd., passive									x
Pull 30 down and fwd., passive									x
Pull 30 down and fwd., 1 lb. wt.									x
Arms pull fwd. and to side 75 with 4½ lb. wt.									x
Arms pull fwd. and up to 115, 1 lb. wt.									x
Arms pull fwd. and up to 110 passive									x
Arms pull fwd. and down 65									x

Test	Researchers								
	Scott	Wiebe	Stevens	Roloff	Luttgens	Phillips Summers	Hart	Bass	Fisher
Rt. hd., 30 lbs. force			x						
Lt. hd., 30 lbs. force			x						
Rt. hd., 10 lbs. force	x		x				x		
Lt. hd., 10 lbs. force			x						
Both arms, 15 lbs. force			x						
Both hands, pull 10 lbs. force	x								
Both hds., push 10 lbs. force	x								
Rt. arm pull 15 lbs.			x						
Lt. arm pull 15 lbs.			x						
Grip dynamometer, duplicate					x				
Grip dyn., dupl. ½ total strength		x							
Grip dyn., relaxation		x							
Grip dyn., ½ effort		x							
Rt. leg, 10 lbs.									
Rt. leg, 20 lbs.	x		x						
Lt. leg, 20 lbs.			x						
Wrist flexion	x								
Wrist extension	x						x		
Finger spread	x								

Test	Researchers								
	Scott	Wiebe	Stevens	Roloff	Luttgens	Phillips Summers	Hart	Bass	Fisher
Balance stick	x	x		x	x			x	x
Body sway	x								
Balance leap	x			x					
Stepping stone								x	
Frankfort plane					x				
Weight shifting	x			x					
Anterior-posterior weight distribution					x				
Lateral weight distribution					x				
Horizontal linear space		x							
Vertical linear space		x							
Arm kinesthetic justement of size		x							
Arm kinesthetic judgement in precision		x							
Pedestrial kinesthesia of size		x	x						x
Parallel feet					x				
Horizontal lines	x						x		
Ball balance	x								
Walking on a path		x							x

Test	Scott	Wiebe	Stevens	Roloff	Luttgens	Phillips Summers	Hart	Bass	Fisher
Walk and turn	x								
Gross kinesthetic movement		x							
Broad jump specified	x		x						
Broad jump maximum	x								
Floor target	x			x					
Target pointing	x								x
Basketball free throws, duplicate		x							
Basketball pass 45 to dominant side		x							
Baseball throw, 45 to non-dominant side		x							
Baseball fielding		x							
Sargent Jump Duplicate		x							
Basketball toss from 7 feet			x						
Underhand volleyball throw									x
Overhand softball throw									x
Arm swinging	x			x					
Arm circling	x			x					

Description of Tests

The descriptions of these types of tests for kinesthesia are brief summaries of the various authors' explanations of the tests used in their studies.

Assumption of arm position --

The subject is asked to move his arm or arms to a certain designated position, recover, and repeat. Score by the number of deviations from the correct position.

Assumption of leg position --

The subject is asked to move his leg to a certain designated position, recover, and repeat. Score by the number of deviations from the correct position.

Assumption of arm position, done with resistance --

The subject moves his arms the specified distance against a pulley weight resistance. Score by deviations from the correct position.

Application of force --

The subject is asked to apply a certain pressure. This is adjusted to the correct pressure. The subject is then asked to repeat the force. Score by deviations from the proper pressure.

Grip Dynamometer, duplicate ½ total strength --

Subject grips to maximum without straining, using the dominant hand. ½ of the maximum is then figured and the subject guided to this figure. Subject then tries to repeat the ½ maximum force. Score by ½ lb. deviations.

Grip dynamometer, relaxation --

Subject grips to tension "a"; increases to tension "b"; relaxes to "a". "a" and "b" are of subject's choice. Score by ½ lb. deviations.

Grip dynamometer, ½ effort --

Subject exerts any amount of pressure, and then reduces the force to ½. Score by ½ lb. deviations.

Wrist extension --

Subject supports forearm on a table, with the hand dangling over the edge. Subject extends wrist 30° in mimicry of a model. Score by deviations from the correct angle.

Wrist flexion --

Similar to test above, only this time the wrist is moved 20°.

Finger Spread --

Subject supports his forearm on a table, with fist closed. Raise arm, keeping elbow intact, and touch the thumb and little fingers to the target. Score by deviations from the center of the target.

Balance stick --

Subject balances on one foot placed on a 1" thick block, with eyes shut. Score by length of time balance is held.

Body sway --

Using a center of gravity apparatus, the subject closes his eyes, puts one foot sideways to the scale, and balances for 10 seconds. Score by the amount of range of body movement.

Balance leap --

Subject leaps sideways, bends forward and moves an object on the floor and then holds balance for at least 5 seconds. Score by the length of time that the balance is held.

Stepping stone --

Subject leaps from one circle drawn on the floor to another. Subject holds balance in each circle for 5 seconds; then leaps to the next one. Score is the total time + 50 - 3 times the number of errors.

Frankfort plane --

Tape is placed between the mid-point of ear and the lowest point on the eye socket. Subject's head is put in a position so the line is parallel to the ground. Subject lowers head forward and then drops it backward, then resumes the parallel position. Score by the nearest degree.

Weight shifting --

Subject stands on a block with weight on one foot. The other foot is placed on a scale until the weight is evenly divided. Score by the difference from the correct amount.

Anterior-posterior weight distribution --

A scale and center of gravity board are used. The subject stands so the weight is evenly distributed in an antero-posterior plane. Have the subject repeat. Score to the nearest 1/4 lb.

Lateral weight distribution --

The same procedure as above is followed, except that the subject equalizes the weight laterally.

Horizontal linear space --

A yardstick is held horizontally in front of the subject. The subject looks at the 18" mark, closes eyes, and points to that spot. Score to the closest 1/4".

Vertical linear space --

This time the yardstick is held vertically in front of the subject. The subject looks at the 16" mark, closes his eyes, and points to that spot. Score to the closest 1/4".

Arm kinesthetic judgement of size --

The subject places his index fingers on a table, and is told to sense the length of a 12" ruler. The ruler is then taken away, and the subject is asked to duplicate the distance. Score to the nearest 1/4".

Arm kinesthetic judgement in precision --

A T-shaped board is placed at right angles to the subject. The subject raises his elbows and brings the index fingers toward each other. Score to the nearest 1/16".

Pedestrial kinesthesia of size --

Subject stands erect, with heels together. Then he separates his feet so the heels are 12" apart. Score to the nearest 1/4".

Parallel feet --

Subject places his feet parallel and pointing straight ahead. Then this position is repeated. Score by deviations from the desired direction.

Horizontal lines --

Subject, with eyes closed, draws four horizontal lines beside a model:

(1) Using hand, going from left to right

(2) Using hand, going from right to left

(3) Using foot, going from left to right

(4) Using foot, going from right to left

Score by deviations from the first horizontal line.

Ball balance --

The subject keeps a golf ball rolling back and forth in a trough over a "finish" line, but keeping it from touching the ends of the trough. Score by the errors within 30 seconds.

Walking on a path --

The subject is told to sense the direction of a path (2 parallel lines, 10" apart, and 18' long). Subject is blindfolded and walks down 10 steps without touching any of the path lines. Score by the number of steps on or off the path.

Walk and turn --

Subject stands at the end of a line. With eyes closed, the subject steps right and turns right, steps left and turns left, and repeats. Score by the angle of deviation from the straight line.

Gross kinesthetic movement --

Subject toes a starting mark, and is told to sense the distance between himself and an arc drawn 5 yards away. Blindfolded, the subject is told to toe the arc line. Score by deviations in inches.

Broad jump specified --

Subject closes eyes and jumps over, but as close as possible to, a line 2 feet in front. Score by deviations of heels from the line.

Broad jump maximum --

Subject jumps as far forward as possible from the take-off board. Score by distance to the heels.

Floor target --

Subject looks at targets on the floor. Then he closes his eyes and touches the center of the target with the first finger. Score by the distance from the center.

Target pointing --

Subject stands sideways to a target. Subject closes eyes and raises a pointer to the target. Score by deviations from the bulls eye.

Basketball free throws, duplicate --

Subject makes four consecutive throws, using a two-hand underhand pass, and trying to duplicate the first throw. Score by deviations in inches.

Basketball pass 45° to the dominant side --

Subject toes on board, and then uses a two-hand chest pass and throw at a 45° angle. Score in degrees.

Baseball throw, 45° to the non-dominant side --

In this test, the subject releases an overhand throw at a 45° angle.

Baseball fielding --

A target is placed on the dominant side at waist level of the subject. After sensing the position of having a pointer touch the target center, the subject assumes a fielding position and then comes up so pointer is in the center circle. Score by deviations from the center.

Sargent Jump Duplicate --

The subject jumps four consecutive comfortable heights, all similar to the first one. Score to the nearest 1/4".

Arm swinging --

Arms swing forward and sideward with the alternate arm holding the first count. Score by precision and number of trials needed for success.

Arm circling --

Circle arms in opposite directions. Score by precision and number of trials needed for success.

Test Batteries

Roloff, Wiebe, and Stevens, suggested test batteries from the results of their tests.

Roloff found that balance stick, arm raising, leg raising, and balance leap tests were the most reliable. (57, p. 49).

Wiebe reported that balance stick, leg raising, vertical space, and pedestrial kinesthesia of size, tests were best for college men. (72, p. 227).

Stevens suggested four different batteries so that at least one would fit most all situations. The six item battery included:

1. Rt. arm 90° to side
2. Lt. arm 90° to side
3. Rt. arm 130°
4. Rt. leg force of 20 lbs.
5. Rt. arm pull of 15 lbs.
6. Lt. arm pull of 15 lbs.

The five item battery dropped out #4; the four item one dropped #2; the three item battery drops out #6. (82, pp. 75-77).

APPROVAL SHEET

Approved by:

Director

Examining committee