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THE PROBLEMS OF SIGHT-READING ON MALLET-PLAYED INSTRUMENTS AND THEIR RELATIONSHIP TO KINESTHETIC SENSATION

APPROVED ~~BY~~

DISSERTATION COMMITTEE

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CHAPTER I

INTRODUCTION

Background and Need for the Study

Musicians are constantly in search of new methods to bring their performance on musical instruments to higher levels of accuracy. Since musicians have basically the same physiology as other people, knowing something of the ways in which persons combine the information received respectively from the senses of sight, touch, and kinesthesia in their perception of spatial relations may be helpful in improving the teaching of performance skills on any musical instrument. Lawrence Baker, in his book, General Experimental Psychology, says:

> Many suppositions are made about improvement in motor skills in athletes, artists, musicians, and industrial workers while not much is known about the part played by the senses most immediately involved in these skills.[1]

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[1]Lawrence M. Baker, General Experimental Psychology (New York: Oxford University Press, 1960), p. 125.

Baker strikes directly at the reason for this study, since the sight-reading problems of a performer on mallet-played instruments (xylophone, marimba, bells, and vibraphone) may be summed up in the following questions:

1. What senses are used when a person sight-reads on a mallet-played instrument?
2. Are we training these senses properly?
3. What are the respective roles of vision, touch, and kinesthesis in sight-reading on mallet-played instruments?

The performer on a mallet-played instrument is the only musician who cannot rely on his tactual sense, since he makes no direct contact with the instrument itself. He must depend more heavily than other musicians on the "sixth sense," usually called the kinesthetic sense by modern physiologists. This is the sense on which one depends heavily when finding his way through a familiar room in total darkness, when performing often-repeated tasks such as typing without having to watch every step of the operation, and when manipulating complicated key punch systems.

The importance of the kinesthetic sense in the mastery of motor skills was demonstrated rather dramatically in 1931 by Coleman Griffith, who carried out a simple experiment on learning to drive a golf ball.[1] In his experiment, Griffith used two groups of persons who had no previous golfing

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[1]Coleman R. Griffith, "An Experiment on Learning to Drive a Golf Ball," The Athletic Journal (June, 1931), p. 11.

experience. Each group consisted of six members who were given the same preliminary instructions on how to drive the ball. There was one basic difference between the two groups: one group was blindfolded. The experiment lasted for six weeks, and the subjects in each group were allowed to drive the ball ten times per day. At the end of the six-week period, the group that had been allowed to watch the ball had made a total of 170 clean (or high-quality) shots, and the group which had been blindfolded had made a somewhat surprising total of 192 clean shots.

Aristotle had thought that there was a "sense" within the muscles. It was not until the nineteenth century, though, that this "muscle sense" came to be called "kinesthesis." Now kinesthetics is a field in which there has been a sizeable amount of research, but there has been little investigation as to how this sense directly affects specific motor skills, such as those used in learning to play any particular musical instrument. The intent of this research is to show how kinesthesis applies directly to the techniques used in learning to sight-read on the mallet-played instruments, with special attention to the respective roles of vision and kinesthesis.

A Brief History of Kinesthesis

Although Aristotle was first credited with having implied the existence of a sixth sense, it was not until the nineteenth century that there was any real research on the subject. Charles Bell, writing in 1826, was the first modern to argue for the existence of a "muscle sense" and be taken seriously. Bell was convinced that the nerves of the muscles contain sensory as well as motor fibers. He believed that when a person experiences tactually any perception of distance, size, form, weight, or hardness, he receives sensations from the muscles as well as the skin. Later physiologists, following Bell, accepted the muscle sense as a sixth sense.[1]

During the second half of the nineteenth century, there was some confusion concerning what the "muscle sense" actually was: Simultaneously, a controversy arose concerning the distinction between muscular sensations and sensations of innervation. Muscular sensations are caused by receptors within the muscles sending impulses to the brain, while innervation is the excitation of muscle responses through afferent nerves. While some nineteenth century psychologists were content to hold a position for both kinesthesis and innervation, others were not. For example, there were important physiologists and psychologists, notably Helmholtz and Wundt, who were convinced that voluntary actions are caused by sensations directly from the brain rather than from the muscles.[2]

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[1] Edwin G. Boring, <u>Sensation and Perception in the History of Experimental Psychology</u> (New York: Appleton-Century-Crofts, Inc., 1950), p. 525.

[2] <u>Ibid</u>.

In the 1880's, Goldscheider made one of the more important breakthroughs in demonstrating the existence of kinesthetics. He not only believed in the existence of the kinesthetic sense, but also believed that the joints are even more responsive to this sense than are the muscles. To demonstrate his point, Goldscheider injected cocaine under the skin to anesthetize its sensitivity. He found that this had little effect upon the process of movement. But when he induced currents of electricity through the joints, he found the sensitivity to movement was greatly reduced. Through this experiment, he established an association between kinesthesis and the mediating sense organs located in the joints.[1]

In 1895, two important physiologists, Mott and Sherrington, provided experimental evidence that conclusively indicated what Charles Bell had earlier asserted. In three experiments, they showed that sensory impulses are necessary for accurate voluntary movement.[2] Sherrington went on to contribute materials to later books on this subject: for example, he contributed a chapter to a book by Schafer entitled <u>The Muscle Sense</u>, in which he employed a new term "proprioception," because he felt the need for a term other than kinesthesis which would have a more "physiological" sound.[3]

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[1]Baker, <u>op. cit</u>., p. 115.

[2]Boring, <u>op. cit</u>., p. 534.

[3]<u>Ibid</u>., p. 525.

Kinesthesis and How It Operates

A person is constantly learning new motor skills the whole of life. During these learning periods, he depends upon information from the proprioceptors. Such information as the distance that a part of the body is extended (technically called "extent of position"), and the sense of direction is important in developing an awareness of "how it feels." Gladys Scott says in her book on human movement, "The development of kinesthetic patterns is a direct by-product of activity and an essential factor in learning skills."[1]

When a person moves any part of his body, successive stimuli enter the nervous system, which are direct results of pressures due to the contraction and tension of the muscles and the articular structures.[2] To be more specific, there are three important sense organs which collect movement sensations and indicate the force, speed, and extent of any bodily change. First, there are the muscle spindles, which are located throughout the muscles themselves. Secondly, there are the tendon organs (organs of Golgi), which are spiral-like, and fastened around tendons or tendon sheaths, which are stimulated by muscular contraction.[3] Thirdly, there are

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[1]Gladys Scott, Analysis of Human Motion (New York: Appleton-Century-Crofts, Inc., 1942), p. 352.

[2]Ibid., p. 352.

[3]Bryant J. Cratty, Movement Behavior and Motor Learning (Philadelphia: Lea and Febiger, 1964), p. 107.

joint-end organs located around the various bodily joints, referred to as Pacinian corpuscles, which are stimulated when deep pressure is applied to an area of the body.[1] These three organs are what Sherrington referred to as the proprioceptors, whose impulses are directed to two brain centers. Some of these responses are directed to the cerebral cortex, giving rise to conscious experiences or sensations. There are also non-sensory afferent tracts which end in the cerebellum.[2]

It is impossible to talk about kinesthetics without bringing into the discussion some mention of the sense of equilibrium, which plays such an important part in the proper function of kinesthetic responses. Before the kinesthetic sense can function properly, the body must maintain some sense of balance. Together, kinesthesis and equilibrium initiate and direct many reflexes and voluntary motor skills. It would be virtually impossible to separate the two in so far as they affect motor responses.[3]

The receptors for the equilibrium (or the static sense) are contained within the vestibular and semicircular canals: the vestibule is part of the bony labyrinth of the inner ear, located between the cochlea (which is part of the inner ear containing the end organs for hearing), and the

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[1]Baker, op. cit., p. 110.

[2]Sarah R. Riedman, The Physiology of Work and Play (New York: The Dryden Press, 1950), p. 188.

[3]Baker, op. cit., p. 109.

semicircular canals. This vestibular system is the neural mechanism which receives sensory data from the static (or semicircular) system. With this sensory data, the vestibular system makes the necessary responses for adjustments of equilibrium.

The semicircular system, like the vestibular system, is located within the temporal bone. The system consists of three canals, two of which are important in maintaining balance. These canals are called the utricle and the saccule. The remaining canal, the cochlea, contains the sense organs for hearing. The utricle and saccule are located within the exceptionally hard and dense portion of the temporal bone called the petrous. Within this bony confine is located a continuous membrane sac which composes these two canals. This membrane sac contains a fluid called endolymph, which in turn suspends a mucous mass called the cupula. The cupula contains hair cells which are stimulated when the head is moved, and this stimulation of the hair cells sends impulses to the brain which change the muscle tone.[1] It is said that the muscle tone of the entire body changes each time the head moves to a new position.

> We may think of this whole system as a very delicately adjusted leveling system and we may think of

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[1]John B. Watson, Psychology from the Standpoint of a Behaviorist (Philadelphia and London: J. B. Lippincott Company, 1919), p. 61.

changes in the head as one of the chief sources of disturbance to the system.[1]

Unfortunately, many music educators know little, if anything, of the tremendous physiological sensitivity of the human body, much less how to utilize the sensitivity in teaching a student how to use his full physiological perceptions in his learning.

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[1]Griffith, op. cit., p. 11.

CHAPTER II

THE PROBLEM AND PROCEDURE

One of the major problems of a student learning a mallet-played instrument is eye movement between the music and the instrument itself. When such a student sight-reads, he seems to be in a constant state of inconsistency. His eyes are continually moving between the instrument and the music: for example, in his sight-reading, he may be confronted with a rather large interval. Because of a rest pattern prior to this interval, he is given enough time to watch as he places the mallets above the large interval he must strike. In this case he can hardly miss. However, in the next measure, he is confronted with the same interval: only this time it is within a cluster of notes allowing him no time in which to look down. This time he must strike the correct interval, using his kinesthetic sense to guide him. In this case, he might strike the correct interval, but he might miss. If he <u>does</u> miss the interval, the mistake is usually dismissed with little, if any, thought as to why it might have occurred.

In 1936, Gertrude Raffel conducted an experiment to test the hypothesis that visual impulses may be organized in one projection center, and kinesthetic impulses in another. She believed that visual observations of distance would be consistent and that kinesthetic observations of distance would also be consistent, but that visual and kinesthetic judgments of distance would be inconsistent with each other. Four subjects were placed in front of a table on which there were various lengths of cardboard. There was a standard strip measuring one inch in length, while the remaining strips were either larger or smaller than the standard. By having the subjects compare the strips by various methods, she was able to arrive at her conclusion.[1]

For example, when the subject was allowed to look at the standard strip, and then select a comparison strip visually, the results of the judgments were very accurate in matching the two. However, when the subject was allowed to view the standard strip and then select the comparison strip by tactual-kinesthetic movement, he selected a longer strip than the standard. Even after several attempts, the results remained the same. Through this experiment, it was possible to arrive at the conclusion that an object seemed shorter to vision than to touch and tactual-kinesthetic stimuli. Although there were several variations to this experiment, they all employed the tactual sense as well as the kinesthetic

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[1]Gertrude Raffel, "Visual and Kinesthetic Judgments of Length," American Journal of Psychology Vol. XLVIII, 1936, pp. 331-334.

sense when selecting comparison strips, and the results did show a definite inconsistency between tactual-kinesthetic and visual distance judgments.

The Problem

Many of the mallet parts performed today are committed to memory. Most performers memorize music at one time or another, and memorization is nearly always recommended as a part of a student's basic musicianship. The practice of memorization is not at question here, however. What is at question is the fact that when a piece is committed to memory, the eyes are no longer needed for reading purposes, and are left to perform other functions. The question is concerned with what these functions are.

As was mentioned in Chapter I, the eyes play a very important part in maintaining balance. It has been determined that when a person performs certain motor skills, his eyes remain fixed upon an object not so much to see the object itself as to maintain the balance necessary to the performance. For example, when a person performs on a tight rope, his gaze is usually fixed on an object directly in front of him: he probably has little interest in the object at which he is staring, but merely has his eyes fixed there for purposes of balance. When a mallet player performs from memory, he usually keeps his eyes upon the instrument for somewhat the same reasons. However, like many players, he is unaware of what part his eyes are playing, feeling that they are his sole key to accuracy. He is usually not consciously aware of a kinesthetic sense.

The reliance upon vision to insure accuracy is no surprise, for it is our strongest and probably our most accurate sense, though it can be deceiving. For example, in 1933, J. J. Gibson conducted an experiment to show the dominance of vision over the tactual-kinesthetic sense.[1] A group of subjects were asked to look through prisms causing vertical lines to bend into curves. Gibson then placed a meter stick vertically in front of the subjects, who were fully aware of the effect of looking through a prism at straight lines. They also knew that the meter stick was perfectly straight. However, when they looked through the prism at the meter stick, the stick not only looked curved, but also felt curved when they ran their fingers along its edge. Even though the importance of vision is without question, this experiment does show that sight certainly is not infallible.

Even though other senses are weaker and less reliable than vision, when a student on a mallet-played instrument sight-reads he must learn to rely on kinesthesis. If a mallet student begins to rely solely on his vision for accuracy, he becomes unable to take his eyes away from the instrument long

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[1] J. J. Gibson, "Adaptation, After-effect, and Contrast in the Perception of Curved Lines," Journal of Experimental Psychology, Vol. XVI, 1933, pp. 1-3.

enough to sight-read music with any degree of success. As is sometimes the case, the student tries to shift his eyes rapidly back and forth between the music and the instrument in an attempt to locate each note his eyes register. This looking back and forth causes the student not only to read very slowly, but also very inaccurately. Rather than suffer the consequences of this insecurity he feels when looking away from the instrument, he will commit the piece to memory, so that he is able to feel the security of having his eyes focused upon the instrument.

The real problem is to determine if the practice of looking back and forth between the music and the instrument is a practice to be condoned or condemned. If, on the one hand, there is nothing wrong with the practice other than the fact that it can be laboriously slow, then the only problem would be to determine a method by which this practice could be speeded up. This would also mean that distances between mallets could be formed accurately either while the student is looking toward the instrument or away from it. For example, if the practice of looking back and forth were accepted then the following procedures would undoubtedly occur: (1) the student might first form a distance between his mallets visually, and later try to repeat the same distance again with vision; (2) the student might form a distance between his mallets while looking away from the instrument, and later try to repeat the same distance by the same procedure;

or, (3) the student may form a distance between his mallets visually one time, and later try to repeat the same distance while looking away from the instrument. If, however, there is any connection between the findings of Raffel mentioned earlier, and the processes of mallet playing, then inconsistencies may be occurring. If so, then the following hypotheses could be true:

1. As long as a student has a piece of music memorized and is able to keep his eyes fixed on the instrument, then any attempt to repeat distances between mallets should be consistently accurate.

2. If a student can keep his eyes fixed on the music without looking down at the instrument, then any attempt to repeat distances between mallets should be consistently accurate.

3. If a student forms a distance between his mallets visually, and later tries to repeat the same distance looking away from the instrument, the second attempt will be inconsistent with the first.

4. If a student forms a distance between his mallets while looking away from the instrument, and later tries to repeat that same distance while looking at the keyboard, the second attempt will be inconsistent with the first.

In order to determine if the hypotheses stated above should be accepted or rejected, the following <u>null</u> hypotheses were tested and the results presented as evidence so that some decision could be reached.

1. There is no significant consistency in accuracy when a visually selected distance between mallets is later attempted by the same procedure.

2. There is no significant consistency in accuracy when a kinesthetically selected distance between mallets is later attempted by the same procedure.

3. There is no significant difference between a visually selected distance between mallets and a later attempt to repeat the same distance without vision.

4. There is no significant difference between a kinesthetically selected distance between the mallets, and a later attempt to repeat the same distance visually.

The Procedures

The experiment itself consisted of a test carried out between a regular xylophone, and a model keyboard made of cardboard: the dimensions of the model were the same as the regular instrument. This cardboard model was then placed on a surface which was exactly the same height as the xylophone. (Another xylophone could have been used for this test; however, one was not available.) Since sound was not a factor to be tested, the fact that a cardboard model was used should make no difference in the outcome of the experiment.

To begin the experiment, seven subjects were chosen who had various backgrounds in performing on mallet-played instruments. The students were tested one at a time, with the same instructions given to all. The subjects were kept unaware of the nature of the experiment.

The subjects were first given regular xylophone mallets and told to place themselves in front of the instrument. They were then told to use both mallets, raise them above the xylophone and strike the instrument, forming a distance between the two mallets. They were made to understand that the object of the test was the distance between the two mallets rather than the interval. When the subjects had formed a distance, they were asked to leave the sticks on the bars they had struck. The distance between the mallets was then measured with a regular yardstick. The measurement was taken as quickly as possible so if the student were interval conscious, he would have little, if any, time to determine what the interval was. After the distance was formed and measured on the xylophone, he was asked to drop his hands, walk to the model, and try to form the same distance that he had formed on the xylophone. A measurement was taken here also. As was mentioned earlier, each subject was given the same instructions to follow. (These instructions are listed on page 18, Table 1.) For example, step one in Table 1 tells the subject to form a distance visually on the xylophone (a) and walk to the model and attempt to form the same distance,

TABLE 1.--A test used to determine consistencies or inconsistencies which might occur in forming distances between mallets by students who attempt to repeat distances both visually and kinesthetically

	Xylophone		Model
Step 1 a.	Form distance by vision	1 b.	Attempt to form the same distance using vision
Step 2 a.	Form a distance <u>without</u> vision	2 b.	Attempt to form the same distance <u>without</u> vision
Step 3 a.	Form a distance by starting with both mallets together, and moving the right one <u>with</u> vision	3 b.	Attempt to form the same distance using the same procedure
Step 4 a.	Form a distance by starting with both mallets together, and moving the right mallet <u>without</u> vision	4 b.	Attempt to form the same distance using the same procedure
Step 5 a.	Form a distance <u>with</u> vision	5 b.	Attempt to form the same distance <u>without</u> vision
Step 6 a.	Form a distance <u>without</u> vision	6 b.	Attempt to form the same distance <u>with</u> vision
Step 7 a.	Form a distance by starting with both mallets together and moving the right mallet <u>with</u> vision	7 b.	Attempt to form the same distance using the same procedure <u>without</u> vision
Step 8 a.	Form a distance by starting with both mallets together and moving the right mallet <u>without</u> vision	8 b.	Attempt to form the same distance using the same procedure <u>with</u> vision

again visually (b). They were asked to perform five attempts in each one of these eight steps: within these five attempts, each subject could form any distance he wanted. The only limitation was that the distance could not exceed the limits of the measuring device. This same procedure was used throughout the test for each one of the individual steps. The data from each step was then recorded on the forms as shown in Appendix A. The total number of inches accumulated for each step was then tabulated and these totals were recorded on bar graphs. The graphs which follow show the total distance covered in the five attempts in each one of the eight steps.

TABLE 2.--Total error (shown in feet) for the "a" and "b" portion of the eight steps listed in Table 1

SUBJECT A: Previous Experience -- 1 year

With Vision   Without Vision   Scale: 3/4" = 1'

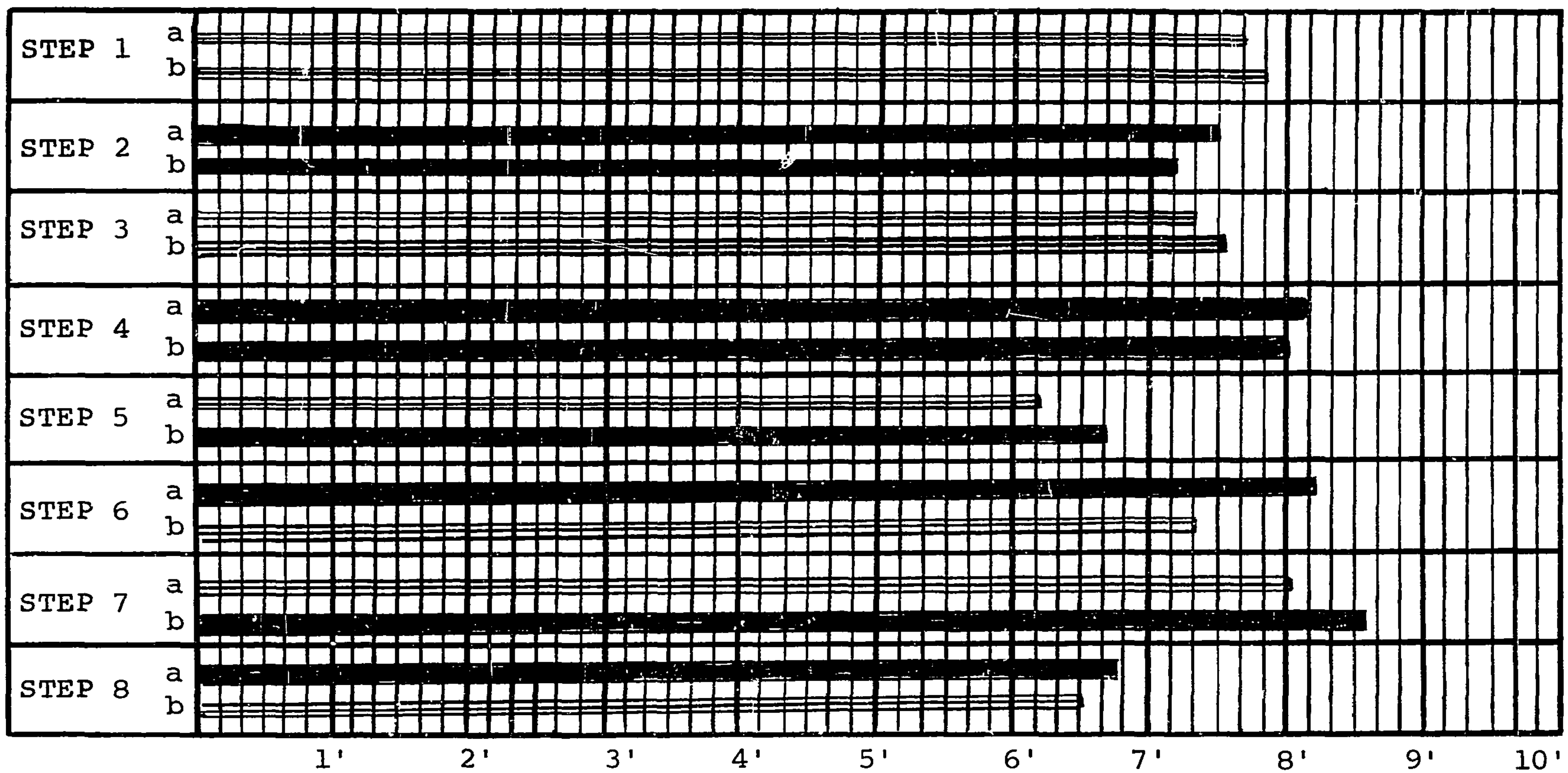


TABLE 3.--Total error (shown in feet) for the "a" and "b" portion of the eight steps listed in Table 1

SUBJECT B: Previous Experience -- 8 months

With Vision   Without Vision   Scale: 3/4" = 1'

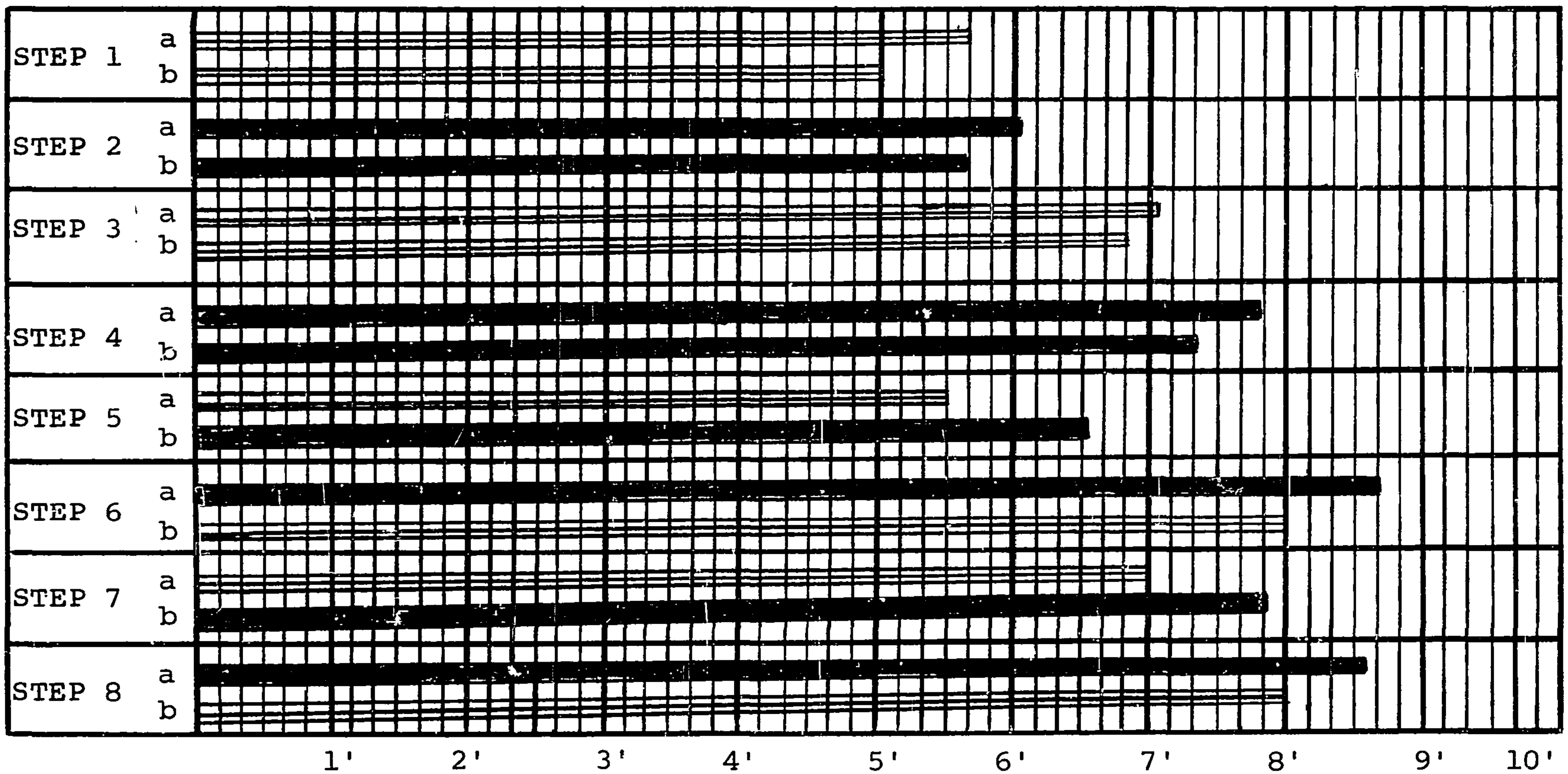


TABLE 4.--Total error (shown in feet) for the "a" and "b" portion of the eight steps listed in Table 1

SUBJECT C: Previous Experience -- 6 years

With Vision   Without Vision   Scale: 3/4" = 1'

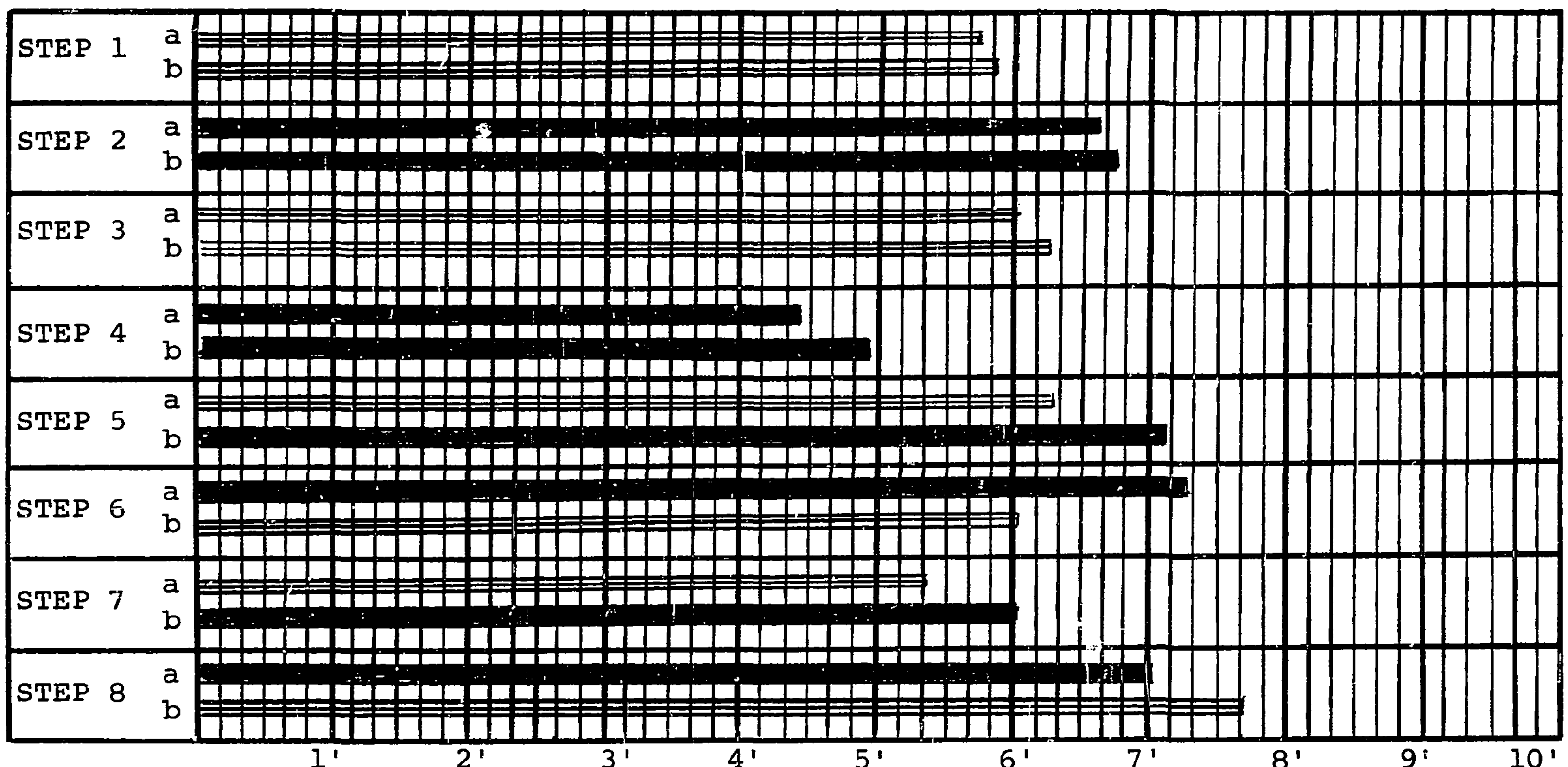


TABLE 5.--Total error (shown in feet) for the "a" and "b" portion of the eight steps listed in Table 1

SUBJECT D: Previous Experience -- 1 year

With Vision   Without Vision   Scale: 3/4" = 1'

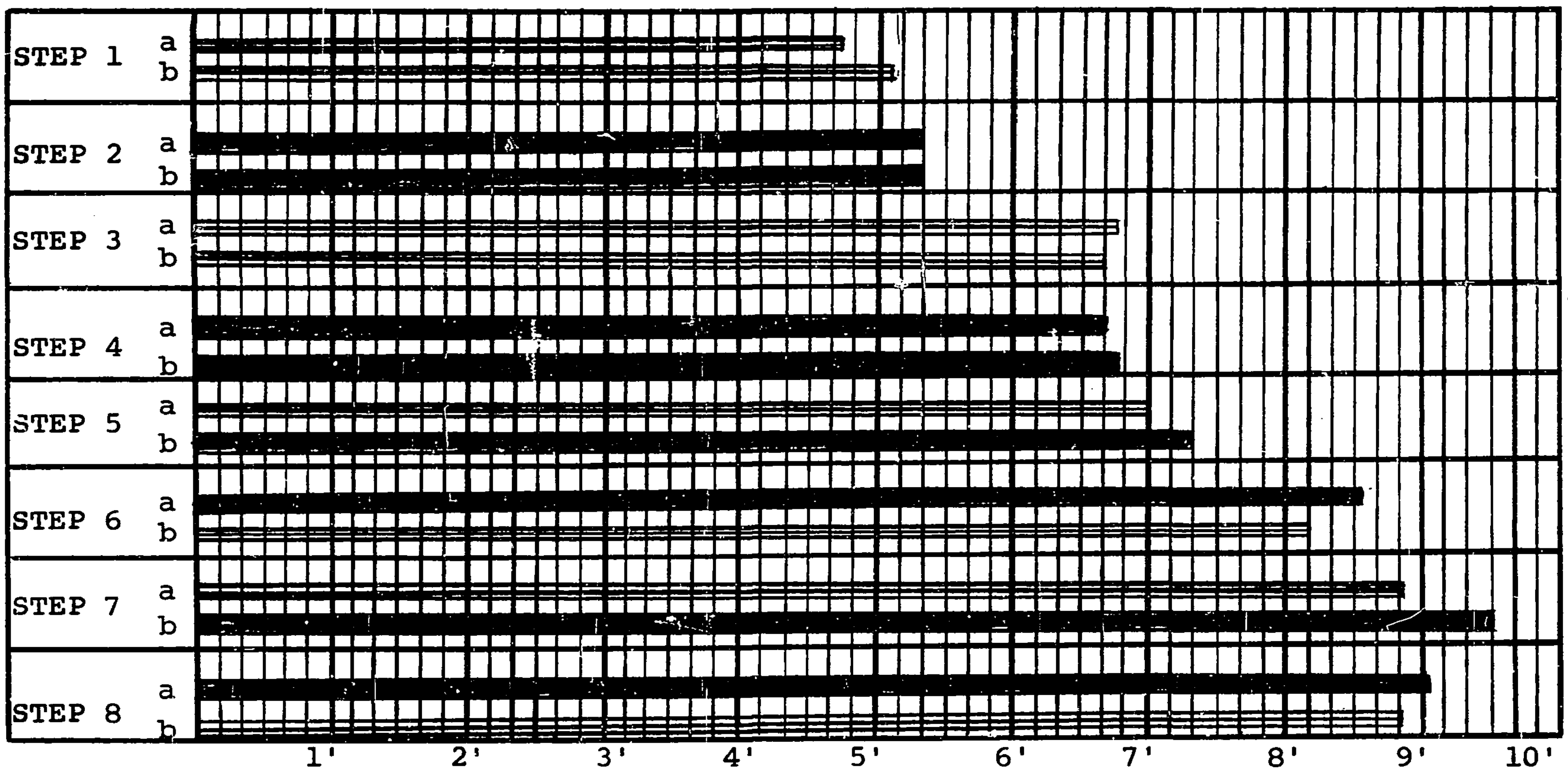


TABLE 6.--Total error (shown in feet) for the "a" and "b" portion of the eight steps listed in Table 1

SUBJECT E: Previous Experience -- 1 year

With Vision | Without Vision | Scale: 3/4" = 1'

TABLE 7.--Total error (shown in feet) for the "a" and "b" portion of the eight steps listed in Table 1

SUBJECT F: Previous Experience -- 2 months

With Vision Without Vision Scale: 3/4" = 1'

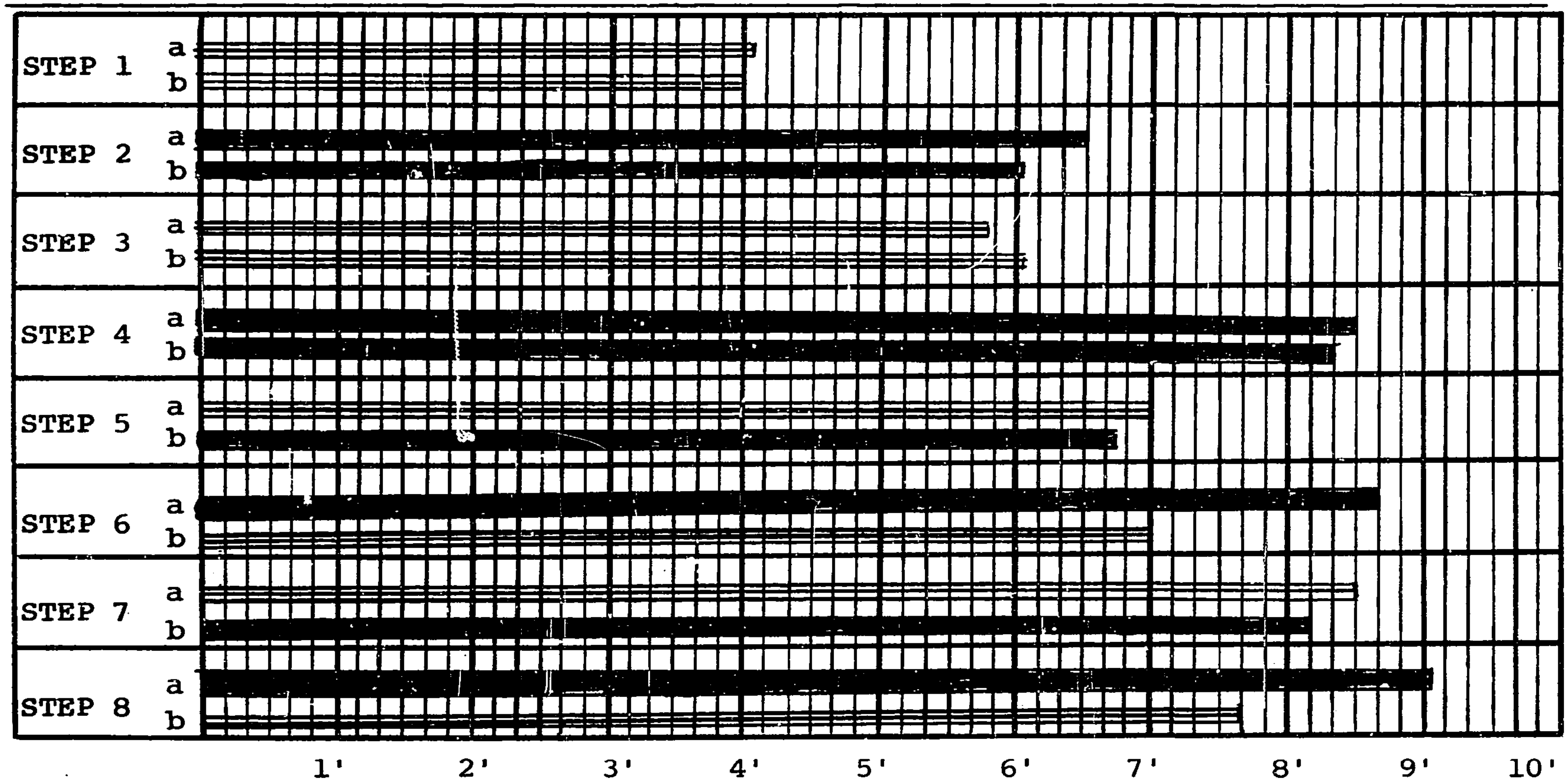
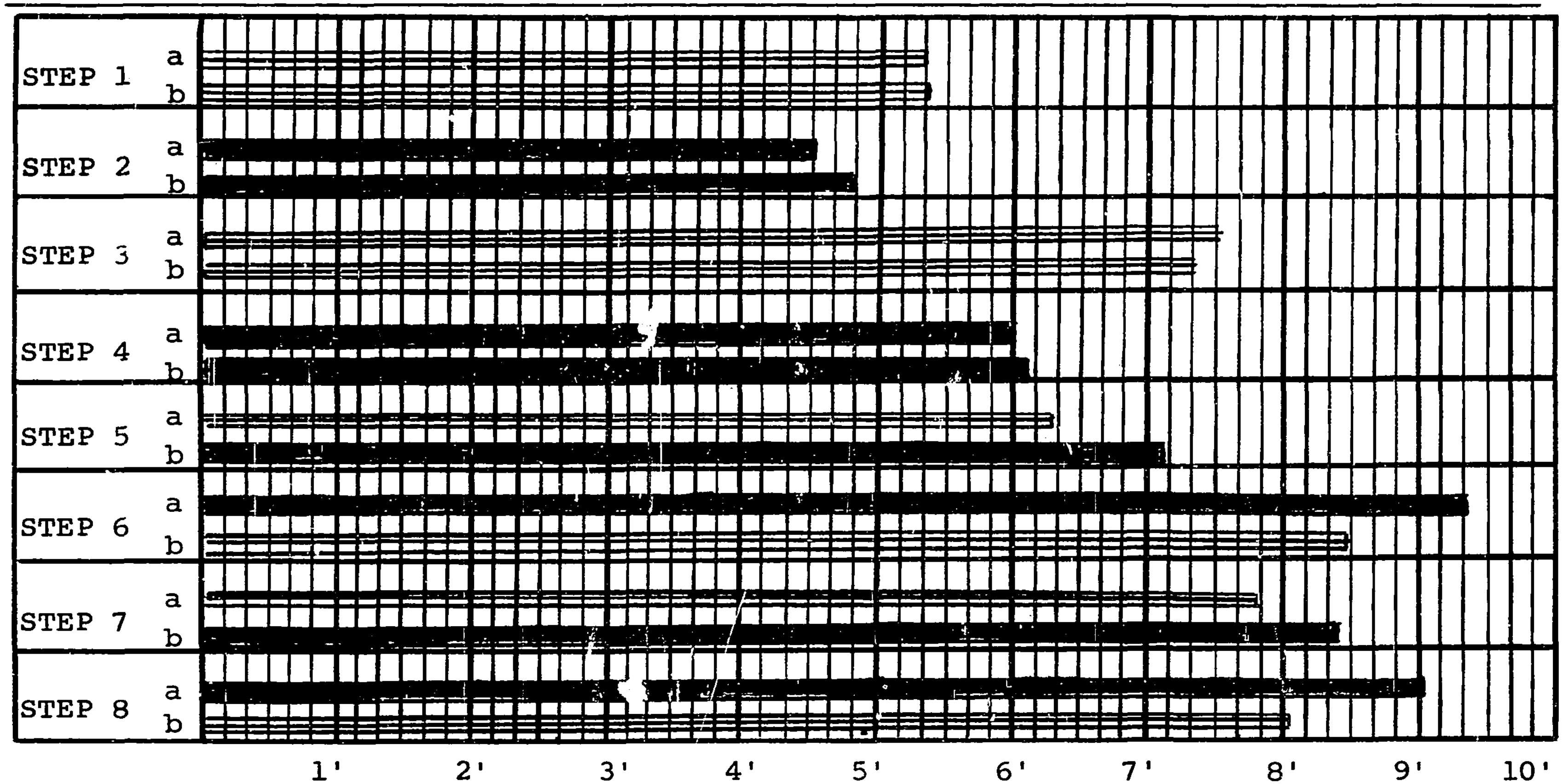


TABLE 8.--Total error (shown in feet) for the "a" and "b" portion of the eight steps listed in Table 1

SUBJECT G: Previous Experience -- 3 years

With Vision   Without Vision   Scale: 3/4" = 1'



CHAPTER III

FINDINGS AND INTERPRETATION OF THE DATA

This chapter presents a listing of the null hypotheses which were disproven by the experiments, and the techniques which were used to test the hypotheses, as well as evidence for a tentative acceptance of some working hypotheses. A review of the data at this point is an advisable first step toward its interpretation.

As was explained in Chapter II, a test was given to seven subjects. This test consisted of eight steps, with five attempts given to both the "a" and "b" portion of all eight steps. (These steps are found on page 18, Table 1.) After the "a" and "b" attempts were completed for each step, they were totaled separately, and the two totals for each step were recorded on bar graphs so that a comparison could be made. These graphs began to show that there seemed to be consistencies and inconsistencies occurring in fairly regular patterns: the next step was to find out just what they were. The following steps were then taken: (1) the totals of the five attempts at the "a" and "b" portion of each step were subtracted from each other to show the total error in inches that took place for each one of the eight steps; (2) these total error scores for each subject were totaled, and a mean score was found for each subject; and (3) from this mean score it is possible to have a basis for accepting or rejecting the null hypotheses. For example, subject A might have a mean error score of 4 inches for the entire eight steps. His attempt at Step 1 gave him an error score of 1 1/4 inches, while his attempt at Step 7 showed an error score of 6 inches. From these two totals, it is possible to see that Step 1 is a more accurate attempt than Step 7, because the total error score for Step 1 is markedly less than the 4 inch mean error score, while the total error for Step 7 is somewhat larger than the mean.

The following "accuracy range" was arbitrarily established to act as a further point of reference: an individual bar on almost all mallet instruments is wide enough that if a person struck 1/2 inch from the center on either side of the bar, he would still remain on the bar. Since there were five attempts at the "a" and "b" portion of each step, and if 1/2 inch of error is allowed for each attempt, the subject would have a total of 2 1/2 inches of error for the five attempts at each step.

Null hypothesis 1 states that there is no significant consistency in accuracy if visually attempted distance between mallets is later attempted by the same procedure. Steps 1 and 3 of Table 1 represent attempts to repeat a distance visually.

Subject A has a mean error score of 4 1/8 inches. The total error in his attempt at Step 1 is 3/4 inch. His total error for Step 3 is 1 1/4 inches. Both of these totals are well below his mean score. The two totals also fall within the 2 1/2 inch accuracy range allowed for each step.

Subject B has a mean score of 8 3/8 inches. The total error in his attempt at Step 1 is 7 1/4 inches. His total error for Step 3 is 2 1/2 inches. Both totals are smaller than his mean score, and one is within the accuracy range.

Subject C has a mean score of 5 7/16 inches. His total error for Step 1 is 1 3/4 inches. His total error for Step 3 is 3 1/2 inches. Both of the totals are well below his mean score, and one is within the accuracy range.

Subject D has a mean error score of 2 3/16 inches. The total error in his attempt at Step 1 is 3 3/4 inches. The total error in his attempt at Step 3 is 3/4 inch. Step 3 is below his mean score and also within the accuracy range.

Subject E has a mean error score of 4 3/32 inches. His total error for Step 3 is 2 1/4 inches. His total error for Step 1 is 3 1/2 inches. The totals for Step 1 and Step 3 are below, or smaller than his mean error score, and one is within the accuracy range.

Subject F has a mean error score of 5 13/16 inches. The total error in his attempt at Step 1 is 1/2 inch. The total error in his attempt at Step 3 is 5 inches. Both steps are below his mean error score, and one is well within the 2 1/2 inch accuracy range.

The remaining student, Subject G, has a mean error score of 6 5/32 inches. The total error in his attempt at Step 1 is 1/2 inch. The total error for his attempt at Step 3 is 1 1/2 inches. Both totals are smaller than his mean error score and both are well within the accuracy range.

The figures mentioned above show that 13 of the 14 totals are smaller than the subjects' mean error scores. Also, 9 of the 14 scores are within the recommended accuracy range; therefore, null hypothesis 1 is rejected.

Null hypothesis 2 states that there is no significant consistency in accuracy if a visually formed distance between mallets is later attempted by the same procedure. Steps 2 and 4 represent non-visual attempts to form distances between mallets.

Subject A's mean error score is 4 1/8 inches. His total error for Step 2 is 3 inches. The total error in his attempt at Step 4 is 1 inch. Both of these totals are smaller than his mean error score, and one total is within the accuracy range.

Subject B's mean error score is 8 3/8 inches. The total error for his attempt at Step 2 is 3 3/4 inches. The total error for his attempt at Step 4 is 4 1/2 inches. Both of these totals are smaller than his mean error score.

Subject C's mean error score is 5 7/16 inches. The total error for his attempt at Step 2 is 2 1/4 inches. The total error for his attempt at Step 4 is 5 3/4 inches. The total for Step 2 is well below his mean error score, and also within the accuracy range.

Subject D's mean error score is 4 3/32 inches. The total error for his attempt at Step 2 is 1 1/2 inches. The total error for his attempt at Step 4 is 1 1/4 inches. Both of these totals are well below his mean error score, and both are within the accuracy range.

Subject F's mean error score is 5 13/16 inches. The total for his attempt at Step 2 is 2 3/4 inches. The total for his attempt at Step 4 is 1/2 inch. Both of these totals are well below his mean error score and one is well within the accuracy range.

Subject G's mean error score is 6 5/32 inches. The total for his attempt at Step 2 is 2 3/4 inches. The total for his attempt at Step 4 is 4 1/4 inches. Both of these totals are well below his mean error score, and one total is within the accuracy range.

The figures for Steps 3 and 4 show that 13 of the 14 totals are smaller than the mean error scores tabulated for each subject. Also, 8 of the 14 totals are within the recommended accuracy range; therefore, null hypothesis 2 is rejected.

With the evidence presented thus far, it has been possible to reject both null hypotheses 1 and 2. The reasons which led to the rejection of these hypotheses can now be considered substantial evidence for the acceptance of the following working hypotheses: (1) as long as a student has a piece of music memorized and is able to keep his eyes fixed on the instrument, then any attempt to repeat distances between mallets should be consistently accurate; and (2) if a student can keep his eyes fixed on the music without looking down at the instrument, then any attempt to repeat distances between mallets should be consistently accurate.

Most mallet performers would have accepted working hypothesis 1 even without the data that has been collected thus far. They would have probably accepted the hypothesis on the basis of their previous playing experience. This hypothesis deals with memorized music where no sight-reading is taking place. Since this study deals with sight-reading problems rather than with memorization problems, there is little need to continue the discussion of working hypothesis 1 here, although it will be mentioned from time to time as a point of comparison in presenting the other hypotheses.

Working hypothesis number 2 states that a subject can repeat distances successfully without the use of vision. The validity of the study depends totally on the truth of this hypothesis.

The most surprising results of the study have come from the data which has led to the acceptance of the two working hypotheses. The following table was constructed using the total error scores for the first four steps. The table is designed to show the combined error each subject made on Steps 1 and 3, and Steps 2 and 4. The surprise was that in this test, the non-visual steps (Steps 2 and 4) showed a slightly smaller amount of error than did the visual attempts (Steps 1 and 3). Chapter IV will discuss working hypothesis 2 further.

Null hypothesis 3 states that there is no significant difference between a distance formed visually with the mallets and a later attempt to repeat the same distance non-visually. Steps 5 and 7 represent attempts to form a distance visually, followed by attempts to repeat the same distances without vision. The "a" portion of each step represents the visual attempt while the "b" portion represents the non-visual attempt.

Subject A has a mean error score of 4 1/8 inches. The total error for his attempt at Step 5 is 8 3/4 inches. The total error for his attempt at Step 7 is 4 1/2 inches. Both of the error scores mentioned above are larger than his mean error score. The total error for Step 5 is more than twice as large as his mean error score. Also, both totals are outside of the recommended accuracy range.

TABLE 9.--The combined total error for Steps 1 and 3 compared with the combined total error for Steps 2 and 4

Subject	Combined Total Error For	
	Steps 1 and 3	Steps 2 and 4
A	2"	4"
B	9 3/4"	8"
C	5 1/4"	8"
D	4 1/2"	1"
E	5 3/4"	2 3/4"
F	5 1/2"	3 1/4"
G	2"	4"
Error Totals	34 3/4"	31"

Subject B has a mean error score of 8 3/8 inches. The total error for his attempt at Step 5 is 10 1/4 inches. The total error for his attempt at Step 7 is 12 inches. Each of the error scores for Steps 5 and 7 are larger than the mean error score. Also, each is far beyond the recommended accuracy range.

Subject C has a mean error score of 5 7/16 inches. The total error for his attempt at Step 5 is 7 1/4 inches. The total error for his attempt at Step 7 is 3 1/2 inches. The total for Step 5 shows a greater amount of error than the mean score, and each total is outside of the recommended accuracy range.

Subject D has a mean error score of 2 3/16 inches. The total error for his attempt at Step 5 is 6 inches. The total error for his attempt at Step 7 is 7 1/4 inches. Each of these total error scores is larger than his mean error score, and both are outside of the recommended accuracy range.

Subject E has a mean error score of 4 3/32 inches. The total error for his attempt at Step 5 is 11 3/32 inches. The total error for his attempt at Step 7 is 4 inches. One total is far greater than his mean error score, and both totals are outside of the recommended accuracy range.

Subject F has a mean error score of 5 13/16 inches. The total error for his attempt at Step 5 is 3 3/4 inches. The total error for his attempt at Step 7 is 4 1/2 inches. Unlike the previous subjects, Subject F's error scores are lower than his mean error score. However, both totals are outside of the recommended accuracy range.

Subject G has a mean score of 6 5/32 inches. The total error for his attempt at Step 5 is 9 inches. The total error for his attempt at Step 7 is 16 inches. The error score for Step 7 is more than twice his mean error score. Also, both error scores are outside the recommended accuracy range.

The 14 figures for the total margins of error for Steps 5 and 7 combined show that 9 of these 14 totals show a greater margin of error than each subject's individual mean margin of error. In 5 of these 9 cases the total margin of error for Steps 5 and 7 combined was more than twice the subject's mean error score for the test as a whole. The figures also show that the remaining 5 margin of error totals were less than the mean error score of the test subjects as a whole. None of the totals listed for Steps 5 and 7 were within the recommended accuracy range; therefore, null hypothesis 3 is rejected.

Null hypothesis 4 states that there is no significant difference between a non-visually formed distance between mallets and a later attempt to repeat the same distance with vision. Steps 6 and 8 represent attempts to form a distance non-visually, followed by attempts to form the same distance visually. The "a" portion represents the non-visual attempt, while the "b" portion represents the visual attempt.

Subject A has a mean error score of 4 1/8 inches. The total error for his attempt at Step 6 is 9 1/2 inches. The total error for his attempt at Step 8 is 4 1/2 inches. Both error totals are larger than his mean error score, and both are outside the recommended accuracy range.

Subject B has a mean error score of 8 3/8 inches. The total error for his attempt at Step 6 is 9 inches. The total error for his attempt at Step 8 is 18 inches. Both totals are larger than his mean error score, and the total error for Step 8 is more than twice his mean error score. Both error scores are outside of the recommended accuracy range.

Subject C has a mean error score of 5 7/16 inches. The total error for Step 6 is 16 3/4 inches. The total error for Step 8 is 4 3/4 inches. As can be seen, the total error for Step 6 is more than twice his mean error score. The error score for Step 8 is smaller than his mean error score; however, both totals are outside the recommended accuracy range.

Subject D has a mean error score of 2 3/16 inches. The total error for his attempt at Step 6 is 2 3/4 inches. The total error for his attempt at Step 8 is 1 inch. The total error for Step 8 is below his mean error total, and is also within the accuracy range. The total error for Step 6, however, is larger than the mean error score and is outside the accuracy range.

Subject E has a mean error score of 4 3/32 inches. The total for his attempt at Step 6 is 3 1/2 inches. The total error for his attempt at Step 8 is 5 inches. The total error for Step 8 is greater than his mean error score. Also, both totals are outside of the recommended accuracy range.

Subject F has a mean error score of 5 13/16 inches. The total error for Step 6 is 21 inches. The total error for Step 8 is 8 1/2 inches. The total error for Step 6 is almost 4 times greater than his mean error score. The total error for Step 8 is also greater than his mean error score. Both totals are well outside the recommended accuracy range.

Subject G has a mean error score of 6 5/32 inches. The total error for his attempt at Step 6 is 11 3/4 inches. The total error for Step 8 is 12 1/2 inches. The total errors for both Steps 6 and 8 are greater than his mean error score. Both totals far exceed the recommended accuracy range.

The figures collected from the subjects' attempts at Steps 6 and 8 show that out of the 14 totals, 11 totals showed greater error than the mean error score for each subject. Only 3 of the total error scores were below the mean error score, and only 1 total was within the recommended accuracy range; therefore, null hypothesis 4 is rejected.

The evidence presented concerning Steps 5 and 7 and Steps 6 and 8 have made it possible to reject null hypotheses 3 and 4. The evidence which led to the rejection of these two hypotheses can now be considered substantial evidence for the acceptance of the following hypotheses which were mentioned earlier in Chapter II: (1) if a student visually forms a distance between his mallets, and later tries to repeat the same distance looking away from the instrument, the second distance will almost always be inconsistent with the first, and (2) if a student forms a distance between his mallets while looking away from the keyboard, and later tries to repeat that same distance while looking at the keyboard, the second distance will almost always be inconsistent with the first.

In summary, with the rejection of the four null hypotheses mentioned in this chapter, definite evidence is presented which may be used to determine possible solutions to the problems which face the mallet sight-reader.

Chapter IV will summarize the study, draw conclusions, and make recommendations.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The concern of this study was to secure data, which, when presented and interpreted, would yield knowledge useful to those persons teaching or studying mallet-played instruments--knowledge concerned mostly with the roles of kinesthesis and vision during the process of sight-reading music for mallet-played instruments.

A review of studies and of related literature revealed no data which resulted from controlled experimentation about the subject. This study seemed necessary because of the growing need for performers who are capable of sight-reading the increasingly demanding repertoire for mallet-played instruments.

The major purpose of this study was to determine what senses are brought into play when a person sight-reads music for a mallet-played instrument, and to determine if these senses are being used to their best advantage. From the study of related literature, it was possible to determine that vision and kinesthesis were the two senses most directly involved in mallet-playing, or, more specifically, mallet sight-reading.

With this knowledge in mind, a test was constructed which would demonstrate the probability of repeating intervals accurately using these two senses in various combinations, much as they would be used in the actual practice of sight-reading. Seven subjects with various mallet-playing backgrounds were selected for the test. The amount of experience with their instruments ranged from two months to over six years. The test consisted of various attempts to match distances between mallets. These attempts were made in the following manners: (1) visually, (2) non-visually, and (3) a combination of both visual and non-visual. A distance was first formed on a xylophone, and then an attempt was made to match the same distance on a model. These attempts were recorded in feet and the totals were recorded on bar graphs for easy reference.

In order to determine if the two senses were being employed properly, four hypotheses were tested. In order to test the hypotheses, it would be necessary to test their use in the various combinations mentioned above. With the evidence from the test, it would be possible to accept or reject these hypotheses. The tests further show where consistencies and inconsistencies in intervalic duplication attempts most frequently occured.

The main evidence came from comparing the individual totals accumulated by the seven subjects for the eight steps of the test. From these totals, mean error scores were figured for each subject, in order to have a point of comparison by which to judge the various totals. Also, an "accuracy range" was established to act as further evidence by which the decisions concerning the hypotheses could be made.

Conclusions

As a result of the findings of this study, the following conclusions were made.

1. As long as a student can keep his eyes fixed on the instrument, then any attempts to repeat distances between mallets should be consistent. This, however, would work only when a piece of music was committed to memory and no sight-reading was to take place.

2. If a student keeps his eyes fixed on the music and does not look down at the instrument, then any attempts to repeat distances between mallets should be consistent. According to the test, the results should be somewhat more accurate than if the distances were formed entirely by vision.

The practice of first forming a distance visually and later trying to repeat the same distance non-visually is inconsistent. The results of the test showed that the distance formed without vision was nearly always larger than the distance attempted when the subject was looking at the instrument.

Also, when a distance was formed without vision, and a later attempt was made to form the same distance visually, an equal inconsistency occurred. Again, the visual attempt was smaller than the non-visual attempt. The results of the test used in this study also suggest the hypothesis that Raffel suggested in her study. Her hypothesis suggests that visual and kinesthetic responses travel to and from different areas of the brain.

Recommendations

The following recommendations seem appropriate as a result of the findings and conclusions in the study.

1. In order for a mallet student to sight-read successfully, his eyes must be in fairly constant contact with the music. As was mentioned earlier, the accuracy is consistent when the eyes are kept on the keyboard; but with the eyes in this position it is impossible to sight-read. According to the results of the experiment used in this study, there is a greater amount of accuracy when all the attempts were made without the aid of vision. The results of the experiment show that when the two senses were used inconsistently, the accuracy was poor in almost every case. These results suggest that the rapid shifting of the eyes from the music to the keyboard is a practice that should be condemned.

The best results would come from simply keeping the eyes on the music the entire time and letting the kinesthetic sense perform the necessary responses. There would, of course, be exceptions to this suggestion. For example, if wide skips of a sizeable distance were to occur, it might be necessary to glance at the keyboard to insure accuracy. Also, if the tempo of the composition is extremely slow, allowing plenty of time to look down the performer would have an extra margin of accracy. However, for the most part, the eyes should stay fixed on the music as much as possible. This should be done to avoid the inconsistencies mentioned earlier.

2. A mallet student should be trained with specific material designed to increase his sight-reading skill. With this statement in mind, a second experiment was to be included within the context of this study, but because of uncontrollable variables, it was discontinued. The experiment was based on the premise that mallet players are sometimes trained to be poor sight-readers. As is demonstrated by the evidence presented earlier, the best sight-reading results occur when the eyes are kept on the music, and are not continually shifting between the music and the instrument.

The premise mentioned above is based on the fact that much of the material presented in method books for mallet instruments allows the reader to let his eyes drift between the music and the instrument. An experiment to demonstrate this point is based upon the presentation of scale studies. In many of the method books, scales are presented only in an ascending or descending fashion with a somewhat continuous rhythm pattern throughout. A repetition of these same patterns is usually used for the presentation of every major and minor scale. The student soon becomes aware of this, and learns to memorize these patterns. Once the patterns are memorized, the need to look at the music is almost completely eliminated. Consequently, he begins to watch the mallets in an effort to perfect the scales.

Even though the speed of the scales continues to increase, problems are beginning to develop. First of all, the student is becoming dependent on watching the instrument to insure his accuracy. This soon develops into a sense of definite insecurity the moment the eyes are not on the keyboard. This insecurity is probably most prominent when the student then attempts to sight-read. He knows that it is impossible to keep his eyes on the keyboard the entire time. In an effort to compensate, he tries to shift his eyes back and forth between the music and the instrument. He does this to satisfy not only his reliance on vision, but also to find as many of the notes as possible. This practice is one which should be condemned.

In most method books, the melodies usually correspond to scales presented prior to the melodies. The melodies which occur in many of the method books also present problems similar to the ones presented by the scales. In many cases, the melodies are of an extremely predictable nature, allowing them to be memorized rapidly. The student learns to play the melody in the way he did the scale: again his eyes are on the instrument. Even though he learns to play the exercises, in most cases his eyes are entirely on the instrument and the music is no longer necessary.

Of course, all cannot be blamed on the music. It is true that many of the compositions in existence are built on predictable scales and melodies. Proper teaching techniques could train the student to read even the most predictable music without looking at the keyboard. However, if there were at least some supplementary materials presented which were designed to train the mallet player to keep his eyes on the music while sight-reading, it would be very valuable to his progress.

The exercises presented in Appendix B[1] are sight-reading exercises designed specifically for the purpose of training the mallet player to keep his eyes on the music. The format for these exercises is about the same as would be found in most method books. First a scale is presented, followed by melodies based upon that scale. The difference here, however, is in the method by which these scales and melodies are presented. Unlike other similar materials, the scales and exercises are of an unpredictable nature. The scales are based on changing rhythm patterns, octave skips, and irregular meter changes. This is done so that regardless of how

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[1]See Appendix B.

familiar the student becomes with a particular scale, it will still be necessary to keep the eyes on the music to avoid rhythm, octave, or meter changes. Here, there has also been an attempt to present the melodies in the same manner: they were made in a somewhat unpredictable manner, but at the same time, there was an attempt to make them as musical and interesting to play as possible.

The scales and melodies mentioned above were to be used in an experiment to compare the results of one group reading this material with a second group reading traditional mallet literature. It was hoped that this experiment would show that the type of material in Appendix B is necessary if a mallet performer is to become a competent sight-reader. However, as was mentioned earlier, uncontrollable variables ruled out the completion of this experiment.

3. The third recommendation is that some research needs to be done on the premise that individual differences do exist among people in relation to their kinesthetic sense. There was some evidence of this occurring in this study. However, only a guess could be made as to what it was or why it occurred. If there were some method by which to show individual differences in kinesthetic response, it would be possible to guide those with strong responses to instruments which depend on this sense. Also, if a person had a poor kinesthetic response, it would be possible to guide him away

from such instruments as piano, trombone, or mallet-played instruments, which depend so much on the kinesthetic sense, thereby avoiding later complications.

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APPENDIX A

RAW DATA RESULTING FROM TABLE 1

SUBJECT A*

	Attempts 1	2	3	4	5	Total Number of Feet	Error Diff. Between a and b
Step 1							
a.	20 1/4	4 1/2	23 1/4	34 1/2	11 3/4	7' 8 1/2"	3/4"
b.	20	5	22 3/4	32	12 3/4	7' 9 1/4"	
Step 2							
a.	11	27 3/4	2 1/2	30	19	7' 6 1/4"	3"
b.	11 1/4	26 3/4	2 1/4	28 1/4	18 3/4	7' 3 1/4"	
Step 3							
a.	17 1/2	6 1/2	24 3/4	27 1/2	12 1/2	7' 4 3/4"	1 1/4"
b.	18	6	23 1/2	27 3/4	14 3/4	7' 6"	
Step 4							
a.	25 1/2	10 1/2	6 1/2	25 1/2	30 1/2	8' 2 1/2"	1"
b.	23 3/4	11 1/2	7 1/2	25 1/4	29 1/2	8' 1 1/2"	
Step 5							
a.	8 3/4	23 3/4	8 1/2	8 1/2	24 1/2	6' 2"	8 3/4"
b.	11	2 1/2	10 3/4	10	26 1/2	6'10 3/4"	
Step 6							
a.	9	29 1/4	25 1/2	6 1/2	27 1/2	8 1 3/4"	9 1/2"
b.	11 1/2	22	22 1/2	7	25 1/2	7' 4 1/2"	
Step 7							
a.	13 1/2	26	18 1/2	10	29 1/2	8' 1 1/2"	4 1/2"
b.	15 1/2	23	19 1/2	13	31	8' 6"	
Step 8							
a.	15 1/2	27 1/4	8 1/2	22 1/4	15	6'11 1/2"	4 1/2"
b.	13	25	7	20	14	6' 7"	

*Mean Score in Inches: 4 1/8"

SUBJECT B*

	Attempts 1	2	3	4	5	Total Number of Feet	Error Diff. Between a and b
Step 1							
a.	5 1/2	6	15 1/4	29 3/4	11 1/2	5' 8"	7 1/4"
b.	5 1/2	4 1/2	11 1/4	28 1/2	11	5' 1 3/4"	
Step 2							
a.	10	10	19 1/4	5	27 3/4	6'	3 3/4"
b.	7 1/2	9 1/2	19 3/4	4 3/4	26 3/4	5' 8 1/4"	
Step 3							
a.	15	6 1/2	22 1/2	30	12	7' 2"	2 1/2"
b.	16	7	20 1/2	28	12	6'11 1/2"	
Step 4							
a.	11 1/2	16 1/2	25 3/4	32	8 1/2	7' 9 1/4"	4 1/4"
b.	10	15	24	30 1/2	9 1/2	7' 5"	
Step 5							
a.	10	28	22	5 1/2	11 3/4	6' 5 1/4"	10 1/4"
b.	8 1/2	25	18	6 1/2	9	5' 7"	
Step 6							
a.	24	5 3/4	24 1/2	23	28	8' 9 1/4"	9"
b.	20	6 3/4	19 1/2	25 1/2	24 1/2	8' 1/4"	
Step 7							
a.	22	18 3/4	6 1/2	28	14	6'10 1/2"	12"
b.	24	22 3/4	7	32	16	7'10 1/2"	
Step 8							
a.	16 1/2	25 1/2	9 3/4	23	28 1/2	8' 7 1/4"	1' 6"
b.	15 1/2	21 1/2	8 3/4	18	22 1/2	7' 1 1/4"	

*Mean Score in Inches: 8 3/8"

SUBJECT C*

Attempts					Total Number of Feet	Error Diff. Between a and b
1	2	3	4	5		
Step 1						
a. 15 1/2	4 3/4	23	18	8 3/4	5'10"	1 3/4"
b. 15 1/2	4 3/4	23 1/2	18 1/2	9 1/2	5'11 3/4"	
Step 2						
a. 6	17	25 1/4	13	18	6' 7 1/2"	2 1/4"
b. 6 1/4	18	23 1/4	13 3/4	17 1/2	6' 9 1/4"	
Step 3						
a. 14 1/2	20 1/2	4 1/2	12 1/2	21	6' 1"	3 1/2"
b. 15	20 1/2	6	13 1/2	21 1/2	6' 4 1/2"	
Step 4						
a. 13 1/2	6 1/2	20	11 3/4	4	4' 7 3/4"	5 3/4"
b. 15 1/2	7 1/2	21	12 1/2	5	5' 4 1/2"	
Step 5						
a. 7 3/4	13 1/2	22 1/4	12	22 1/4	6' 5 3/4"	7 1/4"
b. 10	16 1/2	24	11 1/2	23	7' 1"	
Step 6						
a. 10	25	7	30 1/2	18	7' 5"	16 3/4"
b. 10 1/2	22	6 1/2	27 1/4	17	6' 1 1/4"	
Step 7						
a. 14 1/2	17	4 1/2	20 1/2	8	5' 4 1/2"	3 1/2"
b. 16	18	6 1/2	18	9 1/2	5' 8"	
Step 8						
a. 15 1/2	23	7 1/2	20	19 1/4	7' 1 1/4"	4 3/4"
b. 18 1/4	20	7 1/4	22	22 1/2	7' 6"	

*Mean Score in Inches: 5 7/16"

SUBJECT D*

	Attempts 1	2	3	4	5	Total Number of Feet	Error Diff. Between a and b
Step 1							
a.	8 1/2	13	16 1/2	4 1/2	16	4'10 1/2"	3 3/4"
b.	9 3/4	13 1/2	18	5	16 1/2	5' 2 1/4"	
Step 2							
a.	13	6 3/4	20	9	14 1/2	5' 3 1/4"	0"
b.	12 3/4	7	19 1/2	8 1/2	15 1/2	5' 3 1/4"	
Step 3							
a.	12 3/4	14 1/4	19 1/2	12 3/4	23	6'10 1/4"	3/4"
b.	12 3/4	14	18 3/4	13 1/4	22 3/4	6' 9 1/2"	
Step 4							
a.	20	10 1/2	24 1/4	10 1/2	16 1/4	6' 9 1/2"	1"
b.	18 3/4	11 1/4	25	11	16 1/2	6'10 1/2"	
Step 5							
a.	12 1/4	23 1/2	6 1/4	16	25	6'11"	6"
b.	12 1/4	23	8 1/4	19 1/2	26	7' 5"	
Step 6							
a.	18	9	30 1/2	32 1/2	12 3/4	8' 6 3/4"	2 3/4"
b.	17	8 1/2	27 1/2	31	16	8' 4"	
Step 7							
a.	18 1/2	20 1/2	26	28 3/4	14 1/2	8'11 1/4"	6 1/4"
b.	18	22	27	29	18 1/2	9' 6 1/2"	
Step 8							
a.	23	30	13 1/2	29 1/2	14	9' 2"	1"
b.	22	28	15	32	14	9' 3"	

*Mean Score in Inches: 2 3/16"

SUBJECT E*

	Attempts					Total Number of Feet	Error Diff. Between a and b
	1	2	3	4	5		
Step 1							
a.	11 1/4	21 3/4	31	21	14 3/4	8' 3 3/4"	3 1/2"
b.	12 1/4	22	32	22 1/4	15	8' 7 1/4"	
Step 2							
a.	22 1/2	13	28	15	14	7' 8 1/2"	1 1/2"
b.	21	13 3/4	28 1/2	16	15 1/2	7'10"	
Step 3							
a.	11	20 1/2	14 1/2	8	24 1/4	6' 5 1/4"	2 1/4"
b.	10 1/2	18	15 1/2	9 1/2	21 1/2	6' 3"	
Step 4							
a.	24 1/2	18 1/2	21	15 1/4	21 1/4	8' 2 1/2"	1 1/4"
b.	23	17	21	16 1/2	22 1/4	8' 3 3/4"	
Step 5							
a.	8 1/2	20 3/4	12 1/2	23 1/2	18 1/2	6'10 3/4"	11 3/4"
b.	11 1/2	23 1/2	15	24 1/2	20	7'10 1/2"	
Step 6							
a.	11 1/2	12 1/2	17 1/2	14	13	5' 8 1/2"	3 1/2"
b.	9 1/2	13	17 1/2	14	11	5' 5"	
Step 7							
a.	14 1/2	14 3/4	14 1/2	22	20	7' 2"	4"
b.	16	16	16	22	20	7' 6"	
Step 8							
a.	19	26 1/4	17 1/4	23 1/4	25	9' 8 3/4"	5"
b.	19	25	16	23	25 3/4	9' 3 3/4"	

*Mean Score in Inches: 4 3/32"

SUBJECT F*

	Attempts 1	2	3	4	5	Total Number of Feet	Error Diff. Between a and b
Step 1							
a.	6 1/2	10	6 1/2	14	12 1/2	4' 2 1/4"	1/2"
b.	7 3/4	10 1/4	7	14	11 1/2	4' 1 3/4"	
Step 2							
a.	12 1/2	20 1/2	18 1/2	17 1/2	8	6' 5"	2 3/4"
b.	12	19	17 3/4	18	9 1/2	6' 2 1/4"	
Step 3							
a.	16 1/2	6 3/4	16 3/4	18	11	5' 9"	5"
b.	15	7 1/2	18	18 1/2	15	6' 2"	
Step 4							
a.	7	22	28	14	30 1/2	8' 5 1/2"	1/2"
b.	7 1/2	21	27 1/2	14	31	8' 5"	
Step 5							
a.	8 1/4	22	16	25	14 1/2	7' 1 3/4"	3 3/4"
b.	8 1/4	24 1/2	13	21 1/2	15	6'10"	
Step 6							
a.	19 1/2	28 1/4	21 1/2	15 1/2	19 1/2	8'10"	21"
b.	13 1/2	21 1/2	19 1/2	13 1/2	17	7' 1"	
Step 7							
a.	18 1/2	25 1/2	16 1/2	16 1/2	25 1/2	8' 6 1/2"	4 1/2"
b.	16	26	16 1/2	18 1/2	21 1/2	8' 2"	
Step 8							
a.	22	18 1/2	23 1/2	24 1/2	21 1/2	9' 2"	8 1/2"
b.	15	14	23 3/4	22	18	7'10 1/2"	

*Mean Score in Inches: 5 13/16"

SUBJECT G*

	Attempts					Total Number of Feet	Error Diff. Between a and b
	1	2	3	4	5		
Step 1							
a.	6 1/2	3 1/2	15	27 1/2	11 1/2	5' 4"	1/2"
b.	6 1/2	3 1/2	14 1/4	26 3/4	13 1/2	5' 4 1/2"	
Step 2							
a.	8	2 1/2	24	9	11 1/4	4' 6 3/4"	2 3/4"
b.	8 1/2	2 1/4	23 1/2	10 1/4	13	4' 9 1/2"	
Step 3							
a.	10 1/2	15	11 1/4	23	30 1/2	7' 6 1/4"	1 1/2"
b.	10 1/2	14	10 3/4	23	30 1/2	7' 4 3/4"	
Step 4							
a.	11 1/2	7 1/4	14 3/4	29 1/2	9 1/4	6'	1 1/4"
b.	14	8 1/4	15 1/4	27	10	6' 1 1/4"	
Step 5							
a.	9	24 1/2	9	6 3/4	25 3/4	6' 3"	9"
b.	11	26	11 3/4	8 1/2	26 3/4	7'	
Step 6							
a.	10 3/4	30	25 1/2	18	28 1/2	9' 4 3/4"	11 3/4"
b.	12 3/4	23	22	16 3/4	26 1/2	8' 5"	
Step 7							
a.	14 1/2	25	18 3/4	10	25	7' 9"	16"
b.	16 3/4	24	20	13 1/4	27 1/2	8' 5 1/4"	
Step 8							
a.	25	7	18	31 3/4	27	9' 3/4"	12 1/2"
b.	22 1/2	6 1/2	15 3/4	28 1/4	26	8' 1/4"	

*Mean Score in Inches: 6 5/32"

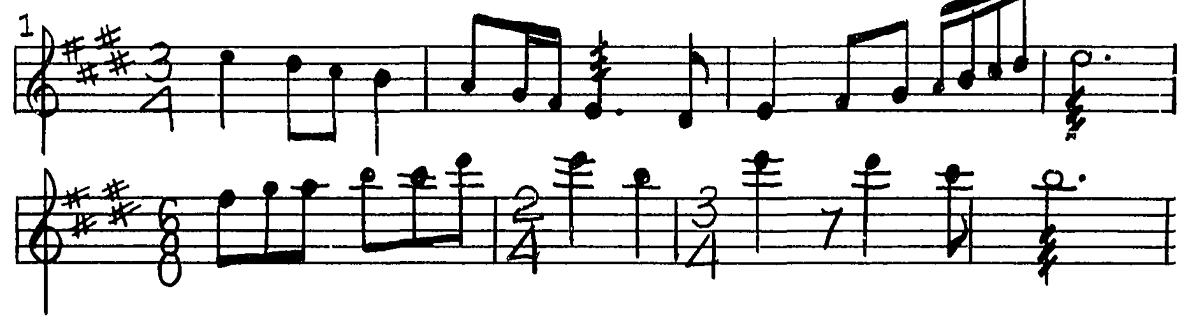
APPENDIX B

RECOMMENDED MATERIAL FOR SIGHT-READING

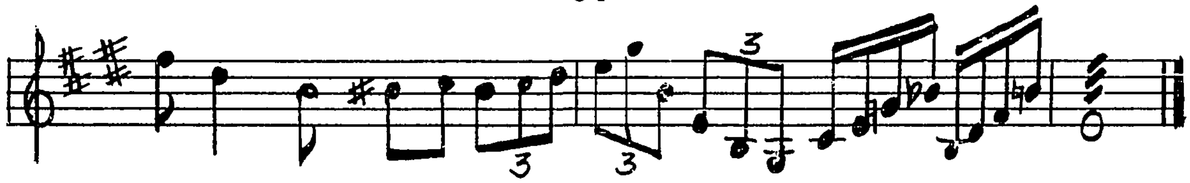
C MAJOR

D MAJOR

E MAJOR



2
Melody I
Melody II



B♭ MAJOR

E♭ MAJOR


Melody I
Melody II
f
rit.

A♭ MAJOR