

them did have about 40 days of experience playing games on the Atari 800 microcomputer. Twenty days of daily one minute timings on basic addition, subtraction and multiplication facts produced the results presented above.

At the end of this experience most of the students were not doing as well on microcomputer-administered, see/type, timings as they were on teacher-administered, see/write, timings. However Group II, the only group doing both see/write and see/type timings, showed only a slight advantage in frequency of see/write over see/type. Explicit keyboard training and a longer or more intensive experience with the microcomputer may overcome the advantage of the see/write learning channel set. Accuracy results were not presented because accuracy was uniformly high, fewer than 3 or 4 errors per minute, for both see/write and see/type. If there was an accuracy advantage, it was a small one for see/type timings.

The data on tool movements and math fact timings are not easy to interpret without indulging in speculation. They are included here primarily as a contribution to an evolving data-base in this relatively new area of Precision Teaching.

Much research is needed before we can determine which educational contingencies are best managed by microcomputer. Certainly the microcomputer has imposing credentials. If it can teach skills effectively, teachers may be able to concentrate on more advanced aspects of skill measurement and development. The Atari 800 is clearly capable of presenting math drill and practice lessons at rates which will not impose machine ceilings on fluency for human learners. All of the popular microcomputers are capable of being programmed to calculate frequencies and store them in a file on tape or diskette. The Atari is capable of presenting the child's learning on semi-log charts done in four colors, including learning lines, aim stars, record floors and the usual features of the Standard Celeration Charts.

We also need to start exploring the use of programs that apply data-decision rules to frequencies stored in the student's learning file. It seems likely that in the near future this application of decision rule technology will signal the learner and teacher that a change is needed before additional time is spent on an ineffective procedure. The potential of the floppy diskette for quick and semi-permanent storage of student's learning frequencies may be a substantial contribution to Precision Teaching. Floppy diskettes have great potential for making it possible to share and analyze the huge amount of data generated by precision learners and

teachers.

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THE RELATIONSHIP OF FREQUENCY TO SUBSEQUENT SKILL ACQUISITION

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The issue of skill proficiency is perhaps the most important issue in education today. It involves the evaluation of students in elementary school through college, and is of such great concern that laws have been enacted to ensure that students are proficient in certain skills.

Teachers must make decisions daily concerning when to advance a student from one skill to the next. In the past, a time criterion was sometimes used. For example, when working on multiplication facts, a student might spend one week practicing his two-times table, then go on to the three-times table the following week. Individual differences were ignored with this method.

With the advent of Precision Teaching, specification of precise personalized aims for children began to emerge in classrooms. A well-specified aim includes a definition of pupil response, conditions under which that response should occur, and criteria for acceptable performance (Haring & Bateman, 1977). Criteria for acceptable performance and advancement to the next skill, that is, proficiency criteria have often been set in terms of frequency correct and incorrect.

Some disagreement exists about what constitutes proficiency (Haring & Gentry, 1976). A review of the literature suggests that research has not conclusively determined specific optimum proficiency criteria for academic skills. Different guidelines are available to assist teachers in determining when to advance children, but there is little specific research or agreement as to which guideline to use. One

way to establish proficiency criteria for a particular skill is to observe progress on the next related skill on a hierarchy of skills. The proficiency level a child attains on a particular skill makes a critical difference to progress on the next skill level (Haughton, 1972).

Specifying relatively high frequency aims appears to be crucial to student competence. However, controlled research is needed to establish when a child has mastered a skill sufficient for adequate performance on subsequent related skills. The objective of this project was to investigate the relationship of different ending frequencies on a particular skill, saying letter sounds, and subsequent ending frequencies on a related skill, saying CVC (consonant-vowel-consonant) trigrams when amount of practice is controlled.

Procedure

The subjects in this investigation were nine learning disabled students in second through fifth grade. All subjects recognized at least ten consonant sounds and were equated on the task of saying CVC trigrams.

Two probe sheets were used in the study. The first sheet included nineteen consonants and the "a" vowel with ten letters in each line (e.g., b, t, a, r, etc.), 80 letters on the entire sheet. The second sheet had ten CVC trigrams on each line (e.g., cat, tag, ham, etc.), all with "a" as the middle vowel, 100 words on the entire sheet.

The study involved three phases (see Figure 1). During the initial phase, an untimed pretest was administered to each subject on the CVC trigram probe. Percentage correct and incorrect were recorded. Each subject was also administered two one-minute timings on the same probe. In addition, a one-minute timing on the letter sound probe was administered.

With one exception, students were randomly assigned into high, medium, and low frequency experimental phases. Subject #1 was assigned to the high frequency experimental phase because his initial high frequency of saying letter sounds exceeded the medium and low frequency criteria used in the study. During the experimental phase, each subject was trained to a different criterion, either a high, medium, or low frequency of saying letter sounds (i.e., 80, 60, or 40 sounds per minute). Three one-minute timings were presented daily. Praise feedback and informational feedback (information concerning incorrect and correct responses) were given upon completion of each timing.

Subjects #1, #4, and #7, assigned to the high frequency experimental group, were presented one-minute timings until a criterion of 80

corrects sounds with five or less errors was attained. Once this frequency was obtained it was held constant by using the controlled reader. The same letters used in the letter probe sheet were on a controlled reader filmstrip designed for this study. Subject #1 was the first to reach the criterion of 80 sounds per minute. His frequency was then maintained for eight timings while subjects #4 and #7 worked to achieve the same criterion. During this phase, Subject #1 said a total of 940 consonant sounds. This number was then used as a criterion for all other subjects during the experimental phase. Thus, all nine subjects had the same amount of practice saying letter sounds.

Subjects #2, #5, and #8, assigned to the medium frequency experimental group, were presented one-minute timings until a criterion of 60 correct sounds with five or less errors was attained. Subjects #3, #6, and #9, all in the low frequency experimental group, were presented one-minute timings until a criterion of 40 correct sounds with five or less errors was attained. These frequencies were held constant by using the controlled reader until the total amount of sounds said was equivalent to the 940 consonant sounds said by Subject #1.

During the final phase, an untimed post-test of saying CVC trigrams was administered to each subject. Percentage correct and incorrect was recorded. In addition, fifteen more one-minute timings of saying CVC trigrams were completed with each subject during the final phase.

Results

Growth on the CVC trigrams from the initial to final phase, and growth during the final phase were represented by add-subtract gain scores, frequency multipliers, and celerations. Frequency multipliers and celerations are displayed in Charts 1, 2, and 3.

Gain Scores

The median correct scores of the first and last three CVC trigram timings of the final phase were compared within subjects with add-subtract gain scores. The high frequency experimental group had the highest total gain of 58 words while the medium frequency group had the lowest total gain of 30 words.

The median correct scores of the first two CVC timings during the initial phase and the median of the last three CVC timings during the final phase were also compared within subjects with add-subtract gain scores. The high frequency experimental group had the highest gain of 107 words, while the medium frequency group had the lowest total gain of 36 words.

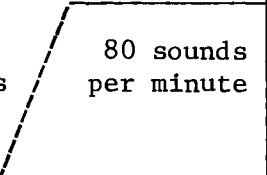
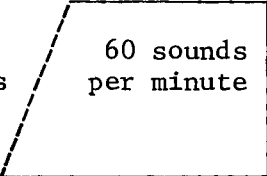
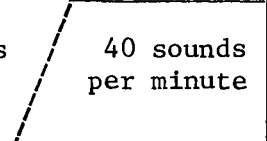
Subjects #1, #4, #7	<u>Initial Phase</u> CVC trigrams: one untimed pre-test, two one-minute timings. Letter sounds: one one-minute timing.	<u>Experimental Phase</u> Letter sounds: three one-minute timings completed daily. High rate maintained with controlled reader until 940 sounds are said 	<u>Final Phase</u> CVC trigrams: 15 one-minute timings (three daily), one untimed post-test completed first.
Subjects #2, #5, #8	<u>Initial Phase</u> CVC trigrams: one untimed pre-test, two one-minute timings. Letter sounds: one one-minute timing.	<u>Experimental Phase</u> Letter sounds: three one-minute timings completed daily. Med. rate maintained with controlled reader until 940 sounds are said 	<u>Final Phase</u> CVC trigrams: 15 one-minute timings (three daily), one untimed post-test completed first.
Subjects #3, #6, #9	<u>Initial Phase</u> CVC trigrams: one untimed pre-test, two one-minute timings. Letter sounds: one one-minute timing.	<u>Experimental Phase</u> Letter sounds: three one-minute timings completed daily. Low rate maintained with controlled reader until 940 sounds are said 	<u>Final Phase</u> CVC trigrams: 15 one-minute timings (three daily), one untimed post-test completed first.

Figure 1. Experimental design

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DAILY CHART TRACER (CT-8)

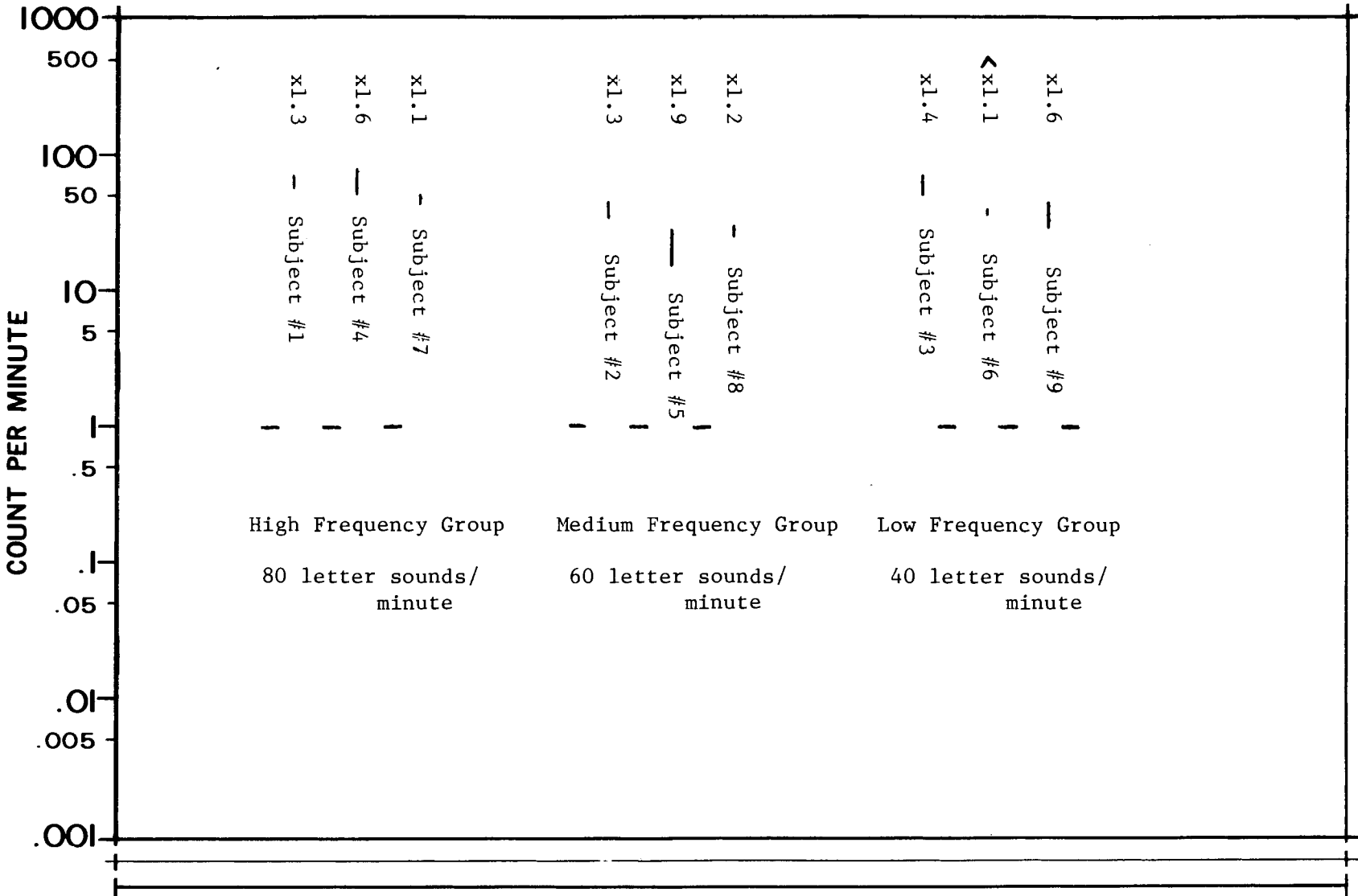


Chart 1. Frequency Multipliers for Median Comparisons during the Final Phase

C. Mercer _____ S. Evans _____

9 subjects _____ say CVC
 _____ trigrams

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DAILY CHART TRACER (CT-8)

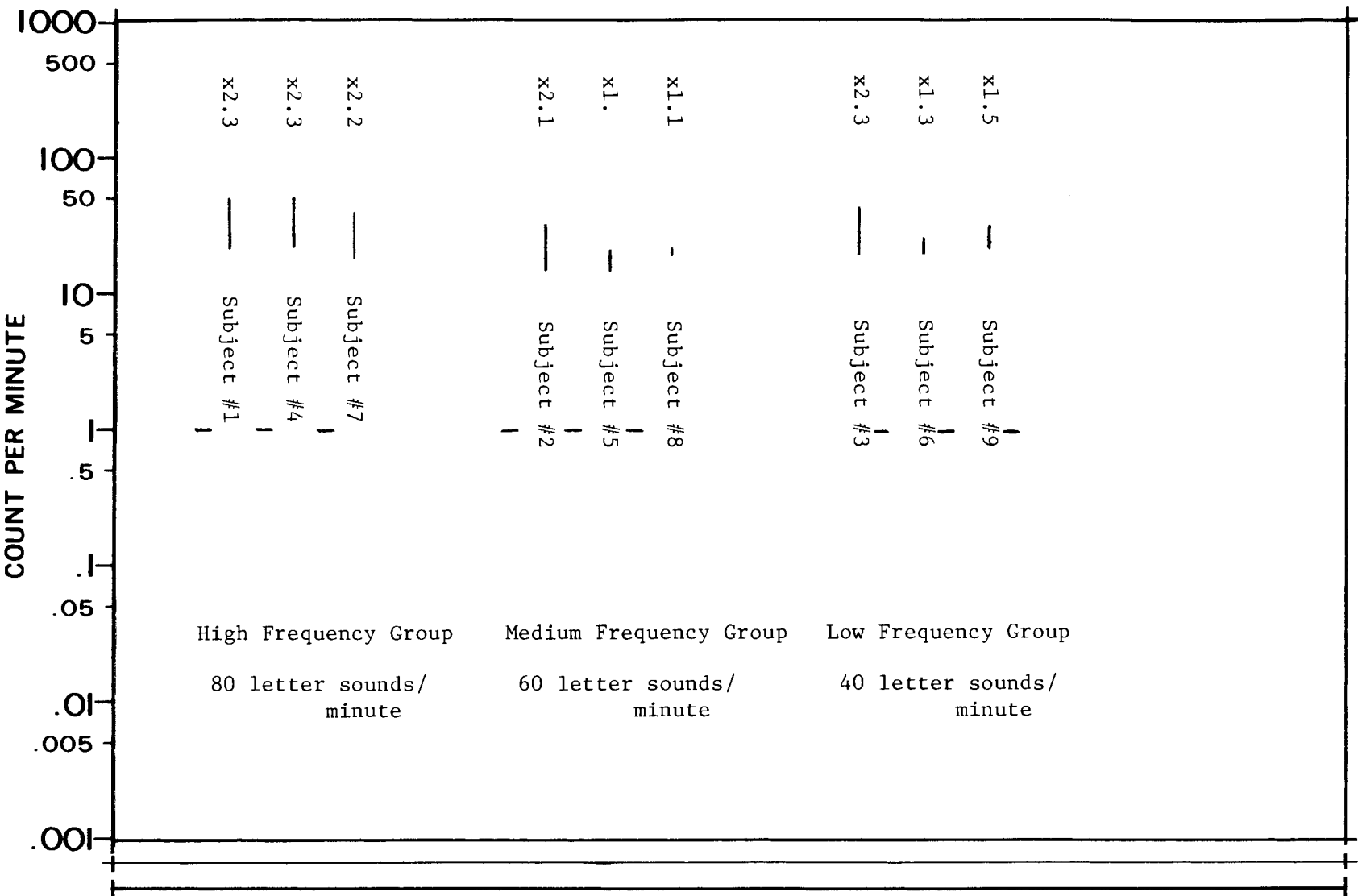


Chart 2. Frequency Multipliers for Median Comparisons of Initial and Final Phases

C. Mercer _____ S. Evans _____ 9 subjects _____ say CVC trigrams _____
 Alachua Co. Public Schools Gainesville, Florida _____

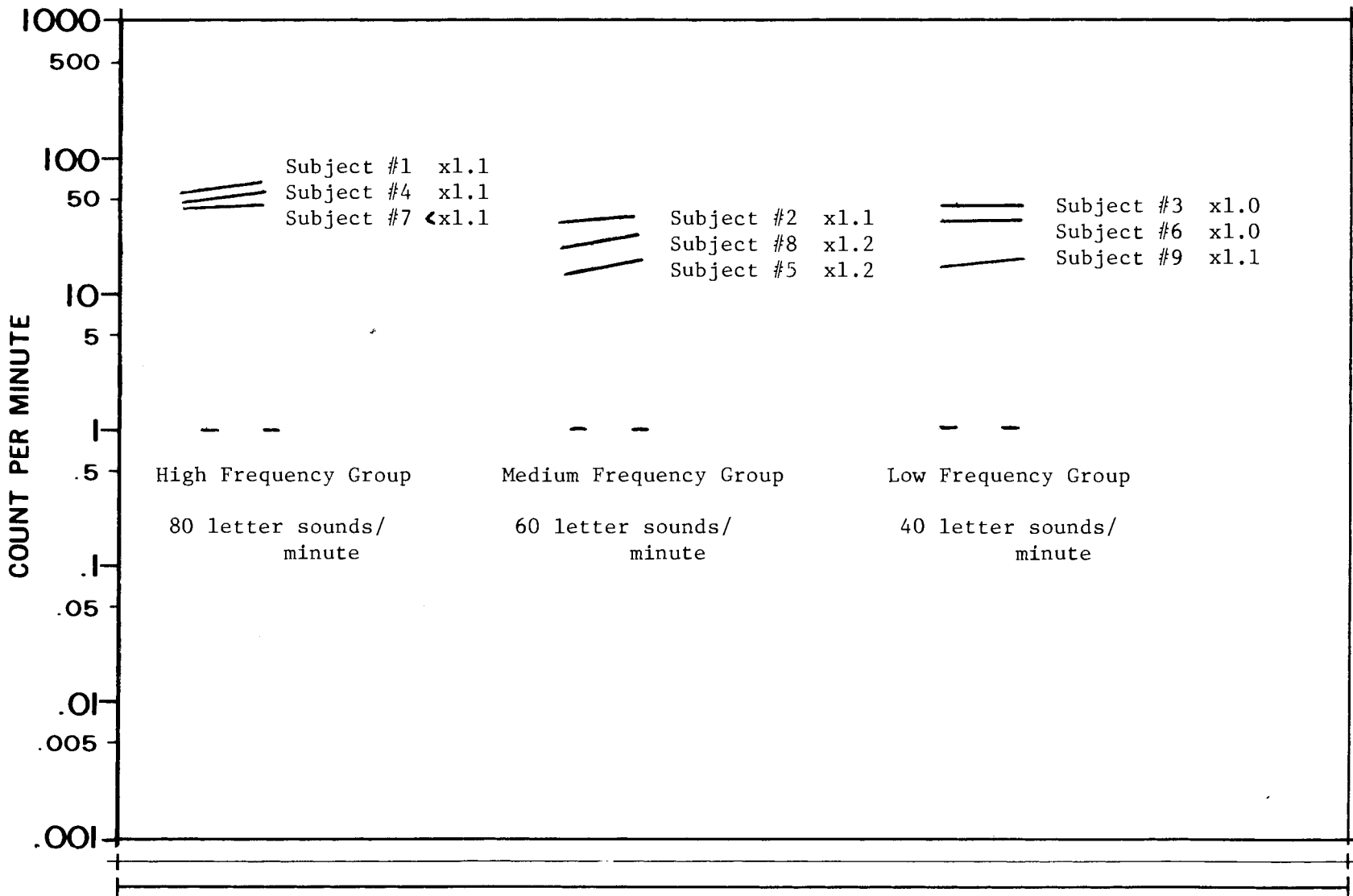


Chart 3. Celerations of CVC Trigram Timings during the Final Phase

C. Mercer _____ S. Evans _____

9 subjects _____

say CVC
trigrams _____

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Percentage correct and incorrect on CVC trigram untimed probes during the initial and final phase were compared within subjects. The highest total gain was 29 points in the high frequency experimental group, while the lowest total gain was 11 points in the low frequency experimental group.

Thus, the high frequency experimental group had the highest total add-subtract gains in all of the measures discussed. Results were divided between the medium and low frequency groups as to which performed the next highest and lowest on the add-subtract gain measures.

Frequency Multipliers

Frequency multipliers were also used for analysis of the experimental results. This ratio comparison of two frequencies is represented as the multiply-divide distance involved in moving from one frequency to another frequency, and is denoted numerically (Pennypacker, Koenig, & Lindsley, 1972). The median correct scores of the first and last three CVC trigram timings of the final phase were used to determine a frequency multiplier within subjects. The median correct score of the CVC timings during the initial phase and the median correct score of the last three CVC timings during the final phase were also used to determine a frequency multiplier for each subject.

Displayed in Chart 1 are the frequency multipliers obtained from the final phase data. An examination of these data indicate little difference between the low, medium, and high frequency groups. Frequency multipliers obtained from initial and final phase data are displayed in Chart 2. An examination of these data indicates that the most growth occurred in the group required to say consonant sounds at 80 sounds per minute.

Celerations

The quarter-intersect method was used to determine celerations of the CVC trigram data of each subject during the final phase. A visual display of final phase celerations is provided in Chart 3 starting at the median of the first three timings of the final phase for each subject. These data indicate little difference between experimental groups.

Discussion

Subjects in the high frequency group showed the greatest growth in the number of CVC trigrams said. This pattern was noted when comparing the add-subtract gain scores obtained from initial to final phases and during the final phase. A

difference in proportional growth in the high frequency group was also noted when using frequency multipliers to analyze the data from the initial to final phases.

However, the frequency multipliers and celerations obtained during the final phase indicated little difference between the groups. As a result, a relationship between frequency of saying letter sounds and growth during the subsequent task of saying CVC trigrams was not clearly demonstrated.

Thus, a need still exists to determine an optimum or critical frequency for this specific prerequisite skill. Effects of training to frequencies of saying sounds above 80 sounds per minute on the subsequent acquisition of saying CVC trigrams needs to be examined. In addition, the relationship of other academic skills and subsequent performance on related academic skills is also a needed area of research. When these optimum aims are established, no more time than necessary will be spent teaching a particular skill.

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