THE UNIVERSITY OF CALGARY

THE ROLE OF THE RIGHT EAR IN ACCURATE PITCH MATCHING

by

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ABSTRACT

The purpose of this study was to determine whether in-tune, soft singing to the right ear of a music student increases the accuracy of the student's pitch reproduction. A formalized experiment to quantitatively assess the role of the right ear in accurate pitch reproduction was implemented over a two month period in 1997. The participants were forty-nine students from a Grade Four and a Grade Three/Four class.

A quasi-experimental design consisting of a control and an experimental group was utilized. A pre-test was given in which the participants were recorded singing two songs from a given pitch. This was followed by the researcher teaching identical singing lessons to both groups. The only variable manipulated within the singing lessons was the treatment given to the subjects in the experimental group. The treatment consisted of the researcher singing softly in-tune into the right ear of each subject two times during each music lesson. At the end of twice weekly singing lessons facilitated over eight weeks, the participants were given a post-test in which they were recorded singing the same two songs as from the pre-test.

Inferential statistics were used in this study in order to determine the likelihood that the results based on the sample group are the same results that would have been obtained for an entire population. An Analysis of Covariance (ANCOVA) test revealed that the pre-test showing differing initial abilities among classes was a significant covariant. When this

covariant was partialled out, there was still a significant influence for treatment. To identify more clearly how much of the variance in the post-test was explained by the pre-test and treatment, a multiple regression was conducted.

The results indicated that of the 65% variance in the post-test scores explained by that model, 61% could be attributed to the covariate pre-test, and the treatment was responsible for 3.5%. This is a statistically significant result confirming the researchers hypothesis that soft, in-tune singing into the right ear of music students will increase the accuracy of their pitch reproduction. A Cronbach Alpha test confirmed an inter-rater reliability of greater then .95.

It is the hope of the researcher that the results of this study will indicate another method for music educators to use to facilitate the acquisition of in-tune singing.

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DEDICATION

To David

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CHAPTER ONE: INTRODUCTION

Singing has been the traditional means through which the elements and concepts of music have been discovered by students in most public educational systems. From Toscanini's insistent cry of "Cantare! Cantare!", encouraging the performers in his orchestras to sing, to Richard Wagner's contention that elementary instruction in singing must be made obligatory for every musician, most individuals in the field of music would agree that primary music education should involve individual and group singing.

Around 300 BC, Aristotle argued for the inclusion of music as part of the balanced education of a gentleman. He recommended that "First… they should while young do much playing and singing." (Politics Book VIII, Chapter 6). Renowned composer and ethnomusicologist Zoltán Kodály strongly advocated that the voice of the child must unequivocably be his or her first musical instrument.

Unfortunately, not all children are born with the ability to sing correctly. For several decades, music educators have sought methods to help children develop in-tune singing and accurate pitch reproduction. It has been the frustration of many a choir director and classroom teacher to be confronted with children who love to sing, but are so out of tune that they are painful to listen to. The reasons for out-of-tune singing are not entirely clear. Debate exists as to whether the inaccuracy is a result of not accurately hearing the melody to be reproduced, or whether the melody is heard correctly, and the student is simply unable accurately to match it. Some researchers suggest that perhaps the child simply cannot remember the pitches for the time required to activate the processes necessary to reproduce them.

The act of singing involves both aural and vocal skills, which may be affected by a multitude of factors, from the physiological to the psychological. Many music researchers and educators believe that accurate singing is a skill that must be learned, and many approaches have been developed over the years to facilitate the acquisition of in-tune singing.

Music educators often ask children to 'echo' or sing back what they have heard, and therefore, it is logical to assume that the ears play a vital role in the hearing and reproduction of pitch. It would be unrealistic to expect accurate pitch reproduction if the model has not been heard correctly. The existence of a dominant, or listening ear has been hypothesized by many theorists, prominent among them is Alfred A. Tomatis, whose work is discussed in Chapter Two.

In an era of budget cuts and program eliminations, educators cannot ignore the fact that singing is the most accessible performance medium for elementary school children. Everyone is born with a voice and a desire to express him or her self. Singing is as natural an activity as speaking, and the quality of one's voice is deeply personal. Researchers have suggested that the child who expresses him or her self through singing, and is praised for it, will develop a more positive self-image (Choksy 1991,p.4). Considerable research has been done with respect to the influence music education has upon other subject areas.

Many theorists have proposed that singing has a positive effect upon other linguistic skills such as verbal and written communication (Choksy 1991,p.4).

The days of asking a child to stay quiet while the rest of the choir sings must be a thing of the past. Children should not have to suffer that humiliation, nor should they be exempt from the lifelong mode of self-expression and enjoyment that singing can provide. However, if all children are to be encouraged to sing, and to have an aesthetic experience through singing, the problem exists of how to facilitate the acquisition of accurate pitch matching. This study will examine one approach for developing in-tune singing.

Definition of Terms:

Accurate singing refers to the ability to reproduce a given melody correctly from a given pitch level.

A capella singing is defined as unaccompanied singing.

Auditory perception is the ability to hear. It includes harmonic, rhythmic, and melodic hearing.

Echo singing refers to the activity of imitating another person's singing. It may also be called pitch-matching or tone-matching.

Inaccurate singing occurs when one is unable to reproduce a given melody at a given pitch level correctly.

Melodic perception refers to the ability to perceive pitch through pitch discrimination and tonal memory.

Modeling refers to the singing of melodies by one of the voice types for another to reproduce.

Pitch contour is the series of absolute pitches whose in-tuneness is interpreted in the song context.

Pitch perception is the ability to make comparisons between pitches to determine whether they are the same or different. It may also be referred to as *pitch discrimination*.

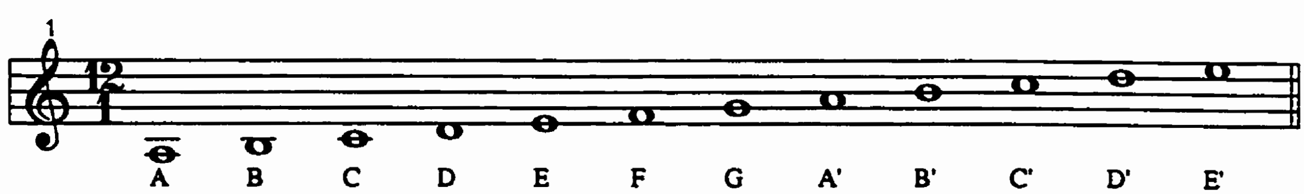
Range is defined as the number of pitches between the lowest and highest notes in a melody.

Register refers to the "portion of the range and compass of the voice" (Baker, 1980, p.163). The *chest voice* is the voice used for speech and low singing. The *head voice* is the voice used for higher pitches, and soft, high speech sounds (Bertaux, 1989, p.95).

Tonal memory is the ability to recall a melody after it is no longer heard.

Vocal exploration refers to techniques of musical play that involve vocal experimentation. Techniques may include vocal glissandi, and imitative sounds.

Absolute pitches referred to in this study are notated as follows:



A review of the literature involving in-tune singing, as well as a discussion of the role of the brain and the ears in accurate pitch reproduction is presented in Chapter Two. Chapter Three explains the hypothesis and design methodology of the investigation. The statistical results of the study are described in Chapter Four, and a discussion of the results and their implications for practice and future research comprise Chapter Five.

CHAPTER TWO: LITERATURE REVIEW

Due to the universal concern with pitch accuracy in children's singing, a considerable body of research exists. A review of various studies and concluding hypotheses from music educators and researchers will be presented in this chapter, followed by a discussion of the role of the ears and the brain in hearing and reproducing pitches.

The child who is unable to accurately reproduce pitches supplied by a model has been described in many different ways. Tone deaf, pitch deficient, monotone, out-of-tune, uncertain, and problem singer are just a sampling of the many terms used by music educators, therapists, and researchers to describe children who are unable to 'sing correctly.' As this study deals with the role of the right ear in accurate pitch matching, the terms accurate and inaccurate singer will be used to refer to those children who respectively can, or can not reproduce a given pitch or series of pitches correctly.

What is an Inaccurate Singer?

An abundance of research projects have been undertaken in order to describe what an inaccurate singer is, and whether gender is influential. Gould (1969) surveyed six hundred and two teachers with respect to the nature of singing problems they encountered in their students. Their responses fell into five classifications of inaccurate singing: the too low and the too high singers, the one note singer, the combination singer who has all three of the above mentioned problems, and the psychologically inhibited singer (p. 14).

Joyner (1969) dealt specifically with the 'monotone' singer in his study of thirty-two eleven and twelve year old students from a boys' grammar school. The teachers were asked to assess the students' singing with a letter mark of an A, B or C. Those students who exhibited no major pitch errors or departures from the melodic outline were graded with an A. Singers who were generally erratic in pitch, but did sing occasionally in-tune were marked with a B, and those boys who displayed no hint of melodic outline or pitch coincidence were rated with a C (p.115).

Swears, in Teaching the Elementary School Chorus (1985), identifies four groups of inaccurate singers. The dependent singer is dependent upon group singing or an accompaniment in order to sing correctly. The speech-like singer sings with his or her speaking voice, the limited range singer cannot sing in the normal expanded vocal range, and the un-tuned singer "lacks any concept of tone matching" (p. 38-40).

Choksy, in Teaching Music Effectively in the Elementary School (1991), describes three pitch problems with respect to children's singing. The first is speech-pitched or drone-like singing, while the second involves the singing of intervals and melodic patterns lower than that which the children are asked to match. The third problem is a wandering pitch; those children whose singing "bears little resemblance to the melody of the song being sung by the class" (p.28-30).

Roulston (1992), in her thesis regarding inaccurate singers in elementary schools, interviewed several music specialists as to their definition of the inaccurate singer.

Responses ranged from those students who have not yet discovered their singing voice, to those who sang too high or too low, to those who displayed only slight intonation problems (p.112).

Katalin Forrai, a former student of Zoltán Kodály, and a leading authority in the field of early childhood music education, claims that some children are upset by physically identical vibrations and this causes them to sing at a lower pitch. She identifies inaccurate singers as those who sing too high, too low, or too loudly (1988, p.46).

While the various researchers and music educators appear to label inaccurate singers differently, very similar behaviors and conditions are being described.

Who Sings Inaccurately?

Since 1954, the incidence of inaccurate singing in children ages seven to thirteen years of age, has been surveyed by several researchers. Bentley (1968) conducted a survey in 1954, and another one in 1957, with students from schools in the United Kingdom. Teachers were asked to identify those "pupils who consistently sing out of tune, on one note or on a few notes only" (p.68). Among 16,699 students, 18% of seven and eight year olds, 13.5% of eight to nine year olds, 11.5 % of nine to ten year olds, and 9% of ten to eleven year old children were classified as monotone singers. The survey responses of the incidence of monotone singers showed that most children who were monotone singers at seven or eight years of age, had 'grown out of' the condition by the time they were eleven or twelve years old (p. 56).

Duell and Anderson (1967) studied the pitch discrimination performance of one-hundred and sixty-eight first, second, and third grade students. The children listened to pure tones presented by a tape recorder and judged them as either the same or different. Results indicated that 30% of the students tested were unable to discriminate differences of a half-step, and 4% were unable to discriminate differences as large as a sixth. The researchers suggest that music teachers should concentrate on improving their students' pitch discriminating abilities before expecting them to accurately sing songs containing half-step intervals.

Gould (1968) sent questionnaires to 1,500 music teachers in the United States. The teachers were asked, " In your experience, what percentage of children at each grade level, on an average, have non-singing difficulties of some sort?" (1968a, Appendix B 1). From six hundred and two replies, 34.6% of first grade children, 24.2% of second grade children, 17.8% of third grade children, 12.9 % of fourth grade children, 11.8% of fifth grade children, and 11.0% of sixth grade children were considered to be "problem singers who cannot carry a tune". The total percentage of inaccurate singers over the six grades was 18.7% (1969, p.14).

The teachers classified the inaccurate singers as either a too low or too high singer, a one-note singer, the singer whose problems were a combination of all three of those just mentioned, and the psychologically inhibited singer. 62% of the teachers surveyed felt that all children can and do match certain pitches. 70% believed that all children can be helped to some extent, but expressed doubts as to how much can be accomplished with the difficult cases of non-singing. 29% believed that all children of normal abilities can be helped sufficiently so that they can participate successfully in classroom singing activities. Only 1% believed it impossible to help some children (1969, p.14).

Davis and Roberts (1975) conducted a survey in the Chester district of England with students from four to eighteen years of age. The music teachers were asked to classify the nature of the singing problems of their students into one of five types. Type One students were those who can correctly sing part, but not all of the melodic line. Type Two were those who could sing the melodic line correctly but at a lower pitch, and Type Three students sing the melodic line correctly at a higher pitch. Type Four singers do not follow the melodic line at all, and Type Five students, considered droners, or monotone singers, display little variation in pitch. From a total population sample of 14,301 students from fifty-one schools, the median incidence of poor pitch reported was 28%.

Inaccurate singing is therefore not an uncommon occurrence. It is interesting to note, however, that in each of the studies presented above, the number of reported inaccurate singers decreased with the age of the children.

Are Females More Pitch Accurate Than Males?

Conflicting research results have emerged as to whether gender influences accurate singing. Petzold (1963) completed a longitudinal study of three groups of grade one to grade three children covering a total period of four, five and six years respectively, and a series of one-year pilot studies dealing with melody, rhythm, timbre and harmony with grade one to six children. The individual testing required that the children give a singing response to an aural presentation of a test item. Results indicated that the gender differences appeared to be related to the task, with girls performing significantly better than boys on the tonal and timbre tests. No significant gender differences were found with the harmony or rhythm test results.

Pedersen and Pedersen (1970) conducted pitch discrimination and vocal pitch production tests with fifty-five sixth grade students. In the pitch discrimination test, participants were asked to identify whether the comparison stimulus was the same as or different from the standard stimulus. The vocal pitch production test measured the ability to produce vocally a pitch that had been sounded on a musical instrument. Results indicated no significant differences between the male and female students in their ability either to discriminate or to vocally produce single, interval, or sequence pitches.

Davies and Roberts (1975) conducted a survey with music teachers from the schools within a five mile radius of Chester College. The teachers were asked to classify every student as either a 'normal singer' or as a 'poor pitch singer'. 'Normal singers' were defined as "children who sing in tune within their vocal range or who make only occasional pitch errors", while 'poor pitch singers' were "children who sing badly out of tune even within their vocal range" (p. 24). From 7,315 male and 6,986 female students between the ages of four and eighteen, 36.6% of the males and 18.3% of the females were described as poor pitch singers (p.25).

Jordan-DeCarbo (1982) measured aural discrimination and singing to determine whether the sex of eighty-nine kindergarten students interacts with aural ability. A control and an experimental group were set up to determine the effect of a four-month preparatory musical training treatment. Results indicated that the scores of the girls were higher on both the aural perception and performance, leading to the conclusion that the girls benefited from the treatment training to a greater degree than did the boys.

Goetze (1985) conducted a study with one-hundred and sixty-five kindergarten, first, and third grade students from three schools. The children were taught two melodic phrases of equal length, intervallic content and direction, and were then recorded individually as they imitated one of the melodies in response to the investigator's voice. An analysis of scores obtained indicated that girls sang more accurately than boys, and that the difference was most pronounced in unison singing.

Smale (1987) tested ninety-three four and five year old children for pitch accuracy by having them echo sing phrases of various songs. The responses of the children were tape recorded and analyzed using a Visa-Pitch to extract the fundamental frequencies. A second judge and the investigator reevaluated the recordings. Results indicated that boys and girls of ages four and five are similar in vocal pitch accuracy.

Goetze and Horil (1989) tested one hundred students from nine kindergarten, first and third grade classrooms in Denver, Colorado. Equal representation from a variety of socio-economic levels, and ethnic and racial groups was attempted. The purpose of the study was to compare the effects of pitch accuracy for individual and group singing, and to determine whether these effects differ by grade level and gender. With respect to gender concerns, it was reported that girls sang at a more accurate pitch level than boys, the difference being more pronounced in group singing. It was also found that the difference between the individual and group responses of the boys was greater than that of the girls, leading the researchers to conclude that the boys were affected more by the presence of other voices than girls.

While the majority of researchers conclude that girls sing more accurately than boys, differing opinions exist as to the reason for this difference.

Why Do Some, And Not All, Children Sing Inaccurately?

The question of why some children sing inaccurately, and others do not, inevitably arises. Bentley (1968) conducted a survey in 1954, and another one in 1957, asking music teachers from schools in the United Kingdom for their evaluation of the pitch accuracy of their students' singing. From an analysis of the responses received, Bentley concluded that inaccurate singers are significantly deficient in pitch discrimination, as well as in tonal memory.

Gould (1969) surveyed six hundred and two teachers for reasons why their students sang inaccurately. Their opinions in order of prevalence, include inattention to pitch and failure to notice pitch changes, psychological inhibitions toward singing created by various environmental impacts, inability to coordinate the vocal mechanism with the pitches heard, the possession of a low speaking voice, a lack of interest in singing, a lack of practice in singing, and a lack of exposure to music at home (p. 14).

Sherbon ((1975) tested thirty music majors and thirty non-music majors to determine the association, if any, between hearing efficiency and performance on selected measures of musical behavior. Hearing efficiency was divided into acuity, diplacusis, and discrimination. Diplacusis is a condition where a given tone is heard as different pitches by the two ears. To measure musical behaviors, a battery of seven subtests were constructed from the standardized tests of Gordon, Gaston, and Seashore. No significant relationship was found between hearing acuity and diplacusis or discrimination, but a significant relationship was found between diplacusis and poor performance in pitch discrimination.

Porter (1977) investigated the effect of multiple discrimination training on vocal and instrumental pitch-matching behaviors, and on the aural music achievement test scores of eighty fourth and fifth grade uncertain singers. Multiple discrimination training ensures that the responses to a concept are controlled by the essential, not the irrelevant, characteristics of the concept. The experimental group was given concept instances in the form of five pitches, while the irrelevant characteristics of duration, timbre, and intensity were varied. Students in both the control and experimental groups were reinforced for successive approximations to the correct pitch.

Results indicated that the students in the experimental group who received the multiple discrimination training performed better on pitch matching tasks than did those students in the control group who were recipients of successive approximation only. These and other conclusions from the investigation such as the superior performance on the instrumental task, leads Porter to determine that there is no evidence to support the claim that faulty singing is the result of inaccurate pitch perception, and to suggest that pitch matching may be the result of inadequate vocal control (p.80).

Jean Ashworth Bartle, a musician, music educator, and author whose success with children's choirs has been recognized internationally, suggests nine factors that explain inaccurate singing of children. They include inexperience and lack of exposure to singing, psychological problems, immaturity, exposure to poor music models, underdeveloped auditory memory, lack of motivation and interest, cultural differences, inability to coordinate hearing, breathing and vocal production, and physiological reasons such as vocal nodes (1988, pp.13-14).

Aaron (1990) classified the causes of inaccurate singing into four categories. The first he calls environmental, and includes a lack of exposure to music, while the second he terms organic, as in retarded maturation, physical defects, and disease. His third cause is psychological, including poor tonal memory, poor pitch discrimination and lack of confidence. The fourth is poor vocal control, which involves poor breath support, straining the voice, a lack of kinesthetic awareness in the vocal mechanism, and the inability to shift into the upper register.

What is the Effect of Vocal Range and Tessitura?

It is logical to assume that children will be more accurate singers when they are singing within their natural range or tessitura. Most music researchers and educators have opinions as to where the comfortable singing range and the tessitura of children lie and how to best develop it.

Welch (1976) studied vocal range and poor pitch singing, determining a general research consensus that the child's vocal range increases with age, and that published music for children is more often than not, written at too high a pitch for children to sing accurately. Most authors cited by Welch seemed to agree on a primary age vocal range of an interval of a fifth or a sixth. Welch also reported research agreement that the vocal center of this range is the absolute pitch of middle C , C#, or D.

In a five year study of the development of the vocal range of children, Wassum (1979) tested elementary school children for range by recording them singing ascending and descending scales on a neutral syllable. Results indicated that the mean ranges progressed from the interval of a ninth in first grade to nearly two octaves in the sixth grade. At every grade level, greater then 50% of the students could sing within a range of an octave or more, and the number of students singing over a range of two octaves or more increased progressively from 9.7% in the first grade, to 52.2% in the second grade.

Joyner (cited in Welch, 1979) discovered that among students classified as 'monotones' by their teachers, there were a number who could sing tunefully in their natural range. The conclusion was that the problem was less with the students' lack of ability than it was with the teachers' ignorance of their comfortable singing ranges.

Apfelstadt (1982), in her review of the research findings and implications regarding the vocal range of children, summarized that the practical range of six year old children is from the absolute pitches of D and A, directly above middle C. She claims that unsuitable singing ranges can create vocal problems such as inaccurate pitch matching. Apfelstadt recommends starting with the limited vocal range of the students in order to avoid technical and attitudinal problems later on. Extreme tessituras should be avoided as to not cause vocal strain. Since range develops with age, and the potential range of children is quite wide, she recommends that vocal development be a sequential process, influenced both by growth and training (p. 31).

Apfelstadt (1988) suggests that there are three actions the child must do in order to sing correctly: hear the vocal example, accurately remember it , and then reproduce it. Apfelstadt advocates that the child's head voice be cultivated in order to increase their vocal range.

Brown (1988) as cited by Goetze et al. (1990) studied the effect of self-selected pitch and prescribed pitch with a model on children's vocal range (p. 21). She reports that children demonstrated a higher and wider vocal range when singing at a prescribed pitch level in the higher vocal register (p. 22). Brown cautions that the existence of the chest and head voices must be considered when assessing the findings of research in the vocal range of children.

Flowers and Dunne-Sousa (1989) in their study of vocal range and tonality in preschool children's singing, reported that children tended to modulate whenever a pitch moved beyond the child's physical or self-imposed vocal production limits. If the pitch was too low for the child, they tended to modulate due to physical limitations. If the pitch was higher than the child preferred, it appeared that the child chose to modulate, rather than to extend his or her voice. Following a modulation, the researchers discovered that the melodic contour of the song was usually accurate, however 'wandering' of the melody was an effect that was noticed. The researchers also reported that the children extended their range more when echoing pitch patterns, as compared to singing songs. They advocate the use of higher pitched echoing exercises to develop a wider singing range.

What Affects Accurate Pitch Reproduction?

Recent research regarding the factors affecting accurate pitch reproduction was classified by Goetz, Cooper and Brown (1990). Their categorization included the model the children were asked to match; the pitch, length, intervals, and direction of the singing task; the singing of the text versus a neutral syllable; group verses individual singing; and the inclusion of melodic and harmonic accompaniment (pp.22-27).

1. The Model:

Green (1989) investigated the effect of three vocal models on pitch matching accuracy of children in grades one through six. The models were a nine-year old child's unchanged voice, an adult female soprano voice, and an adult male tenor voice. Subjects were tested individually on the singing of a descending minor third interval. They were tested over three occasions, each time with a different model. Results indicated that the highest number of correct responses occurred when the child model was imitated. The female model scored second, with the lowest number of correct responses attributed to the male model.

Yarbrough, Green, Benson and Bowers (1991) conducted a study with kindergarten, grade one, two, three, seven and eight students to compare pitch matching accuracy with a male and a female voice model. Results indicated a significant difference between responses to the male versus the female with more correct responses to the female.

The male model may be presented in its falsetto or modal voice. Male falsetto singing is a slightly artificial technique whereby the vocal chords vibrate in a shorter length than usual to produce a high, distinct register. The male modal voice refers to the combined chest and head registers of the male singing voice. Philips (1992), Odem (1992), and Goetze et al. (1990) suggest that male teachers use their falsetto voice rather than their modal voice as a vocal model for children. Montgomery (1988), Price et al (1994), and Paul (1996) all reported significant findings that the male falsetto voice model produces more accurate singing than the male modal model.

To summarize, research regarding appropriate models for children's singing conclude that the child's voice, followed by the female voice, are the best models, and that children have difficulty reproducing sounds heard in a register other than that register in which their voices lie.

2. The Pitch, Length, Intervals, and Direction of the Singing Task:

Regarding the pitch, length, intervals and direction of the singing task, research suggests that children sing more accurately within a song context, as opposed to single tones. Jones (1971) discovered that subjects who could match particular pitches when presented within a pattern, were unable to match these same pitches when they were presented as single tones. Jones claims that the interval of a descending minor third is the easiest interval for children to sing, followed by ascending perfect fourths.

Findings by Young (1971) concur with those of Jones with respect to the descending minor third as the interval sung most accurately, followed by the ascending and descending perfect fifth, the ascending major third, and the descending minor sixth.

Sinor (1985) studied the relative difficulty of singing forty-eight melodic patterns. Three, four and five year old children were asked to repeat a four-note pattern. Results indicated that whole steps and thirds were not more accurately matched than were half steps, and that melodies moving stepwise and by thirds were sung more correctly than patterns containing sixth intervals. Congruent with other studies, Sinor found that the descending minor third was one of the easiest intervals for children to pitch match.

Flowers and Dunne-Sousa (1989) compared aspects of young children's singing on several tasks common in primary music classes. The ability to maintain a key center was discovered as a factor that affects the quality of a child's vocal performance. 47% of the children in their study were classified as modulating singers when singing a song of their own choice. With children from three to five years in age, maintaining tonality within a song and the ability to echo-sing pitch patterns appear to be separate skills.

Goetze, Cooper and Brown (1989) suggest that melodic patterns are more interesting for children to sing and thus may be more motivating than single tones. They concur with the majority of researchers who claim that descending intervals are sung with greater accuracy than ascending intervals.

3. The Singing of the Text Versus a Neutral Syllable:

With respect to the singing of the text versus a neutral syllable, Goetze (1985), in a study with kindergarten, grade one and grade three students found that subjects sing more accurately on a neutral syllable such as 'loo' than with the text.

These results conflict with those of Smale (1987), who tested ninety-three four and five year old children and concluded that the use of the neutral syllable 'loo' does not affect vocal accuracy of children from those age groups.

4. Group Versus Individual Singing:

Regarding group singing and individual singing, Goetze (1985), in a study involving one-hundred and sixty-five kindergarten, first and third grade singers from three schools, found that the children sang more accurately when singing individually than when singing in unison.

Smale (1987) tested ninety-three four and five year old children to determine whether they produce pitches as accurately when singing alone as they do when singing in unison with a female vocal model. An analysis of the data collected indicated that four and five year old children sing more accurately individually than when in unison with a female vocal model.

Goetze and Horii (1989) tested one hundred children from similarly matched kindergarten, and grade one and three classes. Results indicated that the pitch level and contour in children's singing was more accurate when they sang individually, rather than with a group. The researchers postulated that the presence of other voices results in 'faulty self-monitoring of the voice', that young children may be unable to attend to two stimuli at once and thus concentrate more on the other sounds, while not utilizing auditory feedback, and that young children may 'tune' to the inaccurate singing of other children within the group (p.70). The results of their study suggest that children may first demonstrate accurate individual singing, and then perhaps by the sixth grade, will be able to sing with equal accuracy or inaccuracy either individually or within a group situation.

5. The Inclusion of Melodic or Harmonic Accompaniment:

Singing with instrumental accompaniment is a common classroom practice. Petzold (1969) undertook a series of pilot studies of melody, rhythm, harmony and timbre with children from grades one to six. The harmony study showed that the children responded with greater accuracy when accompanied by a simple three-chord progression, compared to their response with a multichord progression.

Moog (1976) found that children up to the age of five are not auditorily aware of harmony. He suggests that music teachers avoid using the piano when teaching primary grades, as the amount of sound overwhelms the voices of young children.

Stauffer (1985) studied primary grade children's pitch accuracy when singing a cappella, or with melodic or harmonic accompaniment. Results indicated that when echo-singing melodic patterns, the children who received accompaniment training in the form of melodic replication sang more accurately than did those who were trained with no accompaniment. The children who were trained with simple harmonic accompaniments sang less accurately than did either the non-accompanied or the melodic replication groups.

Goetze et al (1990) postulate that if the pitch accuracy of children's singing is affected by the presence of one or more voices, than simultaneous harmonic accompaniment may also inhibit pitch accuracy. They also theorize that if the children's ability to monitor their voices is affected by the presence of other voices, then the presence of accompaniment may also inhibit monitoring.

Proposed Methods for Encouraging Pitch Accuracy:

Many methods have been suggested to help with the facilitation of pitch accuracy. Gordon (1971) states that "barring physical disability, anyone can learn to sing, just as anyone can learn to talk" (p. 93).

Gould (1968a) claims that for the children to sing in-tune, they must learn to hear, judge and control their own voices, and must experience unison singing. Gould describes a sequence of six 'concepts' a child should internalize in order to learn to sing:

1. the difference between the singing and speaking voice and related vocal skills,

2. the difference between high and low pitches and the vocal skill of controlling the pitch levels of the voice in speech and song,

3. the sound of a musical tone and the mental skill of translating a tone heard by the ear into a tonal image,

4. the melodic relationship and the mental skill of moving from one tonal image to another,

5. unison and the combined mental and motor skills of matching the vocal mechanism and the tonal image,

6. the vocal quality of the true singing voice and the combined mental and motor of producing and manipulating this singing voice with or without the mental-motor act of adding words (p.20).

From 1965 to 1968, Gould (1968a) conducted a study to investigate and assist with the inaccurate singing of children. Phase One of the study involved observation of the children and a review of the methods that experienced teachers had found helpful. Phase Two of the study was an eighteen week pilot study with grade one to three students in a laboratory school . The treatment was ten minutes of remedial speech to song procedures added to the experimental group's regular twice weekly music lessons. The remainder of the lesson was identical to that given to the control group. Analysis of pre and post-test scores showed an improvement in pitch accuracy for the experimental group.

The results of this investigation encouraged Gould (1969) to recommend a five step remedial procedure to be used with inaccurate singers. The first step involves speech activities, including learning to control various voice levels. Step two adds musical tones to speech activities, while step three involves the singers matching short melodic phrases and songs within their speaking range. At the fourth step, participants find their true singing voice by using very short echo patterns, and then entire songs sung on the neutral vowel sound of 'oo'. Step five involves the development of the transition from the neutral vowel sound to singing songs with text, and the sequential development of several vocal and aural skills (p.21-22).

Boudreau (1990) investigated the effectiveness of this remedial training with one-hundred grade one students. Both the control and experimental groups received thirty minute music lessons, three times a week for eight weeks. For the first fifteen minutes of the lessons, both groups received instruction from the Grade One music curriculum. For the remanding fifteen minutes, the experimental class received instruction with Gould's five step remedial procedure, while those in the control group classes sang additional songs that reinforced concepts from the curriculum.

Results from pre and post-test scores indicated that the students in the experimental group demonstrated significantly better single pitch echo singing, melodic pattern singing, and melodic perception than did the students from the control group.

Joyner (1969), in his study for remedial training for monotone singers, suggests that three abilities must be present for in-tune singing to occur. These include the ability to discriminate one pitch from another, the ability to recall successions of pitches organized into melodic patterns, and the presence of a voice capable of accurately reproducing the melody (pp. 117-118).

Joyner (1969) attempted a study to assist with the severe monotone problem observed in boys aged ten to eleven. The instruction consisted of individual sessions given for twenty minutes four times a week. The training lasted for fifteen weeks and began with vocal production exercises. The students were then taught to pitch the absolute note of middle C. As the instruction progressed, the student was asked to glissando up to the absolute pitch of D. In this manner the boys learned to sing from C to G, ascending and descending, and to imitate short melodies based upon these pitches. A normal legato replaced the glissando, and the vocal quality improved.

Jones (1971) conducted studies with the use of a vertically, and then a horizontally arranged keyboard (1979). The instruction was structured around six sequential steps for singing improvement developed by Myers. The steps include the discrimination between high and low pitches of extreme range, and then within the octave; the matching of a single pitch, and then two or three successive pitches; the singing of a short phrase and then two phrases or one longer phrase. The subjects were eight inaccurate grade two and three singers who received four hours of individual instruction over four weeks. Results showed significant improvement for the experimental group in the area of aural-vocal skills.

In 1979, Jones experimented with a horizontally arranged keyboard. Thirty-six grade two, three and four students classified as inaccurate singers, were given fifteen minutes of individual instruction daily for twelve days. Results showed that the vertical keyboard was more effective than the horizontal keyboard for facilitating accurate pitch reproduction.

Moss (1973) investigated the use of bone conduction hearing as an aid to improving out-of -tune singers. He defined bone conduction hearing as the aural perception that results from continued physical contact with a sound source that vibrates the bones of the head (p.3). An experimental group of fifty-six randomly selected grade three students and a control group consisting of forty-four randomly selected grade three students were given pre-testing, training, and post-testing.

The training was comprised of four thirty minute sessions showing the proper posture and good tone production habits to use when singing. The only differing feature of the training was that the children in the control group were given the starting pitches of the songs from a Clavietta played by the researcher, while the children in the experimental group had their ears covered and were instructed in the use of a pitch pipe, which supplied the starting tone through bone conduction.

An analysis of the results obtained indicated that the training both groups received resulted in general improvement in the pitch accuracy and tone quality of nearly all of the children. The total gain in improvement of students in the experimental group was nearly twice that of the students in the control group.

Davies and Roberts (1975) designed a remedial program for ninety inaccurate singers held over a period of eight weeks. The six, seven, and eight year old subjects had been rated by their school singing teachers as monotones, or droners. The students were randomly divided into three groups. One group received remedial training, consisting of two thirty minute sessions per week, and had practice in singing a note within their singing range. The traditional training group learned contemporary and traditional songs with piano, guitar and percussion accompaniment for the same time length. The control group received only the regular singing lessons of the school. Results showed a much greater improvement on the pitch production tests for the students involved with the remedial training group.

Dennis (1975) used remedial techniques involving pitch discrimination training. The reward of gradual improvements in responses, shown with a flashing light, was found to be more effective than rewarding only correct responses. Porter(1977) conducted a similar study with eighty grade four and five uncertain singers. Results indicated that multiple discrimination training, when added to successive approximation techniques, enabled uncertain singers to match pitches more accurately.

Richner (1976) studied eighty inaccurate singers from four schools. Classes in each school were randomly assigned to one of four treatment groups, which included both accurate and inaccurate singers. Group one was the control group who received the two regular music classes instructed by the classroom teacher. Group two participated in two music classes each week from a music specialist. Students in Group three were split into small pods of nine or ten children who received music instruction in group singing twice a week. Group four was also subdivided and their twice weekly sessions involved remedial vocal techniques. Results showed that the remedial vocal techniques had a significant positive effect on the pitch accuracy of students in Grade Five. There were no significant differences for the group in Grade Four, but the groups three and four in Grade Three showed significant improvement with respect to pitch accuracy.

Apfelstadt (1984) investigated the effects of instruction in melodic perception on the auditory discrimination of pitch and vocal accuracy. Subjects were sixty-one kindergarten students from three intact public school classes, one of which became the control group, the other two comprised the experimental groups. The first experimental class was given treatment one, which consisted of vocal instruction with attention to melodic perception through visual and kinesthetic reinforcement. The second experimental group was given treatment two, with instruction consisting primarily of imitation alone. Treatments were conceptually based as they sought to develop students' awareness of musical elements. The children in the control group were taught songs by rote without overt reference to musical elements.

After eleven hours of instruction delivered over eleven weeks, results showed no differences among groups on the pitch perception test; however, both experimental groups were significantly better than the control group on pitch pattern singing, and that the second experimental group showed significant gains over the first experimental group and the control group with respect to rote singing accuracy. The researcher concluded that melodic perception instruction did not significantly improve pitch discrimination of vocal accuracy on rote songs although it seemed to affect accuracy on pitch patterns.

Phillips (1984) investigated breath control training as a means by which singing could be improved among elementary school children. Forty-four second, third, and fourth grade students were randomly assigned to one of two groups. Each group met for thirty minutes, twice a week, for eighteen weeks. The experimental group was given training in breath management exercises emphasizing psychomotor techniques. The control group was taught using the traditional song approach, and received no instruction in breath management. The results indicated that group breath-control training has a significant effect in changing from chest to abdominal-diaphragmatic-costal breathing, and has a significant effect on the vocal pitch range, vocal intensity, and pitch accuracy of children's singing (pp.22-23).

Welch (1986) proposes that children learn to sing as they proceed through a developmental continuum of singing ability. His observations lead him to list this continuum as five stages:

1. The words of the song, rather then the melody appear to be the initial center of interest.
2. There is some variation in sung pitch which may occasionally coincide with the target.
3. A more active attempt is made to control vocal pitch by making the voice "jump" intervals toward the target.
4. Children are now able to make some fine tuning of pitches.
5. No major pitch or melodic errors (pp.299-300).

Welch (1985) refers to the "psychological literature on feedback which suggests that learning can only take place when a Knowledge of Results is present, and that a variety of experience, rather than repeated measures of the same kind may be more conducive to producing novel patterns of behavior. Applying these findings to the mechanism of singing, a schema theory of how children learn to sing is proposed, under which recall and recognition schema are hypothesized as being responsible for vocal pitch reproduction, and vocal pitch accuracy is determined by the efficiency of an error labeling schema" (p.3).

Aaron (1990) implemented a developmental sequence of vocal coordination activities with inaccurate fourth, fifth, and sixth grade singers. A test of vocal pitch accuracy designed by the author, was used to identify seventy-five inaccurate singers from one hundred and nine students tested. Subjects who scored greater than an average pitch error of one-third of a semitone, were classified as inaccurate singers. Seventy-one students were randomly assigned to the control and experimental groups.

Both groups received ten minutes of special instruction from the researcher within each of the regular twice weekly music lessons. Both experimental and control groups received instruction in rote vocalises, pitch shaping instruction, and song singing (p.109). The treatment given to the experimental group included vocal coordination instruction in the areas of general physical coordination, posture, breathing, phonation, resonant tone production, and instruction in gaining flexibility when crossing the register. Results indicated that vocal coordination instruction is an effective means for improving both the vocal pitch accuracy and the vocal pitch range of inaccurate singers (p.136).

Summary and Discussion:

1. Many music educators and researchers have attempted to define what constitutes an inaccurate singer. While varied labels are used to identify the same phenomena, all are concerned with the child who cannot sing properly. Most propose a hierarchical classification of inaccurate singers, from those who sing accurately, to those who use their speaking voice.

2. Many researchers have tried to determine the percentage of children who sing inaccurately. The range of percentages obtained from elementary school children appears to be from 9% to 22%. The role of maturation in the acquisition of singing skills is clearly implied in the research reviewed. The number of reported inaccurate singers appears to decrease with the age of the children.

3. With respect to gender concerns, conflicting research has emerged. The majority of studies reviewed indicate that females appear to match pitch more accurately then males. A variety of reasons have been hypothesized to explain this occurrence, including physiological and psychological explanations.

Petzold (1963), Pedersen and Pedersen (1970), and Smale (1988) found no significant differences with respect to the pitch accuracy of male and female children. The variety in the number of assessments and the subject's familiarity with the testing procedures may explain some of the diverging results.

4. The research involving reasons for inaccurate singing suggest particular characteristics of the student may be responsible, such as poor pitch perception and tonal memory, psychological and physiological problems, and lack of exposure to music at home.

5. Studies regarding the model the students are asked to imitate conclude that a child's voice, followed by a female voice, the male falsetto voice, and then the male modal voice provide the best models for accurate singing.

6. Research suggests that children sing more accurately within a song context, as opposed to single tones. Most researchers conclude that descending intervals are easier for children to accurately match, especially the interval of the falling third.

7. Regarding the singing of the melody with a text or a neutral syllable, conflicting research has emerged. Goetze (1985) found that singing with a neutral syllable is more accurate, while Smale (1988) did not find a significant difference. The age of the subjects, the criteria for the measurement of singing responses and the methods of assessing pitch accuracy often differ from study to study and may explain this discrepancy.

8. Most researchers agree that children sing more accurately individually, as compared to singing within a group.

9. The majority of researchers reported greater pitch accuracy when children sing a capella as opposed to with melodic or harmonic accompaniment. Stauffer (1986) reported opposite results. One reason for this divergence may be that different tasks are used for assessing pitch accuracy, such as single tones, scales, melodic patterns or entire songs.

10. A variety of methods have been proposed to assist with the facilitation of accurate pitch reproduction. It is a curious phenomena that almost any technique used caused some improvement in children's singing. Perhaps the activity of recognizing the problem, and focusing on the need for improvement, results in improved pitch accuracy.

The Role of the Brain in Processing Music:

Another approach to the problem of in tune singing may be to more directly examine the role the ear plays in receiving and processing the incoming sound the child is to reproduce. As the composition and production of music is a form of behavior, it is controlled by the central nervous system, the spinal chord and the brain. The outer top surface of the brain is covered by a layer of matter called the cerebral cortex, below which are the subcortical and brainstem structures. The cerebral cortex can be divided in half into what is known as the left and right hemispheres. These cerebral hemispheres are mirror images of each other, and each is composed of gyri (ridges) and sulci (valleys). Each hemisphere controls movement in the opposite side of the body due to a criss-crossing of the nerve fibers that lead to the spinal chord (Restak, 1984).

When sensory information from the ears, eyes, nose, tongue, and skin, reaches the two brain hemispheres, it is processed differently and for different purposes. Medical researchers have determined that the left hemisphere is specialized for symbolic representation, while the right hemisphere deals with representations that mirror a more direct reality (Restak, 1984). In addition to left-hand control, the right hemisphere is associated with music awareness, three-dimensional forms, art awareness, insight, and imagination. In addition to right-hand control, the left hemisphere is associated with spoken and written language, number and scientific skills, and reasoning (Restak, 1984).

A common method of determining cerebral hemispheric role in hearing is through the use of dichotic listening tasks. The subject wears a set of headphones, through which he or she hears two conflicting melodies, one through each ear. The subject then listens to each of these same melodies again, this time presented individually, as well as two other new melodies. The subject is asked to identify which one or ones he or she heard previously. If the melody that was heard in the left ear is recognized, it is concluded that the right hemisphere is dominant in processing the two conflicting melodies. If the melody that was heard in the right ear is recognized, the conclusion is that the left ear is dominant in processing the two melodies. It has also been hypothesized that the pathways from one ear to the opposite hemisphere are stronger then the pathways from an ear to the hemisphere on the same side (Kimura 1961, Robinson & Soloman, 1974).

A study conducted by Blumstein, Goodglass, and Tartter (1975) investigated the test re-test reliability of dichotic listening performance on consonants, vowels, and music. Forty-two right-handed adult subjects were tested. The results of the study indicate that the distribution of subjects as either left or right ear dominant is not random. Subjects tend to remain in the same category of ear superiority on re-test, and this stability was most striking in the case of music.

Bartholomeus (1974) attempted to determine whether laterality effects in audition are determined solely by stimulus variables, or whether relative ear superiority is also related to task differences. A series of dichotic trials was presented three times to each of seven adult male, and five adult female subjects. Each trial involved two different sequences of randomly chosen letters of the alphabet excluding the vowels and the letter W. The letters were sung to two different melodies by two different singers. The required tasks were melody, letter, and singer recognition. Results indicated no significant difference between ears in recognition of sung voices, but significant right ear superiority for letter sequence recognition and significant left ear superiority for melody recognition.

As the same acoustical stimuli were presented to the same subjects on all tasks, Bartholomeus concluded that laterality effects in audition are not solely determined by stimulus characteristics but are also dependent on task requirements.

A study by Bryden (1963) suggests that the auditory system is better organized for the perception of verbal material presented to the right ear. In a dichotic listening experiment, thirty-two college students identified numbers presented to the right ear more accurately than numbers presented to the left ear, and preferred to report the material from the right ear first. When three or four digits were presented to each ear, most subjects identified material from the right ear more accurately than material from the left ear. This difference was not observed when five digits were presented to each ear.

Kimura (1964) studied the differences in the way the left and the right brain perceived melodies. Twenty female right-handed nurses and student nurses were given two auditory tests presented dichotically. On the Melodies test, the score for the left ear was significantly superior than the score for the right ear, with the opposite results incurred for the Digits test. The researcher concluded that the right temporal lobe plays a greater role in the perception of melodies than does the left temporal lobe. The researcher cautions however that it does not necessarily follow that the right hemisphere is dominant for all musical functions, for both Milner's study (1962) and Kimura (1964) have emphasized the perceptual aspects of musical ability (p. 357).

Curry (1967) compared the results of twenty-five left-handed and twenty-five right handed subjects on verbal and non-verbal dichotic listening tasks. The results are from comparisons made between mean scores obtained at the right and left ears, as well as between the handedness groups. The mean right ear score was higher than the mean left ear score for both groups on both of the verbal dichotic tasks. The mean left ear score was higher than the mean right ear score for both groups on the non-verbal dichotic task. This between ears difference was statistically significant for the right handed group only (p. 351).

Bakker (1967) investigated children's left and right ear differences in auditory perception. Sixty boys and sixty girls between six and twelve years of age were presented with a series of digits and Morse-like sound patterns to each ear individually. Results indicated that the retention of sound patterns was significantly better when they were presented to the left ear than when they were presented to the right ear. The retention of digits was not significantly better with the right ear than with the left. With the reproduction of sound patterns, fifty-nine children obtained better results with the left ear, and thirty-eight children obtained better results with the right ear. A significant difference between the results of boys and girls was not found.

Molfese, Freeman, and Palermo (1974) recorded auditory evoked responses from the temporal region of the right and the left hemispheres of babies, children, and adults. Two adult male speech syllables and two mechanically produced sounds provided the stimuli for the study. Electrodes were placed over the temporal regions of both hemispheres at the areas found to be important for speech reception, and linked reference electrodes were placed on each ear lobe.

Results indicated that left hemisphere auditory responses were larger in amplitude than right hemisphere auditory evoked responses to speech stimuli for all age groups. The non-speech stimuli produced larger amplitude auditory evoked responses in the right hemisphere. Lateral differences in both types of stimuli were found to decrease with age.

In a study conducted by Bloomstein and Cooper (1974), two dichotic experiments investigated the lateralization of intonation contours. In the first experiment, intonation contours that had been filtered from real speech exemplars of four English sentence types yielded a significant left ear advantage when subjects were given a perceptual matching task. A left ear advantage was also reported when the subjects had to identify the same stimuli by their English sentence types.

In the second experiment, non-filtered versions of four intonation contours superimposed on a nonsense syllable medium, as well as their filtered equivalents, were presented to subjects, again in a matching task. For both sets of stimuli, a left ear advantage was obtained. It was therefore concluded that neither the requirements of a linguistic response, nor the presence of a phonetic medium succeeded in altering the left ear advantages obtained in the perceptual matching tests. Results from the two experiments suggest that the right hemisphere is directly involved in the perception of intonation contours.

Borod and Goodglass (1980), used dichotic listening test to examine the effect of hemispheric specialization for verbal and melodic materials. One hundred and two right-handed males between twenty-four and seventy-nine were tested on two occasions. While the overall accuracy declined with the increasing age of the subjects, there was no interaction between age and the degree of right ear advantage for verbal material and left ear advantage for melodies. No change with age was observed in test-retest stability.

King and Kimura (1982) investigated left ear superiority in the dichotic perception of vocal nonverbal sounds. Hummed melodic patterns and vocal non-speech sounds such as laughing and crying were presented dichotically to forty-eight right-handed college students. In both cases a significant left-ear superiority was found. The researchers concluded that the voice quality does not independently engage left or right hemisphere processes since verbal and non-verbal vocal stimuli may be processed in different hemispheres.

Bryden, Ley, and Sugarman (1982) investigated ear advantage in identifying the emotional quality of tonal sequences. Tonal sequences differing in emotional quality were presented dichotically. Results indicated that accuracy was better for identifying the emotional tone of stimuli presented to the left ear. The left ear advantage was greatest when the target and competing stimuli were of a different affect.

Many researchers have investigated the perception of rhythmic sequences. Results from a study by Robinson and Solomon (1974) suggest that rhythm patterns, unlike other non-speech auditory stimuli, are processed more accurately by the same hemisphere that is dominant for the speech stimuli. Twenty-four subjects listened to thirty dichotic pairs of rhythmic pure tone patterns. Patterns were recognized more accurately in the right ear significantly more often than when presented to the left ear.

Natale (1977) tested two groups of right-handed young adults on a series of handed measures and dichotic nonverbal rhythmic sequences. Cross-validated multiple regression analysis revealed that all of the cerebral-laterization/ manual praxis measures were positively related to the degree of left-hemisphere perceptual asymmetry for nonverbal rhythms. Seventeen of the fifty-two subjects revealed significant left-hemisphere laterality coefficients for the dichotic stimuli. More complex rhythms elicited greater left-hemisphere perceptual preference.

Gregory, Harriman, and Roberts (1986) tested for cerebral dominance in the perception of rhythm. Five right-handed subjects listened to stimuli presented alternately to each ear. A significant difference resulted with the stimulus to the right ear being delayed in the experimental condition relative to the stimulus presented to the left ear. The researchers interpret this as an indication of right cerebral hemisphere involvement in rhythmic stimuli perception.

Doehring (1972) tested ear symmetry in the discrimination of monaural tonal sequences. Six subjects completed twenty-four series of six practice and thirty-six test trials. Eighteen test trials were presented to each ear. Each series consisted of one type of discrimination by one task at one level of test tone. There were twelve series for frequency and twelve for intensity discrimination. Results indicated that left ear accuracy was significantly greater for intensity discrimination, but there was no significant difference between ears for frequency discrimination.

Haydon and Spellacy (1973) examined the effect of manipulating the subject expectation to monotic and diotic sounds, and the effects of verbalization on the response efficiency. The subjects were forty-eight right-handed young women of normal hearing. Results indicated that when the subjects were uncertain as to the site of the stimulation, they showed a right ear superiority for both speech and pure tone sounds. When language encoding is required, the ear preference remains the same but the efficiency of the speed of the response is reduced. The researchers concluded that a right ear advantage is present in auditory signal detection due to attentional processes rather than to language dominance.

Rushford-Murray (1977) investigated left-right ear differences in the processing of instrument tone segments. "Segments of music possessing an acoustical similarity to the verbal stimuli were labeled as the attack transient, the steady state, and the legato transient of an instrumental tone segment. The attack transient was defined as the beginning of an instrumental tone sound containing both the repetitive signal and the noise characteristics of the initial attack. The steady state was defined as that segment after the attack transient during which the sound remains relatively stable. The legato transient was defined as the segment in which the sound changes, but in which no new attack is initiated. During the time of the legato transient, the instrument is producing not a repetitive signal but a noise complex characteristic of the instrument. Using these instrument tone segments as stimuli, the purpose of the study was to test for left-right hemispheric asymmetries in the processing of specific segments of musical instrument tones presented for the purpose of instrument identification" (p. 2).

Results indicated that legato transients are identified more correctly when presented to the right ear, that attack transients are identified more correctly when presented to the left ear, and that steady states are identified equally well regardless of ear presentation (p. 5).

Various researchers have conducted studies that involved musically experienced subjects. Gordon (1970) studied twenty right-handed male college students of above average intelligence who were members of performing musical organizations. A melodies, digits, and chords test as well as the Harris Test of Lateral Dominance were administered to the participants on an individual basis. The left ear showed a significant superiority over the right ear in recognizing chords, while the mean score for the Melodies Test were nearly the same, with a slight favoring of the left ear indicating a lack of superiority for either ear. The Digits Test showed a higher mean score for the right ear, but failed to be statistically significant.

Goodglass and Calderon (1976) studied parallel processing of verbal and musical stimuli in the right and left hemispheres with sixteen trained musicians. Dichotic listening tests resulted in the conclusion that the right ear is superior for verbal stimuli, and the left ear is superior for tonal stimuli.

Bever and Chiarello (1974) investigated the difference in ear dominance with musically experienced listeners as compared to naïve music listeners. They claim that most of the differences between naïve and experienced listeners can be attributed to the superior performance of the right ear in experienced listeners since performance in the left ear does not differ significantly between the two groups of subjects.

The researchers "found that musically sophisticated listeners could accurately recognize isolated excerpts from a tone sequence, whereas musically naïve listeners could not. However, musically naïve people could accurately recognize the entire tone sequences, and did so better when the stimuli were presented in the left ear; musically experienced people recognized the entire sequence better in the right ear. This is the first demonstration of the superiority of the right ear for music and shows that it depends on the listener's being experienced; it explains the previously reported superiority of the left ear as being due to the use of musically naïve subjects, who treat simple melodies as unanalyzed wholes. It is also the first report of ear difference for melodies with monaural stimulation" (p.538).

The researchers concluded that it is the kind of processing applied to a music stimulus that can determine which hemisphere is dominant, and therefore music perception is now consistent with the generalization that the left hemisphere is specialized for internal stimulus analysis and the right hemisphere for holistic processing (p.539).

A study by Bever and Chiarello (1974) compared the response time for music excerpt recognition in boys who sang in a choir with those who did not. The twenty singers were members of the choir of the Cathedral of Saint John the Divine in New York City. The choir is of professional quality, and the boys sing and rehearse approximately fourteen hours a week. The non-choir boys were from the same school and were of the same age and grade as the choir boys. In this study, accuracy did not differ by ear, however, response times were faster in the right ear than in the left for the boys in the choir, and this right ear superiority increased progressively with experience in the choir.

Another study indicated that ear dominance for pitch information was unaffected by linguistic or musical experience (Yund & Efron, 1976). It has been hypothesized that laterality effects in audition are due not only to the sound being verbal or nonverbal, but also by the task required of the subjects (Bartholomeus, 1974).

Auditory research has also been done with subjects who had one hemisphere surgically removed. In one study, patients with their right temporal lobes removed were significantly inferior in dichotic melody recognition compared to those who had had a left temporal labectomy (Shankweiler, 1966).

Another study found patients with left temporal lobotomies to hav

scores then those with right temporal lobotomies on some tests of [redacted]

Musical Abilities. The scores most affected were those for the timb

tests, followed by loudness and time (Gordon, 1974; Milner, 1962)

that the removal of the right hemisphere eliminates the ability to sin

the speaking voice (Gott,1973).

Kimura (1961) studied the effects of temporal-lobe damage on audi

Numbers were presented to the two ears of the seventy-one patient

in pairs, or in rapid succession. After each group of six numbers, th [redacted]

repeat all the numbers he or she had heard. Damage to the left tem [redacted]

to impair over-all performance on this task, irrespective of the ear p

stimuli. A unilateral temporal lobectomy on either side of the brain

recognition of material arriving at the ear contralateral to the remov

interpreted to suggest that both temporal lobes take part in the elab

the auditory receiving area of the same side, and that the left tempo

important in the perception of verbal material.

Shankweiler (1966) studied the effects of temporal-lobe damage on

dichotically presented melodies. The subjects were forty-five patient

whom had left epileptogenic temporal-lobe lesions, and twenty-four

epileptogenic temporal-lobe lesions. The melodies were eighty one

instrumental chamber music divided into twenty sets of four. Two o [redacted] were first heard dicotically, followed by the four melodies heard in succession. The subjects were asked to indicate which of the four melodies they had previously heard.

The digits test involved pairs of numbers from one to nine presented to the two ears so that a different number arrived at each ear at a different time. The subjects were asked to repeat the numbers heard at both ears. Those subjects with a right temporal lobe lobectomy experienced difficulty perceiving the dichotically presented melodies. The subjects with left temporal lobe lobectomies had difficulty perceiving the dichotically presented numbers.

It is possible to functionally depress one hemisphere with the drug sodium amobarbital. When the right hemisphere is treated with the drug via the carotid artery, songs were sung in a monotone; however, the rhythm was unaffected. When the left hemisphere is treated with the drug, both singing and speaking are lost, and singing was regained more quickly than speech (Bogen & Gordon, 1971; Gordon, 1974).

Gott (1973) investigated lateral specialization of the hemispheres by evaluating the cognitive abilities of three patients with hemispherectomy performed for noninfantile disease. Two had the right and one had the left hemisphere removed. Results indicate that after right hemispherectomy in the mature brain, the left hemisphere remains more proficient in verbal than nonverbal functions. In the developing younger brain, less difference exists between abilities in verbal and nonverbal functions, and the level of performance is in general lower than in the adult case, regardless of which hemisphere was removed. Removal of either hemisphere impaired memory functions, with the left hemisphere removal producing the greater deficit.

Sparks, Helm and Albert (1974) studied a form of language therapy for aphasia called Melodic Intonation Therapy. The program involves sung intonation of prepositional sentences in such a way that the intoned pattern is similar to the natural prosodic pattern of the sentence when it is spoken. Subjects were eight severely impaired right handed aphasic patients with left hemisphere damage Six of the eight subjects recovered some appropriate prepositional language due to the Melodic Intonation Therapy. The researchers suggest that both dominance for music and existence of less developed language areas in the right hemisphere are being used to support the damaged left hemisphere which continues to be language dominant.

Brookshire (1975) investigated the recognition of auditory sequences by non-brain-damaged subjects, subjects with right hemisphere damage, and left hemisphere damaged subjects. The test involved the reporting of whether one, two, or four pure tone melodies were the same or different in pitch. As predicted, brain-damaged subjects performed less well than non-brain-damaged subjects. Subjects with right hemisphere damage performed progressively less well as the number of tones within the melody increased. Non-brain-damaged and left hemisphere damaged subjects more accurately reported four tone melodies than two tone melodies.

Alfred A. Tomatis, a hearing specialist, whose work is widely known and respected, has worked extensively with professional singers. Tomatis has developed a specific technique involving the right ear which appears to have been successful in aiding accurate pitch reproduction. Tomatis' theory states that pitch reproduction is primarily dependent upon accurate hearing. He further hypothesizes that due to the position of the heart on the left side of our bodies, the left recurrent nerve connecting the brain to the larynx has to make a detour in its path, whereas the right nerve follows a much more direct and shorter path. (Mandaule, 1994). This leads Tomatis to believe that the right ear processes incoming auditory information faster than the left ear. The question remains as to whether a procedure based upon his hypothesis would be effective with children, and is statistically reliable.

Summary and Discussion:

1. The distribution of subjects as either left or right ear dominant in dichotic tasks is not random. Subjects tend to remain in the same category of ear superiority on test re-test. This stability was most striking in studies involving music.

2. Regarding melody recognition with right-handed subjects, the right hemisphere (left ear), is dominant.

13. With studies involving patients with right or left hemispheric damage, those with left temporal lobe damage had difficulty with verbal stimuli responses, and those with right hemispheric damage had difficulty perceiving non-verbal, or musical stimuli.

Conclusion:

Considerable evidence identifies the left ear as the ear most closely related to processing melody. The researcher was unable to locate any studies in which a left ear teaching approach has been utilized in an attempt to improve pitch perception and reproduction. It is that which the research in this thesis attempts to address.

CHAPTER THREE: HYPOTHESIS AND DESIGN METHODOLOGY

A formalized experiment to quantitatively measure the role of the right ear in accurate pitch matching was implemented by this researcher in 1997. The hypothesis was that soft singing into the right ear of a child will assist the child to more accurately reproduce pitches.

The participants were forty-nine students from a Grade Four and a Grade Three/ Four class at an Elementary/Junior High School in the northwest area of Calgary, Alberta, Canada. According to preliminary discussions with the two classroom teachers, and the two teachers from the previous year who created the class distribution, the Grade Three and Three/Four classes were similar in ethnic background, academic achievement, attitude to music instruction, social skills, and self-esteem. The students were allocated to the two classes in order to create two similar groups with respect to academic achievement, work habits, maturity, and personality type. As the assignment of the students into their classes was not random, the present design is quasi-experimental.

During the three years preceding this study, the school had been participating in a practicum program with the music education faculty of the University of Calgary. Graduate and undergraduate students observed professors teaching a highly structured music program, and then were given their own class to instruct under the supervision of the professors. Therefore, most of the children who participated in this study had been exposed to a very similar, highly sequential and structured music program.

The researcher continued with this type of instruction during the eight weeks of the study. The Grade Four and Three/Four classes were given music lessons twice a week for the eight weeks. As this study was quantitative in nature, an experimental and control group were required. One of the two classes chosen for this study was randomly assigned to be the experimental group. This class is hereafter referred to as "Class A", and the other class is referred to as "Class B".

The researcher met with Class A from 9:00 to 9:30 a.m. on Mondays and Wednesdays, and Class B from 9:35 to 10:05 on the same Mondays and Wednesdays. The students discovered musical concepts through unaccompanied singing, modeled by the teacher-researcher. A phrase by phrase approach was utilized in the teaching of new songs, often with demonstrated Curwen hand signs to reinforce pitch. The repertoire of songs used in the lessons consisted of game songs, folksongs, and simple rounds and canons in both major and minor keys. A sample lesson plan is given in Appendix B.

Prior to the first singing lesson, the researcher reviewed the repertoire of songs the students had been taught that school year, and then met with each class as a group to sing these songs as a review. From approximately forty songs, the researcher decided upon Chairs to Mend and Land of the Silver Birch as the best known, most enjoyed, and therefore most suitable songs for use in the pre and post-tests.

The researcher consulted experienced music professor Jeanette Panagapka as to the song choices, and it was agreed that they were appropriate choices due to the following reasons:

1. Both songs can be sung in the key of D, Chairs to Mend in the major, and Land of the Silver Birch in the minor. The difference in mode provided a contrast for evaluation. The range of each song lies within the easy tessature of children. Chairs to Mend has a range of A to B', and Land of the Silver Birch has a range from D to D'.

2. The song Chairs to Mend consists of perfect fourths, and major and minor seconds. The song Land of the Silver Birch is comprised of perfect fourths and fifths, major seconds, and major and minor thirds. These intervals, common in folk music, provided an effective means for evaluation.

3. Both songs were short enough to be easily sung from memory, thereby eliminating the necessity for a songbook.

4. Chairs to Mend begins with a falling melodic line, while Land of the Silver Birch starts with a rising perfect fifth interval, thereby providing a contrast for evaluation.

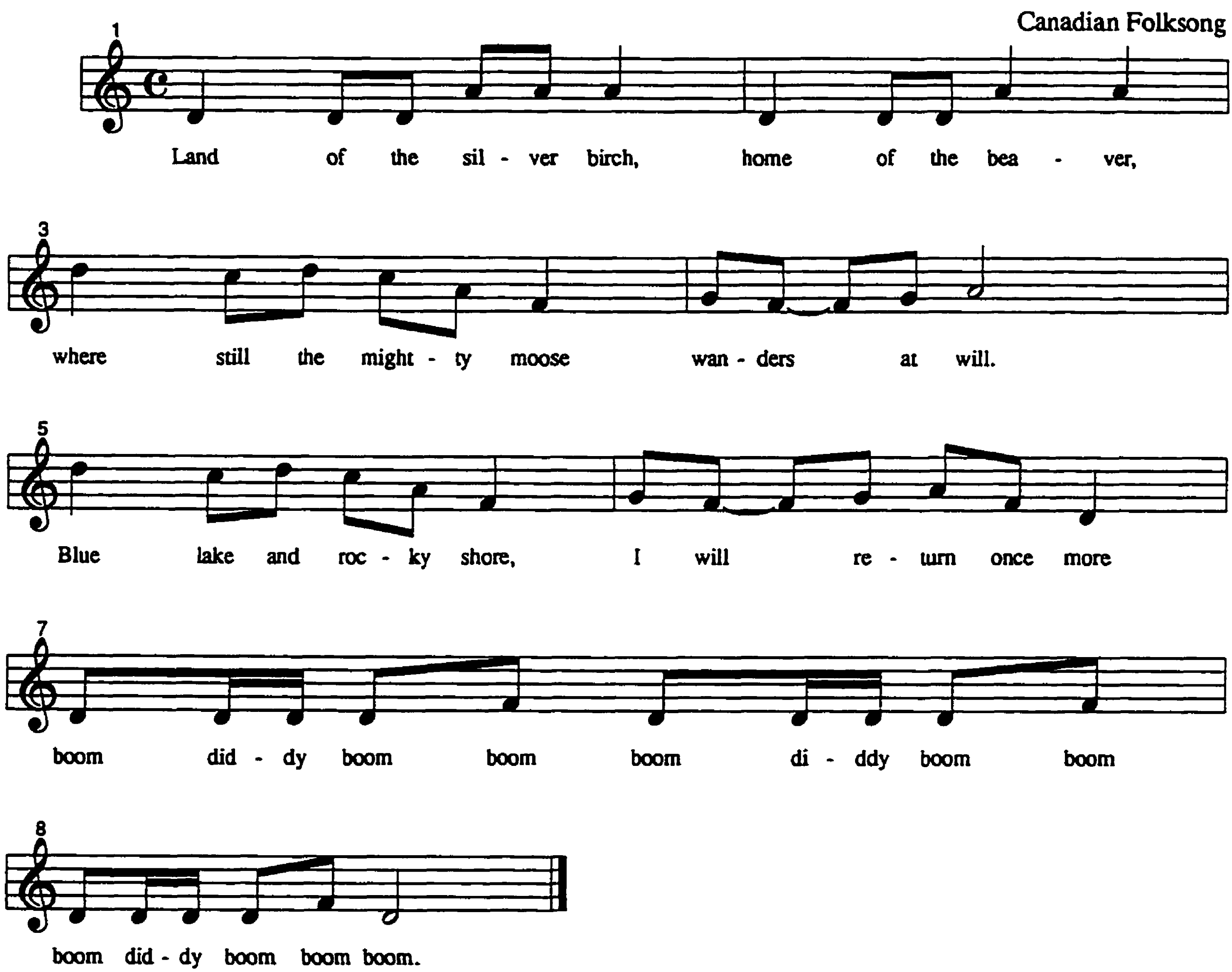
5. The tempo of both songs is moderate.

6. Rhythmically, neither song presented an unrealistic challenge for the students.

Figure I and Figure 2 are the two songs used in the pre and post-tests.

Figure 1: Song Used in Testing: Chairs to Mend

Figure 2: Song Used in Testing: Land of the Silver Birch



After one thirty minute class of familiar song review, including the singing of Chairs to Mend and Land of the Silver Birch, the researcher tape recorded each participant individually singing each of the above mentioned songs. At this private interview session, each participant was asked to sign his or her name beside a number from one to thirty-two on a class list. They were asked to listen to the starting pitch given by the researcher, and then to sing the song, beginning on the given pitch. The participant's class and chosen number was entered into an ECM 909 Sony stereo microphone wired to a Toshiba DB55 portable tape recorder. The researcher then used a tuning fork to establish the absolute pitch of A, and hummed the starting pitch of the song for each individual child. After the child sang Chairs to Mend once, the researcher established the absolute pitch A from the tuning fork. The researcher then hummed a perfect fifth interval lower, the absolute pitch of D, for each individual child. The child then sang Land of the Silver Birch, which was recorded as well.

The students then participated in the eight weeks of identical twice weekly music lessons taught by the researcher. The only variable manipulated within the singing lessons was the treatment given to the subjects in the experimental group (Class A). The treatment consisted of the researcher singing softly in-tune into the right ear of each of the students two times during the music lesson. This treatment was given when the students were echoing a phrase of a song modeled by the teacher-researcher. The students were standing by their desks which were placed in rows. The teacher-researcher walked up and down the rows and randomly stopped by the right ear of each student in order to deliver the treatment while the student was singing. The soft in-tune singing of the teacher-researcher into the right ear of the students was the only differentiating feature in the lessons.

After the sixteen music lessons were taught, the children were once again tape recorded singing the songs Chair to Mend and Land of the Silver Birch. This recording is hereafter labeled as the post-test. The procedure used was identical to that of the first recording, hereafter referred to as the pre-test.

Upon completion of the post-test recordings, copies of the cassette tape and rating guidelines package were given to four music educators who were to rate each participant's performance for accuracy of singing. The rating guidelines were as follows:

Table 1: Rating Guidelines

1 A score of 1 indicates the accurate matching of all pitches in the song without hesitation.

2 A score of 2 indicates that the student slides into one or more of the pitches in the song, but eventually sings all accurately.

3 A score of 3 indicates an exact transposition of the song.

4 A score of 4 indicates that the student maintains the general contour of the song, but sings incorrect intervals.

5 A score of 5 indicates that the student maintains the general direction of the song, but not the exact contour.

6 A score of 6 is given for responses which ignore the contour of the song.

7 A score of 7 is given when the student responds with a speaking voice rather then a singing voice, or does not respond at all.

NOTE: For the purposes of data analysis and graphical presentation, these scores were reversed so that the higher number indicated a better performance.

The four evaluators, one of whom was this researcher, were all University educated, certified, experienced music educators respected by their peers. All have had extensive experience teaching both children and adults, and are accomplished musicians in their own right. Two of the evaluators are University professors, one was the music consultant with the Calgary Catholic School Board, and the other was a music specialist with the same board. To ensure rater objectivity, the participants in the study were referred to by number only, no names were ever used. A Cronbach Alpha test was used to ensure rater reliability, the results of which are presented in Chapter Four. The raw scores of the evaluators are shown in Appendix C.

The applicability of the results of this study are limited to the particular site and setting described herein. Findings in future studies are generalizable only to the extent that they overlap with the present design. The only independent variable was the treatment given to the subjects in the experimental group. While different socio-economic levels, ethnic origins, gender, home environments, and aptitudes are bound to exist in any population of children including the one used in this research, their effects on pitch accuracy were not studied. Only pitch accuracy was considered in this research; no attention was given to rhythmic accuracy, vocal quality, tempo, text, diction, or expressiveness. Human raters were used, and although it is acknowledged that people cannot judge the frequency of individual pitches with the precision of a machine, they were preferred here for their ability to determine pitch accuracy within a song context. It was assumed that the advantages of this holistic, musical approach would produce more trustworthy results.

As this research involved human subjects, written permission from the school board, the principal, the two teachers involved, and the parents or guardians of the subjects was obtained. Approval to conduct this study was granted from the University of Calgary, and the Calgary Catholic School Board. A copy of the letter of consent may be found in Appendix A.

CHAPTER FOUR: INFERENTIAL STATISTICS

Inferential statistics were used in this study in order to determine the likelihood that the results based on the sample group are the same results that would have been obtained for an entire population.

The mean of the pre and post-tests was computed first to determine the arithmetic average of the set of scores obtained for the two songs used in testing. The standard deviation was then computed in order to find the most stable measure of variability which took into account each and every score in a distribution.

An Analysis of Covariance (ANCOVA) was performed to determine whether the groups were significantly different at the post-test which occurred after the lessons were given. An ANCOVA was used because it analyzes the different variance between groups to see if these differences were meaningful. The ANCOVA also allows one to control the effect on influence of the different initial starting abilities. In this analysis, the starting ability was treated as the covariance. The ANCOVA removed the effect of the covariance, and then tested if there was a significant difference in the post-test.

To identify more clearly how much of the variance in the post-test was explained by the pre-test and treatment, a multiple regression was conducted. The results indicated that of the 65% variance in the post-test scores explained by that model, 61% could be attributed to the covariate pre-test, and the treatment was responsible for 3.5%.

Inter-rater reliability was determined by using the Cronbach Alpha test. This is the general formula for estimating internal consistency based on a determination of how all items on a test relate to all other items and to the total test. For the pre and post-tests for both songs the Cronbach Alpha score was greater then .95 indicating very high inter-rater reliability.

The means and standard deviations for the pre and post-test results of Class A and Class B singing the song Chairs to Mend are presented in Table 2.

Table 2: Means and Standard Deviations for the Pre and Post-tests of Chairs to Mend.

	CLASS A (TREATMENT GROUP)		CLASS B (CONTROL GROUP)	
	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
PRE-TEST	4.75	1.58	3.44	1.97
POST-TEST	5.26	1.23	3.84	1.61

An examination of the table shows that Class A improved from an average score of 4.75 for the pre-test, to a mean of 5.26 for the post-test of the song Chairs to Mend. Class B also showed improvement with this song, the mean for the pre-test being 3.44, and for post-test 3.84. Therefore the participants of both classes showed improved pitch accuracy from the pre and post-test of the song Chairs to Mend. Class A, which was given the treatment, demonstrated a greater improvement than Class B, who were the control group.

The means and standard deviations for the pre and post-test results of Class A and Class B singing Land of the Silver Birch are presented in Table 3.

Table 3: Means and Standard Deviations for the Pre and Post-tests of Land of the Silver Birch

	CLASS A (TREATMENT GROUP)		CLASS B (CONTROL GROUP)	
	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
PRE-TEST	3.91	1.53	2.63	1.97
POST-TEST	4.31	1.21	2.95	.95

An examination of the table shows that Class A improved from the pre-test to the post-test, as shown by respective means of 3.91, and 4.31. Class B also improved, the means being 2.63 for the pre-test, and 2.95 for the post-test. Once again, both classes improved in pitch accuracy from the pre to the post- test, however Class A, who received the treatment, showed greater improvement over Class B which was the control group. Figure 3 and Figure 4 provide a graphical representation of the pre and post- test means for the songs Chairs to Mend and Land of the Silver Birch.

FIGURE 3: Graph of Pre and Post-test Means for Chairs to Mend

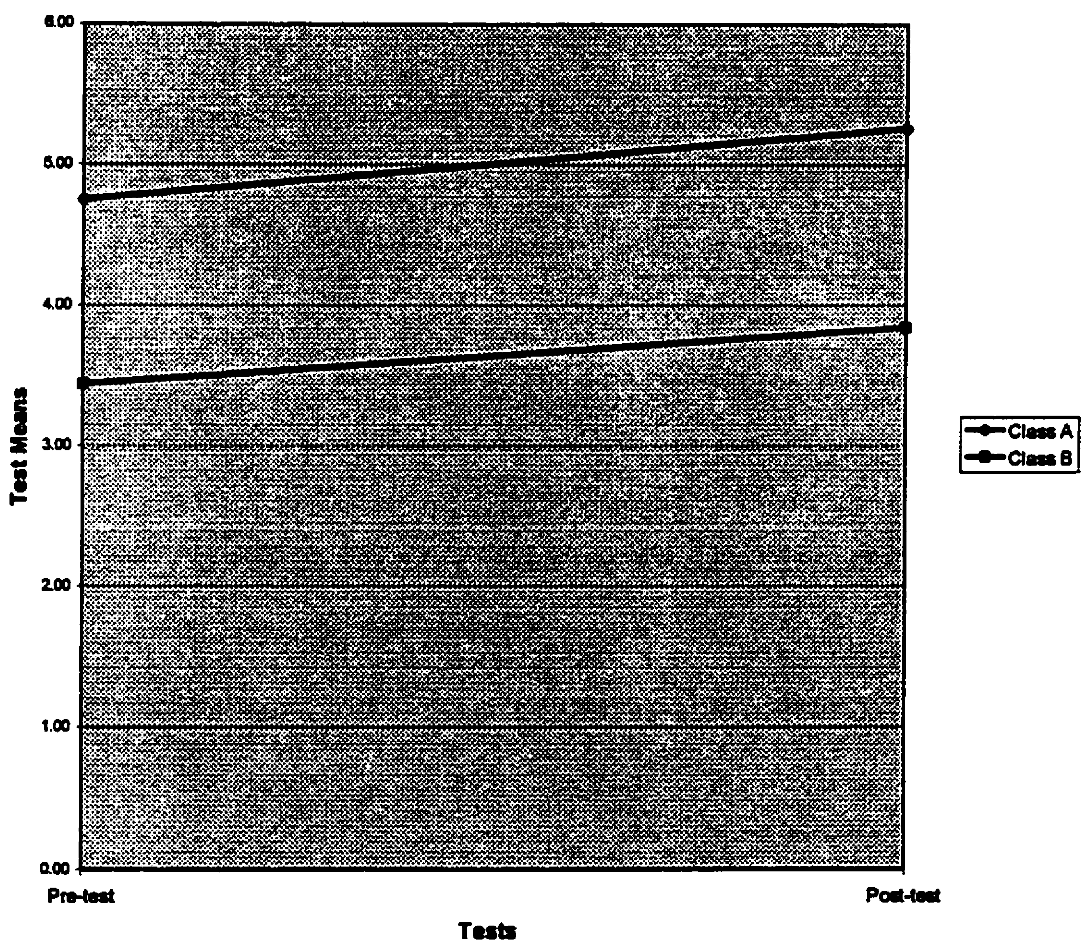
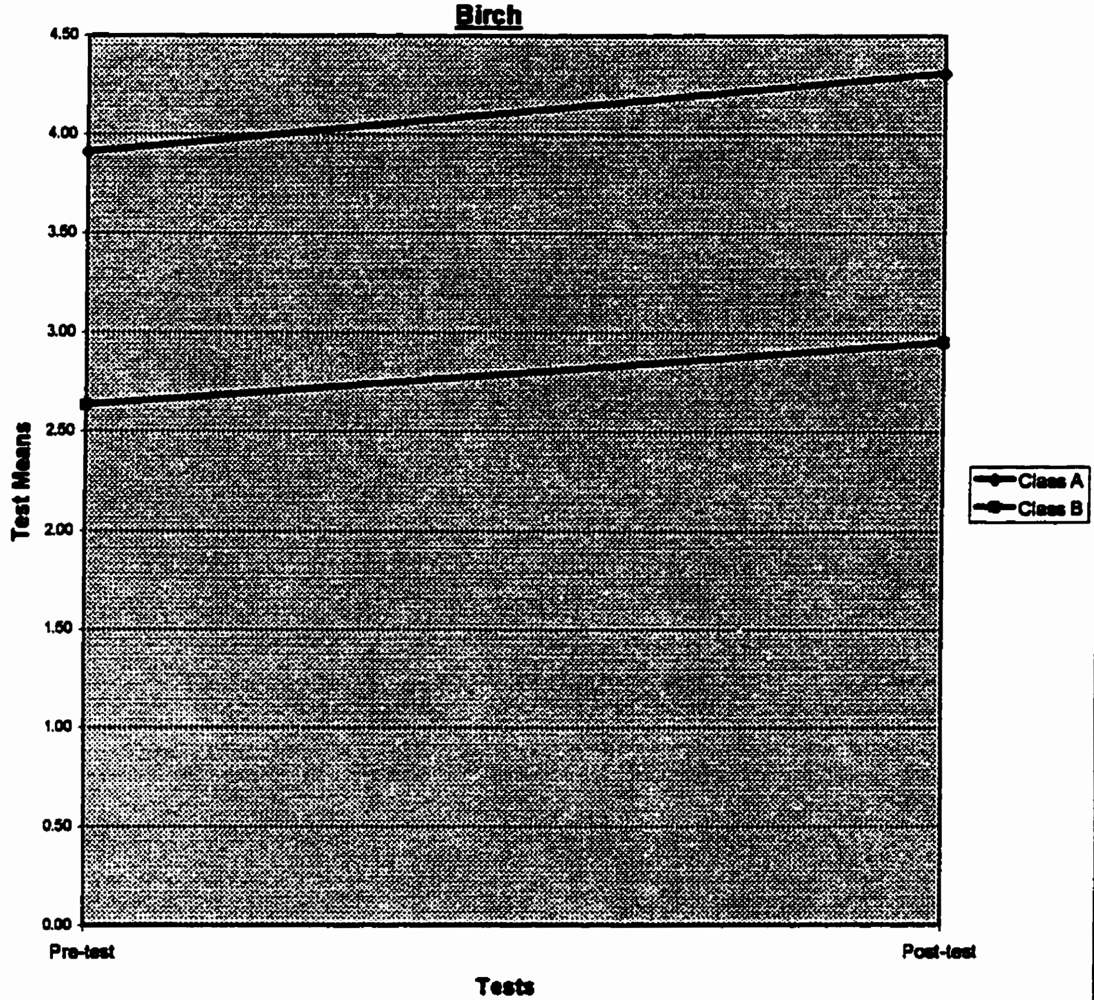


FIGURE 4: Graph of Pre and Post-test Means for <u>Land of the Silver Birch</u>



NOTE: For the purpose of data analysis and graphical presentation, the scores were reversed so that a higher number would indicate better performance.

An examination of the graphs shows that for both songs, each class improved in performance from the pre-test to the post-test. It also appears that Class A, the experimental group who received the treatment, began with higher initial ability.

An Analysis of Covariance (ANCOVA) was performed to determine whether the groups were significantly different at the post-test which occurred after the lessons were given. An ANCOVA was used because it analyzes the different variance between groups to see if these differences were meaningful. The ANCOVA also allows one to control the effect on influence of the different initial starting abilities. In this analysis, the starting ability was treated as a the covariance. The ANCOVA removed the effect of the covariance, and then tested if there was a significant difference in the post-test. The ANCOVA results for the song Chairs to Mend are presented in Table 4.

Table 4: ANCOVA Results for the Post-test Means of Chairs to Mend.

	SUM OF SQUARES	DEGREES OF FREEDOM	F	SIGNIFICANCE OF F VALUE
WITHIN CELLS	42.27	45		
PRE-TEST SCORE	52.64	1	56.04**	.001
CLASS	4.15	1	4.42*	.041
MODEL	76.73	2	40.84***	.001

NOTE: * = p< .05, ** = p< .01, *** = p< .001

The ANCOVA results show that there was a significant effect associated with the model ($F = 40.8$; $p<.001$). That is, both the pre-test (the covariate), and Class A (the treatment) had a significant contributing influence. Together, these two explained 65% of the variance in the post-test (R squared = .645).

The ANCOVA indicated that the pre-test score had a significant influence ($F = 56$; $p < .001$). Even when the differences in the pre-test were controlled for, there was still a significant influence of treatment ($F=4.4$; $p < .05$). The ANCOVA results for the song Land of the Silver Birch are presented in Table 5.

Table 5: ANCOVA Results for the Post-test Means of Land of the Silver Birch

	SUM OF SQUARES	DEGREES OF FREEDOM	F	SIGNIFICANCE OF F VALUE
WITHIN CELLS	23.76	45		
PRE-TEST SCORE	30.52	1	57.80	.001
CLASS	3.58	1	6.78	.012
MODEL	52.86	2	50.06	.001

The ANCOVA results show that there was a significant effect associated with the model ($F = 50.06$; $p < .001$). That is, both the pre-test (the covariate) and Class A (the treatment group) had a significant contributing influence. Together, these two explained 69% of the variance in the post- test (R squared = .690).

The ANCOVA results show that the pre-test scores had a significant influence on post-test performance ($F_{1,45} = 56.0$; $p<.001$). However, even after the differing starting abilities were accounted for, there was still a significant effect for treatment ($F = 6.78$; $p<.000$). Both the differing starting abilities, and the treatment explained 63% ($R^2 = .63$) of the variation in performance at the post-test.

To identify more clearly how much of the variance in the post-test scores were explained by the pre-test and treatment, a multiple regression was conducted. Tables 6 and 7 describe the hierarchical multiple regression that was performed with the pre-test scores entered first, followed by the treatment.

Table 6: Multiple Regression of the Pre-test and Treatment on the Post-test for Chairs to Mend

VARIABLE	R	R2	R SQUARE CHANGE	F CHANGE
PRE-TEST	.78	.61	.61	71.92
TREATMENT	.80	.65	.04	4.42

The results indicated that of the 65% variance in the post-test scores explained by that model, 61% could be attributed to the covariate pre-test, and the treatment was responsible for 3.5%.

The multiple regression showed that the pre-test results explained 61% ($R2 = .61$) and that class explained an additional unique 3.5% beyond the pre-test. This additional 3.5% was a statistically significant improvement ($F1,45$ change = 4.4; $p<.05$) Table 7 shows how the same results occurred for the song Land of the Silver Birch.

Table 7: Multiple Regression Results for the Pre-test and Treatment on the Post-test for Land of the Silver Birch

VARIABLE	R	R2	R SQUARE CHANGE	F CHANGE
PRE-TEST	.80	.64	.64	82.92
TREATMENT	.83	.69	.64	6.78

A Cronbach Alpha test was used to determine inter-rater reliability. This is the general formula for estimating internal consistency based on a determination of how all items on a test relate to all other items and to the total test. The data in Table 8 shows the Cronbach Alpha test results for the pre and post-tests of Chairs to Mend and Land of the Silver Birch.

Table 8: Cronbach Alpha Test Results for Inter-Rater Reliability

CHAIRS TO MEND: PRE-TEST

	MEAN	STANDARD DEVIATION	CRONBACH ALPHA
RATER ONE	3.7	1.8	
RATER TWO	4.0	2.2	
RATER THREE	4.3	1.9	
RATER FOUR	4.1	2.0	
			.96

CHAIRS TO MEND: POST-TEST

	MEAN	STANDARD DEVIATION	CRONBACH ALPHA
RATER ONE	3.9	1.6	
RATER TWO	4.5	1.9	
RATER THREE	5.0	1.7	
RATER FOUR	4.8	1.6	
			.95

LAND OF THE SILVER BIRCH: PRE-TEST

	MEAN	STANDARD DEVIATION	CRONBACH ALPHA
RATER ONE	3.1	1.4	
RATER TWO	2.9	1.5	
RATER THREE	3.5	1.7	
RATER FOUR	3.5	1.6	
			.96

LAND OF THE SILVER BIRCH: POST-TEST

	MEAN	STANDARD DEVIATION	CRONBACH ALPHA
RATER ONE	3.2	1.1	
RATER TWO	3.4	1.6	
RATER THREE	4.0	1.4	
RATER FOUR	3.9	1.3	
			.95

The mean and standard deviation score of each rater for each test and each song leads to a Cronbach Alpha result of .95, .96, .95 and .96 respectively. This indicates very high inter-rater reliability.

Summary and Discussion:

The inferential statistics were a data analysis technique used to determine how likely it is that the results based on a sample or samples are the same results that would have been obtained for an entire population.

An examination of the mean and standard deviation for the scores obtained from the pre and post-test of the songs Chairs to Mend and Land of the Silver Birch, indicates that for both songs, each class improved in performance from the pre-test to the post-test. In each case, Class A, the experimental group, had a greater percentage of improvement. This data also indicated that Class A began with higher initial ability.

An Analysis Of Covariance (ANCOVA) allowed for the controlling, or partialling out of the effect on influence of these different initial starting abilities. The starting ability was treated as a covariance. The ANCOVA removed the effect of the covariance, and then tested if there was a significant difference in the post-test. The results indicated that of the 65% variance in the post-test scores explained by that model, 61% could be attributed to the covariate pre-test, and 3.5% could be attributed to the treatment. Therefore, the 3.5% indicates a significant effect for treatment.

Inter-rater reliability was determined by using the Cronbach Alpha test. For the pre and post-tests for both songs the Cronbach Alpha score was greater then .95, indicating very high inter-rater reliability.

An observed behavioral change was noted in the students who received the treatment. When the teacher-researcher sang softly into the right ear of a student who was singing at a lower pitch, the student immediately raised his or her singing voice to match that of the teacher-researcher. This occurred 100% of the time, and while not statistically upheld, this behavioral response is a valid observation.

The hypothesis of the researcher was proven correct. It appears that the treatment of singing into children's right ears did positively affect their ability to sing in tune.

CHAPTER FIVE: SUMMARY, CONCLUSION, AND IMPLICATIONS FOR FURTHER RESEARCH

The purpose of this study was to determine whether in-tune, soft singing to the right ear of a music student increases the accuracy of the students' pitch reproduction. A formalized experiment to quantitatively measure the role of the right ear in accurate pitch reproduction was implemented over a two month period in 1997. The participants were forty-nine students from two similarly-matched Grade Four and Grade Three/Four classes.

A quasi-experimental design consisting of a control and an experimental group was utilized. A pre-test was given in which the participants were recorded singing two songs from a given pitch. This was followed by the researcher teaching identical singing lessons to both groups. The only variable manipulated within the singing lessons was the treatment given to the subjects in the experimental group. The treatment consisted of the researcher singing softly in-tune into the right ear of each subject two times during each music lesson. At the end of eight weeks of twice weekly singing lessons, the participants were given a post-test in which they were recorded singing the same two songs as from the pre-test.

Inferential statistics were used in this study in order to determine the likelihood that the results based on the sample group are the same results that would have been obtained for an entire population. An Analysis of Covariance (ANCOVA) test revealed that the pre-test showing differing initial abilities among classes was a significant covariant. When this covariant was partialled out, there was still a significant influence for treatment. To identify more clearly how much of the variance in the post-test was explained by the pre-test and treatment, a multiple regression was conducted.

The results indicated that of the 65% variance in the post-test scores explained by that model, 61% could be attributed to the covariate pre-test, and the treatment was responsible for 3.5%. This is a statistically significant result confirming the researchers hypothesis that soft, in-tune singing into the right ear of a music student will increase the accuracy of their pitch reproduction. A Cronbach Alpha test confirmed an inter-rater reliability of greater than .95.

The hypothesis of the researcher has been statistically upheld: soft singing into the right ear of a music student did assist with accurate pitch reproduction. The results, while statistically significant, should however be interpreted with great care, due to the minimal percentage of 3.5.

The researcher recommends that additional experiments involving the role of the right and left ear in accurate pitch matching be undertaken with school-age music students. Future research could be conducted in naturalistic settings, where the researcher is part of the school staff as the music specialist, in order to increase the comfort factor of the participants. The researcher recommends the use of a song as the stimulus, rather then sound patterns, to ensure that a more natural result is studied. It is the opinion of the researcher that children are more comfortable singing a song, rather than an unfamiliar series of pitches, and therefore more reliable results will be obtained.

The researcher also suggests that the human ear be used in evaluation rather than a machine, due to the ease of rating of a song in context, as opposed to the rating of individual pitch accuracy.

The researcher recommends the use of a different experimental design for subsequent investigations. The limitations that occurred with the differing abilities becoming apparent in the pre-test could be eliminated by initially evaluating the subjects according to musical ability, and then creating two evenly matched classes with whom to conduct the experiment. Another possibility could be to give Class A four weeks of treatment, and then four weeks without, while exposing Class B to four weeks of non-treatment, and than four weeks of treatment. This may help to answer the question of the impact of initial ability, and how the treatment affects this ability and the resulting performance.

The present study could be reinvestigated with differing pre and post-test songs. Perhaps unfamiliar songs that were initially taught by the researcher could be used instead of familiar, known songs. Another method could include the singing of the first phrase of each song as the model for the pre and post-test instead of simply giving the student the starting pitch of each song.

The existing study could also be redone with the inclusion of a third group who would be exposed to the treatment via the left ear. An investigation of this type would provide a more complete analysis of the role of both ears with respect to accurate pitch matching.

A more clinical study could involve the use of ear phones with ear blockage ability. A sound pattern of pitches could be transmitted to the participants left ear, and their subsequent modeling of it would be recorded. The same procedure would then be followed with the identical pitch pattern transmitted to the right ear of the participant. The pitch accuracy of the participants imitation of the pitch pattern after hearing it with the left ear, and then the right ear, would then be evaluated by a group of music educators. This type of study, originally proposed by the researcher, could produce more accurate results with respect to the role of the right and left ears in accurate pitch matching.

Although the evaluators were not asked to rate the rhythmic accuracy of the participants singing, many remarked upon the accuracy of the rhythm of both songs on the pre and the post-test. Pitch accuracy verses rhythm accuracy could be a future topic for investigation. Gender and cultural differences among the subjects could also be explored in subsequent studies.

Conclusion:

The area of developing in-tune singing in children is one that has plagued music educators for decades. It is the hope of the researcher that soft in-tune singing into the right ear of the student may be one more technique that music teachers can use when trying to help children acquire singing accuracy.

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APPENDIX A: CONSENT LETTER

(School letterhead)

Re: (Name of Student)

Dear Parent/ Guardian,

As you are probably aware, music students from the University of Calgary have been assisting with the music instruction in the elementary grades. One of these students, Mrs. Janet Seale, is a teacher with the Calgary Catholic Board. Mrs. Seale has taken a leave of absence from her position as a music specialist to complete her Masters of Music Degree at the University of Calgary. In partial fulfillment of her degree, Mrs. Seale is required to undertake a research study which she has requested to conduct with the Grade Four and Three/Four students. The study will involve your child's participation in eight weeks of music lessons. The lessons will be given in two thirty minute periods per week, during the morning school time. The lessons will be a continuation of their previous music instruction.

This study could have important implications for music educators. Would you kindly give your permission for your child's participation by signing the enclosed consent form and returning it to their classroom teacher by tomorrow? An extra copy has been included for you to keep as a reference. No aspect of this research will have any effect on the students' grades or standing in their music program. There are no physical, sociological, or psychological risks involved in this investigation, and the anonymity of the students will be completely guaranteed as the students will be identified by number only. All data will be stored on computer disk and cassette tape in a locked filing cabinet under the control of the researcher, and will be destroyed upon completion of the study. There are no consequences if you do not want your child to take part: however, your approval for your child's participation would be a valuable asset to this study.

Sincerely,

Principal

Mrs. Janet Seale

Teacher -Researcher

University of Calgary Consent Form

Research Project Title: The Role of the Right Ear in Accurate Pitch Matching

Investigator: Janet Seale, Faculty of Music

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Please take time to read this form carefully and to understand any accompanying information.

Description of Research:

It is my belief that if music educators were more knowledgeable with respect to ear dominance in hearing and reproducing specific pitches, they might be more successful in helping children to acquire accurate pitch reproduction. My research will investigate the role of ear dominance in accurate pitch reproduction.

The students will be asked to sing two familiar songs in a private interview session. Their voices will be recorded on a cassette tape. The students will proceed to participate in sixteen singing lessons given in half hour segments over eight weeks. Upon completion of the lessons, the students' singing voices will once again be recorded..

There are no physical, sociological, or psychological risks involved in this investigation. No aspect of this research will have any affect upon the students' grades or standing in the music program of their school. The anonymity of the students will be completely guaranteed as the students will be identified by number only. All data will be stored on computer disk and cassette tape in a locked filing cabinet under the control of the researcher and will be destroyed upon conclusion of the research.

The investigator will, as appropriate, explain to your child the research and his or her involvement, and will seek his or her ongoing cooperation throughout the project. A parent or guardian must sign for children. Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights or release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. If you have further questions concerning matters related to this research, please contact Janet Seale at 283-2237. The supervisor for this research project is Professor Lois Choksy, who is the Head of the Music Department at the University of Calgary. Professor Choksy may be contacted at 220-5376. If you have any questions concerning your participation in this project, you may also contact the Office of the Vice President (Research) and ask for Karen McDermid, 220-3381. Thank-you in advance for your consideration. A copy of this consent form has been given to you to keep for your records and reference.

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Parent/Guardian of Participant Date

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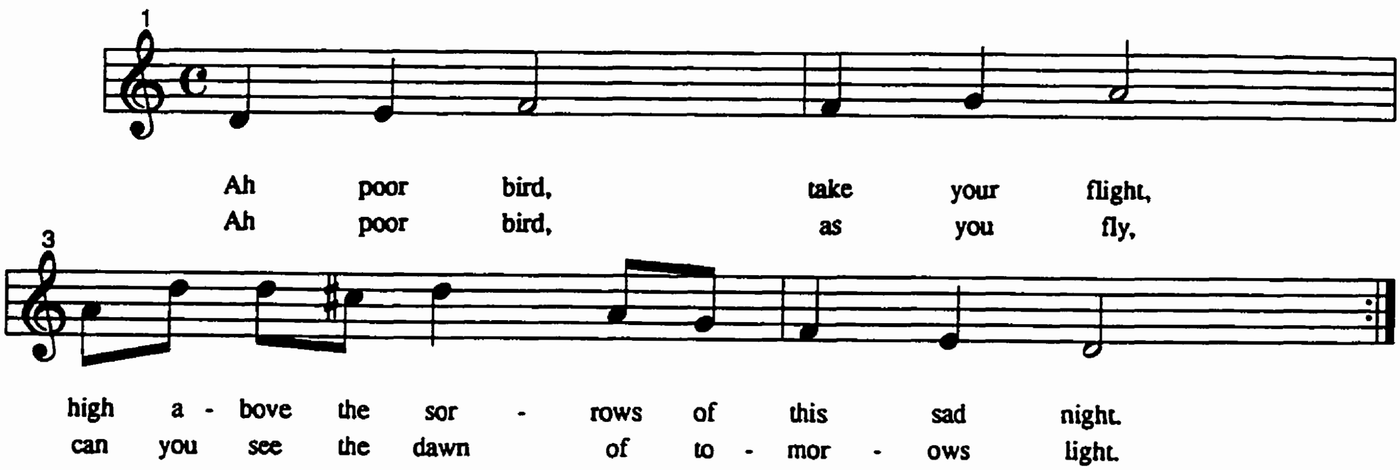
Student Name Student Grade

APPENDIX B: SAMPLE LESSON

I. GOOD-MORNING GRADE FOUR, GOOD-MORNING MRS. SEALE

1. Teacher sings "Good morning Grade Four" ending on the absolute pitch of F (question phrase).
2. Students echo ending on the absolute pitch of D (answer phrase).

II. AH POOR BIRD



1. Teacher leads singing of two verses of Ah Poor Bird in d minor.

2. Class echo sings.

3. Class sings as a two-part canon.

4. Class sings as a four-part canon.

5. Teacher asks what scale the canon is based upon.

6. Class answers the harmonic minor.

7. Teacher notates the harmonic minor scale in solfa on the board.

8. Students sing the harmonic minor scale in solfa with Curwen handsigns.

9. Students sing the harmonic minor scale in absolutes in d minor.

10. Students sing Ah Poor Bird as a 4-part canon with different groups leading.

III. FLUNKY JIM

Chorus:

Knocking around the yard boys, knocking around the yard;

It isn't any easy job, don't fool yourself, old pard.

My overalls are shaby and I have no shirt at all,

but I'm going to get a new outfit with my gopher tails next fall.

Verse 2:

At night when Pa comes from the field he calls for Flunky Jim.

He pats me on my curly head and my hat without a brim.

He's apt to say, "Oh, Flunky Jim, your clothes are far too small."

But I'm going to get a new outfit with my gopher tails next fall.

Verse 3:

I counted all my gopher tails, I've almost got enough,

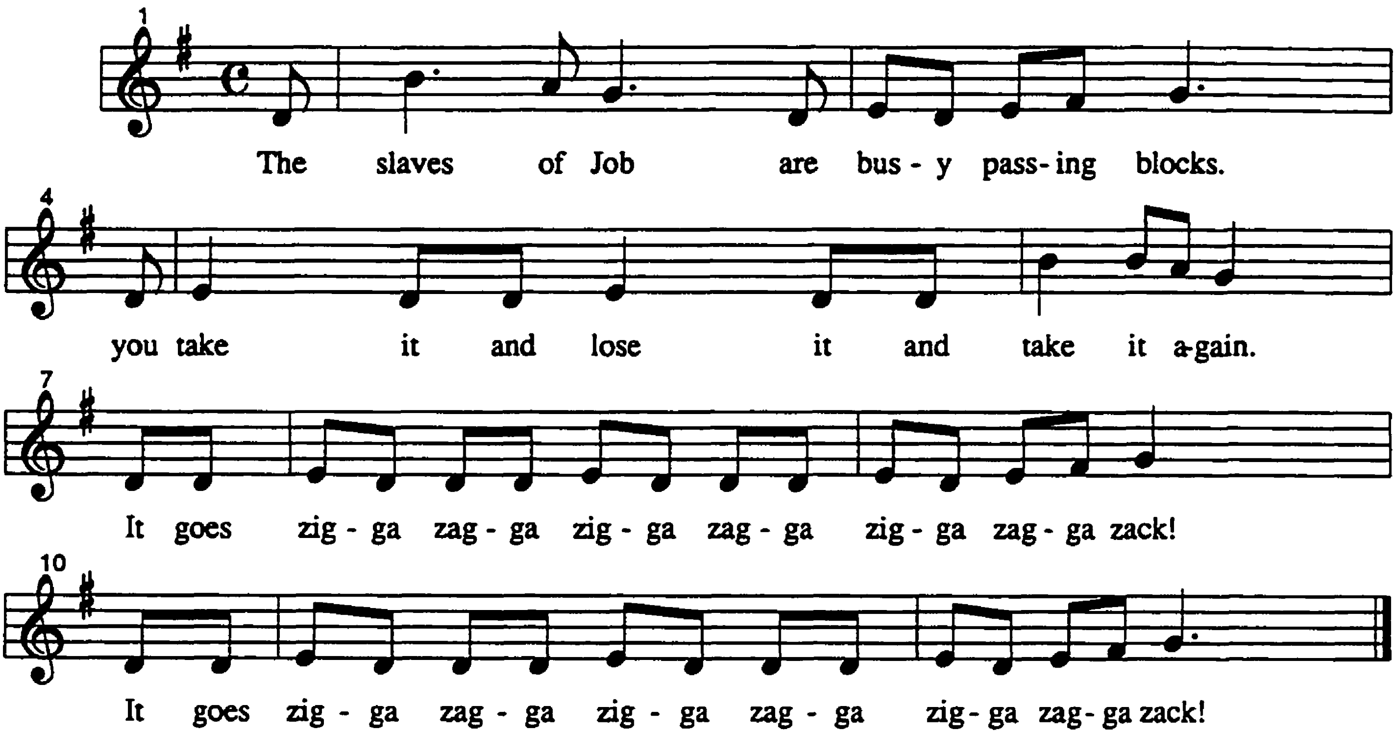
To buy a fancy shirt and pants that have a cuff;

And then I'll hand my old ones down, they really are too small.

Oh, I'll be swell when once I sell my gopher tails next fall.

1. Teacher sings three verses and chorus for students in D major.
2. Teacher explains the story behind the song "In the years known as the "Depression", when many people were out of work and money was scarce, the government gave children money for every gopher tail they turned in".
3. Teacher teaches verse one of song with a phrase by phrase approach.
4. Teacher teaches the chorus of the song with a phrase by phrase approach.
5. Teacher asks students if this is a stepping or skipping song,(simple or compound meter).
6. Students discover, by moving, that the meter is 6/8.
7. Teacher reviews 6/8 conducting pattern.
8. Students sing the first verse and chorus of the song, while conducting in duple for 6/8.

<u>IV. SLAVES OF JOB</u>



1. Students move their desks into groups of four.
2. Students sing <u>Slaves of Job</u> while playing the passing game with their pencils.

V. UN CANADIAN ERRANT

English Words by Edith Fowke

Verse 2:

If you should reach my land,

My most unhappy land,

Please speak to all my friends

So they will understand.

Tell them how much I wish

That I could be once more

In my Beloved Land

That I will see no more.

Verse 3:

My own beloved land

I'll not forget till death,

And I will speak of her with my last dying breath.

My own beloved land

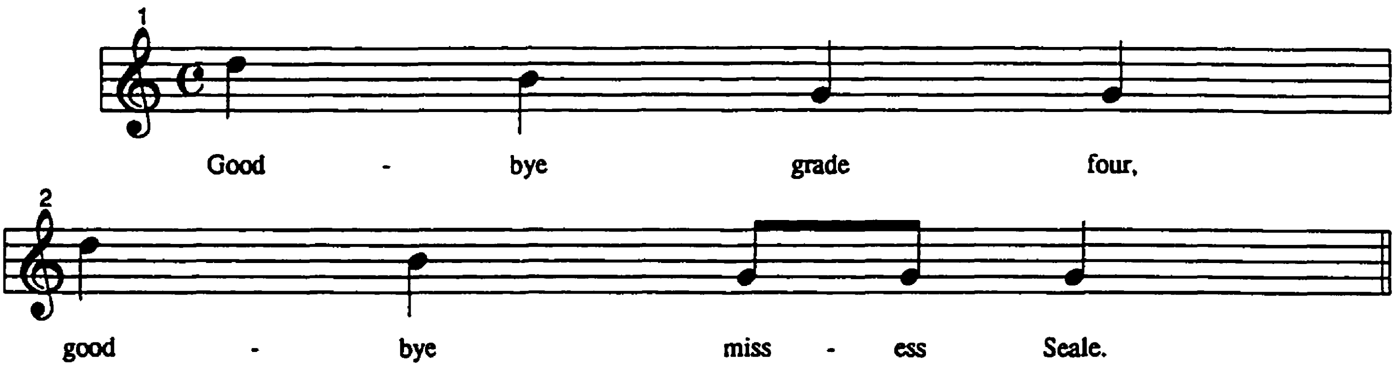
I'll not forget till death,

And I will speak of her

With my last dying breath.

1. Students move desks back and stand by their desks.
2. Teacher leads the class in the singing of three verses of Un Canadian Errant (G major).

VI. GOOD-BYE GRADE FOUR, GOOD-BYE MRS.SEALE



1. Teacher sings "Good-bye Grade Four" ending on the absolute pitch of G in G major.
2. Students respond "Good-bye Mrs. Seale" using the same pitches.

APPENDIX C: EVALUATOR'S RATINGS

Each evaluator was randomly assigned a number from 1 to 4.

PRE-TEST CLASS A

STUDENT	*CHAIRS TO MEND* RATER 1	RATER 2	RATER 3	RATER 4	*LAND OF THE SILVER BIRCH* RATER 1	RATER 2	RATER 3	RATER 4
One	6	6	6	6	6	6	6	5
Two	6	6	6	6	7	6	7	6
Three	1	2	2	2	2	4	3	3
Four	4	5	4	4	4	4	4	4
Five	4	2	2	2	5	5	4	4
Six	4	1	1	2	5	4	2	4
Eight	2	2	4	4	5	5	5	4
Nine	4	3	2	2	4	2	2	2
Ten	4	1	1	1	4	4	1	2
Eleven	4	4	4	4	5	5	5	5
Twelve	4	2	2	2	4	2	2	2
Thirteen	4	2	2	2	4	4	3	4
Fourteen	5	4	4	4	5	5	3	4
Sixteen	4	4	5	4	4	5	4	4
Seventeen	5	4	4	4	5	4	4	4
Eighteen	5	6	4	4	6	6	6	6
Nineteen	2	1	2	1	6	6	6	6
Twenty	2	2	4	2	2	2	3	2
Twenty One	4	2	1	2	5	4	4	4
Twenty Two	4	4	2	4	5	5	4	4
Twenty Three	1	1	1	1	1	1	1	1
Twenty Four	6	6	6	6	6	6	6	6
Twenty Five	1	1	1	1	2	2	1	1
Twenty Six	7	7	6	7	7	7	7	7
Twenty Seven	4	2	2	4	4	5	4	4

PRE-TEST CLASS B

STUDENT	*CHAIRS TO MEND* RATER 1	RATER 2	RATER 3	RATER 4	*LAND OF THE SILVER BIRCH* RATER 1	RATER 2	RATER 3	RATER 4
One	7	7	7	7	7	7	7	7
Two	6	7	6	6	5	7	6	6
Three	4	1	1	1	6	5	5	5
Five	4	4	4	4	5	6	4	4
Six	4	4	4	4	4	6	4	4
Seven	5	4	5	4	6	6	6	6
Eight	4	3	3	3	5	6	5	5
Nine	2	1	2	2	5	5	6	5
Eleven	7	7	7	7	7	7	7	7
Fourteen	4	4	4	4	4	5	3	4
Seventeen	2	1	1	1	2	4	2	2
Eighteen	5	4	4	4	5	4	5	4
Nineteen	1	1	1	1	4	4	2	2
Twenty	6	7	4	6	6	7	6	6
Twenty One	7	7	6	6	7	7	6	6
Twenty Two	5	6	4	4	5	6	4	4
Twenty Three	5	6	6	6	6	6	6	6
Twenty Four	7	7	6	7	6	7	6	6
Twenty Five	7	7	6	7	7	7	6	7
Twenty Seve	1	2	2	2	4	4	4	4
Twenty Eight	5	5	6	6	5	6	6	6
Twenty Nine	6	7	6	6	6	7	6	6
Thirty	2	4	4	4	5	6	5	5
Thirty Two	6	7	6	6	6	7	6	6

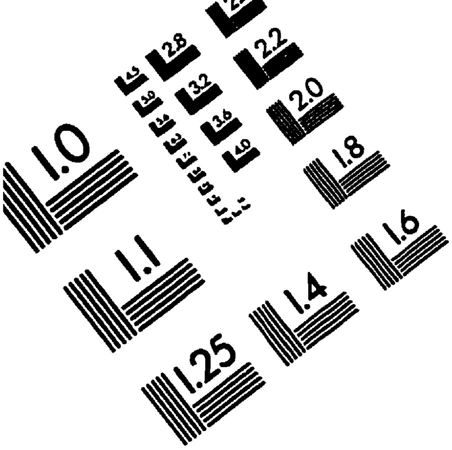
POST-TEST CLASS A

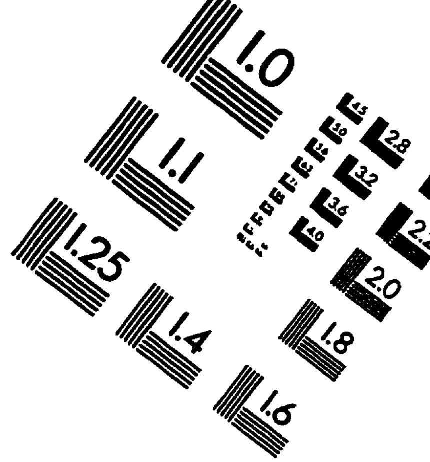
STUDENT	*CHAIRS TO MEND* RATER 1	RATER 2	RATER 3	RATER 4	*LAND OF THE SILVER BIRCH* RATER 1	RATER 2	RATER 3	RATER 4
One	4	3	2	2	4	5	4	4
Two	5	4	4	4	5	4	6	4
Three	2	2	1	2	4	2	1	2
Four	5	4	4	4	5	4	4	4
Five	4	2	2	2	5	5	4	4
Six	4	2	1	2	5	4	4	4
Eight	6	2	1	2	5	4	4	4
Nine	5	2	2	2	4	2	2	2
Ten	1	1	1	1	4	4	3	4
Eleven	5	5	3	4	5	6	4	4
Twelve	2	1	1	1	4	2	2	2
Thirteen	5	3	3	3	5	4	4	4
Fourteen	5	3	4	3	5	6	5	6
Sixteen	5	3	4	4	5	5	4	4
Seventeen	4	1	4	4	4	4	3	4
Eighteen	5	4	4	4	5	6	4	4
Nineteen	4	4	2	2	4	4	4	4
Twenty	2	1	2	2	4	4	3	4
Twenty One	4	2	1	2	4	4	1	2
Twenty Two	4	2	1	2	5	4	4	4
Twenty Three	1	1	1	1	1	1	1	1
Twenty Five	1	1	1	1	1	1	1	1
Twenty Six	6	6	4	4	5	6	4	4
Twenty Seve	1	1	1	1	4	2	1	2

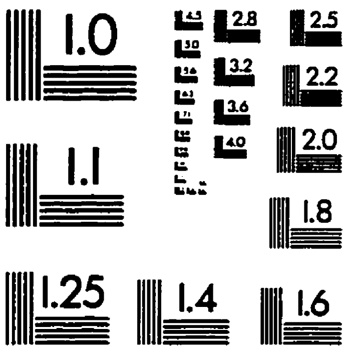
POST-TEST CLASS B

STUDENT	*CHAIRS TO MEND* RATER 1	RATER 2	RATER 3	RATER 4	*LAND OF THE SILVER BIRCH* RATER 1	RATER 2	RATER 3	RATER 4
One	6	6	4	5	6	6	5	5
Two	6	5	4	4	6	6	6	5
Three	2	1	1	1	5	4	4	4
Five	4	4	4	4	4	5	5	5
Six	4	4	2	2	4	5	4	4
Seven	5	3	3	3	6	6	6	6
Eight	4	4	2	4	5	5	4	4
Nine	5	5	5	5	5	5	4	5
Eleven	6	5	6	5	7	7	6	6
Fourteen	2	2	1	1	4	4	4	4
Seventeen	1	2	1	1	5	4	3	4
Eighteen	4	4	4	4	5	4	4	4
Nineteen	4	4	4	4	5	5	4	4
Twenty	6	7	6	6	6	6	5	5
Twenty One	6	7	6	6	7	7	6	6
Twenty Two	5	7	5	5	5	6	5	5
Twenty Three	5	6	4	4	5	6	5	5
Twenty Four	4	6	3	6	5	6	5	6
Twenty Five	5	6	5	5	6	6	5	5
Twenty Seve	2	1	1	1	4	2	2	2
Twenty Eight	5	4	5	4	5	5	5	5
Twenty Nine	6	6	6	6	6	7	6	6
Thirty	5	2	2	2	5	5	4	5
Thirty Two	6	6	6	6	6	7	6	6

TEST TARGET (QA-3)







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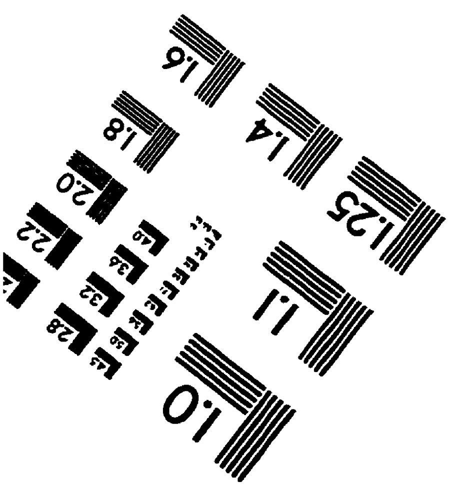

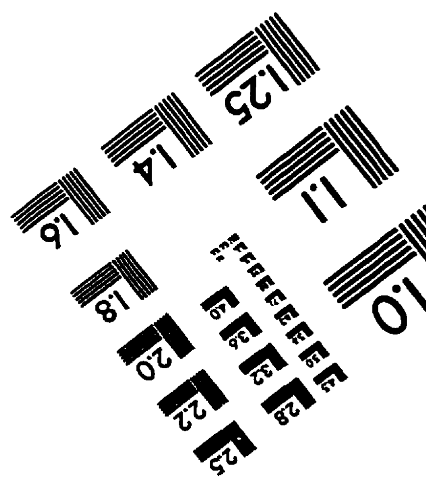

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