A Comparison of Three Teaching Procedures Used in The Development of Improving Intonation in Clarinet Performance

K. Earl Erickson
Utah State University

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A COMPARISON OF THREE TEACHING
PROCEDURES USED IN THE DEVELOPMENT OF
IMPROVING INTONATION IN CLARINET PERFORMANCE

by

K. Earl Ericksen

A dissertation submitted to the College of Education
and Department of Music, Utah State University,
in partial fulfillment of the requirements
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Development and Supervision.

1973
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ABSTRACT

This study assessed the relative efficiency of three teaching procedures used in the development of improving intonation in clarinet performance. The three treatment procedures used included the Beat Method, the C. G. Conn Stroboscope and Johnson Intonation Trainer. During the six weeks study, all Ss participated in two forty-five minute lessons per week. Intonation procedures were studied for fifteen minutes each lesson while other playing problems were discussed for the remaining time. Instruction time totaled nine hours per group. All Ss continued class work with their school music teacher. The experimental design also included a No Contact Control Group which received no special instruction during the six weeks. Standardized tests using specific items and methods needed for this study were not available. This necessitated the construction of tests by the writer (Appendix A, B and C). A Test Reliability Group E (N = 15), took the test twice with ten days between testing periods. Other schools were randomly assigned to one of the treatment groups, (a) No Contact Control Group A (N = 12), (b) Beat Method Group B (N = 15), (c) C. G. Conn Stroboscope Group C (N = 12), and (d) Johnson Intonation Trainer Group D (N = 15).

All groups participated in a pretest and posttest. The Johnson Intonation Trainer was used to produce a constant pitch while the C. G. Conn Stroboscope measured the degree of out-of-tuneness during testing.
procedures. Instructions for the test were read to minimize variation. The test orientation consisted of three parts: (a) Identification of Beats (Appendix A), (b) Pitch Memory (Appendix B), (c) Tuning to Selected Pitches while playing the clarinet (Appendix G). The analysis of variance was used to compute the data.

Ss were unable to tune to specified pitches without practicing systematic procedures on how to accomplish this task. Subjects were unable to change pitches more than .05 of a semitone in the pretest. Tuning to Specified Pitches. After treatment, the ability to change pitches up to .25 of a semitone was accomplished. Clarinet players, considered technically less proficient by their teachers, also accomplished matching pitches on the pretest as accurately as advanced players.

This study strongly confirms the thesis that students can learn to play in tune through using "systematic procedures" with the cooperative efforts of teachers. It is also concluded that the procedures used in the "Beat Method" are significantly better than other procedures tested.
CHAPTER I
INTRODUCTION

Statement of the Problem

The development of good musical performance by an individual involves many physical, environmental and behavioral circumstances. The performance ability to play in tune is one of the primary factors which is essential to any worthwhile musical performance. There is considerable research regarding the physical, environmental and psychological influences on the individual's ability to perform. However, there seems to be inadequate information on "how" to play in tune. This study will focus on the development of systematic and effective teaching procedures to improve the ability of clarinet players to play selected notes in tune.

Justification for the Study

A difficult task for conductors is the development of sensitivity in musicians toward the necessity for good intonation. The importance of intonation in musical performance has been stressed by many writers, musicians and educators. Helmholtz (1912) writes:

...but correct intonation in singing is so far above all others the first condition of beauty, that a song when sung in correct intonation even by a weak and unpracticed voice, always sounds agreeable, whereas the most practiced voice offends the hearer when it sings false, or sharpens., p. 326.
In discussing the aims of rehearsal, Van Bodegraven and Wilson (1942) state:

...the first importance of playing and singing in tune is so obvious that special mention of it seems unnecessary here. It may be well to point out that even the uneducated listener is able to detect faults in intonation, and that no one is able to enjoy a musical performance which is consistently out of tune., p. 70.

In the opening paragraph of his article devoted to intonation in the school band, Revelli (1938) writes:

...the first inevitably recurrent problem facing us in our school band and orchestra work is the securing of good intonation. Success in achieving good intonation determines the beauty and worth of all music performed by these organizations, whether it be the simplest march or the most complex composition., p. 70.

Pearce (1945) indicates that problems of intonation are commonly looked upon as the most difficult problems with which the school bandmaster has to deal. Vandercook (1926) supports this opinion by mentioning that to play in tune is the most difficult point the director has to teach and contend with in ensemble performance. Hawley (1933) writes of the great difficulty of playing in tune in the most emphatic terms by stating that:

...no wind instrument of any kind can be played in tune with any other instrument of any kind except by main force of the performer. Every note on all wind instruments must be carefully tempered by use of breath and lips so that it will sound in tune with the general ensemble., p. 237.

The above statements indicate the recognition of intonation as a serious problem but fail to clarify intonation procedures in performing groups. The disagreement among writers on methods of developing good intonation lends support to the thesis that there is a need to develop additional effective procedures which will be of practical value to the band and orchestra teachers in the public schools.
An examination of many beginning and intermediate method books revealed only a systematic learning sequence emphasizing various skills for the development of techniques for playing. Intonation was rarely mentioned as an important part of the learning process to develop musicianship.

**Delimitations**

The selection of musical organizations for the study was determined through the cooperative effort of the writer, the teachers and Music Supervisor of the Weber County School District, Ogden, Utah. The selected bands had been rated excellent in playing ability by music judges at recent music festivals. The entire clarinet section of the five schools participated in this study because interschool randomization was impractical due to conflicting time schedules, transportation difficulties and excessive travel distances. Each school provided the best facilities for testing and teaching; however, there were differences in the acoustics of the rooms used. Schools were randomly assigned to specific teaching procedures as outlined in Chapter III.

Although the tempered scale is used as a model in the construction of wind instruments of today, the manufacturers find it impossible to build instruments perfectly in tune using the tempered scale. Each instrument has its own acoustical tendencies resulting from shape, size and materials used in its construction. There are other factors which can limit one's ability to play in tune: embouchure, reeds, mouthpiece, temperature and intonational characteristics of any instrument to which one might tune. Considerable research on factors influencing
intonation of musical instrument includes the development of sensitive measuring devices regarding the effect of temperature on instruments, the mathematical explanation of the tempered scale in relation to the just scale, the measurements of tone patterns relating to partials, harmonics and overtone series; the explanation of the mathematical relationship of difference and combination tones; the structural dimensions of the various instruments and their relationship to intonation, tone quality and timbre.

There is much disagreement concerning tuning procedures preferred by musicians and theorists. This study is concerned with the "how" of playing in tune regardless of the choice of tempered or just tuning utilized. It is assumed by the writer that those organizations which seem to have good intonation are adjusting pitches to accomplish the task. It is further assumed that musicians who come to enjoy the sensation of playing in tune will make a continued effort to play in tune. See Pearce (1945) p. 30-60 for detailed discussion and analysis of the merits of just versus tempered tuning.

Some music directors have been successful in teaching intonation to their students. It is assumed that the amount of success is directly related to the ability of the director to detect intonation problems and to develop procedures to fix out-of-tuneness. However, there seems to be vagueness in the procedures used in correcting intonation.

Hypothesis

A procedural sequence of steps to improve intonation in clarinet playing has been developed by the writer. The purpose was to make available a process which would enable students to efficiently learn
necessary intonation adjustments in correcting pitch problems at a faster rate than with other selected procedures. For the purpose of statistical evaluation the Null hypothesis was utilized in the study: "There will be no significant difference between procedures used to correct intonation problems."

Basic Design and Procedure

This study is an investigation of various procedures used to improve intonation in clarinet performance. Three selected procedures were tested utilizing (a) beats, (b) C. G. Conn Stroboscope and (c) Johnson Intonation Trainer.

The experiment followed a pretest-posttest control group design with three experimental groups (Campbell and Stanley, 1966). Ss were randomly selected from T. H. Bell, Sandridge, Roy and South Junior High Schools, Ogden, Utah. North Davis Junior High participated as a Test Reliability Group. Population consisted of all Ss from the five concert band clarinet sections. All Ss continued instruction with their regular school music teachers. All groups were instructed on problems of intonation for thirty minutes per week. All Ss received instruction on all aspects of clarinet performance. Control Group A and Test Reliability Group E received instruction only from their regular teacher. Experimental Group B, C and D received instruction from the writer. The study terminated at the end of six weeks.

Definitions

Operational definitions necessary to the study will be deferred to Chapters II and III.
CHAPTER II
REVIEW OF LITERATURE

A. Related Studies on Intonation

In Pearce's *Intonation and Factors Influencing Its Attainment with Special Reference to the School Band* (1945), he divided intonation into several categories under the heading, *The Theory of Intonation*. The headings are as follows: pitch, beats, overtones, combination tones, beats among overtones and combination tones, temperament, pythagorean intonation, equal temperament, just intonation, the pitch of enharmonic tones, the size of thirds, and melodic and harmonic intonation. Much of this information is highly technical which would, if read and assimilated, help teachers to understand the various factors affecting intonation. The only section which would relate to actual tuning by the student would be one on beats. In Chapter III he begins to explain such concepts as: humoring the pitch, pitching the instruments, tendencies of school instrumentalists, listening, singing, slow practice, stopping to improve intonation and soft playing. Pearce (1968) also states:

...if the intonation of the band is not good and is not improving, it is highly probable that the reasons for this may be found among the following: (1) lack of class discipline, (2) lack of motivation, (3) lack of knowledge of appropriate teaching techniques and procedures, (4) the belief that young students cannot learn to play in tune, (5) the assumption by the teacher that he should be conducting—at the expense of teaching, (6) undeveloped quality of tone, (7) reeds too soft or too stiff to permit control of pitch, (8) inadequate mouthpieces, (9) lack of proper pitching of the instruments, (10) lack of knowledge of the inherent intonation deficiencies
of the instruments, (11) improper adjustment of instruments
(12) failure to make embouchure or other compensations for
changing dynamic levels, (13) failure to make necessary
tuning adjustments to compensate for drastic temperature
changes, (14) dirt or dents in the bore or mouthpiece shank
of brass instruments, (15) dirt in the tone holes of wood-
wind instruments, particularly the register vent, (16) im-
proper methods of supporting the instruments, (17) unsuit-
able sitting positions and (18) habitual use of excessively
loud tone., p. 1.

Pearce (1968) describes in great detail factors which students can
perceive and methods which are understandable regarding the process of
playing in tune.

Backus, in his The Acoustical Foundations of Music, (1969) directs
his theory toward the criteria that affects intonation. He explains
beats, harmonics, frequencies, and other physical phenomenon. He dis-
cusses the reception of musical sounds, the environment of music and
the production of musical sounds on musical instruments. He rarely
mentions methods of playing in tune.

Johnson, in his The Johnson Intonation Trainer Application Manual,
(1966) states:

...possibly the greatest single factor contributing to the
difficulty in obtaining good intonation has been the lack of
a practical and convenient device which could be used in
teaching, learning and practicing the art and science of
good intonation. Because of this lack it has been necessary,
in the past, for music educators to resort to various improvi-
sations and makeshift methods which taxed the ingenuity and
ability of educators and students alike in an attempt to
achieve good intonation. It is certainly to their credit
that they were able to obtain the results that they have,
considering the difficulties which they faced., p. 1.

Johnson (1966) explains how to use his Intonation Trainer in
musical aptitude tests, how to use the Intonation Trainer in ear train-
ing, how to use the Trainer to develop an in-tune embouchure for students
of wind instruments, how to use the Trainer in teaching string instruments,
singing, instrumental and vocal ensembles while improving intonation. He explains many uses of the Intonation Trainer and how to hear beats by using the beat indicator.

There is a scarcity of literature relating to the method or methods of teaching how to play better in tune. The above sources of Pearce (1968) and Johnson (1966) are two which have detailed analysis and steps for improving intonation which are practical in the performance field.

Miles (1970) supports the idea that musicians can learn to play in tune by using the beat method when he tested beginning students in the public schools and found that "all but a small percent of beginning wind instrument students can be taught to play their instruments in tune using the beat method." However, there were no suggested procedures indicating specific steps in learning how to play in tune.

Guerin, in his *A Study of Three Feedback Modes on the External Intonation of Selected Grade School Instrumental Students*, (1972) used visual, aural and verbal feedback to test abilities to play in tune. He used five pitches in a seven tone scale for practice in tuning. The purpose of the study was to see if there was any transfer of intonational improvement from practice at playing five tones in tune to playing the remaining two tones which were unpracticed.

Small gains, and in some cases losses, tended to erase larger gains and produced statistical nonsignificance on parametric tests. Guerin (1972) concluded that students scoring low on the pretest tended to show significant gains. Those Ss scoring high on a pretest showed nonsignificant gains or losses. He did conclude that there is a definite
tendency for fourth, fifth and sixth grade musicians to play flat.

Gilliam, in his *A Survey of the Methods Band Directors and Teachers of Instrumental Music Use to Develop Intonation, in Nine Counties of Southern New Jersey, (1970)* states:

...most music educators are faced with the problems of intonation and many are using the latest devices and techniques to overcome the problem. However, there were a considerable number of music educators still using, according to the expert opinions presented in the study, out-dated techniques., p. 12.

He also found:

...the tuning fork, amplified, received a greater amount of usage. The deplorable misuse of the stroboscope, strobotuner, should be discontinued. A lack of understanding as to the proper use of the electronic devices, by the band director, could do much to stagnate the development of accurate pitch. The student must develop the ability to "humor tones," p. 14.

Gilliam (1970) also found that the directors were using the following tuning devices in which to tune their instruments: piano, tuning bar, pitch pipe, tuning fork, stroboscope, or other electronic tuning devices. There was no reference in the study indicating the use of matching pitches through the beat method.

B. Technical Literature, Essential Information and Definitions.

Pitch Recognition

Pitch discrimination and identification of given notes can be improved through practice. Mull (1925), using college students as Ss, found that ability to judge notes can be improved with training, but a high degree of attention to the stimulus is absolutely necessary. She also indicates that this ability correlates with musical ability. Wedell (1934) has demonstrated that relatively unmusical people can learn to improve their ability to assign pitches to pure tones. The greatest
increase in ability takes place during the first few periods of practice. The amount of development within any person to discriminate pitch becomes a behavioral evolution dealing with past experience from the time a person is born.

**Dimension of Tone**

Sound is produced by setting in motion some object which in turn sets the air to vibrating, which creates sound waves. These waves consist of alternation of condensation and rarefaction which corresponds to the forward and backward motions of the vibrating object. The air molecules are condensed and then rarified as the forward and backward motion of the sound source moves.

Lundin (1953) explains the vibratory motion as:

...having four properties; frequency, intensity, duration and form: (a) frequency, referring to the number of times the motion occurs in any particular interval of time, usually a second, (b) intensity, being the energy or pressure exerted by a vibrating object, (c) duration, referring to the length of time the sound wave lasts, (d) form, referring to the shape or form of the specific sound., p. 13.

The above information is important in that it helps to give an overview of the many facets concerning pitch and intonation. Further explanation of frequency and the individual's ability to discriminate pitch difference is necessary. Lundin (1953) explains how acute an individual's pitch discrimination is by determining the individual's difference limen for various pitches. He states that:

...the difference limen (DL) is the frequency (f.) change in a tone which he is just able to perceive fifty percent of the time. This DL will differ from individual to individual. Let us take a tone, A. This has a frequency of 435 cps. The average individual is able to distinguish it from another tone which is plus or minus three cycles from this standard. So, when the frequency of the tone drops from 435 to 432 cps., or rises to 438, he can just perceive that it has changed., p. 20.
Lundin (1953) also indicates that variables which could determine the consistency of accuracy are the duration of the sound and the volume. He states:

...the longer the wait between tones, the less accurate the DL. By comparing various frequencies with the standard, we are able to determine the minimum point in frequency which is just detectable at any particular frequency level. Individuals will vary for any given frequency. The individual will vary comparing different frequencies. If the smallest DL that the student can detect in testing different frequencies is three cps, the formula would be $3/3^{1/5}$ or any other given frequency which would give the DL., p. 20.

See Lundin (1953) for further information regarding physical, vibrational and psychological aspects of sound.

Playing or singing in tune on any given pitch which is determined by matching frequencies of vibration is considered by many musicians a main objective for creating a pleasing sound.

In the opinion of the writer, two tones which are sounded together with identical frequencies may be called in tune. Helmholtz (1912) writes:

...when tones are sounded together which are consonant they possess identical overtones; however, the variable strength of overtones constitutes the timbre allowing the listener to distinguish between instruments., p. 167.

Dissonance could be described as the result attained by simultaneously sounding two or more tones having few identical overtones or fundamentals. There seems to be ambiguity among many writers concerning the definition of consonance and dissonance. Stumpf (1883) asks the question, if dissonance is due to the beating of fundamentals or their overtones, why does it occur in the absence of beating? He states that: "Through fusion the sounds of two clangs were judged consonant to the degree that they could fuse into a single tone sensation." He mentioned that fusion
was easier when the most nearly perfect intervals were present such as perfect fifth, perfect fourth, major third, major sixth, in that order. He established the following order of consonance or fusion:

1. Consonance is a function of the vibration ratio of the tones (octave, fifth, etc.) and is independent of the region of the musical scale in which tones occur.

2. The degree of consonance is the same for the intervals beyond the octave as for those within it.

3. Consonance is independent of timbre, intensity of tones, or the relative location of source tone., p. 90.

Krueger (1910) explains dissonance as the beating difference tones. All dissonant intervals contain difference tones resulting from two notes which are sounded simultaneously. The difference between their frequencies produces a soft sounding note that beats, while consonant intervals possess no difference tone beats and contain only pure unisons because the difference tones are in a 2:1 ratio.

Lipps (1905) explained consonance by a term called micropsychic rhythms. He maintains that the mind becomes an unconscious calculator. When the cps of two tones bear a simple ratio to each other, the experience becomes a consonant one. It is explained by the ratio of 100 to 200 cps. Every second beat of the 200 cps corresponds with one of the vibrations of the 100 cps. The more the vibration ratio matches that of another, the more consonant the sound.

According to Backus (1969) both ears of an individual are not necessarily the same in their reception of sound. Each ear may perceive a sound as different. This is known as diplacusis. He also indicates that people with normal hearing and without physical defects have very little problem with diplacusis or an extreme change when intensity is increased.
Moore (1914) has brought in a recent concept of a genetic theory of consonance. He explains this as a system whereby a generation that is accustomed to hearing one particular type of combinations of sounds for a number of years accepts it as consonant, familiarity causes it to become uninteresting. As a result, they and their children readily accept tone combinations which at one time were dissonant. Each generation has a new level of tolerance for further dissonant sound; therefore, each new generation becomes accustomed to certain sounds which were dissonant to their ancestors and learns to accept further dissonances during their life, a tolerance which is passed on to their children, thus the genetic theory. One might apply this theory to sociological cultures as well as the evolution of theory of music.

There have been many who have given theories as to the cause of dissonance and consonance as described above. As stated by Lundin (1953) these theories fall into the following categories: (a) numerical relationships, (b) absence of beats, (c) genetics and (d) fusion. According to some theorists, the acceptance of consonant or dissonant is relative to the experience the listener has had with these two terms. What is dissonant to one person will not necessarily be dissonant to another. Some people are capable of accepting greater dissonance than others due to their experience with various kinds and styles of music. Criteria used in labeling sounds dissonant or consonant is of a subjective nature. The clarification of consonance and dissonance was necessary because of the ambiguity and subjectiveness of information relating to intonation problems. This study will attempt to test procedures for playing in tune and the development of pitch discrimination. The writer's definition
of consonance is the absence of beats when two or more tones are played together in unison or an individual members of a chord. Due to the reference to beats in previous statements it is necessary to discuss the term "beats" because of its importance to this study.

Beats

It has been mentioned that one can discern every audible frequency change that may occur within the range of normal hearing. If two tones are sounded simultaneously, which are either mistuned or have slightly different pitches, i.e., 435 and 439 cps, the alternation of condensation and rarefactions will cause the ear drum to stop four times per second which causes a physiological sensation interpreted psychologically as beats. When any two tones are produced which have different cps ratios, the number of beats per second is determined by subtracting the smaller cps from the larger. It has been determined through practical experience that students with normal hearing can detect beats without practice. The teaching procedure involves the identification of this phenomenon for students. Pearce (1945) had constructed in collaboration with J.C. Deagan, Inc., a set of tuned bars made to specification to demonstrate the number of beats produced by the difference between bars tuned at different cps levels. The set of bars is called a deaganometer. It consists of bars tuned at the following cps: 440, 441, 443, 446, 450, 466.2. The first bar is concert A, and the last bar is concert Bb. The difference between the first and last bar is a half step, considered the smallest interval in our modern notation of Western music. By sounding any two of the above bars simultaneously, one can produce beats.

As a lecturer on intonation, the writer has encountered students
with very little formal training in music who can readily hear beats without prior practice or exposure to this phenomenon. It was also observed that some students who were in a band or who previously had some type of formal instruction were not necessarily aware of and could not identify beats better than those without training. However, with explanation and practice, most students were able to improve their abilities to hear beats and determine their rate of speed. It has been observed that the variable rate of beats from zero through ten per second is recognizable, with those of a faster speed being too fast to count. All sounds which create beats are considered dissonant by the writer, with those of a faster speed being more dissonant than those with a slower speed. Consonant sounds would be those sounds without beats.

There are many tests which are designed to measure some forms of pitch discrimination such as: Beach Music Test, Frank A. Beach; Drake Tests of Musical Talent, Raleigh M. Drake; Gildersleeve Musical Achievement Tests, Glenn Gildersleeve; Kwalwasser-Dykema Music Tests, Jacob Kwalwasser and Peter W. Dykema; Malmberg Test of Consonance and Dissonance, C.F. Malmberg; Mainwaring Tests of Musical Ability, James Mainwaring; Seashore Measures of Musical Talent, Carl E. Seashore. All of these tests are directed toward what Lundin (1953) explained as difference limen, (DL). As far as can be determined the only sources of information relating to pitch discrimination through beats are Pearce (1945) and Johnson (1966), who have approached the pitch discrimination factor through the beat method as well as the DL method.
C. Clarinet Performance Essential to the Study

Clarinet Tone Production

There are many factors which affect intonation in clarinet playing. These factors, some physical and some mechanical, are as follows: (a) embouchure, (b) tonguing, (c) breath support, (c) mouthpiece, (e) reed, and (f) clarinet. Each of these factors influences the type of tone produced on the clarinet. It has been observed by the writer that the more acceptable the tone quality, the better the chance for playing in tune and the better chance there is to identify intonation problems.

Clarinet tone production is dependent upon many physical and mechanical considerations. The mechanical problems include a good reed of correct strength, a mouthpiece suited for the player, and a clarinet which is capable of producing a typical timbre of refined clarinet tone. There are so many varied opinions about the three items that it seems impractical to recommend particular brand names.

Assuming that the student has a good reed, a suitable mouthpiece and an adequate clarinet, we would then be concerned with breath support, embouchure and tonguing. Breath support has to do with adequate and constant pressure behind the blown air which cause it to move across the reed at a constant rate of speed. If one holds a paper edgewise and perpendicular to the face while blowing a stream of air with varying degrees of pressure or velocity, the paper will vibrate at different speeds. The air stream moving across the reed starts the air column within the body of the instrument to vibrate. If the amount of air moving across the reed is not adequate and constant, the reed will vary in the number of vibrations produced per second.
The tone of the instrument is also affected by intensity fluctuation of the air stream. Inadequate air pressure causes both tone and intonation problems.

The embouchure is explained by Palmer (1952) as "the mode of applying the lips and mouth to the mouthpiece of a wind instrument as expertly advised and the mode actually adopted or developed by a player for a particular mouthpiece of a wind instrument."

There are many theories of instruction regarding embouchure formation. Each method no doubt produces a slightly different tonal concept. The following embouchure concept is the one which will be used in this study. Dalby (1954) states the following steps for embouchure formation and control of pitch:

1. Stretch the lower lip tightly over the lower teeth with about half of the red part cushioning the place where the reed will rest. The flesh of the lower lip and chin must be spread away from this area. The chin should be down and flat in much the same position as when the vowel "ee" is spoken. A soft, flabby lower lip or one which extends too far over the lower teeth into the mouth will result in a thin, sickly, muffled tone.

2. Place the mouthpiece in the mouth and rest the reed at the break point, i.e., where the mouthpiece begins to curve away from the reed, upon the lower lip. Without disturbing the firmness of the lower lip, lower the upper teeth to about one-quarter inch of the tip of the mouthpiece. (This distance will vary slightly with the lay of the mouthpiece and the jaw formation of the player.) Hold the clarinet in place by exerting a steady upward pressure with the thumb of the right hand. The clarinet should be held at about a forty-degree angle to the body. (A somewhat smaller angle is necessary for players with pronounced "overbite," a larger angle for players with a strong chin and jaw formation.)

3. Place the corners of the mouth firmly in toward each other in an "oo" formation, being careful not to allow the lower lip to change position. This pressure continues inwardly until the mouthpiece is surrounded by the flexed muscles of the mouth, thus effectively sealing in the air. These corner muscles must be developed through daily exercise until they can maintain a constant, firm pressure for the entire period of a performance. There must be no biting of the mouthpiece caused by the use of the chewing muscles of the
jaw. The pressure is exerted almost completely by the inward gripping at the sides of the mouthpiece. This slight lower lip pressure is controlled by almost imperceptible motions of the jaw, an upward push being used to shorten the vibrating arc of the reed for high notes, and a lowering motion for lengthening the arc of the reed for low notes. There is a slightly different pressure from the lower lip, countered still by side gripping for each note of the clarinet scale. This is memorized as the pupil becomes more aware of the tone quality possible and the pitch sound of each note. The relationship of pressure and counter-pressure exerted by the embouchure muscles is the controlling factor of good tone quality and pitch centering.

4. Blow a steady, concentrated stream of air at the reed with the throat open. Here again, the "oo" formation of the lips will aid in opening the throat. The ensuing sound should be clear, firm, full, and of a ringing quality which fills every corner of the room., p. 1.

Improper tonguing could cause intonation problems due to the action of the tongue and possible movement of the chin when the tongue is released. It is difficult to analyze and to make adequate corrections when the tongue is unobservable. Dalby (1954) explains correct tonguing procedure as follows:

1. The mouthpiece is placed in the mouth with reed on lower lip, a breath is taken, and the embouchure is formed about the mouthpiece, the corner muscles of the mouth locking the jaw firmly in place.

2. The tongue is moved up and forward until it presses the reed against the tip opening of the mouthpiece. That part of the tongue which presses against the reed may be at the very tip of the blade or it may be a slight distance behind the blade tip, depending upon the length, size and shape of the tongue itself. In any case, the tongue must be raised and arched to meet the reed, and the part which touches the reed must be firmly flexed in non-legato style.

3. The opening being effectively sealed, the air is now permitted to rush forward and create pressure behind the mouthpiece. (No sound will be produced at this point since the reed is prevented by the tongue from vibrating.)

4. The tongue is now dropped quickly to the bottom of the mouth as when saying "too", thus allowing the air to snap the reed into immediate action. The resulting "T" sound is the basis for normal and staccato tonguing and is the ultimate test of whether or not the entire process has been performed correctly. (The legato is simply a modification of the process in which the tongue is completely relaxed and the syllable "D" is substituted for the "T".)
5. The jaw must not be permitted to move during the tonguing process. Any movement of the jaw changes pressure relationships between lower lip and reed, which in turn causes slipping of pitch. The unpleasant "too-ee" effect is caused by this jaw motion. An effective way to correct this bad habit is to have the pupil practice tonguing open "C" while holding his jaw motionless with his left hand. The practice must be continued until tongue and jaw are completely divorced.

6. Under no circumstances should the tongue be allowed to touch the reed until the note being played has ended. The tongue, in rapid passages, returns immediately to the vicinity of the reed, but actual contact is delayed until the exact time of commencing the next note. Thus we have a continual series of "Tu-tu-tu-tu," never "Tut-ut-ut" or "Tut-tut-tut" sounds., p. 2.

The above information regarding tone production is an important part of the ability to play in tune. It has been observed by the writer that in ensemble playing, a good tone enhances the ability to hear beats distinctly, thereby allowing for quick adjustment by the performer. In contrast, a poor tone creates beats which seem more difficult to hear than beats created with good tone qualities. The beats still exist, and the unpleasant tonal factor is added to the already disagreeable experience of out-of-tuneness for the listener.
CHAPTER III

METHOD

Introduction

The Null Hypothesis of no significant difference between procedures used in teaching clarinet players how to play in tune was tested.

Design of the Study

The experimental design followed a pretest-posttest control group design with three experimental groups (Campbell and Stanley, 1966). The study was an investigation of the various teaching procedures used to attain improved intonation in clarinet performance. Three selected procedures were tested utilizing (a) beats, (b) C.G. Conn Stroboscope and (c) Johnson Intonation Trainer. A standardized test using specific items and methods needed for this study was not available which necessitated the construction of a test by the researcher (Appendix C). All clarinet players from T.H. Bell, Roy, Sandridge and South Junior High School Concert Bands in Ogden, Utah, participated in the study. Members of the North Davis Junior High School Concert Band clarinet section participated in determining the reliability of the test constructed by the writer. The Deagonometer and Johnson Intonation Trainer were used to explain the process of creating and the identification of beats (see p. 30). The above orientation consisted of three parts: (a) identification of beats, (b) pitch memory, (c) tuning to pitches while playing the clarinet using the beat method on specific notes.
Procedure

Instruments which were difficult to play because of mechanical problems were adjusted and repaired to help eliminate psychological and physical problems in the players' habits which might have caused him to play out of tune. All clarinets were checked by the writer using the C.G. Conn Stroboscope in identifying intonation problems which may have been due to manufacturing irregularities. Specific notes which were checked are found in figure 1.

![Figure 1](image)

Mouthpieces of all clarinets were tested for clarity of response. All brands of clarinets and mouthpieces were accepted. Notes which were tested above are those which have been found to cause clarinet players the most severe problems in tuning. It is hoped that the process of correcting intonation used in this study will be useful in correcting all tones which may be found to be out of tune. It is acknowledged that instruments do not always have the same intonation problems. Embouchure adjustment was practiced to accomplish the approximate movement of any tone up to twenty hundredths of a semitone. Twenty hundredths of a semitone was selected as an arbitrary figure by the writer to be considered the limit a person can successfully humor a pitch without serious tonal distortion. Humoring of pitches upward seemed more difficult to accomplish because the prevalent procedures by area band directors is to have students play at the upper limits of each tone except when deliberately altering the pitch.
Control Group A

N=10. This group received no special instruction on intonation other than what their regular teacher gave them as a part of the large group participation of the band. They were pretested and posttested as to improvement over a six-week period.

Experimental Group B

N=15. This group was taught by the writer. All Ss continued instruction with their regular music teacher. They received instruction on intonation for fifteen minutes twice each week for six weeks. This instruction included tuning unisons, major thirds, fifths and sevenths. Other performance problems such as tones, tonguing, phrasing, rhythm and style were included in the remainder of the two forty-five minute class periods per week. Instruction books for this group included the "Rubank Intermediate Clarinet Method," Rubank Inc.; J. E. Skornika and R. Miller, Chicago, Illinois; and "Selected Duets for Clarinet," Volume 1, H. Voxman, Rubank Inc., Chicago, Illinois. The following procedure using sequential steps necessary to play in tune was practiced until all Ss were able to tune quickly to any given pitch. Ss must be able to: (a) sustain a tone of steady pitch, (b) humor the pitch, (c) hear beats, (d) follow prescribed practice habits:

(1) Player one assumed that he was in tune and produced a given pitch.

(2) Player two, after having the tone well in mind, played the same pitch. If he heard beats, he immediately decided either by knowing or by guessing which way to humor his pitch. If player two humor ed the tone in the right direction the beats became slower. If he humored the pitch in the wrong direction the beats immediately became faster which gave the player the signal to humor the pitch in the opposite direction.
(3) After tuning the beats out, player two moved the end of his horn in a circular motion indicating that he had discerned that he was in tune. Both players stopped playing. This process was repeated until player two was able to tune out beats quickly.

(4) Player number two assumed that he could remember what he did in step three to play in tune and both players produced the same tone simultaneously to ascertain if they could produce the same tone without beats. This is termed embouchure memory.

(5) The successful accomplishment of step four allowed the same process to begin on a new tone until the players could play all tones on their instrument in tune.

(6) Players reversed roles allowing both to experience tuning out the beats as found on p. 32 and 33.

Using the beat method as an aid for playing in tune, the following variables were considered as essential aspects of the S's ability to play in tune:

a. **Good Tone.** Admitting the subjectiveness of the term, "good tone", if the suggestions quoted on page 17 and 18, Chapter II, by Dalby (1945) are followed, and with a musical background and experience of hearing good symphonic players of clarinet, it is assumed that a person can develop a concept of a good clarinet tone.

b. **Vibrato.** A vibrato is described as a rapid oscillation to each side of the true pitch on an instrument or with the voice (The New College Encyclopedia of Music, 1960). It is difficult to use the beat method for tuning if vibrato is used because the pitch fluctuation and speed of oscillation are seldom the same among players. Clarinet vibrato is seldom recommended in band and orchestra performance.

c. **Steady Pitch.** Quick tuning is dependent upon one's tone being steady. Holding a tone of steady pitch was practiced using the C.G. Conn Stroboscope.

d. **Tonguing.** Any movement of the jaw while tonguing will result in pitch fluctuation.

e. **Practice.** If more than two tones are present with slight degrees of out-of-tuneness, the tuning problem is compounded. Practice should be limited to two sources of sound until Ss become proficient in tuning quickly. A third subject could be added as members become adroit in the tuning process.
f. **Instrument Insight.** Knowing and the memorization of out-of-tune notes on an instrument in relation to the tempered scale aids in giving direction for humoring notes.

g. **Beats.** The construction of exercises using the Johnson Intonation Trainer in the tuning-out-the-beats process aids in beat detection. For some people beat detection is more difficult than for others; therefore, practice in hearing and tuning-out-beats is a valuable exercise.

h. **Humoring Pitches.** The movement of a pitch up or down is necessary for quick tuning. Exercises using the C. G. Conn Stroboscope or the Johnson Intonation Trainer can be structured for this procedure.

**Experimental Group D**

N=15. This group was taught by the writer. They received instruction on intonation using the Johnson Intonation Trainer for fifteen minutes twice each week. The instruction included tuning unisons, major thirds, fifths and sevenths. Other performance problems such as tone, tonguing, phrasing and style, while playing clarinet, were included as part of the instruction during the two forty-five minute class periods per week. Instruction books used by this group were the same as Experimental Group B.

**Intonation Training Procedure**

The following structured procedure of tuning-the-beats-out of unisons, fifths, thirds, sevenths and major chords on the Johnson Intonation Trainer was used. The objective of this procedure was to see if there was any transfer of knowledge from tuning beats out on the Intonation Trainer and being able to play in tune on the clarinet. Practice with other clarinets followed the exercises utilizing the Johnson Intonation Trainer. The following exercises were constructed...
to develop the ability to hear and tune-the-beats-out while using the
Intonation Trainer:

Exercise 1, Tuning Unisons:

Instructions: Each tone will be mistuned with another note of the same
name. See how quickly you can tune-the-beats-out.

Exercise 2, Tuning Fifths:

Instructions: Each interval is mistuned to create beats of different
speeds. See how quickly you can tune-the-beats-out.

Exercise 3, Tuning Thirds:

Instructions: Each interval is mistuned to create beats of different
speeds. See how quickly you can tune-the-beats-out.

Exercise 4, Tuning Sevenths:

Instructions: Each interval is mistuned to create beats of different
speeds. See how quickly you can tune-the-beats-out.
Exercise 5, Tuning Chords:

Instructions: The following chords are mistuned. Tune the beats out of the chord by tuning the following intervals to the root, the fifth and the third. As soon as they are tuned, play the chord to ascertain if there are beats. If you have tuned accurately you will hear no beats. If there are beats, repeat by first tuning the fifth and then the third of the chord.

Exercise 6, Tuning Seventh Chords:

Instructions: The following chords are mistuned. Tune the beats out of the chord by first tuning the following intervals to the root; the fifth, third, and the seventh. After tuning each interval, play the chord to ascertain if there are beats. If you have tuned accurately you will not hear beats. If you hear beats, repeat by first tuning the fifth, third and seventh intervals with the root.

Experimental Group C

N=12. The Ss were taught by the writer using the C. G. Conn Stroboscope for fifteen minutes twice each week. Instruction included tuning unisons, major thirds, fifths and sevenths using the Johnson Intonation Trainer as a source tone. Other aspects of clarinet performance such as tone, tonguing, phrasing and style were included as part of the Ss instruction.

Intonation Training Procedure

The following structured procedure of embouchure memory and tuning to the stroboscope was employed. Ss practiced tuning to pitches which
were visible on the stroboscope. This procedure was to acquaint the Ss with out-of-tune notes on their instruments and directed practice in humoring the pitch to be in tune. The objective was to ascertain if there was transfer of knowledge from this method to the act of playing their instrument in tune with other players.

**Exercise 1, Tuning Unisons**

Instructions: Tune each one of the following notes by humoring the pitch until the wheel stops on the corresponding window in the stroboscope. Try to memorize the out-of-tune notes and the direction in which they are out-of-tune.

a. [Diagram]

b. 8-va higher [Diagram]

c. chromatic [Diagram]
Exercise 2, Tuning Unisons:

Instructions: Each of the following notes will be mistuned either sharp or flat. Humor the pitch until you stop the window on each of the following notes:

```
d. 
```

Exercise 3, Tuning Unisons:

Instructions: Repeat exercise 1, trying to memorize the out-of-tune notes. Play the following scales humoring each pitch to accomplish quick tuning. Do not look at the stroboscope window. You will be marked on each of the notes as to how far and what direction you are out-of-tune. Repeat this exercise until you play every note as close to the pitch on the stroboscope as possible.

```
a. 
```

```
b. 
```

```
c. 
```
Pretest-Post-test Procedure

The following tests and information required the use of the Deagonometer and the Johnson Intonation Trainer. All Ss from five junior high school concert band clarinet sections were given these tests. Tests Number I and II were given to each clarinet section as a whole, while Test Number III was given to each individual without other Ss being present. All three tests were used in both pre and post-testing. Instructions were given to acquaint the Ss with their specific role in this study. All Ss were told that this is a study on intonation and they would be tested on their ability to play in tune before and after the study. The importance of being present each practice session was emphasized.

Part I: Orientation and Practice

When a musical tone is sounded, the air is set in motion and it begins to move in a wave-like manner at the same rate of speed as the vibrations of the tone. These air waves move against your ear drum causing it to depress and retract at the same rate of speed as the tone vibrations. This is called condensation and rarefaction of the air molecules. Example: Concert A produces sound waves at a rate of 440 vibrations per second (ex: 440 cps). You will now hear two tones sounded together, both being identical in number of vibrations per second resulting in a constant clear sound (ex: 466.2 + 466.2). You will now hear two tones, one which will vibrate at 440 times per second and the other at 443 times per second (ex: 440 + 443). You should hear a loud sound followed by a soft sound identified as beats. When air vibrations are exactly opposite each other, causing one to push on the ear drum
and the other to release, the ear drum will cease to vibrate. This vibrational stoppage resulting from the above tones will cause you to hear three beats per second. Is there anyone who cannot hear the beats? Please demonstrate your ability to hear the following beats by moving your hand up and down at the same rate of speed as the beats which you will hear. Please close your eyes or place your head on the desk while you demonstrate your ability to hear beats at differing speeds created by the following examples: (See Appendix A for a test copy.)

<table>
<thead>
<tr>
<th>Given Tones</th>
<th>Did Identify</th>
<th>Did not Identify</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 400 --- 443 cps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. 443 --- 441 cps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. 441 --- 446 cps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. 443 --- 446 cps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. 441 --- 446 cps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. 443 --- 450 cps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. 441 --- 440 cps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. 450 --- 446 cps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. 441 --- 450 cps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. 440 --- 441 cps</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Part II: Pitch Memory Test

The Deagonometer was used for this part of the test. The tester sounded one bar, silencing it after approximately three seconds, then immediately sounding a second bar for three seconds, the tone of which was either higher, lower or the same in cps.

Instructions: You will now hear an example (446.2 + 440). Was
the second tone higher or lower than the first? (A second example was given $446 + 442$). You will now hear twenty examples. Mark the appropriate place on your paper if the second tone is higher, lower or the same. Are there any questions? (See Appendix B for a test copy.)

<table>
<thead>
<tr>
<th>Given Tones</th>
<th>Higher</th>
<th>Lower</th>
<th>Same</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 443 --- 400 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>2. 443 --- 446 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>3. 442 --- 450 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>4. 450 --- 440 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>5. 446 --- 442 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>6. 440 --- 443 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>7. 442 --- 446 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>8. 443 --- 443 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>9. 446 --- 440 cps</td>
<td>______</td>
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<td>_____</td>
</tr>
<tr>
<td>10. 443 --- 441 cps</td>
<td>______</td>
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<tr>
<td>11. 446 --- 443 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
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<tr>
<td>12. 440 --- 440 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>13. 443 --- 442 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
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<tr>
<td>14. 442 --- 443 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>15. 450 --- 450 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>16. 441 --- 440 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>17. 441 --- 446 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>18. 446 --- 443 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>19. 446 --- 446 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
<tr>
<td>20. 440 --- 466.2 cps</td>
<td>______</td>
<td>______</td>
<td>_____</td>
</tr>
</tbody>
</table>
Part III: Playing Test

This is a test in matching pitches. It was individually given. Before starting this part of the test, the Ss were asked to tune to a concert Bb with the aid of the writer. The Johnson Intonation Trainer was used for this part of the test.

Instructions: You will now hear the tone C. Please tune to it as quickly as possible. When you think the note is in tune stop playing (ex: C). Please try another tone, B---tune to it as quickly as possible (ex: B). You will now be given seven tones in which you will have ten seconds to match each pitch. You are not to move your tuning barrel. When you think each tone is in tune please stop playing. A flash card with the tone will be shown at the same time that you hear it. You will have an opportunity to go through all the tones three times. The following tones will be used:

When each tone is played wait for a few seconds before you start to play to help get the pitch well in mind before you try to match it. (See Appendix C for a copy.)

<table>
<thead>
<tr>
<th>GIVEN NOTES</th>
<th>SECONDS TO TUNE</th>
<th>DEGREE OF OUT-OF-TUNENESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. G</td>
<td></td>
<td>semitone</td>
</tr>
<tr>
<td>2. A</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>3. Bb</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>4. B</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>5. A</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>GIVEN NOTES</td>
<td>SECONDS TO TUNE</td>
<td>DEGREE OF OUT-OF-TUNENESS</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>6. Bb</td>
<td></td>
<td>0 semitone</td>
</tr>
<tr>
<td>7. C</td>
<td></td>
<td>0 &quot;</td>
</tr>
<tr>
<td>1. G</td>
<td></td>
<td>0 &quot;</td>
</tr>
<tr>
<td>2. A</td>
<td></td>
<td>0 &quot;</td>
</tr>
<tr>
<td>3. Bb</td>
<td></td>
<td>0 &quot;</td>
</tr>
<tr>
<td>4. B</td>
<td></td>
<td>0 &quot;</td>
</tr>
<tr>
<td>5. A</td>
<td></td>
<td>0 &quot;</td>
</tr>
<tr>
<td>6. Bb</td>
<td></td>
<td>0 &quot;</td>
</tr>
<tr>
<td>7. C</td>
<td></td>
<td>0 &quot;</td>
</tr>
</tbody>
</table>

SECOND TIME

| 1. G        |                 | 0 "                       |
| 2. A        |                 | 0 "                       |
| 3. Bb       |                 | 0 "                       |
| 4. B        |                 | 0 "                       |
| 5. A        |                 | 0 "                       |
| 6. Bb       |                 | 0 "                       |
| 7. C        |                 | 0 "                       |

THIRD TIME

| 1. G        |                 | 0 "                       |
| 2. A        |                 | 0 "                       |
| 3. Bb       |                 | 0 "                       |
| 4. B        |                 | 0 "                       |
| 5. A        |                 | 0 "                       |
| 6. Bb       |                 | 0 "                       |
| 7. C        |                 | 0 "                       |
CHAPTER IV
RESULTS

Statistical analysis of the data in the study was computed through the Computer Services at Utah State University. A standard Statistical Pack used included a Two-way Analysis of Variance and a single factor Analysis of Covariance. The statistical level of significance selected for the study was .05. The statistical analysis used a (t) distribution with pooled variance to test for differences between paired treatments. The level of significance referred to the probability of making a type I error that of rejecting a true hypothesis. The F test used for analysis is a ratio of two estimators of the population means. They are usually regarded as better estimates of the treatment effects than the unadjusted means because one or more of the sources of experimental error has been removed by the adjustments. Identification of groups and treatment methods are listed below:

Group A = No Contact Control
Group B = Beat Method
Group C = C. G. Conn Stroboscope
Group D = Johnson Intonation Trainer
Group E = Test Reliability

Identification of Beats

One of the questions this study tried to answer was, is there a difference among groups prior to receiving treatment in the identification of beats (Table 1).
### TABLE 1
Pretest-Identification of Beats

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>3</td>
<td>.609</td>
<td>.203</td>
<td>.08</td>
</tr>
<tr>
<td>ERROR</td>
<td>50</td>
<td>126.6</td>
<td>2.53</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUPS</th>
<th>TRT MEANS</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>.666</td>
<td>.459</td>
</tr>
<tr>
<td>B</td>
<td>.666</td>
<td>.410</td>
</tr>
<tr>
<td>C</td>
<td>.583</td>
<td>.459</td>
</tr>
<tr>
<td>D</td>
<td>.866</td>
<td>.410</td>
</tr>
</tbody>
</table>

The analysis of Variance on the pretest of Identification of Beats indicates that there is no difference among groups as shown in Table 1, $F = .08$.

This study attempted to answer the question, is there a difference among groups in the Identification of Beats after treatment (Table 2).

### TABLE 2
Posttest-Identification of Beats

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>3</td>
<td>3.17</td>
<td>1.05</td>
<td>1.17</td>
</tr>
<tr>
<td>ERROR</td>
<td>50</td>
<td>44.9</td>
<td>.89</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUPS</th>
<th>TRT MEANS</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>.583</td>
<td>.273</td>
</tr>
<tr>
<td>B</td>
<td>.000</td>
<td>.244</td>
</tr>
<tr>
<td>C</td>
<td>.000</td>
<td>.273</td>
</tr>
<tr>
<td>D</td>
<td>.000</td>
<td>.244</td>
</tr>
</tbody>
</table>
The Analysis of Variance on the Posttest of Identification of beats indicate that there was still no difference between groups shown in Table 2, $F = 1.17$.

The hypothesis that without practice there is no difference among groups on the Identification of Beats using the pretest as the Covariate was tested (Table 3).

**TABLE 3**
Identification of Beats—Analysis of Covariance

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>MS</th>
<th>ADJ-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>3</td>
<td>1.11</td>
<td>1.44</td>
</tr>
<tr>
<td>REG</td>
<td>1</td>
<td>7.26</td>
<td>9.45</td>
</tr>
<tr>
<td>ERROR</td>
<td>49</td>
<td>.76</td>
<td></td>
</tr>
</tbody>
</table>

The Analysis of Covariance on the Identification of Beats indicates that there is no difference, $F = 1.44$.

Few Ss demonstrated the inability to hear beats either at the pretest or the posttest. All Ss demonstrated the ability to hear beats; however, some were unable to detect the speed of the beats in some examples.
Pitch Memory - Test 2

The question to be answered on Pitch Memory was, is there a difference among groups prior to receiving treatment (Table 4).

TABLE 4

Pretest-Pitch Memory

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>3</td>
<td>97.2</td>
<td>32.42</td>
<td>5.19</td>
</tr>
<tr>
<td>ERROR</td>
<td>50</td>
<td>311.9</td>
<td>6.23</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TRT MEANS</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8.00</td>
<td>.721</td>
</tr>
<tr>
<td>B</td>
<td>10.00</td>
<td>.644</td>
</tr>
<tr>
<td>C</td>
<td>8.75</td>
<td>.721</td>
</tr>
<tr>
<td>D</td>
<td>6.46</td>
<td>.644</td>
</tr>
</tbody>
</table>

The Analysis of Variance on the pretest of Pitch Memory indicate that there is a difference between groups shown in Table 4, $F = 5.19$. This difference may be due to the kind of teaching they have received in school prior to this study. It may also be due to home musical environment and past experience as discussed in Chapter II.

The second question to be answered relating to Pitch Memory was, is there a difference among groups after treatment (Table 5).
The Analysis of Variance on the posttest on Pitch Memory indicates that there is no difference among groups after treatment accepting the Null Hypothesis that of no difference as $F = 1.70$. The reason for the change from pretest to posttest may have been due to treatment. The actual practice of trying to identify slight differences in pitches which are not played simultaneously was not practiced in the procedures of playing in tune. The emphasis placed on playing in tune and identification of beats may have caused the students to be more accurate on the posttest after learning more about intonation.

The hypothesis that without practice there would be no difference among groups in ability to remember pitches using the pretest as the covariate was tested (Table 6).
The Analysis of Covariance on the ability to remember pitches indicates that there is no difference as the adjusted $F = 1.33$.

**Tuning to Specified Pitches - Test 3**

The question to be answered regarding Tuning to Specified Pitches was, is there a difference among groups prior to receiving treatment (Table 7).
### TABLE 7

Pretest-Tuning to Specified Pitches

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>3</td>
<td>20880.0</td>
<td>6960.1</td>
<td>.795</td>
</tr>
<tr>
<td>ERROR</td>
<td>50</td>
<td>437431.0</td>
<td>8748.6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TRT MEANS</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>215.9</td>
<td>27.0</td>
</tr>
<tr>
<td>B</td>
<td>199.6</td>
<td>24.1</td>
</tr>
<tr>
<td>C</td>
<td>206.6</td>
<td>27.0</td>
</tr>
<tr>
<td>D</td>
<td>164.8</td>
<td>24.1</td>
</tr>
</tbody>
</table>

The Analysis of Variance on the Pretest of Tuning to Specified Pitches indicate that there is no difference between groups shown in Table 7, $F = .795$.

This study attempted to answer the question of, is there a difference among groups after treatment in Tuning to Specified Pitches (Table 8).

### TABLE 8

Posttest-Tuning to Specified Pitches

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>3</td>
<td>229428.0</td>
<td>7647</td>
<td>14.29</td>
</tr>
<tr>
<td>ERROR</td>
<td>50</td>
<td>267548.0</td>
<td>5350</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TRT MEANS</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>223.0</td>
<td>21.1</td>
</tr>
<tr>
<td>B</td>
<td>37.93</td>
<td>18.8</td>
</tr>
<tr>
<td>C</td>
<td>129.4</td>
<td>21.1</td>
</tr>
<tr>
<td>D</td>
<td>118.8</td>
<td>18.8</td>
</tr>
</tbody>
</table>
The Analysis of Variance on the Posttest of Tuning to Specified Pitches indicate that there is a difference between groups shown in Table 8, \( F = 14.39 \). All groups improved from pretest to posttest; however, the group which learned to tune using the Beat Method showed more improvement than all other groups. This improvement is believed to be caused by the procedures used to teach Ss how to play in tune outlined in Chapter III.

The hypothesis that without practice there is no difference among groups on playing specified pitches in tune using the pretest as the Covariate was tested (Table 9).

**TABLE 9**

Analysis of Covariance-Tuning to Specified Notes

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>MS</th>
<th>ADJ-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>3</td>
<td>72143.0</td>
<td>16.24</td>
</tr>
<tr>
<td>REG</td>
<td>1</td>
<td>50007.0</td>
<td>11.26</td>
</tr>
<tr>
<td>ERROR</td>
<td>49</td>
<td>4439.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP</th>
<th>ADJ-MEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>216.0</td>
</tr>
<tr>
<td>B</td>
<td>36.42</td>
</tr>
<tr>
<td>C</td>
<td>125.5</td>
</tr>
<tr>
<td>D</td>
<td>129.1</td>
</tr>
</tbody>
</table>

The Analysis of Covariance on Ss being able to play specified pitches in tune indicate that there is a difference, \( F = 16.24 \). Although all groups showed some improvement, the Beat Method Group was significantly better. They showed more confidence and demonstrated the ability to identify and correct out-of-tuneness better than all other groups.
This study tried to answer the question of, is there a difference among groups in the amount of time it takes to tune to specified pitches without practice (Table 10).

TABLE 10
Pretest-Time Variable, Tuning to Specified Notes

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>3</td>
<td>4563.0</td>
<td>1521</td>
<td>4.74</td>
</tr>
<tr>
<td>ERROR</td>
<td>50</td>
<td>16038.0</td>
<td>320.7</td>
<td></td>
</tr>
</tbody>
</table>

The Analysis of Variance on the Pretest of the amount of time it takes to tune to specified pitches without practice indicate that there is a difference among groups, F = 4.74. The difference may have been due to some students not knowing if they were in tune and stopping. It may also have been due to uncontrollable noise in the halls. Each testing station was accoustically different allowing different amounts of outside noise to infiltrate into the room. However, the noise factor was controlled as much as possible.

The second question regarding the time it takes to tune to specified pitches was, is there a difference among groups after treatment (Table 11).
The Analysis of Variance on the Posttest of the time it takes to play selected pitches in tune indicate that there is no difference shown in Table 11, $F = 1.33$.

The hypothesis that without practice there is no difference among groups in the amount of time it takes to play selected pitches in tune using the pretest as a Covariate was tested (Table 12).
TABLE 12

Analysis of Covariance Time Variable-Playing Selected Pitches

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>MS</th>
<th>ADJ-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>3</td>
<td>471.3</td>
<td>1.84</td>
</tr>
<tr>
<td>REG</td>
<td>1</td>
<td>3841.6</td>
<td>15.03</td>
</tr>
<tr>
<td>ERROR</td>
<td>49</td>
<td>355.4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP</th>
<th>ADJ-MEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>63.8</td>
</tr>
<tr>
<td>B</td>
<td>66.5</td>
</tr>
<tr>
<td>C</td>
<td>63.0</td>
</tr>
<tr>
<td>D</td>
<td>76.0</td>
</tr>
</tbody>
</table>

The Analysis of Covariance on the amount of time it takes to play selected pitches in tune indicates that there is no difference as the adjusted $F = 1.84$.

Test Reliability Group E

The tests used in this study were constructed by the researcher to secure pertinent data for statistical analysis. Prepared tests which claim validity were not available. North Davis Junior High School Concert Band Clarinet Section, ($N = 15$) was used for checking the reliability of the constructed tests. There was a ten day interval between testing dates with no special instruction between tests except that information received from regular classroom instruction by their band teacher.
Beat Identification - Test 1

A question to be answered about the ability of the Test Reliability Group regarding the Identification of Beats was, is the group able to recognize beats without practice (Table 13).

**TABLE 13**

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLK</td>
<td>14</td>
<td>29.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRT</td>
<td>1</td>
<td>.533</td>
<td>.533</td>
<td>.25</td>
</tr>
<tr>
<td>ERROR</td>
<td>14</td>
<td>29.46</td>
<td>2.10</td>
<td></td>
</tr>
</tbody>
</table>

The Analysis of Variance on the improvement of the Test Reliability Group E on Beat Identification from the first to the second test period shows no improvement as indicated in Table 12, $F = .25$.

Pitch Memory - Test 2

In the Identification of Beats without practice, the question to be answered was, is there improvement by the Test Reliability Group from pretest to posttest (Table 14).
The Analysis of Variance on the improvement of the Test Reliability Group on Pitch Memory from the first to the second testing period shows no improvement as indicated in Table 14, $F = .08$.

### Tuning to Selected Pitches - Test 3

The study attempted to answer the question, was the Test Reliability Group able to tune to selected pitches without practice (Table 15).
The Analysis of Variance on the improvement of the Test Reliability Group to tune to selected pitches from the first to the second testing period shows no improvement as indicates in Table 15, $F = .375$.

**Time Variable, Tuning to Specified Pitches - Test 4**

The hypothesis that there will be no improvement without practice among Ss on the amount of time it takes to tune to specified pitches from pretest to posttest was tested (Table 16).

<table>
<thead>
<tr>
<th>TABLE 16</th>
</tr>
</thead>
</table>

**Time Variable, Tuning to Specified Pitches-Pretest-Posttest**

<table>
<thead>
<tr>
<th>SV</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLK</td>
<td>14</td>
<td>108437</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRT</td>
<td>1</td>
<td>55987.2</td>
<td>55987.2</td>
<td>8.59</td>
</tr>
<tr>
<td>ERROR</td>
<td>14</td>
<td>91207.8</td>
<td>651484.8</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TRT</th>
<th>TRT MEANS</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIRST TIME</td>
<td>254.5</td>
<td>20.84</td>
</tr>
<tr>
<td>SECOND TIME</td>
<td>168.1</td>
<td>20.84</td>
</tr>
</tbody>
</table>

The study attempted to answer the question, was there improvement from pretest to posttest by the Test Reliability Group on their ability to tune to specified pitches in measured time (Table 16). Test results show a significant decrease in the time it took the Ss to tune to specific pitches, $F = 8.59$; however, as shows in Table 15, $F = .375$, they showed no improvement in being able to tune to the selected pitches. Therefore, the time variable should be considered unreliable and deleted from the test.
The testing of Procedures used in teaching clarinet players how to play in tune was a primary objective. The study showed significant difference between the Beat Method Group B, the Johnson Intonation Trainer Group D and C. G. Conn Stroboscope Group C in tuning to specified pitches at the .05 level. There was no significant difference between the Johnson Intonation Group C and the C. G. Conn Stroboscope Group D in tuning to Specified Pitches. Ss demonstrated the ability to hear out-of-tuneness before treatment but lacked the knowledge and ability of how to fix it. All Ss were able to hear beats without practice and only six out of sixty-nine were unable to determine the speed of the beats in all examples. All Ss possessed the ability to hear out-of-tuneness in the Pitch Memory test without practice. The reliability of Test 1, 2 and 3, i.e., Identification of Beats, Pitch Memory and Tuning to Specified Pitches was accomplished. The Time Variable test, Tuning to Specified Pitches in a measured amount of time showed discrepancies and is considered an unreliable part of the testing procedures.

The Analysis of Variance was used to compute the data. The findings showed insignificant gains by all groups on Test 1 and 2, i.e., Identification of Beats and Pitch Memory because all subjects showed ability to identify beats and remember pitches without practice. Test 3, the Tuning to Specified Pitches showed improvement by all groups with the exception of the Control and Test Reliability Groups.
CHAPTER V
CONCLUSIONS

This study assessed the relative efficiency of three teaching procedures used in the development of improving intonation in clarinet performance. The three treatment procedures used included the Beat Method, the C. G. Conn Stroboscope and Johnson Intonation Trainer. During the six weeks study, all Ss participated in two forty-five minute lessons per week. Intonation procedures were studied for fifteen minutes each lesson while other playing problems were discussed for the remaining time. Instruction time totaled nine hours per group. All Ss continued class work with their school music teacher. The experimental design also included a No Contact Control Group which received no special instruction during the six weeks. Standardized tests using specific items and methods needed for this study were not available. This necessitated the construction of tests by the writer (Appendix A, B and C). A Test Reliability Group E (N = 15), took the test twice with ten days between testing periods. Other schools were randomly assigned to one of the treatment groups, (a) No Contact Control Group A (N = 12), (b) Beat Method Group B (N = 15), (c) C. G. Conn Stroboscope Group C (N = 12), and (d) Johnson Intonation Trainer Group D (N = 15).

All groups participated in a pretest and posttest. The Johnson Intonation Trainer was used to produce a constant pitch while the C. G. Conn Stroboscope measured the degree of out-of-tuneness during testing.
procedures. Instructions for the test were read to minimize variation. The test orientation consisted of three parts (a) Identification of Beats (Appendix A), (b) Pitch Memory (Appendix B), (c) Tuning to Selected Pitches while playing the clarinet (Appendix G). The analysis of variance was used to compute the data.

Ss were unable to tune to specified pitches without practicing systematic procedures on how to accomplish this task. Subjects were unable to change pitches more than .05 of a semitone in the pretest, Tuning to Specified Pitches. After treatment, the ability to change pitches up to .25 of a semitone was accomplished. Clarinet players, considered technically less proficient by their teachers, also accomplished matching pitches on the pretest as accurately as advanced players.

This study strongly confirms the thesis that students can learn to play in tune through using "systematic procedures" with the cooperative efforts of teachers. It is also concluded that the procedures used in the "Beat Method" are significantly better than other procedures tested.
APPENDIX A

Participant Number _____

PERFORMANCE EVALUATION #1

Identification of Beats

INSTRUCTIONS: This evaluation has been structured to determine if you can hear beats.

a. There will be an explanation of what beats are and how to identify them.

b. You will be given two examples: (1) How two tones sound when they are beatless, or in tune; (2) How two tones sound when they create beats or are not in tune.

c. Please do not sign your name. You will be identified by the number seen in the upper right hand corner.

d. You are to move your hand up and down at the same rate of speed as the beats which you hear.

<table>
<thead>
<tr>
<th>Did Identify</th>
<th>Did Not Identify</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
</tr>
</tbody>
</table>
INSTRUCTIONS: This evaluation has been structured to see if you can hear small differences in pitch of slightly mistuned notes of the same name.

a. One example and explanation will be given to clarify what you are to do.

b. One bar will be sounded on the Deagonometer and after approximately three seconds it will be silenced. Immediately following you will hear a second tone which will be silenced after three seconds.

c. You are to determine if the second tone is higher, lower, or the same as the first tone.

d. Please do not sign your name. You will be identified by the number seen in the upper right hand corner. Make an X or check by the appropriate space.

<table>
<thead>
<tr>
<th>Higher</th>
<th>Lower</th>
<th>Same</th>
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<td>20.</td>
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APPENDIX C

Participant Number ___

PERFORMANCE EVALUATION #3

Playing Test

EQUIPMENT: The Johnson Intonation Trainer, Students with clarinets, and the C. G. Conn Stroboscope.

INSTRUCTIONS: This evaluation has been structured to see if you can tune to seven pitches which are placed on flash cards for your convenience. You will tune to your C before the exercise begins and you will receive help if needed.

a. You will now hear the tone C; tune to it as quickly as possible.

b. You will be given seven tones in which you will have up to ten seconds to match each pitch.

c. You are not to move your tuning barrel once you have tuned your instrument.

d. A flash card with the tone will be shown at the same time you hear it on the machine. You will have an opportunity to go through all of the tones three times.

e. When each tone is played on the Johnson Intonation Trainer, wait for a few seconds before you start matching it to help get the pitch well in mind.

f. When you think each tone is in tune, move the end of your horn in a circular motion indicating that you think that the tone is in tune.

g. You will be given ten seconds on each tone to tune as quickly as possible.

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<th>SECONDS TO TUNE</th>
<th>DEGREE OF OUT-OF-TUNENESS</th>
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<td>1. G</td>
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<td>___ semitone</td>
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<td>___</td>
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<td>3. Bb</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>4. B</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>5. A</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>6. Bb</td>
<td>___</td>
<td>___</td>
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<td>7. C</td>
<td>___</td>
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## SECOND TIME

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<td></td>
<td>semitone</td>
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<tr>
<td>2. A</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>3. Bb</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>4. B</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>5. A</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>6. Bb</td>
<td></td>
<td>&quot;</td>
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## THIRD TIME

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<th>DEGREE OF OUT-OF-TUNENESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. G</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>2. A</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>3. Bb</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>4. B</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>5. A</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>6. Bb</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>7. C</td>
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<td>&quot;</td>
</tr>
</tbody>
</table>
APPENDIX D

TUNING UNISONS TO THE TEMPERED SCALE ON A STROBOSCOPE

Tune each one of the following notes by humming the pitch until the wheel stops on the corresponding window in the stroboscope. Try to memorize the out-of-tune notes and the direction in which they are out of tune.

Each of the following notes will be mistuned either sharp or flat. Humor the pitch until you stop the window on each of the following notes.
APPENDIX E

INTONATION MEMORIZATION TEST

Having memorized most of the out of tune tones on your instrument, play the following scales humming each pitch from memory to accomplish quick tuning. Do not look at the stroboscope window. You will be marked on each of the notes as to how far and what direction you are out-of-tune. Repeat this exercise until you can play every note as close to the pitch on the stroboscope as possible.
TUNING-OUT-BEATS ON THE JOHNSON INTONATION TRAINER

Each interval is mistuned to create beats of different speeds. See how quickly you can tune-the-beats-out.

The following triads and seventh chords are mistuned. Tune-the-beats-out of the chords by tuning the following intervals to the root, the fifth, third and seventh. As soon as they are tuned, play the chord to ascertain if there are beats. If you have tuned accurately, you will not hear beats. If there are beats, repeat by tuning the fifth, the third and the seventh to the root.
APPENDIX G

SELECTED NOTES FOR TESTING INTONATION

The following notes have been selected to be tested for accuracy of pitch on clarinets. They are the tones which Test 3 of the study were concerned with.

\[ \text{Diagram of musical notes} \]
APPENDIX H

BEAT METHOD

Beat Method Procedures for Teaching Intonation

1. Be able to hold a tone of steady pitch at different dynamic levels from the moment the sound begins until it ends by practicing with a visual aid such as the C. G. Conn Stroboscope.

2. Be able to hear beats. Practice with any kind of instrument which will produce varying speeds of beats, i.e., Johnson Intonation Trainer, Peterson Multituner or the Deagonometer.

3. Be able to humor the pitch. The ability to move the pitch up and down is a difficult concept for students to learn. The researcher used the concept of jaw vibrato to accomplish this task. Other methods included the use of auxiliary fingerings and tongue placement.

4. At the beginning, practice using two source tones only. While two players practice together, have one assume that he is in tune. The second player should wait momentarily until he has the agreed-upon pitch well in mind before he starts to match it. If there are beats when player two starts his tone, he should immediately humor the pitch until the two tones are as one, without beats. If player number two humors his pitch the wrong direction, the beats will become faster indicating that he should reverse the direction of the humored tone until the tones are beatless. This process should be used on all playable tones on their instruments. It is not important that the given tone be in tune with the tempered scale. Of primary importance is the practice of tuning to any given pitch provided that it is a constant vibrational frequency. The players then should reverse roles with player two assuming player one's role.
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K. Earl Ericksen
Route #1 Box 317
Morgan, Utah 84050

Coordinator, Music Education
Weber State College
Ogden, Utah 84403

Statistical Background

Birthdate: May 22, 1924, Manti, Utah. Married to Gretta Griffiths.

Professional Experience

Bachelor of Science: Physical Education, Brigham Young University
Provo, Utah, 1948.
Master of Science: Music Education and Psychology, Utah State
University, Logan, Utah, 1964.
Ed.D.: Curriculum Development and Supervision. Utah State University,
Dissertation Topic: "A Comparison of Three Teaching Procedures
Used in the Development of Improving Intonation in Clarinet
Performance."
Teacher and Coach, Duchesne High School, Duchesne, Utah, 1948-49.
Band and Choral Director, South Sevier High School, Monroe, Utah,
1950-51.
Band and Choral Director, Richfield High School, Richfield, Utah,
1951-52.
Educational Director and Salesman, Pearce Music Company, Salt Lake
City, Utah, 1952-57.
Band Director, Granite School District, Cyprus High School and
Olympus High School, Salt Lake City, Utah, 1957-60.
Band and Orchestra Director, Weber State College, Ogden, Utah,
1960-64
Coordinator, Music Education, Weber State College, Ogden, Utah,
1964-73.
Title III Grant for Golden Spike Symphony Orchestra Planning Committee
member.
Editor, Utah Music Educator - official state music magazine, 1966-69.

Publications:

"Five Hundred Hours Without Pay," Utah Music Educator, Vol. X, N. 3,
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"Performance vs Education," Utah Music Educator, Vol. XIV, No. 2,
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