BEAT ELIMINATION AS A MEANS OF TEACHING INTONATION TO BEGINNING WIND INSTRUMENTALISTS

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The ability to play in tune starts with the ability to recognize even slight pitch deviations readily. Since music teachers often have explained intonation chiefly through the use of electronic devices, which indicate pitch imperfections visually rather than aurally, many students have not been trained adequately in aural pitch apperception.[1]

In the late 1950s, Leeder and Haynie, followed later by other music educators, began to advocate teaching a tuning procedure long used by piano tuners, physicists, and some musicians.[2] The procedure, called the beat elimination process, is a dependable aural method of achieving correct intonation.[3] The paucity of references in the literature to the pedagogical use of the beat elimination process suggests that this procedure is little known and seldom employed in music education.

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[1] Randall Spicer, "Band Rehearsals for Growth," *Music Education in Action,* edited by Archie N. Jones (Boston: Allyn and Bacon, 1960), pp. 260-261; Robert W. House, *Instrumental Music for Today's Schools* (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1965), pp. 125-126; Robert Karl Webb, "Listen for the Beat," *School Musician,* Vol. 35, No. 9 (1964), pp. 46-47.

[2] Joseph A. Leeder and William S. Haynie, *Music Education in the High School* (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958), p. 135; William Stegeman, "Poor Intonation? No Excuse," *Music Journal,* Vol. 25, No. 9 (1967), pp. 42-44; Webb, pp. 46-47.

[3] William Braid White, *Piano Tuning and Allied Arts* (Boston: Tuners Supply Company, 1962), p. 78; Wilmer T. Bartholomew, *Acoustics of Music* (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1942), p. 118; C. A. Taylor, *The Physics of Musical Sounds* (New York: American Elsevier Publishing Co., 1965), pp. 115-116.

Caused by coincidence of compressions and rarefactions of two sound wave trains, beats are pulsations of sound heard when two tones of slightly different frequencies, such as 440Hz and 442Hz, occur at the same time. Should the two frequencies come closer together, beats will become slower; should the two frequencies become the same, the beats will disappear.[4]

The beat phenomenon has an obvious practical application in tuning musical instruments. The purpose of this study was to determine whether it could be used also by beginning wind students to improve their pitch-matching ability. The object was to determine to what extent beginning instrumentalists could learn to perceive correct intonation through learning to perceive beats in two or more mismatched tones; to what extent students could be taught to use this process to match unison pitches and to play in tune with other instrumentalists in major thirds, perfect fifths, and triads; and whether beginning wind instrumentalists could learn to play their instruments in tune if taught to hear and eliminate beats between the tones of their own instruments and those of other instruments.

The general design of the study required an instrument with a continuous frequency sound source to teach beat recognition at various pitches, a random sampling of beginning wind instrument students from a broad scope of socioeconomic backgrounds, a procedure for presenting and teaching students to hear beats and to use them in tuning their instruments, and a plan for collecting and treating data that would predict whether beginning wind instrument students could be taught to tune their instruments by the beat elimination process.

An electronic pitch matching device called an Intonation Trainer was used in the investigation. The Intonation Trainer consists of two oscillators, a forty-watt stereophonic amplifier, and two six-inch speakers. Designed by Nelson Patrick, a member of the music faculty at the University of Texas at Austin, the Trainer is capable of producing two pure tone frequencies simultaneously. Frequency adjustment is continuous from 20Hz to 500kHz, permitting a reference frequency to be established on one dial by the investigator while leaving the second dial to be adjusted by the student to produce the same frequency. Confronted with beats created by out-of-phase frequencies, the student eliminates the beats by manipulating the frequency control dial to tune the second pitch to match the first.

The study involved teaching sessions in which an investigator described the beat phenomenon and attempted to teach students individually to perceive beats and to eliminate them with the Intonation Trainer. The students were expected to gain a new concept of tuning in this way. Later in the study, an attempt was made to transfer this concept to situations in which the student tuned his instrument to that of another student and still later to the instruments of two other students.

[4] Bartholomew, pp. 54-59.

The 118 beginning wind instrument students participating in the study all had received one full semester of training on their instruments, and were enrolled for the second term of junior high school instruction. Comprised of thirty students from each of two schools and twenty-nine students from each of two other schools in a large metropolitan area, the sample was limited to students who played flute, oboe, clarinet, bass clarinet, saxophone, trumpet, cornet, horn, trombone, and baritone or bass horns. The students were selected by their own band directors, who were asked to choose subjects at random and without regard for musical or scholastic ability.

The investigation, conducted over a four-and-one-half-month period, involved six sessions with each of the participants. At the beginning of each session, the tasks of all earlier sessions were repeated before anything new was done. There were ten steps in all: four demonstrations by the investigator and six pitch discrimination tasks the investigator had devised for the students to perform. In order of ascending difficulty, the student's tasks were to match pitches on the Intonation Trainer, to match the pitch of his instrument with a pitch produced on the Trainer, to match his instrument's pitch with the pitch of the investigator's instrument, to match his instrument's pitch with the pitch of another student's instrument, to eliminate beats while playing perfect fifths and major thirds with the investigator, and to eliminate beats while playing a triad with two other students. Each task, designed to measure one of six abilities in pitch matching, represented, for the purpose of scale analysis, one item in the universe of attributes. Including the repetition of steps, each student performed tasks twenty-four times. A student's performance on each of the twenty-four trials was recorded on a data sheet. All observations were made by the investigator. These sessions were held on an individual basis, although individuals awaiting their turn were allowed to watch the performances of those ahead of them. Each individual was given repeated opportunities to succeed on each task. Only after he had failed on twenty trials of a single task was he credited with failure.

The first session consisted of a demonstration by the investigator of the use of the Intonation Trainer, a demonstration of the beat phenomenon, and a demonstration of the beat elimination process. The student then attempted to use the beat elimination process to match pitches on the Trainer.

In the second session, a review of the first session was followed by the investigator's demonstrating the matching of a wind instrument's pitch to the pitch of the Intonation Trainer. The student then attempted the same task. In the third session, the student attempted to match a pitch on his own instrument with a pitch produced by the investigator on a clarinet. In the fourth session, the student attempted to match pitches on his own instrument with pitches played by another student. In the fifth session, students attempted to produce intervals of major thirds and

perfect fifths, performing with the investigator; tuning was accepted when beats were eliminated. In the final session, each of three students sounded simultaneously one note of a major triad; tuning was accepted when beats were eliminated.

Subjects' performances were scored according to positive responses as specified by the Guttman technique of scale analysis. Scores were treated so that an individual's performance on the items comprising the total scale would be reproducible from his scores.[5] By employing this method of quantifying qualitative data, the investigator simply could test a sample to prove or disprove the hypothesis that the universe of attributes on second-semester wind students' apperception of pitch matching is scalable. Since perfect scales are not found in practice, researchers have made their computations on the basis of any scale that is at least 85 percent perfect as measured by the coefficient of reproducibility.[6] The coefficient of reproducibility for this study was .98.

Scalability indicated that the difficulty ratings of the tasks in the study were correct. Further, since the sample was scalable for the universe of attributes, it can be predicted that the population of beginning wind instrumentalists also is scalable, and that when steps are taken in the same order as in this study, the score of any individual will indicate all his abilities to match pitches by the beat elimination process. Scalability established that beginning wind players can be taught to play their instruments in tune when taught the beat elimination process in accordance with the instructional schedule used in this study.

Observations

Seventy-five of the 118 subjects achieved perfect scores in the study. Since there was no time limit for any session in the study, each individual proceeded at his own rate. Obviously, had either the time or number of trials been limited arbitrarily, results would have been different.

No subject was found unable to recognize beats, and every subject was successful at some time on each step that required him to tune unisons free of beats. Only six individuals, or 5 percent of the total subject population, were unable to play a perfect fifth free of beats. Fourteen individuals, or 12 percent of the population, were unable to tune a major third free of beats. Ninety-four subjects, or about 80 percent of the total, tuned the perfect fifth correctly in a triad; ninety-three, or about 79 percent, tuned the major third correctly in a triad.

Data were obtained by use of a questionnaire on the subjects' musical background. No relationship was observed between the subjects' musical backgrounds and their scores. Thirty of the seventy-five subjects with

[5] Margaret Jarman Hagood and Daniel O. Price, *Statistics for Sociologists,* Revised Edition (New York: Henry Holt and Company, 1952), p. 143.

[6] Louis Guttman, "A Basis for Scaling Qualitative Data," *Readings in Attitude Theory and Measurement,* edited by Martin Fishbein (New York: Wiley, 1967), p. 107.

perfect scores could play other instruments; forty-five could not. Nineteen had been taught preband instruments; fifty-six had not. Forty-seven of them reported that neither of their parents played musical instruments.

Of the twenty-three flutists in the study, only eight achieved perfect scores, whereas twenty of thirty-one clarinetists achieved perfect scores, and fourteen of fifteen cornetists also had perfect scores. All twelve trumpeters achieved perfect scores.

School scores were determined by grouping scores of individuals in each school. It is noteworthy that the first-place and second-place schools, each with thirty subjects, were located in affluent districts, and that the third-place and fourth-place schools, each with twenty-nine subjects, were located in poverty areas. As a measure of socioeconomic background, each subject was asked how much schooling each of his parents had had. Among the parents of the thirty subjects in the first-place school, thirteen fathers and ten mothers were college graduates; among the parents of the thirty subjects in the second-place school, twenty-two fathers and twenty mothers were college graduates; only one child in each of the other two schools reported having a parent with a college degree. As another measure of socioeconomic background, students listed their parents' occupations. In the first-place school, twelve students reported that their mothers worked outside the home; in the second-place school, thirteen reported that their mothers worked; in the third-place school, four subjects had working mothers; and in the fourth-place school, only two of the subjects' mothers worked.

There were no Negroes and only one Oriental in the study; the rest were Caucasian. The two lower-ranking schools' students were predominantly of the Mexican-American minority; the other schools' students were predominantly Anglo-American.

Conclusion and Recommendation

This investigation was made solely to determine whether beginning wind instrumentalists could be taught to play in tune by using the beat elimination process. Whether this method of teaching intonation was better or more efficient than traditional methods was not a consideration. It can be concluded from the results of the study that beginning wind students can learn to perceive beats and perceive when they are eliminated, that beginning wind students can learn to match unison pitches by the beat elimination process, and that most beginning wind students can use the beat elimination process to achieve correct intonation. It is suggested that another study be done with both a control and an experimental group of subjects identical to those used in this study, and that after the experimental group has been taught to match pitches by beat elimination, its intonation be compared with that of a group that has not been taught this process.

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