

The purpose of this study was to investigate the effect of movement instruction on beginning instrumentalists' steady beat perception, synchronization, and performance. Seventy sixth-grade students were randomly assigned to treatment and control groups. The treatment group received movement instruction generated from general music, dance, and theoretical ideas. The control group received "traditional rhythm instruction," operationalized through qualitative description of normal classroom activities. After 10 weeks of instruction, a researcher-designed battery of tests was administered. A *t*-test of the perception measure showed that the groups did not differ significantly, $t(66) = .84$, $p = .41$. The ability to synchronize taps to a musical stimulus varied significantly as a function of group membership, $t(68) = 4.22$, $p = .0001$, favoring the treatment group. Performances differed significantly as a function of group, favoring the treatment group, $t(68) = 5.74$, $p = .0001$. There were low positive correlations among the three dependent variables in this study.

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Effect of Movement Instruction on Steady Beat Perception, Synchronization, and Performance

The sense of underlying beat is an integral aspect of basic rhythmic ability (Radocy & Boyle, 1979). Music educators as well as dance educators have advocated the teaching of steady beat, stressing that it is the most foundational rhythmic competency (Ludowise, 1985; Weikart, 1982). "Watch any group that is singing together, playing instruments, or participating in locomotor rhythmic movements activities—the greater the number of individuals who perceive the common beat, the more successful the group experience will be" (Weikart, 1982, p. 20). Some practitioners have said that "unless an established pulse can be held steady, further development is not possible" (Warner, 1991, p. 35). Many general music methodologies, such as those of Orff, Kodály,

and Dalcroze, have advocated movement instruction as a primary step in the multifaceted process of learning music (Choksy, Abramson, Gillespie, & Woods, 1986). The instrumental music program, however, has not ordinarily stressed this form of basic kinesthetic learning. Instrumental instructors often assume that students have developed elementary rhythmic ability before the age of instrumental ensemble participation.

Yet, this assumption may not be valid. A number of factors in the past several decades may have negatively impacted children's rhythmic development. As shown in Thompson's (1991) study of 576 junior high students from 1970 to 1990, changes in scheduling for classes have had an impact on the regularity of many general music class meetings. The number of minutes allotted to the teaching of general music has also significantly decreased over the last 20 years (Leonhard, 1991). Since sequential movement activities are an important aspect of many general music curricula, the lessening of movement experiences may have a negative impact on students' kinesthetic development.

In the instrumental setting, students without an internalized sense of the steady beat are confronted with the onerous task of learning basic musical skills as well as kinesthetic skills. Instrumental instruction adds the further challenges of note reading, technique, and aural skill development to the task of feeling a steady beat. Miller's (1956) information processing theory describes the limited amount of information the brain can handle before it begins to filter out data. When confronted by a difficult task, the brain defaults to learned strategies while concentrating on the new activity. Once basic concepts are mastered, however, expectations develop about future events allowing learning to be more productive and efficient (Butler, 1992). In beginning instrumental music, this can mean that those children who have an internalized sense of steady beat may more readily learn a new concept, such as slurring or tonguing, while also maintaining a steady beat. What, then, are the best means of reaching the goal of basic rhythmic ability?

Although movement has been documented as a useful learning strategy, in experimental situations, it has had mixed results. Certain studies have noted a lack of effectiveness, citing movements as more difficult than counting with younger musicians (Salzberg & Wang, 1989) and a distraction to rhythmic learning, in that the students concentrate on the movements more than the music (Persellin, 1992). Many researchers studying mixed-age groups postulate that maturation, rather than training, may have the greatest effect on improvement (Groves, 1969; Jersild & Biensstock, 1935; Smoll, 1974).

Studies involving synchronization highlight the many contributing factors that may influence rhythmic assessments. Researchers have noted the difficulty that young subjects have with synchronizing movement to music (Gordon & Martin, 1993/94; Grieshaber, 1987; Rainbow, 1981). Whether the ability to synchronize is stabilized or even fixed early in life (Bayless & Ramsey, 1991) or whether accuracy increases with age (Ellis, 1992; Schleuter & Schleuter, 1985) remains unresolved. The degree of improvement that students can gain from rhythmic

mic training is yet another debated question (Groves, 1969; Howell, Flowers, & Wheaton, 1995). Personal tempo (Nelson, 1991) and the developmental difficulty of the movement task (Rainbow, 1981) may also directly impact subject success rate.

Research describing steady beat skills in a performance setting is limited. Wis (1993) provided a philosophical study which cited active participation, visible accountability, metaphorical learning, natural inclination, and aesthetic sensitivity as viable reasons to use kinesthetic learning in the choral rehearsal. Major (1982), McCoy (1989), and Jordan (1986) noted experimental group improvement in maintaining a steady pulse in high school ensemble settings. Ellis (1992) stated that young musicians are more likely to perform faster than the provided tempo and, in general, young musicians are more accurate at faster tempo.

The purpose of the present study was twofold: to investigate the difference between sixth-grade instrumental music students who participated in a movement treatment and those who participated in traditional rhythm instruction on measures of perception, synchronization, and performance; and to ascertain the degree of correlation of the three dependent variable measures with each other.

METHOD

This experimental study used the posttest-only control group design. The independent variable, movement instruction, had two levels, treatment and control. Three dependent variables (perception, synchronization, and performance) were measured to assess the impact of movement instruction on three aspects of rhythmic ability. Material for the dependent measures was not sampled from the treatment or control activities, but was generated from foundational expectations for perception, synchronization, and performance in an instrumental classroom.

The population of the study was sixth-grade beginning instrumental music students from a medium-sized, midwestern school district. The school was chosen as an experimentally accessible population. The 102-member class of beginning instrumentalists in this study represented 43% of the sixth-grade population of the school. From the 102 beginning instrumentalists, 45 girls and 25 boys consented to participate and were randomly assigned to the treatment or the control groups using a table of random numbers. The instrumentation of the sample was: 12 flutes, 4 oboes, 23 clarinets, 6 alto saxophones, 10 trumpets, 4 French horns, 2 trombones, 3 baritones, and 6 percussion.

Through 3 months of qualitative observation of the research setting, the researcher designed rhythm instruction for the control group that was consistent with the students' everyday classroom activities. The pre-instruction time allowed all of the students to become familiar with the researcher, thereby avoiding any novelty threat. The researcher presented both the treatment and control-group activities. Equal treatment of groups was monitored by the instrumental classroom teacher

so that neither group considered themselves "special," thereby lessening any possible Hawthorne effect. The objectives for the groups were the same. Students concentrated on perceiving degrees of steadiness, synchronizing to music, and performing steadily. The methods, however, were different. The treatment group focused on more overt manifestations of steadiness with larger, fluid movements, whereas the control group used more covert, cognitive processes and traditional small-movement experiences.

The control group participated in rhythm activities based on classroom activities endemic to the school setting. The instrumental classroom teacher used a variety of rhythm syllables and vocalization techniques with all students to reach the goal of rhythmic fluency. Kodály syllables, a numerical syllable system, sizzling and clapping of note values and rests were all teaching techniques used by the teacher. The students were encouraged to tap their feet along with the steady beat in performance and listening activities. To help the students, the teacher either clapped the melodic rhythm, clapped the steady beat, or numerically counted the melodic rhythm.

In each control-group session subjects reviewed lesson book melodies, began new melodies, and played rhythm sequences on single pitches. Classroom rhythm teaching techniques were used in the control-group setting in conjunction with the lesson book assignment given in the full band class. Students were directed to perceive the steadiness of other students' performances as well as their own. As in the classroom setting, new rhythms were introduced to the control group through instructor verbal modeling in conjunction with flash cards, then modeling on an instrument, and finally flash card review without modeling. Students practiced rhythms and melodies individually in group, and synchronized to multiple accompaniments at multiple tempos.

Each treatment group session focused on the perception of steady and unsteady factors in music, synchronization activities to musical stimuli, and performance activities on pitched and nonpitched instruments. Listening activities highlighted possible perceptual distractors, such as syncopation, dynamics, tempo, meter, and expressiveness in musical examples of a variety of styles. The movement activities synchronized to music stressed the concepts of feeling weight, sensing time, and experiencing flowing movements in a set space. Specific activities included nonlocomotor body percussion activities (such as leg-patting, clapping, snapping, and foot and heel movements), beanbag tosses, conducting, rope pulls, and imaged movements, such as weight lifting and basketball playing synchronized to musical examples of a variety of styles. Performance activities stressed the transfer of coordination, listening, and synchronization skills to pitched and nonpitched musical instruments. Students synchronized body movements to other students' performances of rhythms at multiple tempos on drumssticks, drums, tambourines, shakers, and bongos. Students also performed melodies and rhythms on their own instruments, individually, in group, and with multiple accompaniments at multiple tempos.

After the 10-week instructional setting (20 sessions of 10 minutes each), all subjects took the three dependent variable measurements. The perceptual measure was a 33-item, paper-pencil listening test that assessed the students' abilities to perceive degrees of steadiness and tempo change in compared isochronous tap sets. Fifteen of the items related to perception of tap steadiness, and 18 items related to perception of tap tempo change. Subjects indicated the degree of steadiness or tempo change by marking a vertical line on horizontal linear scales. In addition, subjects circled "steady," "speeds up," or "slows down" for each item on the tempo subtest to show tempo direction. The linear scales ranged from "steady" to "unsteady" and from "steady" to "big tempo change."

A perfectly steady series of eight taps was provided before each item to avoid any carryover effects in the form of psychological comparisons made to the steadiness of the previous item. The students completed three practice exercises for the steadiness subtest and four practice examples for the tempo subtest before starting each test. The practice items showed the range of possible responses on the linear scale. The tempo of 90 beats per minute (bpm) was used as a median tempo for the perception tasks since this tempo has been documented as appropriate for this use (Geringer, Duke, & Madsen, 1992).

The primary two taps in each example represented steady beats, providing subjects with the ability to compare from the third tap forward. In the following six taps, two taps were placed that may have had some degree of unsteadiness. The randomly placed taps ranged from exactly steady to as much as one-half beat before or after the intended steady beat. Even though the students were responding on a linear scale, the steadiness subtest contained only five possible degrees of increasing unsteadiness: eight perfectly steady taps, two of the eight taps being one-sixteenth of a beat before or after the beat, two of the eight taps being one-eighth of a beat before or after the beat, two of the eight taps being one-quarter of a beat before or after the beat, and two of the eight taps being one-half of a beat before or after the beat.

The tempo subtest introduced a degree of tempo modulation across the example. All examples began at 90 bpm and then the taps either sped up to some degree, slowed down to some degree, or remained at the set tempo. The possible responses ranged from an item that decreased to an ending tempo of 66 bpm to an item that increased to an ending tempo of 130 bpm. As in the steadiness subtest, even though the students were responding on a linear scale, the tempo subtest contained only nine possible degrees of tempo change: decreasing speed to 66 bpm, decreasing speed to 72 bpm, decreasing speed to 78 bpm, decreasing speed to 84 bpm, no tempo change at 90 bpm, increasing speed to 100 bpm, increasing speed to 110 bpm, increasing speed to 120 bpm, and increasing speed to 130 bpm. Through study of past research and two pilot tests of the perceptual instrument, the researcher determined that increments of 10 bpm were appropriate for the tempo-increase items, whereas 6 bpm were deemed appropriate for the tempo-decrease items.

For the synchronization measure, subjects attempted to tap a steady beat on a synthesizer to three synthesized musical examples: one slow piece (60 bpm), one medium piece (90 bpm), and one fast piece (110 bpm). After hearing four taps in tempo and then four taps synchronized to the music, the subjects were asked to tap the steady beat by themselves on the sequencer while listening to the music.

For the performance measure, students played, on their own instruments, two researcher-composed melodies each at 60 bpm, 90 bpm, and 110 bpm. The tempo for each performance was given in eight-taps prior to each performance. The students performed each melody without the assistance of a synchronized metronomic tap. Melody material was validated through comparison to materials covered in the instrumental music method book. The technical level of the melodies was easier than the music that the students were practicing in band, but included the same note values, key centers, and meters. A panel of experts verified the content validity of the instruments. A pilot test given in a comparable setting of sixth-grade instrumentalists yielded test-retest reliability coefficients of $r_s = 1.0$ (synchronization), $r_s = .90$ (performance), and $r_s = .80$ (perception).

The taps for the perception test and the melodies for the synchronization test were sequenced using Opcode Systems' *Vision 2.0* (1993) and were patched through a Yamaha PSR-410 synthesizer. Recording of the performance test was done on a Sony DAT TC-D7 recorder with Sony SRS-PC40 powered stereo speakers. Digital audio tapes (TDK, DA-R60) were used to ensure that note attacks were as precise as possible. Analysis of the performance test was conducted using *Digitdesign's Sound Designer II* software (1994).

Data analysis for the three measures was based on how much a subject's response deviated from the true response. Nondirectional hypothesis testing was performed at an alpha level of .05. Perception items were measured on a pencil-and-paper, linear scale describing the deviation of the subject marked response from the correct item response. Items were analyzed by measuring, in millimeters, the distance from the subject response to the correct response on the linear scale. Steadiness scores of the deviations could range from 0 to 80 (millimeters) for each item. Tempo scores of the deviations could range from 0 to 160 for each item, because the answer could be faster or slower in this category. Two subjects' scores, one control and one treatment, could not be used because of student mistakes in filling out the form. The 68 remaining perception scores were compared for treatment and control groups.

Deviations were described for the synchronization measure by the numerical amount that the subject's tap occurred before (showing a faster performance) or after (showing a slower performance) the steady beat. The software numerically described each beat in 480-unit segments per beat. For ease of viewing and description, each subject's beat scores were multiplied by .001. Each beat, therefore, would normally range from .00 for perfectly synchronized to .480 for unsynchronized within that beat. Subjects who deviated more than one beat

ahead of or behind the beat had 0.480 of a unit added each time the tap deviated more than one beat ahead or behind the intended beat.

The performance measurement provided results in real time, detailed in hundredths of a second. Each performance started at zero and additively progressed until the end of the melody. The times for each beat were then compared to the metronomically correct times for performances at each tempo; deviations were then assessed for each beat. The perception, synchronization, and performance tests each resulted in a summed score for each individual.

RESULTS

Perception scores ranged from 258 to 864 points for the treatment group and from 324 to 1,195 points for the control group. Lower scores indicated more accurate responses. The mean (517.79) and the standard deviation (133.95) for the treatment group were smaller than the control group mean (548.88) and standard deviation (170.00). The scores were compared statistically for group differences. A *t*-test of the perception measure showed that the groups did not differ significantly, $t(66) = .84, p = .41$.

In both of the perception subtests, subjects in the treatment and control groups heard the "perfectly steady" response most accurately. Subjects used the "perfectly steady" response as a default response, however, for several unsteady items. Many of the poorest scores, therefore, showed dichotomous labeling—steady or unsteady. The most accurate scores displayed a more continuous scale response. Subjects in both groups more often perceived the items in the steadiness subtest as steadier than they actually were. Subjects more often perceived the items in the tempo subtest as faster than they actually were.

Synchronization scores ranged from 3.39 to 13.77 points for the treatment group and from 4.72 to 46.22 points for the control group. Lower scores indicated more accurate responses. The standard deviation (2.28) for the treatment group was smaller than the control group standard deviation (12.55). The mean (6.35) for the treatment group was lower than the control group mean (15.45). The scores were compared statistically for group differences. The ability to synchronize taps to a musical stimulus was found to vary significantly as a function of group membership, $t(68) = 4.22, p = .0001$, favoring the treatment group.

Musical context affected many students' synchronization scores. Heightened melodic/rhythmic activity, without a bass line that emphasized the steady beat, detrimentally affected synchronization scores. Strong cadential endings detrimentally affected some subjects' scores and positively affected those of others.

Performance scores ranged from 24.95 to 202.74 points for the treatment group and from 66.84 to 373.96 points for the control group. Lower scores indicated more accurate responses. The mean (98.18) and the standard deviation (43.96) for the treatment group were smaller than the control group mean (183.54) and standard deviation

(76.30). The scores were compared statistically for group differences. The performances differed significantly as a function of group membership, $t(68) = 5.74, p = .0001$, favoring the treatment group.

Synchronizations and performances which were faster than the steady beat were observed more often in slower than in faster pieces. Although not to the same degree, synchronizations and performances that were slower than the steady beat were observed more often in faster than in slower pieces.

There were low positive correlations among the three dependent variables in this study. The synchronization and performance measures were more highly correlated with each other ($r_s = .39$) than the perceptual measure was to either the synchronization ($r_s = .18$) or the performance ($r_s = .08$) measure.

CONCLUSIONS

The results of the current study highlight many important factors of rhythmic development. As in studies by Douglass (1977) and Jordan (1986), treatment-group improvement was noted for overt measures of rhythmic ability, but not for the perceptual measurement. Schmidt and Lewis (1987), and Lewis (1988) reported mixed results in studies of multiple aspects of rhythmic perception.

The failure to find significant group differences in many perceptual studies may show that perception is a more enigmatic trait to measure than are the more overt skills associated with synchronization and performance. The low positive correlation found between perception and the other two variables in the present study suggests that the perceptual measure, as measured, is not closely related to the more overt rhythmic skills of synchronization and performance. As Thackray (1969) indicated, the imperfect correlation of multiple rhythmic variables may demonstrate the differential learning of rhythmic skills.

Results of the perception measurement show a dichotomous categorization (steady or unsteady) for the most inaccurate responses and a more continuous response scale for the most accurate responses. The items that were answered correctly most often were the extreme examples (steady or unsteady). This finding coincides with Wang's (1983) finding that the items with greater tempo change were easier to discriminate than were items where such change was more subtle. The finding that subjects perceived tempo changes as faster than the true response is consistent with the majority of research on tempo perception. As in the present study, past research has documented the tendency to perform faster rather than slower (Ellis, 1992).

The difference between the treatment and control group scores for the synchronization measure suggests that an individual's ability to move rhythmically can be improved with training, so as to accommodate synchronization of movements in many tempi. This is in agreement with studies by Douglass (1977) and Howell, Flowers, and Wheaton (1995), but not with findings of Jesild and Bienstock (1935) and Groves (1969). For beginning music ensembles and general music classes, the importance of participating in movement activities in multiple tempi should be considered. Although practicing teachers may note students' tendencies to gravitate to one comfortable performance tempo, efforts should be made to stretch students' tempo experiences for instruction in multiple tempos may benefit the students' steady beat skills.

Results concerning context show that melodic material may or may not have

a detrimental effect on synchronization ability. Heightened melodic activity detrimentally affected some subjects' synchronization scores, and strong cadential material positively affected some subjects' synchronization scores and negatively affected those of others. Context seems to be a highly complicated factor that can interact with variables such as memory, prior experience, and perceptual acuity.

The findings of the present study's performance scores are in agreement with results of studies done by Major (1982), Jordan (1986), and McCoy (1989). Using bodily movement and participating in musical activities in a variety of tempos appear to have a positive effect on performance ability. It may be beneficial for beginning instrumental music directors to note that longer duration notes gave students greater steadiness problems than shorter duration notes. Because many elementary instrument methods begin the books with whole notes to avoid psychomotor challenges, supplemental activities may be warranted for the goal of steady beat development. Teachers who provide basic kinesthetic experiences for their students may help to connect the cognitive understanding of note length to the overt experience of movement in time.

The large spread of scores for the synchronization and performance measures highlights the inability of some students to tap or perform with a steady beat. Certain students seemed unable to vary performance tempo when playing melodies by themselves. Although students practiced melodies at various speeds and in various contexts in both the treatment-group and control-group settings, not all students were able to make this crossover to playing melodies with much success in a solo setting without accompaniment. The chosen tempo at which these students performed may have overridden their ability to accomplish the task. This inability to vary performance tempo was a notable phenomenon associated mainly with the control-group students.

Subjects with the most accurate responses on the synchronization and performance measures displayed the ability to correct their performances. The ability to correct could be seen in performances and synchronizations that sped up and slowed down around the steady beat in a pendular manner. Treatment-group subjects demonstrated a greater tendency to correct their performances than did those in the control group. The least accurate responses most often showed a progressive deviation from the steady beat.

From this study, the most basic and important finding for music educators is that steady beat skills can be improved. Even with beginning band students, such as sixth-graders, who may be less accustomed to kinesthetic learning than are preschool-age or early-elementary-age students, movement activities may develop psychomotor awareness and lead to more steady performances. Movement activities designed for students in their younger years may provide a rhythmic foundation that will enable even further rhythmic growth.

Educators should not assume that all beginning instrumental students have a sense of steady beat. The majority of the control-group subjects had difficulty synchronizing and performing to a steady beat.

Attention clearly needs to be given to this basic skill. Providing movement and performance opportunities in short segments on a regular basis may help students bridge the gap between their body knowledge and their instrumental performance skill.

Future research focusing on the long-term development of perception, synchronization, and performance skills related to steady beat would be of benefit to the community of educators. Although single-measurement studies have their use, musical growth is a complicated topic warranting many perspectives. Also, development of perceptual instruments that creatively and intelligently stretch the bounds of the current measures would help the profession further assess perceptual abilities.

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Participants from Grades 3, 4, 5, and 6 ($N = 238$) rated selections on an 18-item music listening type four consecutive times at 2-week intervals, alternately using pictorial and verbal Likert-type response scales. The order of response scale administration was counterbalanced among the classrooms involved. There was no significant difference between preference scores generated by participants using either form of response scale. Test-retest reliabilities ranged from .65 to .88 using a 4-week time interval, with higher grade levels associated with higher reliabilities and the pictorial scale generally associated with higher reliabilities. Internal consistency reliabilities measured by coefficient alpha ranged from .90 to .93 for the verbal scale and .92 to .93 for the pictorial scale. A large and statistically significant majority of participants (84.9%) expressed a preference for using the pictorial scale to record their music listening preferences.

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Pictorial versus Verbal Rating Scales in Music Preference Measurement

During the second half of the 20th century, traditional scales of attitude measurement have been applied and refined in music preference measurement, and some entirely new methods have been developed. The new methods of preference measurement have all shared certain

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