

Effects of Finger Markers and Harmonic Context on Performance of Beginning String Students

Playing in tune on a stringed instrument can be thought of as a process requiring an aural conception of correct intonation prior to playing and the use of complex physical motions to produce the desired sounds. Authors writing about teaching beginning string players have recognized that the ability to hear the sound before engaging the pitch-producing mechanism is essential to good intonation (Behrend, 1984; Hockett, 1985; Matesky & Rusch, 1963). Because this process depends on a player's ability to produce internally an accurate preconception of the desired intonation, teaching and learning to play

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in tune on a stringed instrument must include the development of this capacity.

This ability may be more challenging for beginning string players than other beginning instrumentalists, save trombonist and timpanists, given stringed instruments' fretless fingerboards. Although the physical technique used for producing accurate intonation is more accessible (e.g., visible and logical) to beginning students on stringed instruments than on wind instruments (Lamb & Cook, 1994), the "unlimitedness" of the fingerboard has led many string teachers to provide students with finger placement markers—in a sense, creating "keys, valves, or holes" for the fingers.

Use of Finger Placement Markers (FPMs)

Pedagogical use of FPMs as a way of providing a visual/kinesthetic reference for finger placement can at least be traced back to the pedagogical tutorials of Corrette (see Riley, 1954), Geminiani (179[?]), and Leopold Mozart (as translated by Knocker, 1951). Recommendations to use FPMs are also evident in contemporary literature on teaching beginning strings (Anderson & Frost, 1986; Johnson, 1985; Kohut, 1973; Matesky & Rusch, 1963). Young (1978) emphasized the use of FPMs as an aid in the formation of correct left-hand shape. Dillon and Kriechbaum (1978) suggested that, in teaching beginners, initial attention be directed to the physical relationship of one finger to the next and recommended that students be taught that the sound must be correct, regardless of the position and use of FPMs. In Suzuki methodology, FPMs have been viewed as aids to proper left-hand position (Behrend, 1985; Zahulla, 1972), as guides for parents (Behrend, 1985), and as being of secondary importance to the ear in matters of intonation (Behrend, 1985; Starr, 1976).

Others have warned that the use of FPMs may mask a lack of aural readiness or even delay its development (Colwell, 1969; Creider, 1989; Gordon, 1988a; Shuler, 1989). The debate over the use of FPMs has often been resolved in a statement that is part recommendation and part warning: to use whatever works for however long it works, but to prevent the aid from becoming a crutch through overuse (Dillon, Kjelland, & O'Reilly, 1992; Kohut, 1973; Shuler, 1989).

The development or refinement of string intonation performance skills has been investigated in relationship to hand position (Cowden, 1969/1970; Jacobs, 1969); visual stimulus and instruction (Salzberg, 1977/1978); immediate, self-evaluative feedback (Smith & Brick, 1990); computer-assisted tutorials (Eisele, 1985/1986); and the tonicism (diatonic versus pentatonic) of the musical material used (Maag, 1974/1975). The use of FPMs has not been shown to affect the violin intonation performance of either undergraduate music majors enrolled in a beginning string techniques class (Smith, 1985) or fourth and fifth graders (Smith, 1988). In contrast, the current study explores the potential effect of FPMs as a kinesthetic/tactile reference in combination with harmonic accompaniment as an aural reference.

The Role of Harmonic Context in Intonation Performance

Both music educators and cognitive music-psychologists have contended that harmonic accompaniment may help students develop a sense of tonality (Kohut, 1973; Krumhansl, 1979; Shepard, 1981) and that this is basic to the development of other essential aural skills (Funk, 1977/1978; Gordon, 1988a; Grutzmacher, 1987). There is theoretical support for the use of harmonic accompaniment as a means of directly developing and improving instrumentalists' intonation (Petzold, 1966; Schleuter, 1984). Harmony may also provide an aural reference against which the relative "in-tuneness" of a performance can be aurally gauged by the performer (Gordon, 1988a; Kohut, 1973; Schleuter, 1984).

The effect of harmonic accompaniment on music performance seems dependent on the research setting. Results of randomized, laboratory-based experiments involving college students indicated that harmonic context improves tonal accuracy in the contexts of vocal performance (Small, 1977/1978), sight-reading (Boyle & Lucas, 1990), and instrumental intonation performance (Geringer, 1976/1977). Field-based research involving school-age children has yet to identify any effects on their vocal performance (Atterbury & Silcox, 1993; Stauffer, 1985). However, it seems that, compared to other possibilities, traditional, nonchromatic harmonization may be the most beneficial to accurate vocal intonation (Petzold, 1966; Sterling, 1985). The use of piano accompaniment in string classes has not been shown to affect individuals' intonation performance (English, 1985).

There is theoretical and empirical support for the use of harmonic accompaniment and of FPMs as means to develop and improve string players' intonation performance skills. There is no consensus, however, on the general role of FPMs in teaching beginning string players, or specifically on the relationship between FPMs and the development of intonation skills. In this study, the investigator focused on the effects of FPMs and harmonic context on the development of intonation and overall musical performance skills in elementary-school beginning string players. Central to this research was the question of how a tactile/visual reference and an aural reference influence, separately and in combination, the development of string intonation performance skills.

METHOD

Subjects were the 76 sixth-grade students in the Waterloo (Ontario, Canada) County Board of Education who attended 3 of the district's 10 elementary schools and who were enrolled in the district's string lesson program. Although interested students were selected to participate in the program by a committee composed of the building principal, the classroom teacher, and the general music teacher, all but two students who indicated interest in the 1990–91 string lesson program were allowed to participate.

The study was a 2 × 2 factorial (FPMs by harmonic training), non-equivalent control-group design. FPMs were applied to stringed instruments within schools on an individual random basis, stratified by upper (violin, viola) and lower (violoncello) stringed instrument type. Harmonic training was randomly assigned to intact groups within schools. Scores on the Musical Aptitude Profile (Gordon, 1988b) served as a covariate.

The author's Test of Beginning String Performance (TBSP) was used as a posttest to evaluate students' individual performance skills. Musical materials were a one-octave D-major scale and arpeggio and four simple songs ("Twinkle, Twinkle, Little Star," "Boil Them Cabbage Down," "Row, Row, Row Your Boat," and "Ode to Joy") from the school district's first-year string curriculum. Students prepared songs with teacher assistance (the songs were taught as part of a sequence of lessons) and without teacher assistance (the teacher instructed students to learn a song on their own by following classroom routines at home).

Two comparable forms of the TBSP were constructed by arranging the test items into two identical halves that differed only in the type of background (rhythm-only versus rhythm-harmony) that accompanied both test items and student responses. The purpose of creating these two forms of the test was to control for testing bias in assessing long-term effects of harmonic context. The order of administration of the two test forms was counterbalanced within each intact class (unit of harmonic treatment condition) to reduce carryover effect.

The TBSP was administered to students individually in a school conference room with an unremarkable level of ambient noise. The accompaniment was presented using a stereo cassette deck with variable pitch, an amplifier, and a speaker. The test administrator tuned the students' instruments to the test tape's recorded tuning pitch prior to beginning the test administration.

Student performances were video-recorded and evaluated using separate sets of technical and musical criteria. To reduce any halo effect across the two sets of criteria, the technical and musical evaluation of student performances were isolated according to the different types of musical material found in the test. Student left-hand technique was measured by applying technical criteria only to the performances of scales and arpeggios; applying musical criteria to only the song material provided a measure of student overall musical-performance ability. Elements of left-hand technique, specifically the position and functional movements of the arm, hand, wrist, thumb, and fingers, were scored using a 4-point scale, ranging from (1) unacceptable to (4) exemplary. Only those elements of left-hand technique that were taught in the string lessons and that may have been hindered or aided by the use of FPMs were included as criteria. Owing to differences in playing technique, there were separate technical criteria for upper and lower strings (see Table 1).

Musical criteria included intonation, tone quality, consistency of tempo, rhythmic accuracy, and musical expression. Musical criteria

Table 1
Technical Criteria from Test of Beginning String Performance

Element of left-hand technique ^a	Criteria
<i>Violin and viola</i>	
Arm	Center line of instrument is at 10 o'clock; center line of body at 12 o'clock.
Hand/wrist	Unbroken wrist, straight line from elbow to base of pinkie. Finger, hand, wrist, and elbow move together when crossing strings.
Fingers	Rounded and over string. Middle two finger knuckles are higher than the string. Base knuckle of index finger lightly touches instrument neck.

<i>Cello</i>	
Arm	Arm raised away from body
Hand/wrist	Wrist and forearm are in a straight line Shape of hand (palm/fingers) is arched Finger, hand, wrist and elbow move together when crossing strings.
Fingers	Fingers rounded and over the string. String crosses the tip of the finger, parallel to fingernail.

^a A criterion related to the position of a student's thumb was deleted following pilot-testing of the TBSP because it was not possible to view students' thumbs on the video recordings, nor was it desirable to add a second videocamera to the testing procedures.

were evaluated using a 5-point scale that ranged from 1 (poor) to 5 (excellent).

The two raters used for the TBSP, employed as public-school string teachers at the time of the study, held master's degrees. Each rater had more than 7 years of successful string-teaching experience. During a training session, recordings of student performances exemplifying each of the scores were played for the raters. Judges rated song performances during two separate, consecutive viewings, evaluating intonation first and then the other musical criteria. In preparation for the scoring process, raters also completed the part of the *Violin Left Hand and Instrument Position: Diagnostic Skills Training Program* (Gillespie, 1987) that was relevant to the TBSP, specifically the technical criteria used therein and as part of the TBSP.

Instructional Procedures

As part of the cooperating school district's first-year curriculum, all students received 90 minutes of weekly, heterogeneous-class instruction designed to improve music performance skills, including proper left- and right-hand playing mechanisms. Intonation was approached with an aural emphasis, including vocal and instrumental imitation of melodic patterns and the singing of musical materials using tonic-solfa syllables. Development of the physical aspect of string technique was based on a sequence of instruction that combined the principles of string playing and teaching of Paul Rolland and of Shinichi Suzuki. Following an initial 5-month period of rote instruction that included some materials from *Tunes for Strings* (Fletcher, 1971), all classes followed a sequence of materials selected from *All for Strings, Book 1* (Anderson & Frost, 1985).

For the purpose of the study, harmonic accompaniment consisted of tonic, subdominant, and dominant harmonies in D-major played using a synthesized piano timbre. Harmonic background duplicated a song's melodic rhythm in a style similar to the piano accompaniments written for the primary string method book used by the instructor. In addition, students in the harmony classes played other musical materials (e.g., scales in rounds) that also provided an aural reference for intonation accuracy.

To standardize and maximize the potential effect of the harmonic treatment, an audio cassette recording was developed by the researcher for in-class and home use. There were two versions of the recording, each containing the same 20 selections and differing only in the presence or absence of recorded harmonic backgrounds. Each selection consisted of (1) melodic patterns extracted from a particular song, to be used in a recorded presentation-student imitation routine; (2) a complete musical performance of the song on viola, to be used for silent fingering or bowing practice; and (3) an accompaniment (minus melody) to the selection for student or class performances. Selections on the tapes used by students in the harmony groups had both harmonic and rhythmic accompaniments; selections for students in the no-harmony groups had only rhythmic backgrounds. Rhythmic accompaniments were musically appropriate dance patterns of unpitched rhythm-instrument sounds produced by a drum machine. Audio duplication was done by a professional recording studio to ensure pitch accuracy. Students were allowed to take home a free copy of the tape for individual practice. All students reported having access to a cassette player for this purpose.

Finger placement markers, in the form of .75-inch- (1.91-cm-) wide pieces of transparent adhesive tape, were applied to the fingerboard under the strings, marking finger placement for pitches sounding a major second and perfect fourth above the open string. This is as recommended by Behrend (1985), Young (1978), and Johnson (1985). FPMs were left on the instruments for the entire school year. Because FPMs were made of transparent adhesive tape, they were not visible to

the judges on the video recordings of the student performances and thus did not introduce rater bias due to the knowledge of a subject's placement in the FPM research groups.

Due to the fact that students whose instruments did and did not have FPMs were in the same string classes, methodological precautions were taken to prevent the threats to internal validity known as resentful demoralization and compensatory rivalry (Cook & Campbell, 1979, pp. 54-55). First, FPMs were made from pieces of transparent tape, which is less visible to other class members than opaque tape. Second, FPMs were installed on the instruments prior to the first lesson, before students had opened their instrument cases and well before the instructor addressed left-hand finger placement. Third, initial instruction regarding the use of the left hand focused on the shape of the hand and the position of the fingertips to the string, and not on the accurate placement of the hand in first position. This eliminated the need for students to be concerned with the placement of their fingers on the string for the pitches corresponding to the FPM locations. Fourth, during the first few lessons in which finger placement in first position was introduced, the instructor physically set each student's left hand so that all students received individual instruction about hand and finger placement. Fifth, the teacher attempted to use the simple direction "adjust your fingers" as often as possible to direct students' attention to their finger placement, rather than making reference to the FPMs. This held true for all lessons that followed one focusing on finger placement and intonation. During part of this session, the teacher instructed the students without FPMs to listen to each other and/or the accompaniment and try "to fit in." Students with FPMs were asked to do the same as well as to consider their finger placement with respect to the markers when playing.

The treatment period lasted approximately 33 weeks. No attempt was made to reschedule lessons missed due to student absences or school vacations.

RESULTS

Development of the Final Sample

A complete data set was obtained for 68 of the original 76 subjects. In the interest of maintaining the integrity of the analyses, a decision was made to use scores from only those subjects for whom a complete data set was obtained. Results of supplemental analyses indicated that the 8 students for whom data were missing were not significantly different from those students for whom a complete data set was obtained regarding assignment to research conditions, instrument type, school, gender, and music aptitude. Statistical comparisons by these same background and musical characteristics were conducted and revealed that there were no significant differences across schools between intact classes assigned to harmonic conditions, which led to a decision to pool data across schools in order to increase statistical power. Groups

Table 2
Comparison of Groups Using Two-Way ANOVA for Pretreatment MAP Scores

Source	df	F
<i>Tonal imagery</i>		
FPM	1	2.67
Harmony	1	.05
FPM × Harmony	1	.15
Error	64	(62.05)
<i>Rhythmic imagery</i>		
FPM	1	.70
Harmony	1	1.08
FPM × Harmony	1	.31
Error	64	(42.46)
<i>Musical sensitivity</i>		
FPM	1	1.33
Harmony	1	.38
FPM × Harmony	1	.02
Error	64	(42.94)
<i>Composite</i>		
FPM	1	2.50
Harmony	1	.00
FPM × Harmony	1	.01
Error	64	(30.04)

Note. Values enclosed in parentheses represent mean square errors. All *F* values are not significant ($p > .05$). MAP refers to the Musical Aptitude Profile (Gordon, 1988).

demonstrated comparable degrees of musical aptitude, as mean differences on the Musical Aptitude Profile (Gordon, 1988b) were not significant (Table 2).

A poststudy survey of the subjects was conducted to estimate the extent of subjects' practice time and use of the practice tapes during home practice. Results of a two-way analysis of variance, or ANOVA (FPMs × harmonic context), of scores representing the level of student home practice time between lessons indicated that subjects' level of practice was comparable across research assignments, $F(1, 1, 1, 60) = .083, .565, .764$, respectively; $p > .05$. Student use of the audio practice tapes was also comparable for all groups, $F(1, 1, 1, 62) = .249, .249, .546$, respectively; $p > .05$. These results suggest that these factors would not contribute to any significant differences found between groups.

Analytical Procedures

Analyses were conducted to investigate the effects of FPMs and har-

monic context on string performance, specifically intonation performance skills and overall musical performance; and left-hand position, specifically the position and functional movements of the arm, hand, wrist, and fingers. An alpha level of .05 was used for all statistical tests. All statistics were calculated using SPSS-X (1988).

Calculation of test reliability for the TBSP was based on the concept of the split-halves technique. Total technical criteria scores from each half of the test were correlated, as were overall composite performance scores. Coefficients, which were adjusted using the Spearman-Brown Prophecy Formula, indicate that students were consistent in their responses to sets of technical ($r = .95$) and musical tasks ($r = .96$) across the halves of the test. Coefficients of interrater reliability for the three subscores of the TBSP that were used as dependent variables are presented with the results of each analysis.

Analyses of left-hand technical criteria scores were conducted on standardized *z*-scores across instrument type. Raw scores were standardized due to differences in technical criteria by instrument type. Technical scores were analyzed using a two-way ANOVA.

Posttest scores of musical performance were analyzed using a two-way analysis of covariance (ANCOVA). Scores from the Musical Aptitude Profile (Gordon, 1988b) were used as a covariate to adjust for musical traits that might have influenced the effects of the treatment on students' musical achievement and that were not controlled by the research design. Owing to the fact that there were no significant pre-experimental differences in musical aptitude, the use of ANCOVA was done in particular consideration of the assignment of intact classes to harmonic context conditions as a way of increasing the precision of the analyses, rather than as a necessary adjustment for significant pre-experimental group differences (Wildt & Ahtola, 1979) and as a means of investigating different treatment effects by musical aptitude.

The development of two versions of the TBSP test items, differing only in the presence or absence of harmonic accompaniment, and the counterbalancing of student assignment within intact string classes meant that approximately half the students received harmony and approximately half the students received no harmony during each half of the test. This was done to control for testing bias in assessing the long-term effects of harmonic accompaniment as implemented during the experimental period.

This arrangement also allows for the testing of the immediate effects of harmonic accompaniment as a testing condition and for any differences in these effects by assignment to long-term research conditions (FPMs and harmonic accompaniment). However, inherent in this crossover design is the potential for the effect of harmony as a testing condition to be different depending on the order of presentation. Although the administration of the two forms of the test in a counter-balanced design was intended to balance any carryover effect, one cannot assume that there will be no differential carryover. To ensure that the assessment of the immediate effects of harmonic context would be unbiased with regard to potential carryover effect, only scores from the

Table 3
Observed and Adjusted Means

Group	Song intonation		Song performance		Left-hand position
	Observed	Adjusted ^a	Observed	Adjusted ^b	Observed ^c
No FPM	46.55	47.17	140.89	142.91	-.02
FPM	54.53	53.67	151.68	148.30	.02
No harmony	48.97	49.17	139.62	139.64	.12
Harmony	50.90	51.67	150.14	151.57	-.09
No FPM/No harmony	46.00	46.98	135.93	138.53	.05
No FPM/Harmony	46.91	47.36	144.13	147.30	-.06
FPM/No harmony	52.14	51.36	143.57	140.75	.20
FPM/Harmony	56.63	55.98	158.78	155.84	-.14

^a Adjusted for tonal imagery scores from the Musical Aptitude Profile.

^b Adjusted for composite scores from the Musical Aptitude Profile.

^c Standardized z-scores, across instrument type.

first half of the test were used in the related supplemental statistical analyses.

Despite counterbalancing, significant differences in musical aptitude between the testing groups (harmony first versus no harmony first) were found. To control for these differences, posttest scores were adjusted for musical aptitude. Multiple regression analyses were conducted that included MAP scores, research group (FPMs and harmonic context), and testing group, as well as interaction terms between the dependent variables and MAP scores. Results indicated no significant interactions by aptitude. Given this desirable situation, scores from the first half of the TBSP were adjusted for musical aptitude but without consideration of interactions by aptitude.

Effect Analyses

Table 3 shows observed and adjusted posttest means. Factor means indicate that, on average, students whose instruments had FPMs or students whose practice and instruction were accompanied by harmonic background had higher scores than did their counterparts for both performance tasks.

Results of ANOVA of left-hand technique scores suggest that the use of FPMs and harmonic context both separately and in combination neither assisted nor hindered the development of students' left-hand technique (see Table 4).

With regard to intonation, results of a two-way ANCOVA suggest that, when performing songs, students with FPMs played significantly more in tune than students who did not have FPMs (see Table 5). In

Table 4
Two-Way ANOVA of Standardized Technical Criteria Scores

Source	df	F
FPM	1	.02
Harmonic context	1	.78
FPM × Harmonic context	1	.22
Error	64	(1.11)

Note. Value enclosed in parentheses represents mean square errors. Interrater reliability = .77.

addition to being independent of musical aptitude and assignment to a long-term harmonic accompaniment research group, supplemental analyses that also considered harmony as a testing condition yielded nonsignificant interaction terms and a significant main effect only for FPMs. This indicates that the effect of FPMs on intonation was also independent of harmonic accompaniment as a testing condition.

Students whose instruction and practice were accompanied by harmonic background demonstrated a significantly higher degree of overall performance skill than did students whose instruction and practice were not accompanied by harmonic background. As well as being independent of musical aptitude and FPM assignment, supplemental analyses indicated that this effect was independent of the presence or absence of harmonic context during testing.

The extended treatment period of 33 weeks raises the possibility that factors uncontrolled by the research design or analyses contributed to this difference. Results of a supplemental three-way ANOVA (FPM × harmony × school) of scores from both halves of the test confirmed that this harmony effect was consistent across the three schools. This reduces the possibility that the results of the study were influenced by confounding factors related to the extended treatment period.

DISCUSSION

Recommendations for the use of FPMs as an aid to learning to play a stringed instrument have been made for at least 250 years. FPMs seem of obvious assistance in teaching beginning string students the approximate placement of their fingers on the fingerboard, how to play in tune, and proper left-hand position. Indeed, results from this study suggest that the use of FPMs assists in the development of string-intonation skills. This is in contrast to the results of previous research involving only violin students (Smith, 1985, 1988). Authorities on string teaching recommend the use of FPMs not for the development of accurate intonation performance but for the advancement of correct left-hand technique. However, results of this study do not support this popular professional viewpoint. Thus, string educators should refine their rationale for the use of FPMs in beginning string instruction.

Table 5
Two-Way ANCOVA of Intonation and Song Performance Scores

Source	df	F
<i>Song intonation</i> ^a		
FPM	1	8.76***
Harmonic context	1	1.34
FPM × Harmonic context	1	.97
Covariate: TMAP	1	10.60***
Error	63	(75.86)
<i>Song performance</i> ^b		
FPM	1	1.30
Harmonic context	1	6.64**
FPM × Harmonic context	1	.47
Covariate: CMAP	1	39.72***
Error	63	(351.08)

Note. Values enclosed in parentheses represent mean square errors. All interactions with the covariate were not significant.

^a Interrater reliability = .70.

^b Interrater reliability = .89.

** $p < .01$; *** $p \leq .001$.

The use of harmonic accompaniment as a means of fostering and improving intonation has been recommended by expert authorities and has been the subject of contemporary research in the disciplines of psychology and music education. At the level of music-education practice, portable electronic keyboards, MIDI technology, and the increasing availability of recorded accompaniments to method books facilitate the delivery of customized harmonic accompaniments to almost any home or classroom. There is evidence from this study that, rather than specifically aiding intonation accuracy, harmonic accompaniment assists in the development of string students' overall musical-performance ability. This finding is not in agreement with that of earlier research involving the use of piano accompaniment in string classes (English, 1985). However, the current study focused on intonation performance by individual students and not by entire string classes. In addition, the current study attempted to systematize and amplify the use of harmonic accompaniment via the use of practice cassettes.

It is possible that the theoretical effect of harmonic accompaniment on intonation accuracy was suppressed by the strong presence in the instructional procedures of other tasks designed to aid the development of aural musicianship, predominantly the vocalization and performance of melodic patterns and song materials using tonic-solfa syllables. The inclusion of melodic models on the practice tapes also provided limited tonal information. Studies that consider the effects of FPMs on the development of intonation skills in which the use of FPMs potentially plays a more dominant role are recommended.

Assessing intonation accuracy in a study such as this one can be made more precise by the use of highly accurate pitch-measurement technology, such as a digital pitch extractor. Studies that involve this technology and that establish the construct validity for such measurements are needed.

The potential effectiveness of these teaching techniques is realized in the results of this study to a meaningful degree. This investigation offers empirical support for the use of FPMs in teaching string-intonation skills and for the use of harmonic context in developing overall musical-performance ability. The overwhelming degree of expert consensus on the link between the aural and kinesthetic dimensions of string intonation requires that teachers and researchers continue to explore and systematically investigate ways of developing string students' aural awareness during their first attempts at musical performance on a stringed instrument.

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