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A latent-trait model describing the influence of musical aptitude, academic ability, music experience, and motivation for music on the development of aural skills by 142 music theory students was evaluated. The model accounted for 73% of the total aural skills variance, with the ear-training and sight-singing components variance being accounted for by the model at 79% and 44%, respectively. Musical aptitude had the largest effect on performance in the aural skills components of the theory course, and the effects of academic ability and music experience were also statistically significant. Motivation for music did not affect aural skills performance, and it did not correlate significantly with any of the other latent variables.

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Effects of Musical Aptitude, Academic Ability, Music Experience, and Motivation on Aural Skills

The study reported in this article is part of a series of investigations into the relationships of selected background variables with achievement in college freshman music theory course work. In the first study, multiple regression analyses were used to determine the best predictors of course grades in each of the two semesters of freshman music theory (Harrison, 1990a). The main purpose of the second study was to identify the best predictors of grades in each of the four components of the first semester of freshman music theory: written work, sight-singing, ear training, and keyboard harmony (Harrison, 1990b). The independent variables used in both studies included sex and several measures of music experience, academic ability, and musical aptitude. This study evaluates a latent-trait model that describes the influence of musical aptitude, academic ability, music experience, and motivation for music on the development of aural skills as typically taught in music theory course work. The purpose of this research was (1) to evaluate the suitability of the explanatory model and (2) to determine the relative contribution of

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the variables within the model. Results of this research should enhance our understanding of the acquisition of aural skills and important factors that influence aural skill achievement.

Research exploring those factors that affect music achievement has been of ongoing interest to music educators and others involved in the field of music education. Five variable types have been emphasized in the search for predictors of music achievement: (1) musical talent and aptitude, (2) academic achievement, (3) intelligence, (4) musical experience, and (5) motivation for music. Few studies, however, have simultaneously incorporated all five variables as predictors of music achievement. Investigators in most of these studies have looked at the simple relationship between music achievement and one of these five variable types.

In a large number of studies, measures of musical talent and aptitude have been used to predict music achievement. Investigators in this research have generally found strong relationships between these types of measures and music achievement (Gordon, 1968; Helwig & Thomas, 1973; Hufstader, 1974; Kehrberg, 1989; Norton, 1980; Roby, 1962; Walters, 1991; Whellams, 1970; Young, 1971; Zdzinski, 1992).

Academic achievement variables have included measures of reading, mathematics, and verbal skills, as well as more global measures such as performance on standardized achievement tests like the Iowa Test of Basic Skills. This research has revealed significant relationships between academic achievement and achievement in music (Arenson, 1983; Ernest, 1970; Gordon, 1968; Harrison, 1990a, 1990b; Hedden, 1982; Klinedinst, 1991; Roby, 1962).

Related to academic achievement is the more global assessment of intelligence through measured performance on IQ tests. IQ scores, too, have been shown to have significant relationships with achievement in music (Gordon, 1968; Helwig & Thomas, 1973; Hufstader, 1974; Norton, 1980; Young, 1971).

Music experience has usually been measured by amount and type of involvement with music. Often studies involving this variable type use years of musical experience, years playing an instrument, ensemble experience, and type of instrument played as indicators of music experience. In general, this body of research has also revealed strong relationships between music experience and music achievement (Austin, 1988; Berberich, 1989; Kehrberg, 1989; Zdzinski, 1992).

Motivation for music learning has been empirically investigated primarily through the principles of attribution theory. In this theory, students' beliefs of the causes of success and failure are analyzed to determine how students are motivated or what motivates them. Five primary causal categories have been identified from high school music students' attributions: effort, musical ability, background, classroom environment, and affect for music (Asmus, 1986a, 1986b). Research has shown that students tend to attribute success and failure in music to the internal causes of ability and effort (Asmus, 1985, 1986a, 1987; Austin, 1988, 1991; Austin & Vispoel, 1992). The type of musical experience that a student experiences can influence the kinds of causes students cite. Successful musical experiences produce more internal causes, whereas unsuccessful experiences produce more external causes (Chandler, Chiarella, & Auria, 1987), though contest format produced no significant effect on cited causes (Austin, 1988). No significant relationship between motivation and musical aptitude has been identified (Asmus & Harrison, 1990).

Few studies exist in which investigators have attempted to use more than one or two types of predictors in analyzing influences on music achievement. Fewer researchers still have attempted to evaluate a model that clearly articulates the important relationships between these variable types and music achievement. A path-analysis model has shown that the best predictors of musical achievement are scholastic achievement and academic intelligence, followed by musical training and musical aptitude (Asmus, 1989). The present research uses four of the five variable types (aptitude, academic achievement, musical experience, and motivation) in a latent-trait model of influences on the achievement of music theory students in aural skills.

METHOD

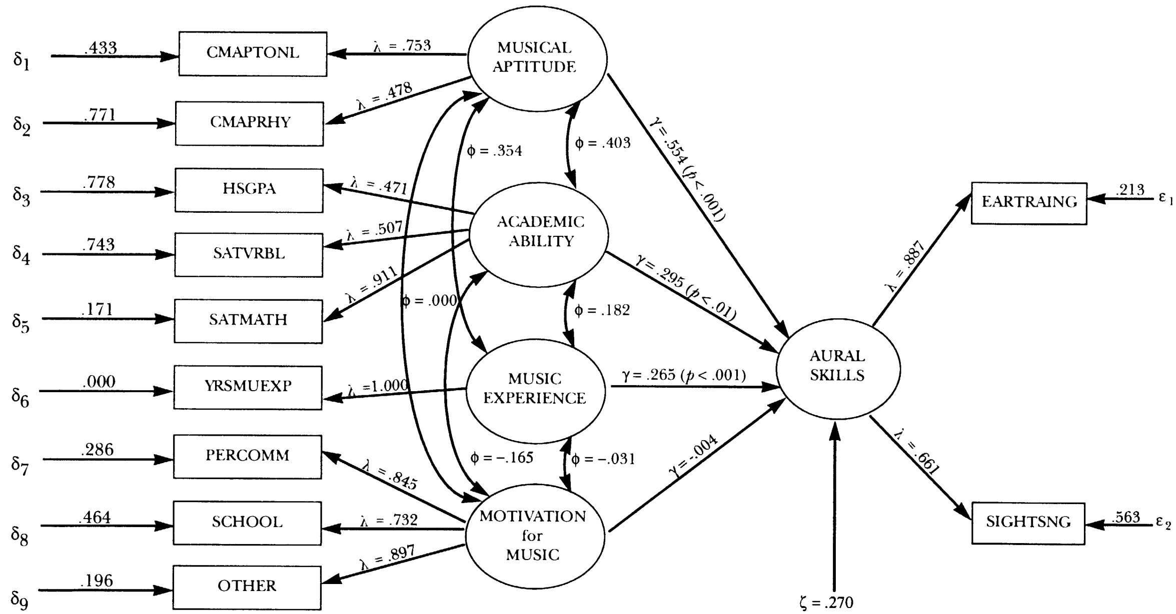
The subjects used in this investigation were 142 students who completed the first-semester music theory course for music majors and for whom complete data were available. This sample included 106 students used in an earlier study (Harrison, 1990b). The data used in this study and the previous studies in this series were collected over a period of 10 consecutive semesters. Beginning with the fifth semester of data collection, the portion of the Motivation for Music survey used in this investigation was included. Early in the semester, all students took the Tonal Imagery and Rhythm Imagery Tests of the College Musical Aptitude Profile (CMAP) (Schleuter, 1978; Schleuter & Schleuter, 1978) and the portion of the Motivation for Music survey that assesses magnitude of motivation in three areas (Asmus, 1986a; Asmus, 1986b) and completed a questionnaire that provided information about their music experience. High school grade point averages and Scholastic Aptitude Test (ETS, 1948–1987) scores were obtained from the Office of Admissions and Records. At the end of the semester, grades for the ear-training and sight-singing components of the music theory course were provided by the three theory/composition area instructors who teach the course.

The structural and measurement parameters for the hypothesized model examined in this study are presented in Figure 1. Boxes denote measured or observed variables, called indicators or indicator variables, and ovals signify latent (unobserved) variables or constructs. As can be seen in Figure 1, the study involves one latent endogenous (dependent) variable, Aural Skills, and four latent exogenous (independent) variables: Musical Aptitude, Academic Ability, Music Experience, and Motivation for Music. Single-headed arrows show the hypothesized effects of the four exogenous variables on Aural Skills. Coefficients indicating the size of the effect are given above the arrows. The curved arrows linking each pair of exogenous variables indicate that the two variables were permitted to covary. We did this because we believed the variables were related (i.e., high musical aptitude is related to high academic ability), and because the correlations between the observed variables for these latent variables supported this belief (e.g., the correlation between YRSMUEXP and CMAPTONL is .255). The degree of correlation between the exogenous variables provided by the analysis is indicated by the phi coefficient.

The indicators of the four latent exogenous variables are: scores on the Tonal Imagery (CMAPTONL) and Rhythm Imagery (CMAPRHY) Tests of the College Music Aptitude Profile; high school grade point averages (HSGPA); scores on the verbal (SATVRBL) and math (SATMATH) components of the Scholastic Aptitude Test; the total number of years of experience on all instruments (YRSMUEXP); Personal Commitment to Music (PERCOMM); the Importance of School Music (SCHOOLMUS); and the Importance of Music Compared to Other Activities (OTHER). All measured variables except the three that indicate Motivation for Music are the same as those used in previous studies (Harrison, 1990a; Harrison, 1990b; Harrison, 1991). Figure 2 is a key to the acronyms for the variables used in this study.

The two variables that serve as indicators of Aural Skills are grades in the ear-training (EARTRAING) and sight-singing (SIGHTSNG) components of the first-semester music theory course. A scale of 3 to 16 points was used to record all grades (F = 3; A+ = 16). For both the ear-training and sight-singing components, grades were based on the number of errors made. For grades in the sight-singing component, fluency of performance within the context of tempo was also a consideration. The materials, approach, evaluation instruments, and grading procedures for both components were agreed upon by the three instructors who teach the course. An analysis of variance (ANOVA) indicated no significant difference in the means of the grades assigned by the three professors, and Bartlett's test for homogeneity of variance indicated that the three groups had the same variance.

Data were analyzed with SYSTAT (Wilkinson, 1987) and LISREL VI (Jöreskog & Sörbom, 1986). Internal-consistency reliability coefficients (coefficient alpha) for the two CMAP tests used in the study (N = 265) were: Tonal Imagery, .790; and Rhythm Imagery, .684. The sample used to calculate the reliability coefficients for the CMAP tests was comprised of all students who took these tests, including those for whom complete data were not available. For the three measures of Motivation for Music, the internal consistency



δ and ε = measurement errors
λ = standardized factor loadings
γ = standardized effect coefficients
ζ = error (residual variance)

R^2 for Ear-training Grades = .787
R^2 for Sight-singing Grades = .437
Coefficient of determination = .730
Goodness-of-fit index = .954
Adjusted goodness-of-fit index = .912

Figure 1. Effects of Musical Aptitude, Academic Ability, Music Experience, and Motivation for Music on Aural Skills

Acronym	Variable name
CMAPTONL	Tonal Imagery score on the College Music Aptitude Profile (CMAP)
CMAPRHY	Rhythm Imagery score on the CMAP
HSGPA	High school grade point average
SATVRBL	Verbal score on the Scholastic Aptitude Test (SAT)
SATMATH	Math score on the SAT
YRSMUEXP	Total years of music experience on all instruments
PERCOMM	Score on the Motivation for Music measure that assesses the magnitude of personal commitment to music
SCHOOLMUS	Score on the Motivation for Music measure that indicates liking for music classes
OTHER	Score on the Motivation for Music measure that indicates the importance of music in relation to other activities
EARTRAING	Grade in the ear-training component
SIGHTSNG	Grade in the sight-singing component

Figure 2. Key to acronyms for variables used in this study.

reliability coefficients (n = 143) were: Personal Commitment, .715; School Music, .837; and Other, .759. Means, standard deviations, and intercorrelations of variables are presented in Table 1. The one case that was identified as a multivariate outlier because of its unusual pattern of scores was deleted from further analysis, yielding a sample of 142 students. Subsequent examination of scatterplots and normal probability plots of residuals for the observed variables revealed no violation of the assumptions of normality, linearity, and homoscedasticity.

Maximum likelihood parameter estimates were obtained by applying LISREL to the correlation matrix presented in Table 1. To ensure that the latent variables, Musical Aptitude, Academic Ability, Music Experience, Motivation for Music, and Aural Skills, were measured on the same measurement scale as the corresponding observed indicators, one loading was fixed to 1.00 for each latent variable. To test the adequacy of the hypothesized model, several indices of fit were examined. These included the coefficient of determination, goodness-of-fit index, overall chi-square measure, modification indices, standardized residuals, and the significance of the estimates. Structural equations modeling and the LISREL program are discussed in a number of articles and books (e.g., Asmus, 1989; Blalock, 1985; Harrison, 1991; Hayduk, 1987; Jöreskog & Sörbom, 1986; Long, 1983).

Table 1
Correlations, Means, and Standard Deviations (N = *142)*

VARIABLES	EAR-TRAING	SIGHT-SNG	CMAP-TONL	CMAP-RHY	HSGPA	SAT-VRBL	SAT-MATH	YRSMU-EXP	PER-COMM	SCHOOL-MUS	OTHER
EARTRAING		.589	.528	.296	.261	.291	.471	.434	–.024	–.036	–.024
SIGHTSNG	.589		.318	.369	.258	.102	.273	.423	–.112	–.095	–.103
CMAPTONL	.528	.318		.360	.108	.190	.290	.255	.037	.006	.011
CMAPRHY	.296	.369	.360		.071	.058	.142	.201	–.083	–.020	–.042
HSGPA	.261	.258	.108	.071		.176	.434	.166	–.073	–.018	–.091
SATVRBL	.291	.102	.190	.058	.176		.465	.132	–.093	–.130	–.220
SATMATH	.471	.273	.290	.142	.434	.465		.152	–.058	–.105	–.156
YRSMUEXP	.434	.423	.255	.201	.166	.132	.152		.018	–.059	–.044
PERCOMM	–.024	–.112	.037	–.083	–.073	–.093	–.058	.018		.625	.758
SCHOOLMUS	–.036	–.095	.006	–.020	–.018	–.130	–.105	–.059	.625		.652
OTHER	–.024	–.103	.011	–.042	–.091	–.220	–.156	–.044	.758	.652	
Mean:	8.873	10.718	30.070	34.711	3.200	436.514	479.155	8.600	25.247	23.500	24.085
SD:	3.760	3.074	5.408	3.851	.437	109.942	103.372	3.651	2.409	3.529	3.075

RESULTS

The effect coefficients and the values for the goodness-of-fit measures obtained with the LISREL analysis are summarized in Table 2 and are given on the path diagram (Figure 1). All coefficients are from the standardized solution.

Table 2
Results of LISREL Analysis of Causal Model Hypothesizing Relationships between Aural Skills, Musical Aptitude, Academic Ability, Music Experience, and Motivation for Music

Parameter	Effect	$p <$
Structural coefficients:		
Effect of Musical Aptitude on Aural Skills	.554	.001
Effect of Academic Ability on Aural Skills	.295	.01
Effect of Music Experience on Aural Skills	.265	.001
Effect of Motivation for Music on Aural Skills	–.004	—
Correlations between exogenous variables:		
Musical Aptitude and Academic Ability	.403	.001
Musical Aptitude and Music Experience	.354	.01
Musical Aptitude and Motivation for Music	.000	—
Academic Ability and Music Experience	.182	.05
Academic Ability and Motivation for Music	–.165	—
Music Experience and Motivation for Music	–.031	—
Measurement Model		
Loadings on the exogenous variables:		
CMAPTONL on Musical Aptitude	.753*	—
CMAPRHY on Musical Aptitude	.478	.001
HSGPA on Academic Ability	.471*	—
SATVRBL on Academic Ability	.507	.001
SATMATH on Academic Ability	.911	.001
YRSMUEXP on Music Experience	1.000*	—
PERCOMM on Motivation for Music	.845*	—
SCHOOL on Motivation for Music	.732	.001
OTHER on Motivation for Music	.897	.001
Loadings on the endogenous variables:		
EARTRAING on Aural Skills	.887*	—
SIGHTSNG on Aural Skills	.661	.001
Reliabilities:**		
CMAPTONL	.567	
CMAPRHY	.228	
HSGPA	.222	
SATVRBL	.257	
SATMATH	.830	

(continued)

Table 2 *(continued)*

Parameter	Effect	*p* <
YRSMUEXP	1.000	
PERCOMM	.714	
SCHOOLMUS	.536	
OTHER	.805	
EARTRAING	.787	
SIGHTSNG	.437	
Goodness-of-fit:		
Coefficient of determination	.730	
Chi-square (*df*)	37.360 (35)	.361
Goodness-of-fit index	.954	
Adjusted goodness-of-fit index	.912	

* Asterisk denotes a fixed parameter.
** Squares of the loadings.

The total amount of variation accounted for in the model, as indicated by the coefficient of determination, is 73%. The adjusted goodness-of-fit index is .912, indicating that the model fits the data well. Consistent with this result, the chi-square value of 37.36 with 35 degrees of freedom and a .361 significance level indicates that the differences between the model-implied covariance matrix and the observed covariance matrix are small enough to be sampling fluctuations. In addition, all standardized residuals were small, indicating that most of the error is random.

The amounts of variation accounted for in the two indicators of Aural Skills (ear-training and sight-singing grades) are 79% and 44%, respectively. The coefficients indicating the effects of Musical Aptitude, Academic Ability, Music Experience, and Motivation for Music on Aural Skills are .554, .295, .265, and –.004, respectively. Except for that of Motivation for Music all coefficients were statistically significant at the .01 level or greater.

Correlations between the latent exogenous variables ranged from .403, between Musical Aptitude and Academic Ability, to –.165, between Academic Ability and Motivation for Music.

Except for the indicators of Motivation for Music, which involve both negative and positive correlations, the correlations between the observed variables were uniformly smaller since they were affected by errors in measurement (See Table 1).

As indicated by the loadings and the error terms, the more reliable measure for Musical Aptitude is the Tonal Imagery test; the most reliable measure for Academic Ability is the SAT math test; and the more reliable measure for Aural Skills is grades in the ear-training component of the theory course.

The latent variable, Music Experience, has only one indicator, YRSMUEXP. In the results reported in this paper, this indicator was treated as a perfectly reliable and valid measure of Music Experience as the loading was set at 1.000 and the error variance was zero. Before the decision to do this was made, an analysis was completed in which the value for the error variance was specified. The value of the error variance is determined by multiplying the variance of the indicator by the proportion of the indicator that the researcher believes is error variance. Using 20% as the proportion of error variance, we found that the results of the analysis indicated an increase of only 1.8% in the coefficient of determination and no improvement in the goodness-of-fit indices. Thus, it was decided to treat the variable YRSMUEXP as a reliable and valid indicator of Music Experience.

CONCLUSIONS AND RECOMMENDATIONS

In this study, we examined several possible determinants of success in the aural skills components of the first semester music theory course. A causal model hypothesizing that musical aptitude, academic ability, music experience, and motivation for music have direct effects on achievement in the aural skills components of music theory was developed and tested. Because the results of the analysis indicate the fit of the model to the data is good, it is reasonable to accept the results as valid.

One of the major theoretical outcomes of the analysis is that musical aptitude, academic ability, and music experience do affect achievement in aural skills. This finding is consistent with those of Harrison (1990b) using multiple regression analyses to predict grades in the ear-training and sight-singing components of the first-semester music theory course. The finding is also consistent with that of a previous study using a structural equation model involving the latent variables Musical Aptitude, Academic Ability, and Music Experience (Harrison, 1991). Although the effect of musical aptitude seems to be almost identical in both studies, as indicated by an effect coefficient of .554 here and a coefficient of .575 in the previous study, the effects of academic ability and music experience are, in this study, slightly stronger than those reported previously. These differences, however, could be the result of the relatively small samples used. In both studies, the correlations between the latent exogenous variables (Musical Aptitude, Academic Ability, and Music Experience) are all statistically significant (Table 2). This finding suggests that for the samples of students used in these studies, those who have more aptitude for music also have more music experience and demonstrate more academic ability.

The second major theoretical outcome of this study is that there is no significant effect of Motivation for Music on Aural Skills performance as indicated by a coefficient of –.004. Since the internal-consistency reliabilities of the three variables are strong (from .72 to .84) and since the reliabilities of the variables as indicators of Aural Skills are also strong (from .536 to .805), the problem is not one of poor measures or invalid and unreliable indicators. One explanation of the finding is that because most of the students in the sample work from 20 to 40 hours a week, they have little time to devote to the various assignments that improve sight-singing and ear-training skills, even though music may be the most important thing in their lives.

Another explanation is that the motivation indicators are based on self-reports of the subjects. These beliefs may not be accurately reflected in the learning cycles of the aural skills task. That is, what subjects believe about themselves may not be operationalized when the subjects are involved in music learning. This disparity between self-motivation appraisal and actual learning may be maximized in situations such as aural skill learning where skills are traditionally difficult for many students to acquire.

A different means of measuring motivation for music may be necessary. The appraisal of factors such as effort, musical ability, and musical background needs to be made on the basis of external observations. Such appraisals of motivation would ideally be made before, during, and after the learning tasks. Developing an objective motivation appraisal system will require considerable future research effort.

The lack of relationship between Motivation for Music and Musical Aptitude is somewhat puzzling. Generally, motivation theory maintains that people strive in areas where they have success. Therefore, a fairly substantial degree of relationship would be expected between Musical Aptitude and Motivation for Music. This did not happen here. Furthermore, these findings verify the findings of an earlier study in which researchers also found no relationship between these variables (Asmus & Harrison, 1990).

The amount of variation accounted for in ear-training and sight-singing grades was 78.8% and 43.7%, respectively, as compared to 66% and 53.7% in the previous study. Perhaps the reason less variation was accounted for in sight-singing grades than in ear-training grades in both studies is that, for sight-singing grades, fluency of performance in relation to tempo was a consideration. Assessment of such performance, of course, involves subjective judgment. And when subjectivity is involved, so usually are unreliability and fairly large amounts of error.

Since the results of the measurement part of the structural model provide the loadings and error terms for the indicator variables, those variables with low loadings and high error coefficients can be easily identified. In this study, variables that have low loadings and high error terms are CMAPRHY as an indicator of Musical Aptitude and HSGPA and SATVRBL as indicators of Academic Ability. Since in both this study and the previous study (Harrison, 1991) the loadings for these variables are not as high as one might like, questions of reliability and validity might be raised. Examination of other measures of musical aptitude and academic ability is certainly appropriate and may result in the identification of instruments that better represent the concepts. For example, the Advanced Measures of Music Audiation test (Gordon, 1989), which was developed for use with college and university students, could be explored as an alternative measure of musical aptitude. Like the Musical Aptitude Profile tests (Gordon, 1965) and the tests of CMAP, the Advanced Measures of Music Audiation includes Tonal and Rhythm subtests.

The transferability of the latent-trait model to other music settings where different measures of achievement are used requires additional research. The achievement measures of this study focus exclusively on aural skills taught in music theory classes. In a 1981 study, Brand and Burnsed concluded that performance in music theory classes and ear-training skills are not related to error detection achievement.

This would suggest that various forms of musical achievement may have distinctly different sets of predictors, since these forms may require different skills and capacities for success.

In summary, the results of this study confirm the findings of previous investigations that indicate that measures of musical aptitude, academic ability, and music experience affect achievement in the aural skills components of the first-semester music theory course. Thus, while some of the less reliable indicators need to be replaced and investigation of other indicator variables completed, knowledge of scores on the Tonal Imagery Test of CMAP, SAT math test scores, and years of music experience could be used by instructors of freshman music theory to identify students who might benefit from additional assistance in their area(s) of weakness. Knowledge of students' abilities and music experience could also assist instructors in selecting course materials and in determining the amount of class time devoted to particular activities.

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