AN ASSESSMENT OF MOTOR MUSIC SKILL DEVELOPMENT IN YOUNG CHILDREN

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The purpose of this research was to describe the characteristics of motor music skill development in children aged three to six. Variations in development were also examined in relation to age, sex, race, community size, and previous musical instrument experience. Data were gathered via administration of the Motoric Music Skills Test (MMST) to 808 children selected from seven eastern Kansas communities. Measures of central tendency and variability for each age group indicated that the skills tested by the MMST improve with increases in chronological age. Inferential statistical procedures included a canonical analysis to reduce the number of independent variables, followed by a multiple analysis of variance. Race, community size, and previous musical instrument experience were not significantly related to test performance, and no interactions were discerned among the variables.

Recent research in psychology and child development has focused on age-related motor development, both as an entity in itself and as an attribute affected by exogenous factors. This research concentration has resulted in the publication of several normative schedules of general motor development (Bayley, 1935; Frankenburg, Dodds, & Fandal, 1970; Gesell & Amatruda, 1949; Sloan, 1955).

Music performance is one functional area in which motor skills are integrally involved. Since participation in music activities often requires performance, motor skill is a necessary prerequisite for optimum musical response. Motor skills constitute a central aspect of musical functioning, and professional music educators must acquire as much information as possible concerning the development and manifestation of these skills. Results of music education studies clearly indicate that rhythmic ability (Groves, 1969; Smoll, 1974, 1975), conceptualization (Pflederer & Sechrest, 1968), and perception (Pflederer, 1967) improve with age.

Although not developmental in nature, additional research has examined the relationship between motor and music skills. Bond (1959) found no significant relationship between objective measures of motor performance and rhythm perception. Gates and Bradshaw (1975), however, concluded that the performance of bimanual music tasks is affected by

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such perceptual variables as auditory input format. Rhythmic movement activities have been used successfully to improve sight-reading (Boyle, 1968) and rhythm perception (Ruckmick, 1945). On the other hand, a structured music skills program has been used effectively to enhance the perceptual-motor development of educable mentally retarded children (Elrod, 1972).

Examination of general motor development literature may provide an indication of how motor skills develop in a music performance context. Aspects of motor performance that theoretically and empirically discriminate from immature performance include timing, speed, and range of movement (Connolly, 1968; Kerr, 1975; Wickstrom, 1970), plus elements of motor complexity, including eye-hand coordination, synchronization of movement patterns, and speed (Henry & Rogers, 1960; Ward & Lerch, 1975). Capability for movement complexity also increases with maturation and is related to the number of elements and demands on attention involved in task performance (Fitts, 1954; Stelmach, 1976). Rarick (1976) and Woodrow (1938) contend that performance variance is also age-related. Variance is relatively small at the initial stages of task acquisition, increases during the intermediate stages when some children master the task more quickly than others, and decreases when the upper age limit for task mastery is reached.

Research examining motor development in the music setting must also consider exogenous factors that affect this development. Studies by Boley (1975), Milne, Seefeldt, & Reuschlein (1976). and Herkowitz (1978) indicate that motor performance and development may vary according to sex. Other research (Isaac, 1973) indicates that racial and socioeconomic factors may interact to influence motor performance. In music education research, Parker (1961) found no differences in the music perception of advantaged and disadvantaged groups, whereas Hill (1968) discovered significant socioeconomic differences in music achievement variables. To determine the validity of the resulting data for possible general application to children from a variety of community and experiential backgrounds, the variables of community size and previous experience with musical instruments should also be examined.

Skills in musical and motor performance thus seem to be related and to influence each other. Research is needed, however, to identify the motor skills that are integrally involved in performing music. Research is also needed to examine these skills in a developmental context, and to determine how external factors may affect skill development.

The purpose of the present study was to describe the characteristics of motor music skill development in children aged three through six years. Variations in skill development were also examined in relation to age, sex, race, community size, and previous musical instrument experience. For purposes of this research, motor music skill was defined as facility in the motor performance aspects directed music tasks. These skills were defined further to emphasize skills used in instrumental music. The following research questions were established:

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1. Do motor skills involved in music performance improve with increased chronological age?
   a. At what ages do specified motor music skills typically appear and mature in young children?
   b. Do the variance patterns suggested by Rarick and Woodrow also appear in the development of motor music skills?
2. Is sex related to motor music skill development?
3. Is race related to motor music skill development?
4. Is community size related to motor music skill development?
5. Is previous experience with musical instruments related to motor music skill development?

Method

No measurement scales were located that examined motor skill development in a musical context; therefore, the initial phases of this research were directed toward developing the Motoric Music Skills Test (MMST). Briefly, the MMST is a 44-item test measuring motor music skills through five subtests: (1) Motor Pattern Coordination; (2) Eye-Hand Coordination; (3) Speed of Movement; (4) Range of Movement; and (5) Compound Factors (Gilbert, 1980).

The MMST was administered to 808 children aged three through six, who were selected from seven eastern Kansas towns. Prior to actual test administration, general information was obtained from parents concerning each child's age, sex, race, community, and amount of previous experience with the musical instruments used in the study. The MMST was then administered individually to participating subjects. Children's test performances were recorded on an automatically operated Sonymatic videotape recorder. Videotapes were viewed and analyzed by independent judges who recorded each subject's performance scores on a standard scoring form.

Results

Descriptive data were analyzed to determine whether test performance improved with increases in age. Mean performance scores increased at each age level; comparison of means and medians also revealed that MMST subtests were generally normally distributed, with slight negative skewing at some age levels (see Table 1).

Tasks mastered at the earliest ages, as indicated by performance medians and modes, included most items in the Motor Pattern Coordination subtest. At the youngest ages, the large discrepancy between mean and median on one hand and mode on the other hand suggests that motor pattern coordination tasks may represent all-or-nothing skill acquisition, since few moderate performances contrasted with numerous extremely high or low scores.

Median performance scores also indicated that eye-hand coordination tasks are mastered at a later age than the corresponding motor pattern

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Table 1
Means, Medians, and Modes for the MMST by Age Level

Age	Motor Patterns			Eye-Hand			Speed			Range			Compound Factor		
	Mean	Med.	Mode	Mean	Med.	Mode	Mean	Med.	Mode	Mean	Med.	Mode	Mean	Med.	Mode
3.0	28.6	29.0	37	31.1	31.0	47	48.0	46.0	57	142.5	168.0	189	35.1	33.0	22
3.5	33.0	39.0	35	39.4	41.0	44	63.5	63.0	61	181.0	193.0	192	48.4	47.0	38
4.0	35.8	37.6	39	45.6	47.2	51	81.4	86.0	87	203.8	207.2	204	65.8	68.8	78
4.5	37.3	38.0	39	50.2	51.0	56	94.4	95.0	81	233.3	226.0	214	78.1	77.0	77
5.0	37.9	38.7	40	54.2	55.5	53	109.6	112.2	109	233.3	235.5	234	94.9	97.5	101
5.5	38.4	39.5	40	57.5	57.5	56	119.7	121.2	124	238.8	239.1	232	106.2	108.5	109
6.0	39.2	39.8	40	60.9	61.0	61	132.8	137.8	141	254.9	255.2	268	120.3	123.2	108
6.5	39.5	40.0	40	60.1	61.0	64	156.4	157.2	169	278.6	278.7	286	145.2	146.5	165

coordination tasks. Scores on the Eye-Hand Coordination subtest manifested a gradual, although not invariant, improvement as subject age increased. Data from the Speed, Range, and Compound Factors subtests demonstrated similar improvement and distribution patterns.

Variance data for the MMST subtests were presented by age level and did not confirm the theoretical postulates in all cases, although some general developmental trends were noted (see Table 2). the Motor Pattern Coordination subtest was mastered by many of the youngest children, and performance variance generally decreased from that point. The Eye-Hand Coordination subtest was characterized by an irregular variance pattern that decreased, then increased, followed by an abrupt decrease. The Speed and Compound Factors subtests demonstrated similar variance patterns. Range of Movement subtest variance progressed from a high level in the youngest age groups to the lowest variance in the oldest age group, with only one intervening increase in variance between the two age extremes.

Statistical Analysis of Null Hypotheses

A canonical analysis procedure was used as an initial step in this analysis to reduce the number of predictor variables. Age, sex, race, community size, and the amount of previous musical instrument experience were predictor variables; the five MMST subtests were criterion variables. As a result, all MMST subtests were retained for more detailed examination; community size and previous musical instrument experience failed to load on either significant canonical variate and were eliminated from further consideration.

Next, a multiple analysis of variance was conducted to explore more fully the relationships discerned through canonical analysis. All possible hypotheses, excluding the grand mean, were tested using the orthogonal contrast procedure. To compensate for unequal cell size, tests of the seven

Table 2
Variance on MMST Subtests by Age Level

	MMST Subtest				
Age	Motor Pattern	Eye-Hand Coordination	Speed	Range	Compound Factors
3.0	53.9	145.9	315.9	2,897.0	248.9
3.5	48.7	170.9	521.7	1,236.8	475.6
4.0	19.4	79.4	523.2	448.8	414.6
4.5	20.8	55.8	358.9	516.0	339.3
5.0	18.1	50.9	341.4	441.6	304.0
5.5	12.4	73.6	324.5	344.2	400.0
6.0	5.9	91.4	458.0	204.5	522.3
6.5	4.3	50.5	551.9	134.9	567.7

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resulting hypotheses were reordered so that each effect was tested last. Discriminant analysis was used as a post hoc procedure.

Examination of the *F* ratios for equality of mean vectors revealed significant main effects for age and sex, but no significant main effect for race and no significant interactions (see Table 3). Univariate *F* ratios indicated that age was a discriminating factor for all subtests ($p < .001$), with older children performing better than younger children (see Table 4).

Univariate *F* tests of the dependent variables for the sex main effect identified significant differences on three MMST subtests: Motor Pattern Coordination ($p < .001$), Eye-Hand Coordination ($p < .001$), and Compound Factors ($p < .04$) (see Table 5). Examination of mean scores revealed that girls performed better than boys on the three significant subtests, whereas mean scores for boys were higher on the nonsignificant subtests (see Table 6).

Table 3
Summary of *F* Ratios for Multivariate Test of Equality of Mean Vectors

Factor	*F* Ratio	*p*
Age	150.4571	<.001
Sex	7.0203	<.001
Race	1.4959	NS
Age × Sex	1.6110	NS
Age × Race	1.0325	NS
Sex × Race	.4144	NS
Age × Sex × Race	.4829	NS

Table 4
Univariate and Step Down *F* Tests for Age Factor

Variable	Univariate *F*	*p*	Step Down *F*	*p*
Motor Pattern Coordination	214.1673	.001	214.1673	<.001
Eye-Hand Coordination	403.3079	.001	142.5497	.001
Speed	723.6590	.001	212.8850	.001
Range	542.1246	.001	53.1354	.001
Compound Factors	752.6260	.001	17.1056	.001

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Table 5
Univariate and Step Down *F* Tests for Sex Factor

Variable	Univariate *F*	*p*	Step Down *F*	*p*
Motor Pattern Coordination	20.7209	.001	20.7209	<.001
Eye-Hand Coordination	10.9125	.001	.1109	NS
Speed	2.1408	.1439	2.0547	NS
Range	0.4076	.5234	8.3130	<.005
Compound Factors	4.2504	.0396	3.5823	NS

Table 6
MMST Subtest Means by Sex

Subtest	Male	Female
Motor Pattern Coordination	35.89	36.73
Eye-Hand Coordination	49.72	50.22
Speed	102.30	99.27
Range	222.10	216.90
Compound Factors	85.78	87.82

Conclusions

Analysis of descriptive and inferential data indicate that motor music skills improve with increased chronological age, and that differences exist in the performance of boys and girls. The information obtained from this research provides a sound basis on which to build developmental research investigating motor music skills. Future use of the MMST might include validation of cross-sectional data through longitudinal testing, investigation of motor music skills of older children, and description of skill development of children who are mentally retarded, learning disabled, or perceptually handicapped.

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