

Children's Invented Notations as Measures of Musical Understanding

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The purpose of this study was to investigate the validity of children's invented notations as a measure of their musical understanding. Notations were compared on the basis of their inventor's performance on tests of perceptual discrimination, performance by singing and playing, and their age. Sixty children aged between 4 and 8 years were tested for their perceptual discrimination with the rhythm and tonal subsets of the *Primary Measures of Musical Audiation* (PMMA) (Gordon, 1979). After each child reproduced a short folk song by singing and playing, he or she was asked to "write the way the song sounds". Three independent judges scored the children's singing and playing for their tonal and rhythmic accuracy and the children's invented notations for indications of tonal and rhythmic awareness. A correlation of all independent variables showed scores on PMMA rhythm, PMMA tonal, singing, and playing and the child's age to be significantly related. Because of the multicollinearity among variables, a principal components analysis was performed that extracted one factor and assigned a factor score to each subject. Inventors were divided into two groups. Mean factor scores for each group of inventors were compared using a one-way ANOVA. Significant differences ($F = 39.12, p < .001$) were found between musical understanding factor scores for groups of inventors. The higher the musical understanding factor score, the more likely the notation reflected pitch awareness. Likewise, inventors were grouped according to rhythm awareness. Mean factor scores for groups were found to be significantly different ($F = 24.41, p < .001$). The higher the musical understanding score, the more likely that the notation embodied an awareness of rhythm. The results of this study suggest that skills in perception and performance, as well as age, may contribute to musical understandings that are reflected in children's invented musical notations, lending evidence to the validity of children's invented notations as a measure of their musical understanding.

Invention, Piaget (1973a) believed, is the inevitable result of understanding: to understand is to invent. Invention is the process by which an original solution is found for a problem. According to Piaget, understanding is the prerequisite or motivating agent in the process of reflection upon a problem's solution. As Dewey (1933) explained, "Given a difficulty, the next step is suggestion of some way out—the formation of some tentative plan or project, the entertaining of some theory which will account for the peculiarities in question, the consideration of some solution for the problem" (p. 12). Young children confronted with the difficulty of needing to "write the way the song sounds" find themselves with a problem. Without extensive musical training or knowledge of the symbol system that music traditionally employs, they must invent a solution that satisfies the inherent conditions of the problem. Prerequisite to invention of the problem's solution is an understanding of what

the song is. Inherent in the problem's solution is the need to invent a way to write that. Hence, for young children to invent a musical notation, certain prerequisite understandings must exist: (a) children need to have experienced the object (the song) such that the experience has been conserved or represented within their minds, and (b) they must translate their experience into a representation that can be written in some form. Bruner (1966) states: "Intellectual growth involves an increasing capacity to say to oneself and others, by means of words or symbols, what one has done or what one will do" (p. 5). The ability to write what one has experienced musically would seem to reflect not only what a child has done musically, but the meaning a child has made of the musical experience. According to Piaget (1969), the child retains in memory what is understood rather than what is merely perceived. Their drawings from memory, therefore, correspond more to their level of understanding than to the phenomenon observed. Representations change as perceptions that are "syncretic and general" give way to ones with "imitation of detail, with analysis and reconstitution of the model" (Piaget, 1962, p. 78).

A growing body of research in children's invented notations has shown that the nature of a child's representation changes with musical experience and over time (Bamberger, 1982, 1991; Cuddy and Uptis, 1992; Davidson and Scripp, 1988, 1989, 1992; Uptis, 1990, 1992; Wolf and Gardner, 1981). Davidson and Scripp (1988) found that most 5-year-old children in their sample (69%) used either pictorial or abstract patterning systems without reference to musical dimensions. By age 7, however, more children used both abstract to musical and words to represent text and musical dimensions together. In fact, most 7-year-olds (64%) were "elaborators" who "modified the text to show how the words are to be sung" or "combines" who "recorded the text and abstract patterning of the 'notes' as two separate but necessary ingredients of the song" (p. 208). The 5-year-olds tended to represent a song in musical units, from units that embodied pulses to units that reflected melodic contour. By age 7, more children incorporated rhythmic structure and pitch relationships into their notations.

Davidson and Scripp found that when children were asked to notate a song they knew, children at the earliest stages of notational development drew a picture or an icon and later drew units that reflected quantity of sounds. The units gradually became more descriptive as the child's understanding increased, with units grouped according to pulse or proximity (e.g. two eighth notes followed by a quarter note would be grouped together). Finally, units were grouped metrically (e.g. two eighth notes were differentiated from the quarter note). Children's melodic development moved from perception of contour to perception of pitches in relation to rhythm. Uptis (1992) based her developmental sequence on children's invented notations for original compositions. Her sequence of symbolic notational development in music shares features in common with invented spellings. Children at early stages of development showed some knowledge of musical symbols, but lacked a sound-symbol correspondence. Symbols were used as pictures. In their development of symbolic fluency, children in Uptis' studies moved gradually from sound units to units descriptive of the sound's melodic shape or rhythmic pulse to notations that resembled standard musical notation.

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Projects such as those conducted in the middle school general music classes in Pittsborough, as discussed by Gray (1993), and in elementary general music classes in Boston, as discussed by Uptis (1990, 1992), showed that children's invented notations may provide a valid assessment of musical understanding. While Davidson and Scripp (1988; 1989; 1992) and Uptis (1990, 1992) found that children's invented notations were related to age and musical experience, invented notations have not been examined in relation to children's perceptual discrimination of tonal and rhythmic patterns and song production as measured by singing and playing.

The purpose of this study was to investigate the relations between children's perceptual discrimination abilities, performance skills, and age, and their effects on the quality of children's invented notations. Does the ability to invent a notation for musical sound reflect a child's ability to perceive pitches and rhythms and to produce pitches and rhythms, or does it reflect general understandings associated with maturation or age?

Method

Subjects. Subjects ($N = 60$) for the study were preschool and elementary children from a mid-western public elementary school ($n = 42$) and a mid-western private school ($n = 18$) in the USA. Data from both schools were combined to expand and diversify the sample. All children in the public school were taught twice weekly in 30-minute sessions by a music specialist. The private school children experienced music with a music specialist once a week for 30 minutes. Parents, informed about the nature of the research project in a letter, approved their child's participation in the study and recorded their child's birthdate.

Procedure. On the first day of testing, all public school children in kindergarten ($n = 22$) and second grade ($n = 20$) were measured for perceptual discrimination of tonal and rhythmic patterns with the *Primary Measures of Musical Audiation* (Gordon, 1979). Kindergartners were tested in two groups in their classrooms at tables separated by cardboard dividers. To control for fatigue, a song and dance was performed midway through the tonal subtest, between tonal and rhythmic subtests, and again at the midway mark of the rhythmic subtest. Testing on the *PMTA* took approximately 60 minutes in each kindergarten. Second graders were tested in one group at tables in the school's media centre. The tonal and rhythmic subtests were separated by a brief song and dance interlude, but were otherwise taken without interruption. Testing took 40 minutes in the second grade. On a separate day, all children from the private school ($n = 18$) were tested on the *PMTA* in three separate groups, none larger than 15 students. Testing took approximately 50 minutes in each group.

Musical ability was tested and invented notations created in individual sessions that lasted between 10 and 15 minutes for each child. In the testing room the child had paper and pencil on their right, three tone bells (e', g',

Each student was taught a folk song consisting of two phrases, identical in melodic contour with slight differences in surface rhythms:

(Sol)	La	Sol	Mi)
Bounce	High	Bounce	Low
(sol-	la- la	Sol	Mi)
Bounce	ball to	Shi-	Loh

The researcher sang the first phrase; the child imitated. The second phrase was sung; the child echoed. The two phrases were combined and the child sang the same. When the children could independently sing the song twice without error to the best of their ability, the performance was taped. Three independent judges scored the singing. If the child could neither match pitch in the key of C nor sing the intervals in tune, the singing was coded as "1". If the child could sing the melodic intervals in tune (for instance, an ascending major 2nd, followed by a descending major 2nd and a descending minor 3rd in the first phrase), but could not sing in the C major range, the singing was coded as "2". Singing that was accurate was coded as "3".

Each child was taught the song on the bells by first playing two beats at a time with the child imitating. The researcher then played 4-beat patterns and the child repeated, followed by all 8 beats. The child played the same. When the children could independently play the song twice without error to the best of their ability, their performance was taped. Three independent judges scored the playing. If the child could not reproduce the pitches or the rhythms of the song, the playing was coded as "1". If the child could not reproduce the patterns without distorting the rhythms, the playing was coded as "2". Playing that was accurate was coded as "3".

After the children sang and played the song, they were instructed to "write the way the song sounds so that you will remember the song tomorrow and so that a child who isn't even here today will know how the song sounds by looking at what you have written on your paper" (Bamberger, 1982, p. 194). When the children were finished with their notation, they were asked to sing the song again and conduct from their notation. Children were given the chance to elaborate upon their notation if they desired.

Three musician judges worked independently to score the second phrase of the notation for both pitch and rhythm awareness. Because of the pitch cues inherent in the words "high" and "low" in the first phrase, only the second phrase was evaluated for pitch awareness. Notations of pitch were coded as "1" if children did not indicate an awareness of pitch on the second phrase (see Figure 1) and as "2" if indications of pitch were present (Figure 2). Because of the lack of differentiation among the four steady beats in the song's first phrase only the second phrase was evaluated for rhythm awareness. Notations of rhythm were coded "1" if children did not indicate an awareness of rhythmic differences between the steady beats and divided beats in the second phrase (see Figure 3); notations were coded as "2" if indication of

Matthew & METUM hoy soft
 BOUNCE hoy BOUNCE
 LOW BOUNCE
 TO Cholew The Ball

FRANNEY

BHB/BBSI



Fig. 1

Samples of invented notations coded as "1" with no indications of pitch awareness in the second phrase. When asked to "write the way the song sounds", Matthew first wrote the words, "metum (medium) hoy (high) soft (soft)". Below that, he wrote the song. When asked if her notation was "enough", Franny added a picture of the ball below her notation of the song.

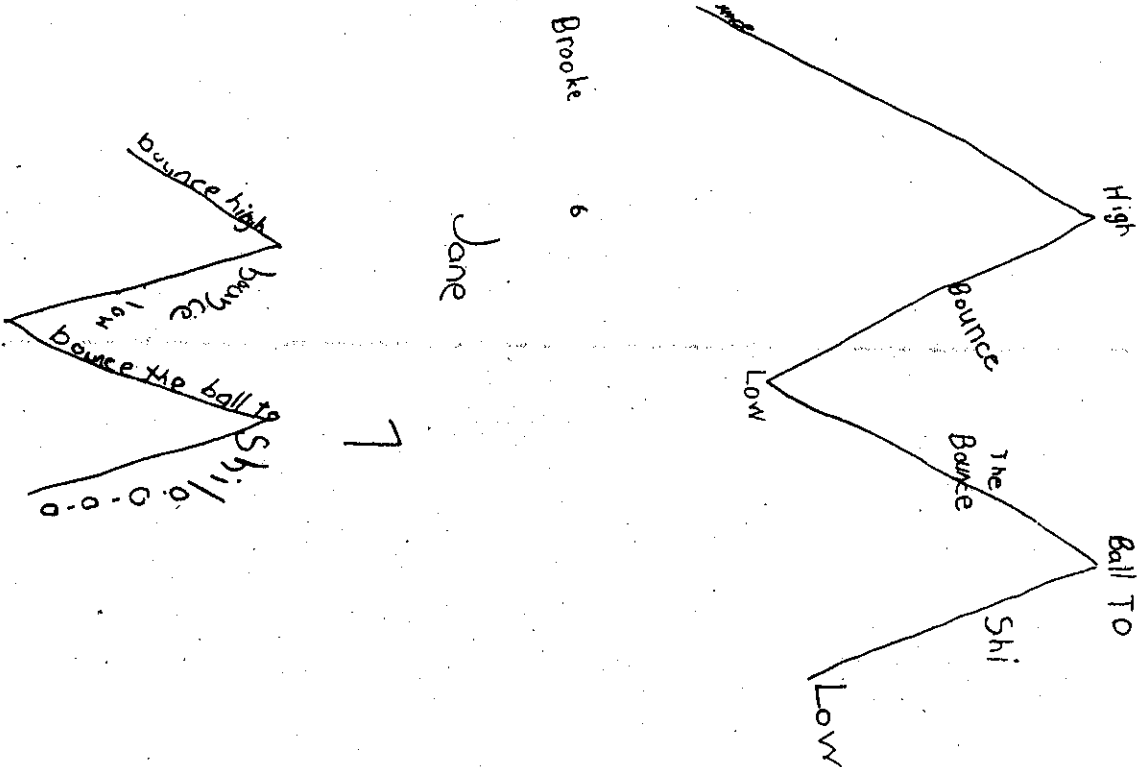


Fig. 2

Invented notations coded as "2" that indicate an awareness of high and low pitch in the second phrase.

Storm

Sxi

BOUNCE high BOUNCE LOW
BOUNCE the ball to Shiran

Adam

8

bons High bons low
bons the ball to Shiran

David

7

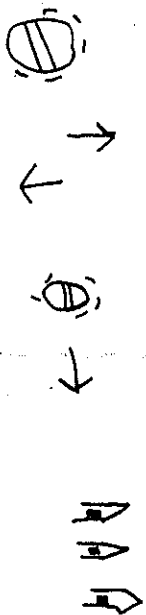
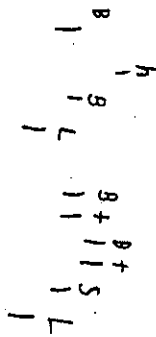


Fig. 3

... with no indications of rhythmic aware-

Skylar

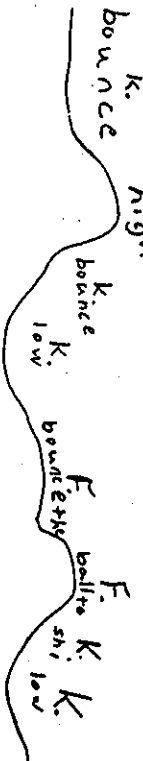
8



Chelsey

8

bounce high bounce low



Math

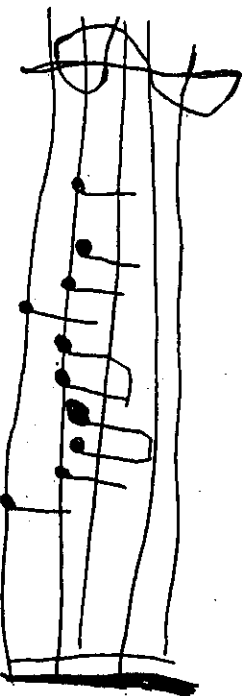


Fig. 4

Invented notations coded as "2" that indicate an awareness of rhythmic differences in the second phrase. Skylar expressed the differences between quarter notes and eighth notes by placing the rhythmic marks more closely together. Chelsey explained that "K" meant "kinda s..." and "F"

Results

The data from both schools ($N = 60$) were combined and analysed with SPSS Release 4.1 for IBM (1992). Inter-judge reliability scores were calculated (SPSS, Reliability, model alpha, 1992) for the three independent judges: singing (.97), playing (.96), pitch notation (.97), and rhythm notation (.99). The three judges' scores were averaged for singing, playing, and notation and all scores were converted to standard z-scores for subsequent analyses.

To determine the degree of relationship among the independent variables, correlation coefficients were computed. The correlation matrix for perception (PMMA tonal and PMMA rhythm), singing ability, playing ability, and age in months appears in Table 1. Scores on the PMMA subtests resulted in the highest coefficient ($r = .74, p < .01$), but all, with the exception of singing and age, were found to be significantly correlated ($p < .01$). Because of the multicollinearity among perception, performance, and age, a principal components analysis was conducted.

TABLE 1

Variables	Age	PMMA Tonal	PMMA Rhythm	Singing
Tonal PMMA	.45***			
Rhythmic PMMA	.46***	.74**		
Singing	.18	.50***	.54**	
Playing	.39***	.54**	.52**	.36**

** $p < .01$.

Principal components extracted one factor with an eigenvalue of 2.91, explaining 58% of the variance in the set of five variables. All five variables loaded on the first factor in the following order of magnitude: rhythm PMMA = .88; tonal PMMA = .87; playing = .74; singing = .67; and age = .63. This factor was interpreted as "musical understanding". In order to compare mean factor scores for musical understanding by inventor groups, univariate analyses of variance were conducted. The results appear in Tables 2 and 3.

A one-way analysis of variance was performed to compare the factor score mean for the group of inventors whose notations did not indicate an awareness of pitch with the factor score mean for the inventors who did indicate an awareness of pitch in their notations. The ANOVA showed significant differences by groups [$F(1,58) = 39.12, p < .001$]; the 45 subjects whose notations did not embody pitch awareness averaged a -0.36 factor score for musical understanding (read as a "z score" with a mean of "0"), while the 15 subjects who did reflect an awareness of pitch averaged a 1.09 factor score (see Table 2).

A one-way analysis of variance that compared the factor score means for rhythm notation groups also showed significant differences by groups [$F(1,58) = 24.41, p < .001$]: the 47 subjects whose notations did not indicate an awareness of rhythm averaged a -0.28 factor score for musical understanding and the 13 subjects whose notations reflected an awareness of rhythm averaged a 1.02 factor score (see Table 3).

TABLE 2

One-way analysis of variance summary table (factor scores by pitch notation).

Source of Variation	Sum of Squares	df	Mean Squares	F	P
Main Effect	23.76	1	23.76	39.12	<.001
Pitch	35.24	58	.61		
Residual					

TABLE 3

One-way analysis of variance summary table (factor scores by rhythm notation).

Source of Variation	Sum of Squares	df	Mean Squares	F	P
Main Effect	17.48	1	17.48	24.41	<.001
Rhythm	41.52	58	.72		
Residual					

Discussion

The results of this study show that children's perceptual discrimination abilities (tonal and rhythmic PMMA), and their performance skills (singing and playing) are significantly related to one another. Furthermore, scores on the PMMA subtests and reproduction of a folk song by playing are also related to maturation or age. Because of the problem of multicollinearity among the five variables, a principal components analysis was conducted which determined that all variables could be explained by one factor, interpreted as "musical understanding". When factor scores for musical understanding were compared for groups of inventors, a significant difference was found. Children whose notations reflected an awareness of pitch received significantly higher scores in musical understanding. Likewise, children whose notations reflected an awareness of rhythm received significantly higher scores in musical understanding. The ability to invent a notation for musical sound that embodies pitch and rhythm differences seems to reflect that child's ability to perceive pitches and rhythms and to produce pitches and rhythms. While age loaded on the factor, it was the least strong of the five. Uptitis (1992) also found age to be less important than "the nature of the development that occurs when children begin to explore and use notation" (p. 77). These results support the developmental sequences described in earlier research (Bamberger, 1982; Davidson and Scripp, 1988; Uptitis, 1987; 1992): notations that embody pitch and rhythm awareness appear later in development than those that do not. The findings, therefore, support the validity of a child's invented notation as a musical assessment measure given its relationship to aural perception and musical production.

As Piaget (1962, 1969) proposed, the level of one's understanding directs the construction of one's inventions. When treated as a problem to be solved, the necessity of notating "the way the song sounds" requires invention. The ability to write what one has done, Bruner (1966) asserted, is a measure of intellectual growth, and by extension, so then is the ability to write what one

has done musically a measure of musical growth or understanding. Piaget (1973b) believed that intelligent actions are necessary but not sufficient for representational thought. He asserted, "To move about is one thing and to summon to mind the displacements by representation is something quite different" (p. 18). The ability to sing and to play a folk song may predispose a child to the ability to represent the folk song symbolically, but does not assure it. Likewise, the ability to discriminate small differences between tonal and rhythmic patterns may predispose a child to express differences related to pitch and duration in their invented notations, but may not assure such expression.

What then, in addition to performance and perception, explains a child's ability to reconstruct the child's musical experience such that a representation is possible? Invention, however primitive its quality, may motivate the child to think. In a related study, albeit in a different context, Uptits (1987) found that children who invented figural rhythm notations, but had been exposed to metric rhythm notations, could subsequently use metric notations for reading tasks. In other words, while children at earlier stages of their development grouped sounds according to their proximity in a sequence (figurally) in their invented notations, these children could read sounds organised in relation to an underlying beat (metrically). Exposure to metric notation in conjunction with opportunities for inventing notations hastened development. Uptits (1992) found that children as young as five may notate melodic contour if involved in composition (p. 77). Thus, creating a notation for an intelligent musical experience may prompt the classification, organisation, and connections that enable the child to transform the concrete experience into one that can be represented in icons or symbols. Opportunities to write about musical experiences, while reflective of understanding, may also assist the child in gaining understanding.

In this study, children were asked to invent a notation for a song provided by the researcher. Would the same relationships be found if the children were asked to invent notations for their own compositions? Inventing notations for original compositions may encourage children to reflect upon their musical experience, to improve the exactness of their kinesthetic, visual, and aural observations, and to exercise their imaginations. Further research is needed to establish the effects of invention and composition on children's musical understanding.

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