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Abstract

This study investigated children's tonal awareness by measuring their abilities to detect dissonance in major tonality using the author-created *Tonal Dissonance Detection Test*. A two-way analysis of variance of 312 elementary school subjects' Tonal Dissonance Detection Test scores revealed that first- and second-graders' dissonance detection abilities were significantly weaker than those of their third- to sixth-grade counterparts. Subsequent analysis revealed neither a significant gender effect nor interaction between grade level and gender. Findings are consistent with related study of the perception of tonality and tonal expectancies in children and adults. Given the homogeneity of the sample, the longevity of the music instructor, the school's sequential Kodály-based curriculum, and conclusions of prior research, discussion considered the impact of musical instruction and musical development on the ability to perceive tonality. The author suggested the two aforementioned constructs might be studied by comparing the same perceptual skills of children from both Western and non-Western cultures.

Keywords

dissonance, elementary, music, perception, tonal,

In *Music, the Arts, and Ideas*, Leonard Meyer (1967) theorized that a person's responsiveness to music is contingent on the balance of familiar and unfamiliar musical material or information present. An individual comes to a music listening experience with idiosyncratic and prior musical knowledge that can be as broad as a musical style and as narrow as a specific tonality or meter. When the listener is "surprised" by an unexpected musical event, he or she can accommodate or assimilate the event into his or her existing musical schema or reject it as unfitting or a violation of musical expectancy.

The ideas of Meyer suggest that people who have had years of structured musical experiences may respond to a given piece of music differently than those who have had more casual experiences (primarily as listeners) with music. For example, people with an aural acceptance and understanding of late-19th-century chromaticism would more readily assimilate music conceived in tone rows than those whose musical experiences are limited to the more diatonic harmonies of folk and country music. Key studies over two decades have explored the roles of age and musical experience on musical understandings and musical expectancies and collectively can shed light on how age and experience might shape musical responsiveness in the manner described by Meyer.

Related Literature

Recent research studies examined musical perception differences between adults and children. Holohan, Saunders, and Goldberg (2000) revealed that collegiate musicians discerned similarities and differences between pairs of tonal patterns significantly more accurately than college nonmusicians. The differences, however, in scores between the same nonmusician group and a group of first graders were found to be statistically insignificant, although the speed with which the nonmusicians responded was significantly faster than that of the first graders.

Schellenberg, Purdy, Adachi, and McKinnon (2002) examined and compared melodic expectancy in children and adults in two settings. First, subjects were asked to rate continuations of four tonal melodies on a 7-point scale ranging from "extremely poor" continuation to "extremely good" continuation. The researchers found that accuracy of ratings increased with age and exposure

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to music and that with increased age and exposure to music the ratings seemed to be influenced by the musical make-up (pitch patterns, metric stress, etc.) of the melodies. A second component of the study analyzed musically talented children's sung continuations of 50 two-tone melodic intervals sung by a woman using no vibrato. Subjects' responses to each of the 50 stimuli were compared with what might be expected in a typical tonal melody. Analysis of 5-, 8- and 11-year-old children's responses revealed no significance differences; results were attributed to the fact that all subjects were chosen on the basis of talent and experience and therefore were more capable of appropriate continuations than their more typical peers.

Morrongiello and Roes (1990) studied the developmental changes in children's perceptions as affected by musical training. Five- and 9-year-old subjects were asked to draw lines that represented what they heard in nine-pitch tonal and atonal melodies. At both ages, the scores of the musically trained children were superior to those of their untrained peers. The children who were 9 years of age performed better for melodies that were tonal, whereas there were no observed differences for the 5-year-old subjects. The lack of differences in the successes of 5-year-olds may be related to their abilities to perceive tonality, putting into play the question of exactly when or if development (that which is determined by nature) and/or purposeful musical instruction (nurture) effects perception of the presence of tonality.

Other studies suggest that higher musical aptitudes yield more highly rated creative output (composition and improvisation). Kratus (1994) demonstrated that audiation is somewhat related to tonal and rhythmic cohesiveness ($r = .45, p < .01$; $r = .39, p < .05$) as well as time spent in developing ideas for compositions ($r = .36, p < .05$). Time spent in developing a melody might indicate that a child has a tonal skill set that allows him or her to consciously create according to the basic syntactical elements of tonality. Auh's (1995) investigation concerning the perception and creativity skills of fifth and sixth graders supported the conclusions of Kratus by identifying moderately strong relationships between compositional creativity and both tonal music aptitude and tonal achievement ($r = .65, p < .01$; $r = .58, p < .01$, respectively). One might suppose from the results of these two studies that children who have stronger audiation skills are better suited to manipulating musical materials to form cohesive and more meaningful tonal (as opposed to atonal or noncohesive) musical creations. Conversely, children whose audiation skills are weaker are less aware of tonality create melodies with a lesser regard to tonality.

A number of recent studies have investigated relationships between children's singing achievements and tonal

aptitudes (Hornbach & Taggart, 2005; Phillips, Aitchison, & Nompula, 2002; Rutkowski & Snell Miller, 2003). In each of the aforementioned studies, the relationships were found to be quite weak among the youngest children studied (K-2), whereas some significant relationships were observed in children third grade and older.

Study of musical perception has also been extended to the realm of harmonic perception. Costa-Giomi (1994) explored the capabilities of 4- and 5-year-old children to discriminate between two chords played alone and as an accompaniment to two different melodies. Having had brief instruction in harmonic discrimination prior to engaging in the researcher's tasks, children were asked to make distinctions between chords in a V-I progression as well as a i-VII-i progression. An analysis of variance (ANOVA) with repeated measures revealed that 5-year-old children were able to detect chord changes in the accompaniment only mode, whereas 4-year-old children were not able to make accurate discriminations in either mode. The author concluded that young children are capable of making harmonic discrimination skills but suggested further study on their performance as results of actual ability to discriminate or more as a function of ability to perceive multiple musical dimensions in a given stimulus.

Costa-Giomi (2003) continued her study of the harmonic and tonality perception of young children, noting that these musical constructs are seldom taught in schools in the lower elementary grades. Following a series of experiments related to the effects of harmonic instruction on lower elementary children's perception of harmony, Costa-Giomi concluded that instruction has little effect on perception and that the sudden improvement in perception around age 9 is a function of gradual tonal development, cumulative exposure to tonal music, and knowledge of tonal music's rules and principles. The author proposes that younger children's weaker harmonic perceptual abilities are more a function of the ability to perceive multiple musical features simultaneously, skills that are more developed in older children.

Although gender was not a consideration in the aforementioned studies, a number of studies did examine gender as an independent variable with regard to both pitch discrimination tasks and pitch matching accuracy. Cooper (1994) examined elementary children's abilities to discriminate differences in pitch within a semitone. Although second- through fifth-graders were significantly more accurate than their first-grade counterparts, the researcher discovered no differences for gender. Similarly, Phillips and Aitchison (1997) compared the pitch discrimination of inaccurate and accurate singers. A variety of measures including the tonal portions of the Musical Achievement Tests 1 and 2 (MAT; Colwell, 1969) and the tonal portions of the Primary Measures of Music Audiation

(PMMA; Gordon, 1979) revealed that scores on the MAT were not significantly different for accurate and inaccurate singers but indeed significantly different for the same two groups on the PMMA (accurate singers scored higher). Regardless of measures used, there were no differences between male and female and no interactive effects among gender, accuracy of singers, or pitch discrimination skills regardless of testing instrument used. Pollatou, Kardimou, and Gerodimos (2005) also explored gender and tonal skills with the PMMA but with 5-year olds exclusively. As with the subjects of Phillips and Aitchison, there were no significant differences identified on the PMMA as a result of gender.

One of the primary foci of Trollinger's 1997 study was examining differences in pitch matching accuracy among 3- to 6-year-old children. The researcher had subjects replicate (via singing) pitch patterns in three different ranges (low, medium, and high). Females were significantly more accurate on the medium and higher pitch matching tasks, whereas males were significantly more accurate on the lower pitch matching tasks. Overall, females were found to be more accurate. The aforementioned study corroborated results of an earlier study investigating pitch matching skills of inaccurate singers in which students were asked to replicate minor thirds presented by a male voice, a male falsetto, and a sine wave (Yarbrough, Moore, Price, & Jones, 1994). Like Trollinger's subjects, the males were more accurate in their responses to lower-pitched stimuli (male voice in the lower octave), whereas the females responded more accurately to higher-pitched stimuli (male falsetto and sine wave). From the limited research that has included gender as a variable, it appears that gender is not a factor in pitch discrimination skills but could be a factor in pitch matching skills.

The sampling of research discussed above suggests that, developmentally speaking, younger children (K–2) manipulate and respond to musical stimuli with less depth and understanding than older children do. The research also suggests that experience (as opposed to development) also plays a key role in how one perceives musical information. Talented, more musically experienced children perform better than their more typical peers on variety of musical tasks (composition, discrimination, melody continuance, expectancies) and musically trained college-age students outperform their nonmusical counterparts in similar perception tasks. Perhaps the impact of experience (or lack thereof) is most notable in the similar perceptual skills of young children and musically *untrained* adults. As already mentioned, the issue of gender in matters of pitch perception seems to be less of a factor in pitch discrimination tasks although gender may play a more prominent role in pitch matching tasks.

Purpose

The present study is inspired by extant research and Meyer's (1967) proposition that the amount of musical information in a piece of music and a listener's prior musical experiences and expectancies affects the listener's response. Although research has demonstrated that age and experience promote a gradual increase in one's ability to perceive, manipulate, and discriminate music, there is no certainty as to when children, in particular, become acculturated to and perceive Western major tonality. In consideration of Meyer's musical information theory, ability to perceive tonality might be best measured by observing responses to musical stimuli that violate basic expectancies of tonal music. In other words, a child's ability to perceive a wrong note or dissonance in a simple melody and accompaniment would be an indication that he or she has been "tonally acculturated."

The primary concern of this study, therefore, may be stated as follows: Is a child's perception of tonality as evidenced in the ability to identify dissonance in a simple tonal (major) melody and accompaniment related to his or her grade level in school? In the interest of the seeming paucity of study related to gender and pitch discrimination, a secondary question is the following: Does gender play a role in a child's perception of tonality and is there an interactive effect between grade level and gender?

Method

Subjects

To control for variations in instruction and itinerancy, subjects ($N = 312$) were purposely selected from a multigenerational Midwestern community and elementary school at which the only music instructor had taught for 14 years. The distribution of subjects by grade is as follows: first ($n = 49$), second ($n = 44$), third ($n = 63$), fourth ($n = 43$), fifth ($n = 40$), and sixth ($n = 73$). In essence, the selection of subjects as described provided the opportunity for a cross-sectional examination of children's perceptual abilities with regard to tonal dissonance.

Data Collection

To assess subject awareness of tonality, students completed the 26 items of the *Tonal Dissonance Detection Test* (TDDT), created by the present study's author. The creation of items was inspired by the author's many years of working with elementary children and observing their reactions to "clinkers" or wrong notes that sometimes unfortunately found their way into periodic

Figure 1. Sample items from *Tonal Dissonance Detection Test*.

accompaniment of class singing or musical games. For each of the test items, all written in C major tonality, the subjects were asked to determine if the aural stimulus contained a mistake, defined for the purposes of this study as a minor third in the right hand or melody against a major I, IV, or V chord in the block chord accompaniment (see Figure 1). In other words, mistakes or “clinkers” were indicated by an Eb in the melody accompanied by a C major triad, Ab for IV or F major chord, and Bb for V or G major chord. Thirteen items contained dissonances, seven of which occurred with tonic triads, three with subdominant triads, and three with dominant triads. The answer sheet comprised pairs of “smiley” faces for consonant items and “sad” faces for dissonant items (see Figure 2). Data were collected toward the end of the academic year in the month of March.

The aural stimuli, played on a Schimmel CO 256T 7-foot grand piano, were recorded with a MOTU 8 pre-audio digital system and two Shure SM57 microphones

with X2U USB signal adapters. The recordings were processed with AudioDesk V2 for Mac OS X and burned to a MAXELL CDRPRO professional-grade audio compact disc. To control for novelty effect (the subjects’ music instructor was female), a women’s voice provided instructions and numbering for each of the 26 items. Instructions, reviewed by the music instructor for colloquial clarity, were recorded as follows:

You are about to hear several very short tunes. After you hear each tune, you will need to decide whether it sounded right to you or whether something sounded wrong to you. If a tune sounds right, you will circle a smiley face. If something seems wrong about the tune, you will circle a sad face.

Before we start, let’s try a couple of practice examples.

Look on your paper for the box with the big letter A. Listen to this example and decide whether it

TONAL DISSONANCE DETECTION TEST

Name _____ Grade _____

Practice Examples:

A. ☺ ☹

B. ☺ ☹

1. ☺ ☹
2. ☺ ☹
3. ☺ ☹
4. ☺ ☹
5. ☺ ☹
6. ☺ ☹
7. ☺ ☹
8. ☺ ☹
9. ☺ ☹
10. ☺ ☹
11. ☺ ☹
12. ☺ ☹
13. ☺ ☹

Figure 2. Answer sheet (front side) for *Tonal Dissonance Detection Test*.

sounds right or whether it sounds wrong. (Play example). If you think the tune sounds right, circle the smiley face. If you think something sounded wrong, circle the sad face.

Now, look on your paper for the box with the big letter B. Listen to this example and decide whether it sounds right or whether it sounds wrong. (Play example). If you think the tune sounds right, circle the smiley face. If you think something sounded wrong, circle the sad face.

Now we will begin at Box Number 1 and continue until all 26 tunes have been heard.

Three expert general music teachers (two of whom were “music educators of the year” in their states) and three music education researchers unanimously confirmed

Table 1. Means and Standard Deviations of Scores on Tonal Dissonance Detection Test by Gender and Grade.

Grade	Gender	N	Mean (SD)
1	Female	27	17.78 (3.47)
	Male	22	15.96 (3.57)
	Total	49	16.96 (3.59)
2	Female	25	18.32 (3.58)
	Male	19	18.68 (3.99)
	Total	44	18.48 (3.72)
3	Female	30	20.97 (3.45)
	Male	33	22.06 (3.09)
	Total	63	21.54 (3.29)
4	Female	15	23.13 (2.53)
	Male	25	22.60 (2.48)
	Total	40	22.80 (2.48)
5	Female	20	22.45 (3.20)
	Male	23	21.13 (3.79)
	Total	43	21.74 (3.55)
6	Female	37	23.24 (2.44)
	Male	36	22.72 (3.22)
	Total	73	22.99 (2.85)
All	Female	154	20.93 (3.81)
	Male	158	20.91 (4.03)
	Total	312	20.92 (3.92)

content or face validity of the test and its items. All agreed that the TDDT measured subjects’ ability to perceive simple dissonance in major tonality. Because the TDDT was created in two mirrored halves, reliability was established via split-halves employing the Spearman-Brown prophecy formula: entire sample ($N = 312$) = .81, Grade 1 = .76, Grade 2 = .70, Grade 3 = .71, Grade 4 = .75, Grade 5 = .71, Grade 6 = .76. The author deemed reliability adequate in light of the small number of items used in each half of the test.

The author calculated mean scores and standard deviations for the entire sample by grade level. Additionally, a two-way ANOVA was calculated to identify any effects of grade level and gender or an interaction between grade level and gender with regard to the TDDT test scores.

Results

Mean scores (and standard deviations) by grade level were the following: Grade 1—16.96 (3.59); Grade 2—18.48 (3.72); Grade 3—21.54 (3.29); Grade 4—22.80 (2.49); Grade 5—21.74 (3.55); Grade 6—22.99 (2.85). The total sample mean was 20.92 with a standard deviation of 3.92. Table 1 details results by not only grade level but also gender.

The two-way ANOVA indicated that grade level is related to test scores, $F(5, 311) = 29.64, p < .001$. A

Table 2. Tukey's Post Hoc Analysis of Scores on the Tonal Dissonance Detection Test as Affected by Grade Level.

Grade	N	Subset	
		1	2
1	49	16.96	
2	44	18.48	
3	63		21.54
5	40		21.74
4	43		22.80
6	73		22.99
p		.188	.234

Tukey's post hoc analysis (Table 2) identified two distinct or homogeneous subsets—(a) Grades 1 and 2 and (b) Grades 3, 4, 5, and 6—indicating that the older children's performances on the TDDT were significantly more accurate. According to the same analysis, there were neither effects as a result of gender, $F(1, 311) = 1.45$, $p = .23$, nor a grade level and gender interaction, $F(5, 311) = 1.44$, $p = .21$.

Discussion

To consider the meaning of the current study's results, one must revisit the notion that the TDDT measures awareness of tonality. To discern the presence or absence of a mistake in each of the test's examples, a subject must be able to perceive basic tonal syntax, that is, his or her ears grasp the structure of a major triad. As Meyer (1967, p. 10) suggests: "music meaning, then, arises when our expectant habit responses are delayed or blocked—when the normal course of stylistic-mental events is disturbed by some form of deviation." For the purposes of this study, "stylistic-mental events" equates with awareness of tonality and "some form of deviation" is the dissonance created by playing a minor third above a major triad's root.

Because the subjects were purposely drawn from a stable (as opposed to itinerant) population whose school music instruction had been delivered by the same music teacher, the results of this study provide an interesting look at how children's awareness of tonality might progress from both developmental (as a result of nature) and/or instructional (as a result of nurturing) perspectives. The music curricular content for all elementary students in this particular school is based on the Kodály method in that students initially are immersed in the aural relationships between *sol*, *mi*, and *la* for K–2 and continue with *do*, *re*, and *mi* into Grade 3 (*fa* and *ti* are incorporated later). The results of post hoc analysis (Grades 1, 2 and Grades 3, 4, 5, 6 form two distinct groups of perceptual abilities) parallel the shift in content toward "do" or tonic in the third

grade, suggesting that instruction or guided experiences with aural stimuli could affect one's ability to perceive tonality (as demonstrated by accurate identification of dissonance). The results also closely parallel Gordon's (1997) assertion that musical aptitude stabilizes around age 9 (a majority of children in this sample reach age 9 in the third grade because of data collection late in the school year), supporting the notion that awareness of tonality is a function of development that may or may not be influenced by instruction (Gordon's extensive study of children did not involve controlling for differences in instruction).

The results of the current study are related to findings of a number of prior examinations of children's perceptual skills. Studies that examined relationships between singing skill and tonal aptitudes (e.g., Hornbach & Taggart, 2005; Phillips et al., 2002; Rutkowski & Snell Miller, 2003) found that said skills are more strongly (and significantly) developed in children age 9 and older. Nine-year-old subjects of Morrongiello and Roes (1990) more successfully drew contours of tonal melodies (as opposed to atonal melodies) than 5-year-old subjects who not only underperformed the 9-year-old subjects but also demonstrated no differences on the drawing tasks with regard to tonality or atonality. Subjects deemed "talented" outperformed their peers regardless of age. Most notably, the findings of the present study resemble those of Costa-Giomi (2003) in that older children (from age 9 years and older) were more capable of making harmonic/tonal distinctions than their younger counterparts.

Although there are similarities to previous findings, the present study alone cannot definitively shed light on the issue of whether musical development or musical instruction (or both) is at work in a child's ability to perceive tonality. For the purposes of the present study, musical development is defined as what happens as a result of nature (native talent), whereas musical instruction is that which occurs in the elementary music classroom and in some cases, private instruction such as the study of piano (nurture). The talented children (those deemed to have native musical talent) in the study by Schellenberg et al. (2002) continued tonal melodies equally well, regardless of their ages (5, 8, and 11 years), suggesting that native musical development as opposed to musical instruction influenced their abilities to perform the requisite tasks. The collegiate musicians in the study by Holohan et al. (2000) outperformed collegiate nonmusicians in identifying similarities and differences in tonal patterns, perhaps as a result of knowledge obtained through years of musical instruction. This notion can be supported in consideration of the same study's nonmusicians whose performances on the discrimination tasks were statistically similar to first graders (first graders would have a limited instructional background as perhaps would the collegiate nonmusicians).

Regardless of which factors affect perception of tonality, the present study's findings are not only consistent with previous findings with regard to pitch perception and gender but also provide additional and more direct evidence that children are able to perceive presence of tonality by the end of third grade or age 9. Future research should compare samples of American children of varying ethnicities in which the scales of their various musical heritages are different from the predominant major scale of typical Western music. With an ethnically varied sample, empirical study might afford additional information about the effects of musical development (nature) versus musical instruction (nurture) on not only one's ability to perceive tonality but also at what point and how the ability to perceive tonality is acquired.

Declaration of Conflicting Interests

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