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# Music Education and The Development of Structural Hearing A Study with Children.

Isabel Cecilia Martínez y Favio Shifres.

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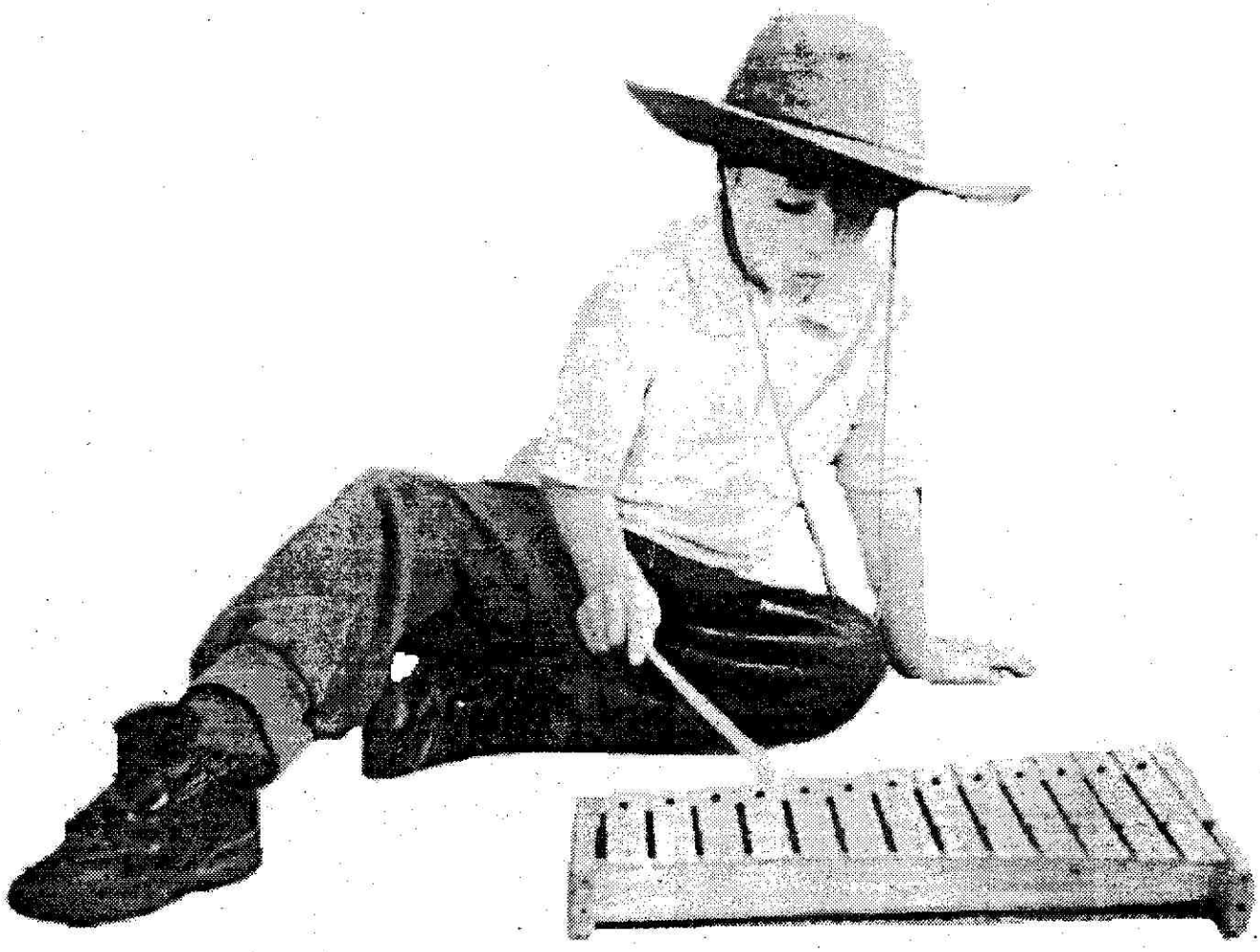
# Children and Music: Developmental Perspectives



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# Education and The Development of Structural Hearing: A Study with Children

Isabel Cecilia Martínez & Favio Shifres

## Abstract

The purpose of this study has been to explore evidence about the acquisition of *structural hearing* (Salzer [1962]-1990) from a developmental perspective. Results of an experiment with children between six and fourteen years old are presented. In this exploratory study we have hypothesised that some of the variables involved in structural hearing are: the quality of the surface to convey direction and its relationship with the conveyed direction of the underlying structure, the actual length of the prolongation. In this way there would be certain melodic movements that would benefit the prolongation of the underlying structure. In addition, it has been hypothesised that, as long as tonality is acquired by cultural exposure (Sloboda, 1985) the ability to implicitly recognise the components of structure and prolongation would be dependent on age.

## Introduction

Tonal Music is the focus in most of the current approaches in Music Education. Tonality has been studied both from an experimental and a theoretical perspective. Representational models have been created to explain both musical coherence (Schenker, [1934] - 1979; Lerdhal & Jackendoff, 1983; Meyer, 1973) and musical cognition (Krumhansl, 1990; Bharucha, 1984; Butler & Brown, 1994; Dowling, 1994). It is assumed that the former models show an isomorphism with the mechanisms of music cognition which would fit the assumptions of music theory (Swain,1986).

Psychology of Music is analysing this problem. There are not enough studies on this issue in the field of research on Musical Development, in spite of its importance in Music Education. The present study aims to empirically contrast certain properties of Schenker's model ([1934]-1979) as an initial endeavour to investigate the acquisition and the development of *structural hearing* (Salzer, [1962] -1990).

The abstraction of the hierarchic structure as a cognitive process was analysed at the foreground and the concept of *melodic diminutions* (Schenker [1934] - 1979; Forte & Gilbert, 1982) was used as a methodological tool in order to accomplish the analysis. Serafine, Glassman & Overbeeke (1989) studied some aspects of this model and found some evidence of the way in which listeners unconsciously use hierarchic structure in a similarity judgement task between melodies. However, the research of hierarchic structure entails methodological difficulties to isolate experimentally such variable. Research concerning the understanding of melody has focused on features of *musical surface*. It is assumed that surface attributes might compete in salience with those features of structure during tonal information processing. According to Dowling (1994) the contour is a melodic attribute that is perceived by the listener from the first listening. It does not depend on tonal context and is acquired in the early infancy (Trehub, Bull & Thorpe, 1984). Its development follows the pattern of enculturation during the childhood (Dowling, 1988). Studies about contour offer methodological tools to describe the musical surface in order to control musical structure as an experimental variable.

Concerning the development of tonal cognition, it has been observed that both in singing (Davidson, 1985) and in perception (Lamont, 1998) pre-scholar children acquire the tonal framework through a process of an increasing stability until it is completely acquired at the age of 5 and 6 years. In spite of the evidence that 8 year old children perceive hierarchic levels in simple melodies while matching them with their reduced structures (Serafine, 1988) developmental trends seem to show a period of rapid growth in the understanding of music between the ages of 8 and 11. Structural hearing as a non temporal process of musical thought would be set at this age in human cognition. In order to obtain further information about this process, we investigated the way in which 6-14 years old children use hierarchic structure during a similarity judgement task between pairs of melodies.

## Method

### Subjects

N=774 children belonging to 8 public and state schools. The curricula included music as a regular subject in all of them.
3 Age Groups: 1: 22, 9% from 6 to 8 years old; 2: 47,2% from 9-11and 3: 30% form 12 -14. 39. Children reported taking music lessons out of school. There were randomly distributed in each of the groups that were set for the test.

### Stimuli

20 melodic fragments (plus 2 examples as warmup) (M) (see appendix I) from 9 to 29 pitches. In each example:

1- a representation of a structural reduction ($R_1$) was obtained from the analyses of melodic diminutions
2- $R_1$ was modified and a second reduction ($R_2$) was obtained.
3- The surface of M was modified in order to obtain a comparison melody ($CM_2$) that could be reduced to $R_2$
4- The surface of M was modified in order to obtain a comparison melody ($CM_1$) that could be reduced to $R_1$. Surface changes in $CM_1$and $MC_2$ were homologated in accordance to each other (Table 1).

**Table 1**

| | $CM_1$ | $CM_2$ |
|---|---|---|
| M | SAME Structure<br>SIMILAR Surface | DIFFERENT<br>Structure<br>SIMILAR Surface |
| $CM_1$ | | DIFFERENT<br>Structure<br>SIMILAR Surface |

The similarity at the surface level is crucial to isolate the structure and the surface as experimental variables. Thus, the composition of the CMs was limited by a series of constraints in order to control the similarity in the surface level of both MCs (Shifres & Martínez, *submitted*). In this paper controls on the *melodic shape* are reported:
The literature about melodic cognition analyses separately i) the contour information in terms of up and down movements of the melodic line and ii) the interval information in terms of the amplitude of the intervals (Edworthy, 1985). Some authors refer to i) as a feature of the surface and to ii) as an attribute of the structure as long as it compromises some tonal*invariance* (Dowling, 1988). However, from the Schenkerian point of view both of them are surface attributes. As a consequence, both attributes were treated as a unique variable and were measured in a way that revealed the *melodic shape* as a feature of melodic surface.

The variable was controlled as follows:
i) the amplitude of each interval was analysed in number of semitones and a + or - according to the interval direction. The *shapes* were compared by calculating a coefficient of correlation between them: $CM_1$ and $CM_2$ ($r_0$); $CM_1$ and M ($r_1$), and $CM_2$ and M($r_2$).
According to these results, the examples may be grouped in three categories indicating the highest similarity level between the *shapes* of M, $CM_1$ and $CM_2$:

- *InterCM Shapes Group*: $r_0$ was the highest value indicating the major similarity between *shapes* of $CM_1$ and $CM_2$ (7 examples)
- *$CM_1$ Shapes Group:* $r_1$ was the highest value indicating the major similarity between melodic shapes of M and $CM_1$ (it does not help to isolate the components of structure / surface) (1 example)

- *$CM_2$ Shapes Group*: $r_2$ was the highest value indicating the major similarity between the melodic shapes of M and $CM_2$ (the major surface similarity belongs to the melody that does not share the structure; thus, structure would be isolated) (12 examples)

Musical stimuli were played on a Yamaha SY 55 keyboard with piano sound belonging to a Kurzweil 2000 (sound target Pinnacle) and recorded by a Cakewalk Pro Audio 7.0 sequencer on CD. All the parameters of $CM_1$ and $CM_2$ except pitch were the same as the parameters of M. Expressive deviations were applied to the performance according to general stylistic criteria. The duration of the fragments was distributed in a range from 5 to 22 seconds. All the repetitions were recorded electronically.

## Procedure

The test was administered in group or individual sessions. The environment for the task was comfortable and the acoustical listening conditions were arranged according to reliable criteria. Children were told that another child was learning to play the piano and for this he proceeded in the following way: he listened to a melody twice and then he tried to imitate it. The children's task consisted in judging the degree of accuracy of the child's imitation of the melody by representing the level of the teacher's approval of the performance. Children had to answer marking the corresponding "teacher's face" in the form given to them.

For each item of the test subjects listened to the following sequence: M- M- CM (1 or 2) . The time between one and other was up to 2 seconds and the time available to answer at the end of the sequence was up to 12 seconds. Each presentation of the melody (M or CM) was announced by a voice in off. Children were told that the judgement was based on their personal opinion and that there was not *an incorrect* answer. There were also told not to leave any blank items.

## Design

The test was organised in two 13 minute sessions. Each session had 12 items: 1 warmup item, 10 test items, and 1 repeated item to measure the test's reliability. Different sets containing the 24 items in random orders were recorded in CD and they were equally distributed among the test groups. The children were randomly set in two groups. In each group they listened only one sequence M - M and CM randomly assigned to each example. Two examples that shared MC served as pre-test to compare the initial condition of the groups. The results didn't show significant differences ($F_{[1,773]}=3.29$; $p>.05$). At the end of the test they answered a questionnaire about their musical background.

## Results

An CM x Age Group ANOVA simple factorial was done. It showed a result for the combined main effect of ($F_{[3,15432]}=62.838$; $p<.000$) A significant main effect both of Age Group ($F_{[2,15433]}=91.968$; $p < .000$) and a moderately significatn main effect of CM were found ($F_{[1,15434]}=4.576$; $p<.032$) The means showed a moderate preference for $CM_1$ (Graph 1a) which increased with age. In the 6 - 8 year - old group children preferences followed a chance pattern. Later, the preferences for $CM_1$ slowly show an increasing pattern.

An CM x Age ANOVA simple factorial was done. It showed the following result (Main Effect combined $F_{[9,15427]}=23.389$; $p<.000$ . Main effect CM $F_{[1,15435]}=4.757$; p=.032. Main effect Age $F_{[8,15428]}=25.741$; $p <.000$) – Graph 1b-. It was observed that a change in the answer pattern appears between 6-7 years old. The developmental trend follows an increasing pattern that reaches its maximum peak between 12 - 13. At 14 the pattern is inverted.

However, the analyses of the results for each melody revealed different tendencies in the subject's answers (Table 2). Beyond the level of significance of the results for each melody, subjects show a moderate preference for $CM_1$.

**Table 2: Results for each example**

| Example | Main Effect CM | Main Effect Age Group | Main Effect Combined |
|---|---|---|---|
| | Sig. | Sig. | Sig. |
| 1 | .758** | .027 | .063 |
| 2 | .000** | .005 | .000 |
| 3 | .071* | .002 | .001 |
| 4 | .000* | .506 | .000 |
| 5 | .000** | .000 | .000 |
| 6 | .223* | .246 | .232 |
| 7 | .005** | .000 | .000 |
| 8 | .000** | .000 | .000 |
| 9 | .208** | .000 | .001 |
| 10 | .196* | .001 | .002 |
| 11 | .318* | .096 | .129 |
| 12 | .145** | .005 | .005 |
| 13 | .000** | .002 | .000 |
| 14 | .081* | .013 | .008 |
| 15 | .000* | .174 | .000 |
| 16 | .787* | .046 | .136 |
| 17 | .000* | .009 | .000 |
| 18 | .023* | .000 | .000 |
| 19 | .000** | .049 | .000 |
| 20 | .000* | .001 | .000 |

** The highest rating was to $CM_1$ - ** The hignest rating was to $CM_2$*

Examples were divided according to the subjects preferences in *Rating $CM_1$ Group* ($CM_1$ obtained the highest rating) and *Rating $CM_2$ Group* ($MC_2$ obtained the highest rating). It was calculated the Exact probability of Fisher for the distribution of the examples both in the *Rating Groups* and the *Shape Groups* ($CM_1$ Shape Group was not taken into account): $p$=.00238 - Table 3 -.

Therefore, only the melodies of the *Inter CM Shapes Group* were analysed (7 examples). The results of the CM x Age Group ANOVA simple factorial showed a significant combined effect of $F_{[3,5405]}$=49.181; $p$<.000. The Main effect of CM was $F_{[1,5407]}$=93.128 $p$<.000. And the Main effect of Age Group was $F_{[2,5406]}$=27.222; $p$<.000 (Graph 1c). For the MC x Age ANOVA simple factorial the values were: Main combined effect $F_{[9,5399]}$=17.878; $p$<.000. Main effect MC $F_{[1,5407]}$=93.917; $p$<.000 and Main effect Age $F_{[8,5400]}$ = 8.373; $p$<.000 (Graph 1d).

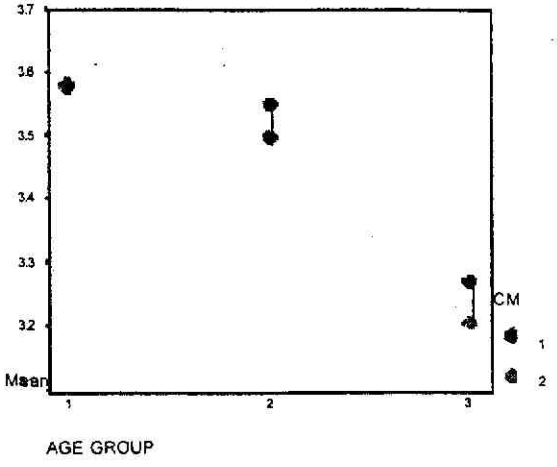
## Table 3

**RATING * SHAPE Crosstabulation**

| | | | SHAPE | | Total |
|---|---|---|---|---|---|
| | | | 1 | 2 | |
| RATING | 1 | Count | 7 | 3 | 10 |
| | | % within RATING | 70.0% | 30.0% | 100.0% |
| | | % within SHAPE | 100.0% | 25.0% | 52.6% |
| | 2 | Count | | 9 | 9 |
| | | % within RATING | | 100.0% | 100.0% |
| | | % within SHAPE | | 75.0% | 47.4% |
| Total | | Count | 7 | 12 | 19 |
| | | % within RATING | 36.8% | 63.2% | 100.0% |
| | | % within SHAPE | 100.0% | 100.0% | 100.0% |

## Graph 1

a

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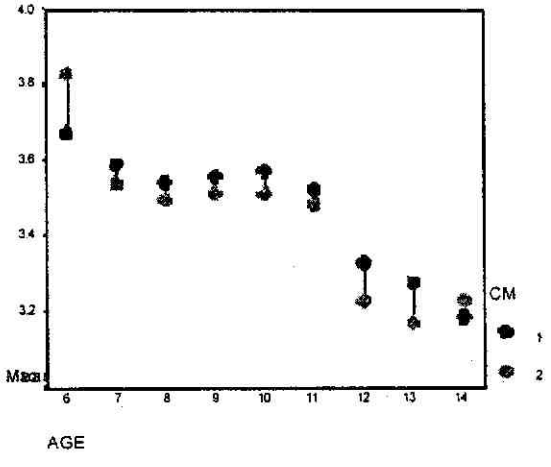


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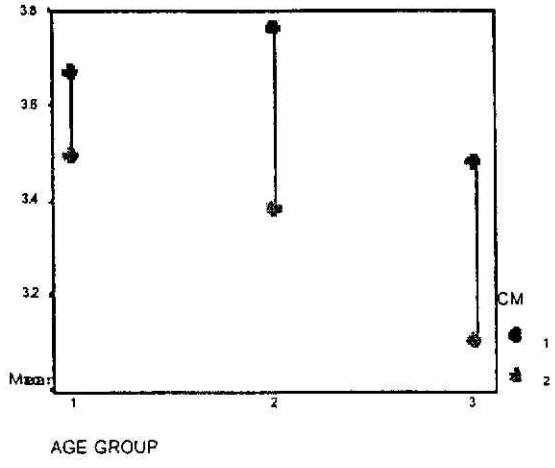


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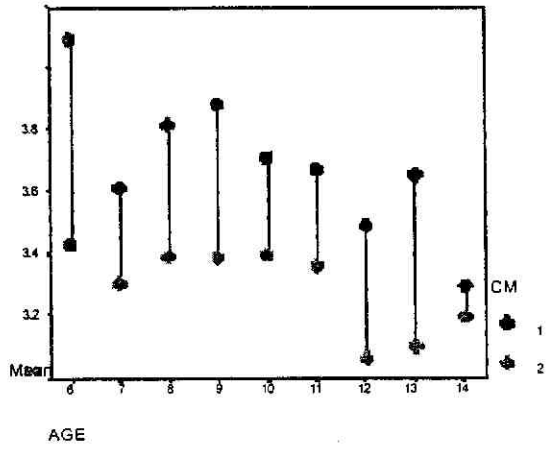

## Discussion

The results show that subjects make unconscious use of hierarchic structure in their judgements of similarity between pairs of melodies. These results confirm Serafine (1988) findings related to the acquisition of hierarchic levels as a generic non temporal cognitive process that is developed during childhood and that is used under specific conditions. But these results are expanded in two ways:

1- the comparison is established between two melodies representing the same structural level, not between a melody and its rendered structure

2- the proposed comparison task represents a simple task in common listening activities, because it is set between pairs of stimuli (answering to the question: in which degree are they similar?) and not between trios ( answering to the question: which is the most similar?).

All the melodies in which children chose $CM_2$ were more similar in surface to the corresponding M. It is thus demonstrated that in this election it is the surface the variable that seems to play the main role. These findings confirm previous results (Dowling, 1994) relative to the nature of melodic contour as a perceptive attribute of immediate access. Melodies that have a major surface similarity between $CM_1$ and $CM_2$ have a neutral salience of contour. In all these cases children's preferences tend to $MC_1$, that is , to the melody that keeps M structure. Thus, when surface shape is not different enough to make them different, structure would be chosen. Although the number of melodies that fit this condition was limited, these results would prove the procedure to be valid to control the musical surface. Nevertheless, it is necessary to accomplish further investigations in which comparison melodies will be composed following this criteria.

It is also necessary to analyse the cases in which even though $CM_2$ shape is more similar to M, subjects chose $MC_1$. Results confirm developmental trends derived from previous studies related to the understanding of melody (Serafine, 1988; Lamont, 1994). The development of structural hearing shows few differences between surface and structure at the age of 6. Later on, the competence is acquired and it increases with age. However, these results require more investigation.

The identified developmental curve is similar to others already reported (Serafine, 1988) and confirms assumptions relative to the role of enculturation in the acquisition of tonality (Sloboda, 1985). This is particularly interesting due to the fact that previous investigations refer to children of developed countries, not existing any reports related to this acquisition in South America.

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