

# Children's abilities to conserve some basic sound parameters

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**ABSTRACT:** In my contribution I will present the results of a series of tests concerning the perception of three fundamental parameters of sound: pitch, duration, and timbre. The tests are based on the concept of "conservation" elaborated by J. Piaget. They were carried out in a didactic setting of ca. 50 children, divided into 5 groups of ca. 10 children each, according to their age, from 5 to 10 years, and of 8 children of a first middle school class. The aim of the tests was to observe how the ability of "conservation" of one parameter of sound, re-presenting this latter while varying another parameter, differs in the various age groups. This study emerges from the observation of some characteristics of musical perception in children in the different grades, during educational activity. Far from any pretence of exhaustiveness, it may be considered the beginning of a more ample study. A first version of this project presented at the 9<sup>th</sup> International Conference on Music Perception and Cognition (Bologna, August 22-26, 2006).

## INTRODUCTION

This work was born from the curiosity stimulated by the observation of children's abilities during music lessons held by me in a scholastic context. The interest was focalized on what children are able or aren't able to do, in different grades, and consequently in different ages. I thought to link this kind of observation to some of the main theories about the development of children. As is well known, J. Piaget's theories on the mental development of children are an important touchstone for, among others, the field of developmental psychology of music.

In particular the developmental psychology of music has been influenced by three aspects of Piaget's thought, synthesized in his *Six études de Psychologie* [1964]: the different stages in children's mental development, the symbolic aspect of thought, and the ability of conservation.

The present research makes referral in particular to this latter aspect. Conservational ability is defined as both the condition and the result of the quantification of quality, process which leads to the ability of measurement [Piaget-Inhelder; 1962]. Among the many tests that Piaget proposes to subjects in formulating his theories, the present work is based in particular upon two: that in which an initial material under observation is first presented, then later re-presented in a varied form; and that in which an initial material under observation is then compared with an object that has a characteristic in common with the first (its weight, for example), but whose other characteristics are different (for example, its volume).

In the field of music this aspect of perception is known as "music conservation" and the application of the theory of Piaget is the object of a debate that is still open. "Music conservation" is at the centre of many studies and experiments. The first studies in this direction were carried out by M. Pflederer (1967), M. P. Zimmerman and L. Sechrest (1962). Pflederer proposes a pioneering study that applies the entire system of laws of conservation theorized by Piaget; Zimmerman e Sechrest propose the same laws, using both melodic and rhythmic patterns and well known music for their observation material. They test subjects of 5, 7, 9, and 13 years of age. From the results of these tests one can understand that: the ability of music conservation improves with growth; the ability of pitch conservation precedes that of rhythmic figurations; the most evident improvement in music conservation comes about between 5 and 7 years of age; the greatest difficulties are to be found in the variations of timbre and tempo. Other studies have been undertaken in this direction, and although the results are not unequivocal, it is possible to affirm that around 9 years of age an interesting development of conservation ability takes place. These experiments have since been repeated and amplified by various researchers. P. R. Webster e M. P. Zimmerman (1983) repeat the experiment of Zimmerman and Sechrest, testing subjects in elementary school age, from second to sixth grade. The results show that: there are significant differences in conservation ability between second, fourth and sixth grade, whereas third and fifth grades seem to be transitional phases. In general the conservation of rhythmic patterns presents greater difficulties than that of pitches; the conservation of major

and minor tonal patterns, with rhythmic changes, presents less difficulties than that of pentatonic patterns. Moreover, R. Crowther, K. Durkin, B. Shire, D. Hargreaves (1985) repeat the experiments of Pflederer and Zimmerman, confirming once again that conservation ability increases with growth, and that a significant difference comes about between 5 and 7 years of age. The tests that I propose come out of a didactic experience. The attention is focalized on the children's ability to abstract and to "conserve", on a perceptive level, one parameter of sound (ex. pitch), when another is varied (ex. duration). The melodic fragments proposed in the test do not involve known melodies. In my research I have also taken account of other studies, which do not specifically treat music conservation, but contribute to the knowledge of the various strategies that children may use while listening to music, for example those of J. Bamberger (1991).

## **METHOD**

### *Subjects:*

The tests were carried out on 51 children from 5 to 10 years old, divided into the five grades of an elementary school:

- 1 5-6 years of age, 11 children: first grade
- 2 6-7 years of age, 12 children: second grade
- 3 7-8 years of age, 9 children: third grade
- 4 8-9 years of age, 10 children: fourth grade
- 5 9-10 years of age, 10 children: fifth grade.

All the subjects were female.

All of the children participate regularly in a one hour weekly music lesson, held by me during school hours. Some of them partake in extra-curricular musical activities, but none with the specific intention of studying music professionally.

### *Materials:*

The tests that I present are inspired by those proposed by Piaget, focusing on the perception of three basic parameters of sound: pitch, duration, and timbre, which substitute the three variables of Piaget's experimentation: Substance, Weight, and Form.

The tests are as follows, in which "A" is the musical departure material, "B" is the transformation; below is indicated the question asked:

- Test 1 (keyboard)



Has the pitch of any sounds changed? If yes, that of which sound?

- Test 2 (voice)



Has the pitch of any sounds changed? If yes, that of which sound?

- Test 3a (keyboard)



Has the pitch of any sounds changed? If yes, that of which sound?

- Test 3b (keyboard)



Has the pitch of any sounds changed? If yes, that of which sound?

- Test 4 (voice)



What has changed?

- Test 5 (voice)



What has changed?

- Test 6 (keyboard)



Has the duration of the second sound changed?

- Test 7 (keyboard)



Has the pitch of the second sound changed?

- Test 8 (keyboard, voice)



Has the pitch of any sounds changed? If yes, that of which sound?

- Test 9 (keyboard, voice)



Has the duration of any sounds changed? If yes, that of which sound?

All of the tests require the comparison of 3 + 3 sounds, except for tests 4 and 5, in which the comparison is between 2+2 sounds.

As far as the vocabulary used in the questions of the test is concerned, the common technical terms (pitch, duration) were used, given that they had already been introduced, in a playful way, in the activity of musical education, beginning from first grade.

### *Procedure:*

The tests followed were the same in all five classes, and the procedure was the same.

The children were given the test in a written form, during class time, as a normal classroom activity. The tests were carried out in the following way:

The first group of three or two sounds was played at the keyboard or intoned vocally, followed by the group to be compared. After this the question written on the sheet was read by the teacher. The two groups of sounds were then played twice more.

For the tests 1, 2, 3, 3b, 8, and 9 the children were invited to express their answers with crosses that indicated which sound had changed. The tests 4 and 5 required an answer in the children's own words, without crosses, to the question "what has changed?". The answer is only apparently free, given that

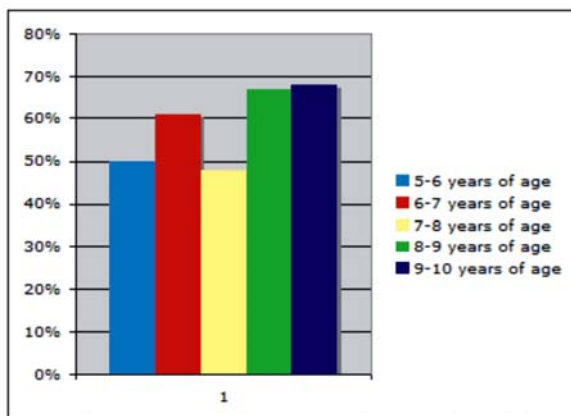
there was only one correct answer: respectively “vocal” and “pitch”. In tests 6 and 7 the children had to express their answer with a cross only on the answer (yes-no), given that the answer already stated which sound had been changed. Given that there was no opportunity to repeat the tests, proposing them in a different order, the order indicated above was chosen, in the intent of offering the children a rather various succession of tests, in order to stimulate their attention in the most constant way possible.

The decision of playing and singing the sounds of the tests was aimed at inserting the experimentation within the normal didactic activity, and therefore meets the aim of presenting the test with the same means with which the classes’ normal didactic activities are proposed.

## RESULTS

The following histogram indicates the overall results of the 10 tests, given in percentage of correct answers:

Table 1



From the overall result one can note an increment in conservation ability from first grade to second grade (11%), while between second and third grade there is a notable decrement (-13%); again, between third and fourth grade there is an increment (20% circa), and a negligible difference between fourth and fifth grade (1%). The answers of 11 years old children confirm those of the fifth grade. Further along we will try to comment and explain these variations. The results of the test were then analysed according to groups as in the following division:

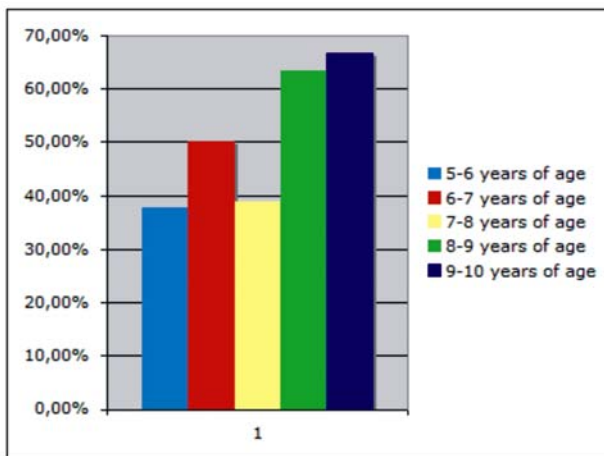
A) Tests 1, 2, 3, 3b, 7, 8; question involving pitch, comparison of two groups of three sounds; B) Tests 4, 5; pseudo-free question, on pitch and

timbre parameters, comparison of two groups of two sounds; C) Test 6, 9; question involving duration, comparison of two groups of three sounds.

The results of the test on conservation of the parameter pitch are:

The following histogram indicates these results, according to the percentage of correct answers:

Table 2



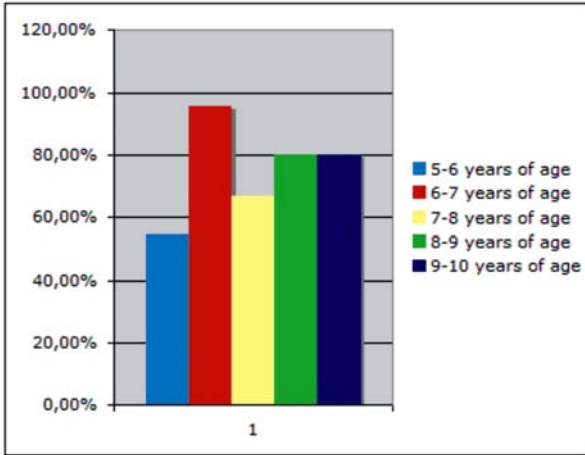
The results of the tests indicate that for the conservation of pitch the highest number of correct answers is reached between 8 and 10 years of age, in fourth and fifth grade, with a minimum difference between the two. In fact, in fifth grade only 3.3% more correct answers were given.

One can note a 13% increment of correct answers between first and second grade, whereas compared to second grade, the correct answers given by third-graders are 11.2% lower. The significant differences between consecutive grades making use of chi square are: between first and second in test 1 (chi square 4.339; d.f. 1; p. 0.037), test 2 (chi square 12.800; d.f. 1; p. 0.000), test 3b (chi square 5.868; d.f. 1; p. 0.015); between second and third the only significant difference is in test 7 (chi square 6.173; d.f. 1; p. 0.013), between third and fourth in test 2 (chi square 4.109; d.f. 1; p. 0.043) and test 7 (chi square 11.202; d.f. 1; 0.001); between fourth and fifth there are no significant differences.

According to the chi square significant differences between the grades, taking errors into account, come about: test 1 (chi square 17.104 (a); d.f. 4; p. 0.002), test 2 (chi square 20.062(a); d.f. 4; p. 0.000), test 7 (chi square 15.520; d.f. 4; p. 0.004).

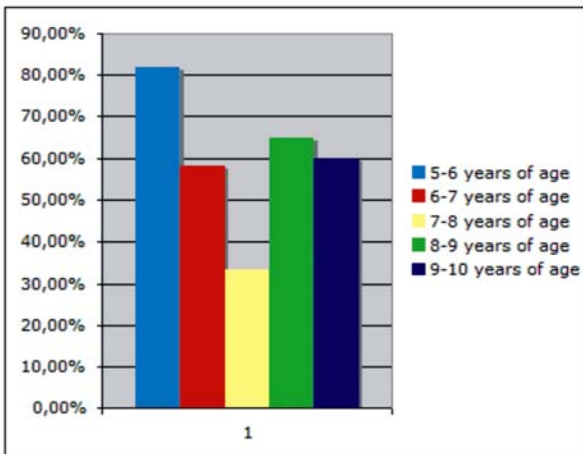
Correct answers according to the histogram following the percentages:

Table 3



One can note an increment in capacity between first and second grade (41.3%), a decrement between second and third (-29.2%), and again an increment between third and fourth (13.4%). Between fourth and fifth grade there is a situation of perfect stability. According to the chi square the only significant difference is between first and second grade, in test 4 (chi square 7.401; d.f. 1; p. 0.007).

Correct answers according to the histogram following the percentages  
Table 4



One can note that the highest percentage of correct answers came about in first grade; between first and second there is a decrement of -23.5%, and again a decrement from the second to the third (-25%). There is



an increment from fourth to fifth grade (31.7%), that presents itself again, if in a hardly noticeable way, between fourth and fifth grade (5%). Using the chi square the only significant difference comes about in test 6 between first and second grade (chi square 7.118; d.f. 1; p. 0.008). In no class was a different duration in three or two sounds indicated, but in all classes an error was committed, with the highest percentage in third grade. According to the chi square the significant differences among all the classes taking account of errors comes about in test 6 (chi square 16.370(a); d.f. 4; p. 0.003).

## **DISCUSSION AND CONCLUSIONS**

Notwithstanding the reduced dimension of the sample used in this research, I believe it is possible in any case to reveal some peculiarities of the ability of conservation of the three parameters of sound considered, comparing the results that I obtained with those of the studies mentioned in the introduction. These take into consideration quite a large sample of subjects, and analyse the results primarily on the basis of age groups. On this point, I will limit myself to three considerations. First: from the results analysed it is clear that conservation ability increases with growth (tab. 2). This emerges from all studies mentioned.

Second: on the basis of the overall results, it is impossible trace a linear development of conservation abilities, given that there is a notable increment between first and second grades, an evident decrement between second and third grades, an even more noticeable increment (20%) between third and fourth grades. Between fourth and fifth grades the situation is almost stable. These observations concord for the most part with that which emerges from the studies of Pflederer, Zimmerman and Sechrest, and also from the later ones of Crowther, Durkin, Shire and Hargreaves, that is that the most evident improvement comes about between 5 and 7 years of age, that is when according to Piaget one passes from the preoperational intuitive stage, to the concrete operational stage, and that the greatest development comes about at nine years of age. From Webster and Zimmerman's study it furthermore appears that between these evident phases of improvement there are phases of transition, as third grade might be considered. In the results of the present study the decrement between second and third grades, in every group of tests, in addition to the overall results, prevents any definition of a linear development of conservation ability. This kind of development has already been described as a "u" in recent studies of developmental psychology [Mounoud, 1995].

Third consideration: although all of the studies mentioned agree on the fact that melodic conservation ability precedes that of rhythm, from the results one can gather that in first grade the subjects conserved the parameter of duration with greater ease than that of pitch, with a difference of 44%.

The above-mentioned studies are based on materials that are substantially different from those used in this study. They use both known and unknown melodies, whereas for this study very brief musical fragments were chosen, without any mnemonic object. For this reason, the test turned out to be more difficult (to the point that no subject responded exactly to all of the questions). The choice of this kind of musical material had one further objective. This was not only a new discussion and possible confirmation of the influence of age on the development of conservation ability as regards musical parameters, but also that of pushing the enquiry towards other aspects of the cognitive process of conservation. The doubt emerged whether the ability to individuate aspects of conservation might not depend only on age, and that the characteristics of the problem being proposed might influence the answers given by the subjects. Our tests were therefore designed towards an inquiry on this point as well, and for this reason we chose brief melodies and questions that were sometimes problematic. In test 1, for example, two variables greatly influence the subjects' responses: one is the brevity of the musical fragment, the other is the manner in which the question is formulated. If the fragment had had four notes instead of three, and had been organized with four equal durations in the departure material, and equal in couples in the transformations the differences between the durations in the two fragments would have been easier to perceive, because the duration of the first G would have been confirmed by the duration of the following A. What's more, the question "has the pitch changed?" induces the subject to contract her perception on the parameter of pitch, and deviates her perception from the parameter on which she should concentrate. If the question had been formulated in a different way, for example "what has changed?", the answer would have undoubtedly been easier, as the results of tests 4 and 5 demonstrate. The results of these tests therefore depend on the way in which the query is formulated. Other variables can also influence the result, for example the relation between the speed of the notes in the first and second groups of sounds presented (see test 3 and 3 b). The first group of sounds offers the model to be referred to: if it is presented more slowly the subject is allowed a more accurate initial perception. The comparison with the second fragment becomes easier if the first has been perceived well.

The present study has no pretence of exhaustiveness, on the contrary represents a point of departure, or eventually a pilot-study for further studies on conservation ability in this age category, and for studying in greater depth the listening strategies that govern its development. Advantage may therefore be taken of the experience here obtained, which has offered a few suggestions. Our next aim is to investigate in more detailed and systematic way those cognitive strategies that preside over the relation between parameters, and over the abstraction of each parameter from its own global perceptive context.

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