

CHILDREN'S AURAL PERCEPTION AND POLYPHONIC MUSIC: AN EXPERIMENTAL STUDY

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ABSTRACT

Background. A review of the literature in developmental psychology and in music education highlighted the multi-faceted nature of music cognition, drawing together aspects of the physiological, psychological and acoustical in the listener and aspects of stylistic and structural organisation inherent in the music. This paper describes a study which considers how these aspects might have relevance for children's musical perception and in particular on how they might apply to the development of children's ability to apprehend polyphonic music.

Aims. The experimental study investigated whether children would be able to attend to two melodies presented simultaneously, whether this ability was developmental and to what extent recognition might be affected by the pitch interval separating the two melodies. The criterion task conducted for the experiment was the ability to hear the lower melody of a passage in which two melodies were sounded simultaneously.

Results. The results confirmed that the ability in children to attend to two parts simultaneously is present at seven years with a plateau appearing to be reached at the age of ten.

Conclusion. The experimental study confirmed that children's powers of perception may be enhanced with due regard to structural organisation and musical meaning across a wide range of musical styles.

1. BACKGROUND

In terms of music cognition, monophonic music may be termed horizontal in that the material is presented to the listener in a manner which is consecutive. This means that the tones in single-stream melody are processed according to their role in the melody as it is presented successively. The melody possesses a quality which is the quality of an entity and not of a number of tone-sensations. The listener hears and repeats a simple tune as a tune, without conscious knowledge either of its constituent intervals or of any other of its analysable characters. Whereas in monophonic or single-streamed music, the interest lies in the movement of tones in proximity to each other, music which is polyphonic includes a vertical dimension involving the organisation of successive and simultaneous sounds. In such music, the individual tones receive a vertical force and become part of a sound-complex created by the simultaneous sounding of two tones.

This can be shown to exist in music across a wide range of styles. In the two-voiced compositions of early organum of the eleventh century, for example, it could be said that there occurred two melodic lines united in the most intimate combination, appearing in parallel motion, crossing each other and continuing their motion in oblique direction. Similarly, polyphonic music

which aimed at individual parts of equal importance may be characterised by horizontal and vertical aspects becoming separate entities with demands that the listener attend to both. With the Alberti bass, the listener is presented with the notion of foreground and background, where a lower line may be said to act as supporting role for the upper melody. With regard to music not governed by tonal constraints (as evidenced in compositions of the second Viennese school in the twentieth century), the construction process arguably tended to fuse together the vertical and horizontal aspects.

In summary, it could be said that for the listener, in multi-streamed or polyphonic music, although there are two (or more) lines simultaneously sounded, there are stylistic reasons for processing them vertically and horizontally and for when to use an interplay between them.

2. AIMS

Against this background, this paper describes an experiment (Stakelum 1993) which investigated the development of listening skills in children and in particular their ability to apprehend polyphonic music. The study aimed to explore the extent to which the cognitive processes involved in the perception of multi-streamed music might depend on maturation or might be acquired by training and experience.

It is a necessary condition for polyphony that independent melodic strands be sounded simultaneously. A minimum requirement would be the presence of two melodic parts, and the criterion for achievement of this ability was therefore taken for the purposes of the experiment to be the ability to attend to two melodies sounded simultaneously. Following reviews of literature in music cognition by *inter alia*, Dowling, (1988) and Bregman (1990), it was assumed that an upper melody would have greater attentional value for children than would a lower, or an inside part of a passage of polyphonic music. The criterion task constructed for this experiment was therefore the ability to hear the lower melody of a passage in which the two melodies were sounded simultaneously. Success in the task was marked by recognition of the lower melody, demonstrated through naming its title or quoting the first line of its word. The lower of the two melodies sounded in a test item therefore was held to comprise its CRITERION melody. [\[FILE/ Criterion melodies\]](#)

In order to minimize distraction of attention caused by the presence of an upper melody, and to maximize the test's efficacy in determining whether the lower melody was heard by subjects, and successful recognitions made, it was decided that the same upper melody would be used at all times. This melody therefore comprised the STANDARD Melody. The song 'Yankee Doodle' was adopted for this purpose (following the work of Deutsch, 1972). [\[FILE/Standard melody\]](#)

In order to strike a balance in the test between the likelihood of recruiting low recognition rates through use of too large a number of different criterion melodies, and the probability of obtaining a large number of chance 'recognitions' from use of too few, either of which would introduce a level of contamination into the data, the number of criterion melodies to be used was set at nine.

Since subjects of the ages to be tested might have had difficulty in recalling the titles of all nine melodies at any one time, thus introducing memory artifacts into the data, it was decided that subjects would be provided in each item with a list of titles of five criterion melodies and would be asked to identify from among them the correct title for the melody heard.

A secondary interest of the research was to investigate whether recognition rates would be affected by the size of the vertical interval separating the standard melody and the criterion melodies. Within the procedure described above, two conditions were therefore constructed. The first was CLOSE condition [[AUDIO/Close condition](#)] where starting pitches of standard melody and criterion melodies were separated by an interval no greater than one octave and DISTANT condition [[AUDIO/Distant condition](#)] where starting pitches of standard and criterion melodies were separated by an interval greater than one octave.

Fifteen items of the test represented the CLOSE condition [[PDF FILE/close condition](#)] and fifteen items the DISTANT condition. [[PDF FILE/distant condition](#)]

3. CONSTRUCTION OF TEST ITEMS

Test items were constructed and in each item, the standard melody and criterion melody were presented twice with a three-second pause between presentations. From the nine selected melodies, a thirty-item test was created. Items were arranged in order such that no two successive items used the same criterion melody. Items were separated by a pause of circa five seconds to eliminate any residual effects from the previous item, to allow the researcher time to announce the following item and to allow time for the subjects to respond. Response sheets were prepared, containing thirty numbered groups of five tune titles. The correct position of the title was randomized among the five possible included for each item.

The selection of melodies for construction of test items was influenced by the following factors:

Familiarity

Because it was desirable that all criterion melodies should be familiar to subjects, melodies were selected from those experienced by subjects during their regular music lessons.

Harmonic structure

The harmonic structure of the standard melody 'Yankee Doodle' was analysed as I - V - I - V/I - ii(IV) - V - I. Only melodies having an harmonic structure that conformed reasonably well to this pattern were selected.

Metric organisation

Only melodies conforming to simple or compound duple metre were included.

Tempo

It was undesirable that the characteristic tempi of criterion melodies should be altered, therefore reducing their recognisability. Melodies were selected so that their natural tempo was compatible with that of the standard melody.

Melodic range

In order to avoid excessive overlap of standard melody and criterion melodies, only melodies falling within a tonal range of one octave or less were selected.

Tonality

In order to standardise the tonality of items, all were presented in the key of C major. The combinations of two independent melodies inevitably created some moments of harmonic conflict. However, the harmonic considerations in selection of melodies ensured that these 'collisions' were minimized, and were only of local effect. Similarly there were moments when the two melodies of an item used a common pitch, creating a unison at these moments. However, the effect of these was only local and was judged not to affect the item.

The test materials were recorded onto cassette tape from piano at the Institute of Education, University of London.¹

4. EXPERIMENTAL METHOD

The experiment, carried out by the author, involved three class groups, corresponding to pupils aged 7, 9 and 11 in an elementary school in the Irish Republic, during regular school hours and, in each case, with the class teacher (generalist) present. The experiment was carried out in two stages. The first was introductory and was designed to ensure that all criterion melodies were known to subjects, to familiarize them with the test procedure to be used and to ensure that all subjects were able to read the titles of the melodies. A second stage- the main experiment- followed in which the null hypotheses were expressed as follows:

1. Children will not be able to attend to two melodies presented simultaneously, and recognitions of criterion melodies will not be better than would occur by chance

¹ The original test used a recording compiled by two pianists, one playing standard melody and the other playing criterion melody. The author wishes to acknowledge the technical assistance of Karen Power, Mary Immaculate College, University of Limerick, in the preparation of the audio and visual files for the present paper.

2. Ability to attend to two melodies is not developmental, and no two differences between age-groups in number of recognitions made will be observed
3. Recognition will not be affected by the pitch interval separating the standard and criterion melodies – a wider interval of separation will not bring better recognition.

5. RESULTS

Mean scores for responses to the test are shown by age group in Table 1.

Age group	Mean	σ	Range
7 year olds	13.2	8.74	4-30
9 year olds	25.8	7.46	7-30
11 year olds	27.0	5.69	7-30

Table 1. Mean scores

Note: a test of thirty items, with an item-probability of 1:5 ($p=0.2$) would produce a mean chance score of 6. Allowing for a maximum standard error of the mean (of $\sigma = 2.19 \times 1.96$), the upper boundary of chance-generated recognitions would be 10.292. All age groups were therefore performing at a level significantly above chance in this test.

The first null hypothesis must therefore be rejected, and it must be concluded that children are able to attend to the lower of two melodies sounded simultaneously.

A series of t-tests was carried out to test the differences between means for age-groups. The results are presented in Table 2.

Age group	t-value	p-value
7 vs 9	6.01	<0.001
7 vs 11	7.17	<0.001
9 vs 11	0.07	Not significant

Table 2.

These results show a significant improvement between age-groups 7-8 and 9-10 and between age-groups 7-8 and 11-12. Differences between 9-10 and 11-12 year age-groups were not significant, however. The second null hypothesis must therefore also be rejected. The ability to attend to the lower of two melodies increases with age, but with a plateau appearing to be reached circa 10 years of age.

The results obtained for CLOSE and DISTANT conditions were examined. Each condition contained fifteen items.

Age group	Mean	σ	Range
7 year olds	6.70	4.09	2-15
9 year olds	12.83	3.65	4-15
11 year olds	13.27	2.94	4-15

Table 3a. CLOSE condition

Age group	Mean	σ	Range
7 year olds	6.50	4.80	1-15
9 year olds	12.95	3.94	2-15
11 year olds	13.73	3.12	2-15

Table 3b. DISTANT condition

To determine the significance of the difference in mean scores within each age-group, between CLOSE and DISTANT conditions, t-tests for related measures were applied. Results are shown in Table 4.

Age group	t-value	Significance
7year olds	0.61	Not significant
9 year olds	0.62	Not significant
11 year olds	1.68	Not significant

Table 4. With $df=29$, a t-value of 2.045 is required for significance at 0.005 level.

None of the values of t obtained from these data proved significant. The third null hypothesis therefore could not be rejected and it was concluded that the recognition of the criterion melodies was not more easily achievable when the size of the vertical interval separating the standard melody and the criterion melodies was increased.

6. CONCLUSIONS

The results supported the notion that the ability to attend to two melodies simultaneously is present in children, with a significant plateau occurring at age of circa 10 years of age. The study confirmed the importance of taking into account the hierarchical nature of perception, where there are melodic, rhythmic and harmonic aspects to musical organization. There is room for application of such findings in the music education context, where traditional practices have arguably tended towards a reductionist notion of music cognition, defined in terms of identification of vertical and horizontal aspects of music separately and within a limited range of musical styles. An alternative view is to consider the process of listening to multi-streamed musical compositions across a wide range of styles and genres, where the parsing of any single note is significant in many schemata and on many different levels. The challenge for the music educator is to develop this musical grammar wherein children's powers of perception may

be enhanced in the areas of composing, listening and performing with due regard to the preservation of the musical integrity of the repertoire and attention to the layers of meaning inherent in the music.

7. REFERENCES

1. Bregman, A. (1990). *Auditory scene analysis: the perceptual organization of sound*. Massachusetts Institute of Technology.
2. Carterette, R. and Kendall, R. (1999). Comparative music perception and cognition. In D. Deutsch (ed), *The psychology of music 2nd edition* (pp. 725-791). Academic Press.
3. Deutsch, D. (1972). Octave generalisation and tune recognition. *Perception and Psychophysics*, 11(6), 411-412.
4. Dowling, J. (1988). Tonal structure and children's early learning of music. In J. Sloboda (ed), *Generative processes in music, the psychology of performance, improvisation and composition*. Oxford: Clarendon Press.
5. Imberty, M. (1996). Linguistic and musical development in preschool and school-age children. In I. Deliège and J. Sloboda (eds), *Musical beginnings, origins and development of musical competence* (pp.191-213). Oxford University Press.
6. Stakelum, M. (1993). *An investigation of aspects of children's listening skills*. Unpublished MA dissertation. University of London, Institute of Education.