CHILDREN'S PERCEPTION OF SIMILARITY RELATIONS IN MUSIC

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ABSTRACT

Background. Music theory provides elaborate accounts of similarity relations in music, yet experimental studies in psychology have struggled to demonstrate that listeners are able to perceive these relationships between parts of pieces of music. This has only been demonstrated for listeners with musical training, or who are explicitly instructed in the categorisation processes required, or are very familiar with the specific piece of music; in most situations listeners categorise musical events based on surface similarities such as dynamics or melodic contour.

Aims. The current research addresses some of the methodological problems demonstrated by previous research. The focus on children's perception of similarity relations enables this study to explore the effect of age and musical training, independently and together, on listeners' sensitivities to various levels of similarity in music.

Method. The research piloted a new technique of free sorting of musical extracts alongside a more conventional attribute ranking task, both using a computer interface, in order to explore how children perceive similarity relations in music. Participants were 71 children aged between 5 and 12, with three levels of instrumental musical training (Suzuki, Standard and None). The music used was Haydn's string quartet Op 50 no. 4, chosen as an unfamiliar piece in a familiar (tonal) idiom.

Results. Both training and age have significant effects on how children perceive similarity. Older and more trained children use similarity criteria characterised by intermediate and deep level features, whilst younger less experienced participants rely mostly on surface features.

Conclusions. There are differences in children's perception of similarity dependent upon age-related development and level and type of training. This supports the new explanation-based theories in psychology as an explanation of similarity perception in music, since listeners do not use attributes in a logical and ordered way.

1. INTRODUCTION

Music theory provides elaborate accounts of similarity relations in music, yet experimental studies in psychology have struggled to demonstrate that listeners are aware of the relationships which have been identified by music theory. Theorising in cognitive psychology currently believes: 1) the explanation-based view is the best available explanation of the categorisation process and perception of similarity, and a better explanation than prototypes or exemplar-based approaches; 2) both perceptual, surface level similarities and conceptual, deeper, theoretical levels of similarity are important in terms of the categorisation process; and 3) the input of context and prior or background knowledge (or experience) are involved in the development of representations and categories (Hayes & Taplin, 1995). Empirical evidence supports the importance of experience: training promotes expertise (e.g. Chi, 1978), and age-related development leads to different organisational strategies (Olver and Hornsby, 1966).

In music psychology, research has provided conflicting results on the issue of how experience affects listeners' musical judgements. In terms of expertise, Deliège, Mélen, Stammers and Cross (1996) noted differences between adult musicians' and non-musicians' performance on a music construction task with musicians producing more coherent music with some structural aspects correct. The observed differences were however not as clear as would be predicted, implying that the methodology may not have allowed participants to use the knowledge they possess. Contradictory evidence was found by Lamont and Dibben (2001) who found no substantial differences between musicians' and non-musicians' performance on a similarity judgement task.

Fewer studies have been conducted into age-related development, although Chapin (1982) found that young children outperformed adult musicians on a thematic recognition task. A few studies have explored the combined effects of expertise and age-related factors. Morrongiello and Roes (1990) observed differences, with musically trained children consistently outperforming their untrained peers on a melodic contour matching task. Conversely, Koniari, Predazzer and Mélen (2001) found no differences between musically trained and untrained children on categorisation and similarity judgement tasks, with some evidence for sensitivity to structural features of the music.

The studies conducted with children all share a similar flaw, namely that extensive training is given. In music perception in general, when a task is easy or training is given on how to complete it, participants do better (Smith, 1997). Koniari et al. (2001) suggest that the high levels of performance shown could result from the simple nature of the music. However, it can be argued that the amount of training given to the children on the task and identification of the parent motives could also be a factor (cf. Smith, 1997).

Considering the contradictory research on similarity perception the following questions are posed: How do different children listen to music? More specifically do they listen at a surface level (e.g. loudness, contour) or at a 'deeper' level (e.g. harmonic structure) as hypothesised by music theory? Are there any developmental changes in the way children come to understand musical similarity and does musical training have any effect on this? Experience and training in a given area can be seen to facilitate performance on subject-specific tasks. It is therefore hypothesised that participants who have received musical training will understand musical similarity differently to those who have not received musical training, and that the level of training and age will affect the level at which similarity is perceived.

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2. METHODOLOGY

A number of guiding principles were decided upon in an attempt to rectify some of the methodological problems noted in previous research: (1) The study was as unguided as possible; (2) Music from the western tonal repertoire was used, allowing participants to draw on existing knowledge; and (3) No unnecessary extra-musical variables or labels were used.

2.1. Design

Two tasks were used in an attempt to access different elements of the children's understanding of similarity relations. The first, a Free Sorting task adapted from a pilot study by Lamont and Dibben (2002), allows the kind and level of similarity being perceived to be uncovered. This task was repeated, enabling participants to re-evaluate the method they used on the first presentation of the task. This also allowed participants to access deeper and more conceptual elements of similarity and categorisation, which may not be possible on an initial encounter (Heaps & Handel, 1999).

The second task, an Attribute Ranking Task, was adapted from a study by Heaps and Handel (1999) as a more ecologically valid alternative to the Attribute Rating Task used by Lamont and Dibben (2001), where participants rate each extract they have already categorised on adjective rating scales. Participants should find it easier to make comparisons between simultaneously (or very closely) presented extracts along one dimension at a time than to rate each extract on a range of dimensions. This task attempts to separate out attributes at the different proposed levels of music (cf. Lamont & Dibben, 2002).

2.2. Participants

The sample comprised 71 participants (44 females, 27 males) in 3 training groups (Suzuki-trained, Standard-trained, Non-trained). Within each training group there were 3 age groups, 5-7, 8-9, and 10-12 years old.

2.3. Materials

The music used was the first movement of Haydn's String Quartet op. 50/4. This piece was chosen because it is in a familiar tonal idiom but it is not a well-known piece. As a monothematic piece in sonata form, it also consists of only one main theme. The second subject is thus clearly related to the first by motivic and thematic similarity in music theoretic terms, and there are fewer complications from a second less related theme in terms of selection of extracts and interpretation of data. Finally, the choice of music allows the current research to be compared to previous research in the area of music perception. Nine extracts were selected from the piece, which were used for both tasks. Each extract was four bars long and was related to the main thematic material in some way.

Each extract was represented by a counter on a computer screen within a custom Category computer program (written by Sol Nte, Keele). The program tracked and recorded the co-ordinates of every movement and the final locations of the counters.

2.4. Procedure

Each participant was tested on a one to one basis. Demographic data was collected at the start of the session. The participant was then told that they would be completing three tasks. Participants were played the entire piece, without the repeated exposition. This was a form of training so participants knew what to expect from the extracts (i.e. if there was an instrument change it would not be a surprise and therefore become a focus point), but it did not give clues as to any expected responses. The three tasks then followed.

Free Sorting Task. Participants were seated at the computer facing the display of nine counters and a circle in the centre of the screen. They were informed that nine extracts had been taken from the music, each corresponding to a counter on the screen, and were asked to arrange the counters within the circle space according to 'how much they sounded like each other' using any method that made sense to them. They could play each extract as often as they liked, and in any order or combination, by using the mouse to click on the relevant counter.

Attribute Ranking Tasks. In a second display, participants were shown the counters with a line in the centre of the screen, with bipolar attribute words at either end of the line. They were asked to place the extracts in the order they should go along the line on the screen in terms of the attributes at either end of the line.

Second Free Sorting Task. It was explained that this was the same task as the first one. However, due to the tendency of children to believe they have done something wrong when asked to re-do a task and subsequently make a conscious effort to change their methods, participants were assured they had not completed the first task incorrectly.

3. RESULTS AND INTERPRETATION

To explore group differences, the free sorting tasks were first investigated separately.

3.1. First Free Sorting Task

The similarity data for each participant were recorded as pairs of co-ordinates representing the position of each extract in the circle. For each participant the final co-ordinates for each counter, on each of the tasks, were extracted from the Category program. The resulting data was then submitted to a repeated measures ANOVA, which produced two significant interactions. Firstly, the two-way interaction between First Similarity Ratings and Training was found to be significant ($F(2,630)=10.387$, $p=.000$) and post-hoc tests showed differences between the similarity ratings of all three training groups. Secondly, although the two-way interaction between First Similarity Ratings and Age was not significant, the three-way interaction between First Similarity Ratings, Training and Age was significant ($F(4,630)=3.914$, $p=.004$).

To explore this further and establish where the training differences lay, a series of ANOVAs were carried out comparing the three training groups and age groups. The results established that for the First Free Sorting Task there were three training groups of participants whose composition, mean age and mean months of training are shown in Table 1.

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Group.	Composition.	Age	Months Training
Least Experienced Group	Non-trained 5-7 Non-trained 8-9 Non-trained 10-12 Standard-trained 5-7 Standard-trained 8-9	8.18	4.57
Moderately Trained Group	Standard-trained 10-12 Suzuki-trained 5-7	8.71	17.36
Highly Trained Group	Suzuki-trained 8-9 Suzuki-trained 10-12	9.7	35.8

Table 1: Composition, mean age, mean months of training and mean time taken on First free sorting task for training groups.

3.2. Second Free Sorting Task

A repeated measures ANOVA produced two significant interactions. Firstly, the two-way interaction between Second Similarity Ratings and Age was significant ($F(2,630)=4.430$, $p=.012$), showing that there were differences between the similarity ratings of all three age groups. Secondly, although the two-way interaction between Second Similarity Ratings and Training was not significant, the three-way interaction between Second Similarity Ratings, Training and Age was significant ($F(4,630)=5.860$, $p=.000$).

To explore this further and establish where the age differences lay, a series of ANOVAs was carried out. The results indicated that for the Second Free Sorting Task there were two age groups of participants, whose composition, mean age and mean months of training are summarised in Table 2.

Group.	Composition.	Age	Months Training
Older Group	8-9 Non-trained 10-12 Non-trained 5-7 Standard-trained 8-9 Standard-trained 10-12 Standard-trained 8-9 Suzuki-trained 10-12 Suzuki-trained	9.31	15.54
Younger Group	5-7 non-trained 5-7 Suzuki-trained	5.97	6.8

Table 2: Composition, mean age, mean months of training and mean time taken on second free sorting task for age groups.

3.3. Attribute Ranking Tasks

A repeated measures ANOVA indicated that although each of the attribute pairs was treated separately ($F(1,630)=28.105$, $p=.000$) there were no group differences in the way they were used. Factor analysis was also performed to discover whether any of the tasks were tapping the same construct, i.e. whether the counters were arranged in the same way on some or all of the five tasks across the different groups. The analysis produced a single factor of Jumpy, Big and Loud, explaining 41% of the variance. A second factor of Beginning and Happy emerged when a further series of group-by-group factor analyses was performed, explaining approximately 20% of the variance for the older groups.

Finally, a series of linear regressions was performed to determine whether these factors explained any of the dimensions on the free sorting tasks. The factors did not explain any dimension for any participant group. The average ratings given by each group, for each extract counter for the free sorting tasks, were therefore plotted and analysed visually in relation to the musical extracts themselves, in order to attempt to interpret what had influenced the different groups' arrangements.

In the first sorting task all three training groups seemed to have used surface features as similarity criteria, but to varying degrees. The Least Experienced group used the most surface feature of loudness and seemed to use a multiple grouping strategy (when sub-groups are formed but no links between them are stated), without any deeper level features. Neither the Moderately Trained nor the Highly Trained group showed a tendency to arrange the extracts on the basis of a single feature level. For the Moderately Trained group, surface features (e.g. texture) provide an interpretation, and this group appeared to use an edge matching strategy (involving the formation of associative links between neighbouring items or groups but with one consistency in the attribute that is used). These were based mostly on surface properties, with the inclusion of the intermediate feature of mode and the deep feature of thematic relation. The Highly Trained group appeared to use an edge matching strategy based largely on intermediate (mode) and some deep level (thematic relations) features, with some surface level features (loudness). In summary, the higher the level of training, the more intermediate and deep level features were used as similarity criteria.

On the second free sorting task the Older group seemed to use the more surface features of contour and rhythm, along with the intermediate feature of mode. This group also seemed to be using a multiple grouping strategy in their arrangement. In comparison, the Younger group appeared to rely on surface features, and in this case the surface feature of texture played a prominent role in their arrangements. This group may also have used an edge matching strategy but only on part of the arrangement, all based on surface features.

4. DISCUSSION

The findings from previous research were inconclusive, yet the current study supports some conclusions that have been drawn previously. The composition of and differences in training groups found for the first sorting task appear to be in line with some previous findings. This study found an overlap between training groups, with the youngest members of the more experienced training groups being collapsed into a single group together with the older members of the less experienced training group. This appears to support earlier studies indicating that children could out-perform adults on tasks within their range of expertise (Chapin, 1982; Chi, 1978). This shows that a child's knowledge of an area is more important than their chronological age. The current finding of differences according to the level of training brings into question the results of Koniari, Predazzer and Mélen (2001) that non-musicians and musicians performed in similar ways, and suggests that the criticism levelled at the methodology used in their study may be upheld.

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The developmental trends found in the second free sorting task are supportive of Schwarzer (1997) who found that children and adults used different strategies in the perception of melodies but that they were both based upon surface features. The results also support Deliège *et al*. (1996) whose adult musicians and non-musicians performed differently but using the same levels of features (i.e. surface). The present study found that on the first free sorting task all three training groups based their similarity judgements mainly on surface features, and only the more musically experienced children identified any deep level features. On the second free sorting task both the younger and older children used different surface features, and the results thus also confirm those of Lamont and Dibben (2001).

Siegler's (2000) work on cognitive variability both between and within children helps to explain the different groupings of participants for the two identical free sorting tasks. Differences were found by training group for the first free sorting task and by age group for the second free sorting task, suggesting that the participants may have used different strategies on each task. This may have been a result of the second free sorting task following the attribute-ranking task, which some participants mentioned had influenced their subsequent sorting arrangements.

The strategies used by the participants correspond to work by Olver and Hornsby (1956) in that for the first free sorting task the participants used progressively more sophisticated strategies and used them more often as the level of training increased. Olver and Hornsby assumed that edge matching and multiple grouping were unsophisticated strategies used by younger children in the absence of any other strategies or to fall back on when the task was difficult. However, this study suggests that when dealing with music as a stimulus this is not the case. Music is a multidimensional stimulus, and if a child is using one of these strategies, rather than a superordinate grouping (e.g. loud and soft), this shows an ability to consider more complex, multidimensional aspects of the extracts and consider more than one element of the music at a time.

The relation of the current findings to cognitive psychological theories of similarity can also be seen. The current study provides support for the explanation-based view as an explanation of similarity perception in music. It shows that people do not use attributes in a logical and ordered way, as was suggested by earlier theories of categorisation (e.g. prototype view adopted by previous studies such as Deliège *et al*., 1996). The differences observed between musicians and non-musicians support the hypothesis that background knowledge and expertise are used to create categories, and this is also supported by the fact that the participants appeared to carry out the tasks in a seemingly ad-hoc way. The new free sorting tasks used in this study allowed for the possibility that participants would not fit in to stages (as suggested by Piaget), and allowed them to change the strategies that were used and use their knowledge. Overall, the new task was very flexible, and enabled the consideration of variability within, as well as between, participants (cf. Siegler, 2000).

Further study to clarify the differences found in children's perception of similarity is needed. The use of a larger sample may help to confirm both the developmental and training differences observed here. Research is required into the interpretation of meaning for the attributes, as in the current study different meanings were imposed by the experimenter and some participants. These suggestions may help to gain more in-depth knowledge of the processes children use when using similarity relationships to categorise music. An interesting extension would also be to use different styles of music, as increased familiarity with the style (e.g. popular music) might lead to deeper level features of the music being perceived.

To summarise, this study has been successful in showing differences in children's perception of similarity both according to development and the level and type of training. In particular, the higher the level of training received, the more intermediate and deep level features are used as similarity criteria, and the younger the participant, the heavier their reliance on surface features as criteria of similarity. The current study has supported some of the previous research (e.g. Schwarzer, 1997; Deliège *et al*., 1996) and has substantiated some approaches from developmental psychology (Siegler, 2000; Olver and Hornsby, 1966). This study also provides support for the explanation-based theory of cognitive psychology as an explanation of similarity perception in music.

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