AN APPROACH TO THE STUDY OF MELODIC PERCEPTION IN INFANTS AND YOUNG CHILDREN: STIMULUS SELECTION[1]

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In designing experiments on melodic perception, the experimenter can select a large or small number of test melodies. This paper discusses advantages of a small stimulus set particularly in developmental research. With this approach it has been shown that preschool children can remember a sequence based on the major triad more easily than a sequence based on the augmented triad, and this performance difference exists for various conditions of delay. Thus, at an early age, children show an adult pattern of sensitivity to music structure. On the other hand, infants, who discriminate a semitone at each serial position of the sequences, show no difference in performance for the two melodies. While the economy provided by studying a limited number of melodies must be weighed against the potential lack of generality of the results, it is concluded that the approach has special viability in research on infants and children.

In setting out to test an hypothesis about melodic perception, the experimenter must select the variables of interest, for example, the effect of degree of music structure, contour, or familiarity upon melodic memory or perceived emotional quality. Then it is necessary to decide upon test sequences for the experiment, that is, which and how many. A set of test melodies may be created by a quasi-random selection of tones (e.g., Chang & Trehub, 1977; Cuddy, Cohen, & Miller, Experiment 1 & 2, 1979; Dowling & Fujitani, Experiment 1, 1971). This approach has produced many empirical contributions and has the precedent of nonmusic, psychological research in information processing. A viable alternative, however, is the use of a small but select set of melodic sequences. For example, consider the study by Cuddy and Cohen (1976) which investigated the recognition of the six sequential orderings of the major triad under transposition. There were six discriminations for each pattern, resulting from the change of one note in the sequence to be one semitone higher or lower in pitch. This small subset of test stimuli revealed that (a) sequences with more complex contours were more difficult to recognize, (b) effects on recognition of altering each note in the triad up or down by one semitone were not equal, (c) performance improved with increasing music experience, and (d) a model in which information between non-adjacent tones was processed could not account for the high performance of musically experienced subjects.

For the purpose of examining whether children of three different age levels processed information between non-adjacent tones, Billingsley and Rotenberg (1982) modified the paradigm of Cuddy and Cohen (1976). They *randomly* drew 14 sequences of three tones from an octave range. The random selection of tones prevented examination of differences resulting from sequence structure (e.g., tonal or contour), although such differences may have occurred and, in fact, may have been responsible for the absence of other effects (Cohen, 1984).

Illustrating further the power of the approach of using a few sequences, Cohen (1982) employed two sequences that differed in degree of harmonic structure and revealed the significance of the four independent variables of timbre, degree of transposition, experience level, and tonality in a transposed recognition paradigm similar to that of Cuddy and Cohen (1976). The two sequences were representative of the classes of stimuli having high and low degrees of music structure that had been studied earlier (Cuddy, Cohen, & Mewhort, 1981).

At the Centre for Research in Human Development, University of Toronto, Erindale College, the early development of the sensitivity to music structure has been explored. The limitation in these studies to a few selected sequences has special advantages for work with children whose attention span and comprehension are constrained in comparison to adults. Therefore, we have examined preschool children's memory for two short sequences based on the major and augmented triad (Trehub, Cohen, Thorpe, & Morrongiello, 1986). The two standard sequences of five notes, as shown in Figure 1, were the ascending-descending major triad and augmented triad. They can be considered to represent different levels of harmonic structure as a result of special properties of the major triad, none of which is shared by the augmented triad.

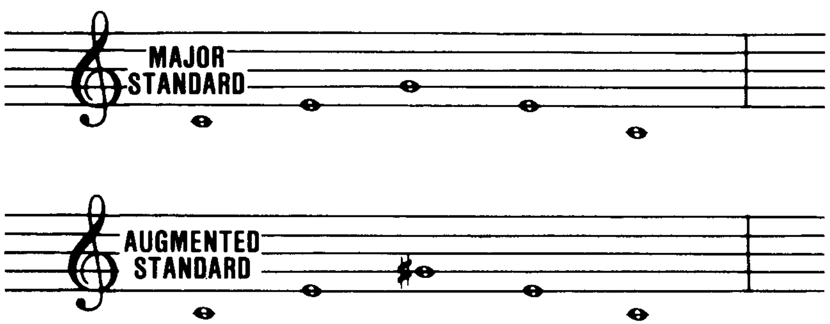

Figure 1. Ascending-descending major and augmented triads.

In these studies, the child was told that he or she would be playing a game with songs. The same melody would be repeated a few times, followed by a presentation of the same song or by a new song. The child was to indicate when a new melody occurred by speaking, clapping, raising a hand, or whatever response was mutually acceptable to experimenter and child. If the child responded to the new melody, a toy near the loudspeaker was activated.

Once the child met a training criterion, the test phase began. Each child received a randomized ordering of 10 trials with each standard sequence, including: 5 presentations of no-change trials and 1 presentation of each of 5 change trials (i.e., one type for each of the 5 serial positions), for a total of 20 trials. For 30 preschool children whose mean age was less than 5 years, performance of the major triad discrimination significantly exceeded that for the augmented.

When the intersequence interval was increased to 2.6, 4, and 6 s, in subsequent unpublished experiments, performance decreased, but the overall advantage of the major triad was retained. However, there was some suggestion that this advantage was lost when serial position 3, in particular, was changed. This may have resulted from the fact that raising the third serial position in the major triad change trials produced the augmented triad. Subjects may have recognized the difference between the major and augmented triad, but may have forgotten whether the preceding sequences of the trial were, in fact, major or augmented. Thus, including even two different sequences in an experimental session may cloud the issue under investigation. With only two sequences, however, anomalous performance can be attributed to some specific aspect of the procedure and associated mental processing.

Because sequences were always presented at the same frequencies, solution of the task just described could have relied heavily upon memory for absolute frequency information. In order to determine the role of relational information in the advantage of the major triad, the two patterns were presented in a transposition paradigm. Sequences were this time isolated in blocks, that is, only one sequence type per experimental session. The three repetitions of the standard within the trial were transposed in a way that would reduce overlap in frequencies, a potential source for extraneous facilitation. Because four different augmented triads can be generated from the 12-note chromatic scale, each trial of the augmented condition of the experiment could contain four different presentations of augmented triads without repeating any frequencies. Each trial was therefore composed by randomly selecting four augmented triad groups without replacement (see Figure 2a). Incorrect comparisons altered only the third serial position. Because any order of the notes in

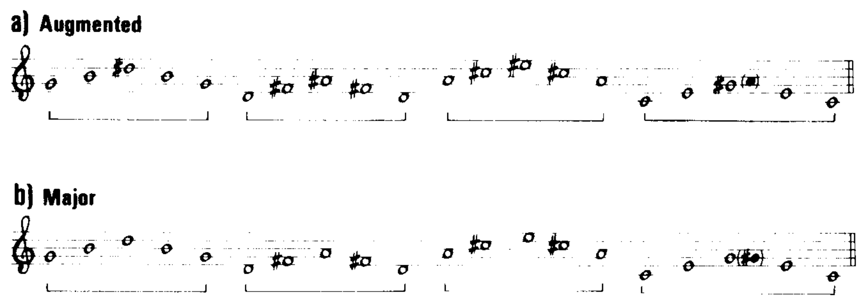

Figure 2. "Roving" transposition paradigm: (a) four augmented triads in a trial (b) corresponding trial with major triads.

the group produced an augmented triad, the starting note for each of the four groups was randomly selected.

Ten such trials with "roving" transpositions were created. For the major triad condition, the augmented fifth of each triad of the corresponding augmented condition was lowered to form the perfect fifth.

In an initial experiment, children found the task impossible with either the major or the augmented sequence condition. The task was subsequently simplified by reducing the uncertainty of the pattern of transpositions. In this case, each successive transposition began on the adjacent semitone, for example, C for the first

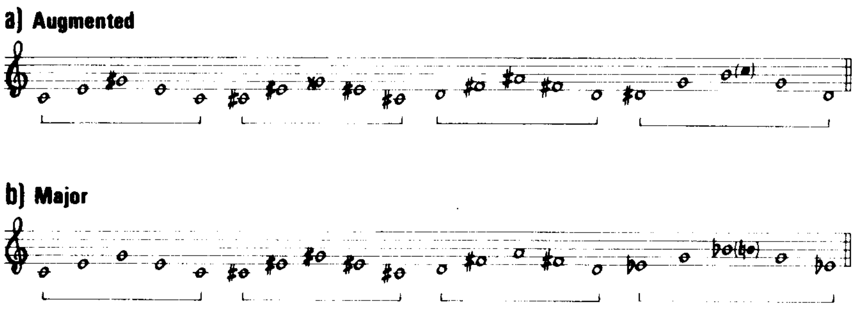

Figure 3. Successive transposition paradigm: (a) four augmented triads in a trial (b) corresponding trial with major triads.

sequence, C# for the second sequence, D for the third sequence, and D# for the fourth sequence (see Figure 3). The starting frequency of a trial was random.

By reducing the uncertainty of the pattern of transposition of the sequences within a trial, the task became possible for the children. However, the superiority of the major triad was not significantly greater as had been found for the untransposed case. Nevertheless, adults in comparable studies with the "roving" transpositions do experience an advantage for the major triad sequences (Cohen, Trehub, & Thorpe, in press). The task may have been too difficult for structural advantage to assist children as we had found when the retention interval was increased for third position change in the untransposed conditions previously mentioned.

This transposition study with limited stimulus materials does however provide evidence for the ability of children to recognize patterns on the basis of relational information. Furthermore, the overall uncertainty of the pattern of transpositions of sequences within a trial affects the ability of children to process the sequences. The effect of uncertainty may be understood as a higher-order effect of contour complexity.

The demonstration of the preschool child's sensitivity to melodic structure encourages similar research at even younger age levels. We have been interested in determining the sensitivity of infants to melodic parameters, but the problems of

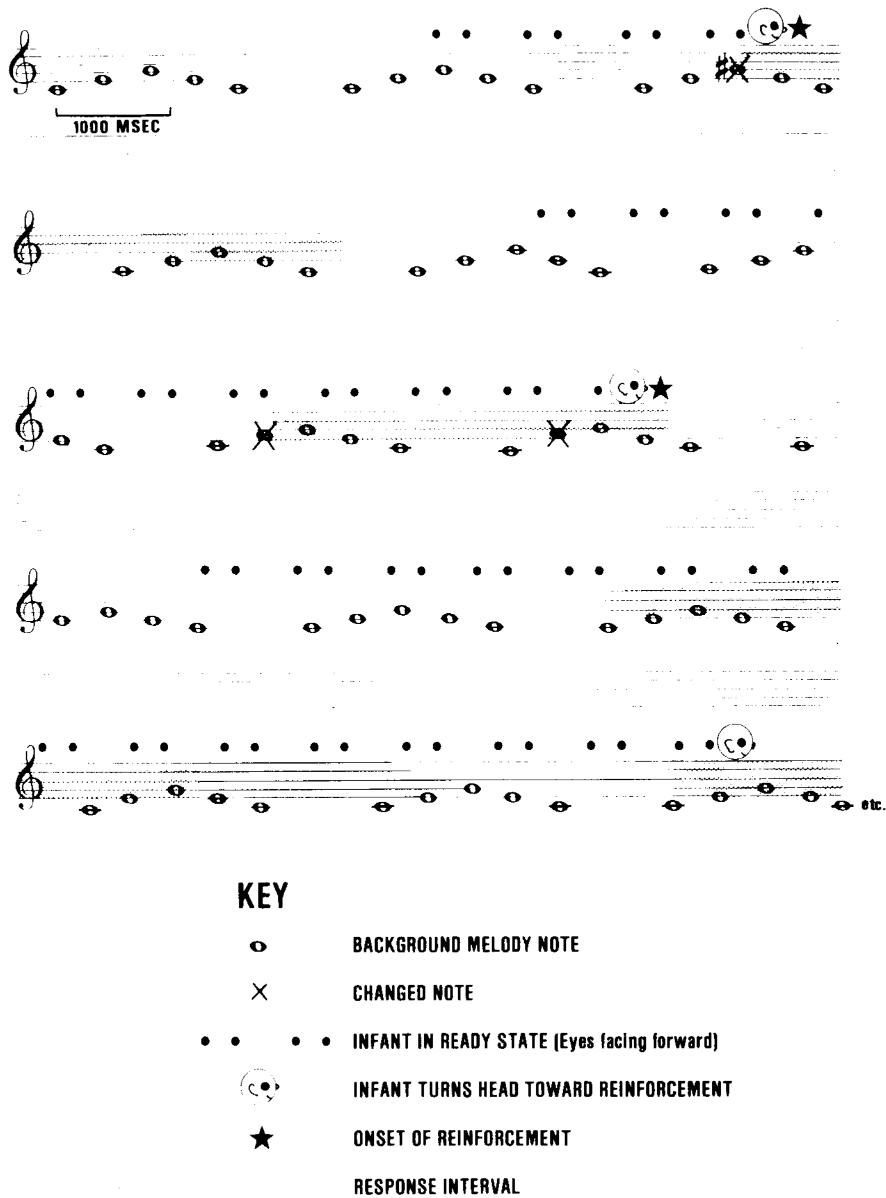

Figure 4. Representation of the temporal parameters of the change and no-change trials used in the conditioned headturn procedure. The "x" refers to a changed tone. (Number of no-change background sequences in the experiment was at least two, although for spatial consideration, this has not been represented in all cases.)

limited attention and comprehension are obviously even more pronounced for infants than for young children.

A conditioned headturn procedure has been found to be effective for examining the ability of infants to discriminate auditory patterns (e.g., Eilers, Wilson, & Moore, 1977; Trehub, Bull, & Thorpe, 1984; Trehub, Thorpe, & Morrongiello, 1985). During the session the infant is seated on the parent's lap in one corner of the testing booth, facing the experimenter. To the infant's side, at an angle of 45 degrees, are a loudspeaker and the Plexiglas display box.

In a training phase, each infant is presented repeatedly with one standard tone sequence; for example, the major triad melody, separated by 800-ms intervals. The experimenter first attracts the infant's gaze with a small silent toy. When the infant is quiet and facing directly ahead, the experimenter initiates a training trial by pressing a button, at which time a contrasting melody is presented. For example, the first note of the contrasting melody might be raised by two semitones relative to the standard melody. If the infant turns 45 degrees or more toward the loudspeaker, the experimenter presses another button. If this response occurs within the response interval (typically 3 or 4 s from the time of the first changed note) a computer illuminates and activates one of the reinforcer toys for 4 s. Turns at other times or in the opposite direction are not reinforced. Following the presentation of the contrasting melody and reinforcer (if relevant), repetitions of the standard background melody continue as before. If the infant turns on two consecutive trials, the change in the first note of the subsequent contrasting melody is reduced to one semitone. If the infant fails to turn correctly on two consecutive trials, the change in the first tone is increased to three semitones, with successive reduction in frequency change contingent on correct performance.

Once a training criterion is met, the test phase begins. The standard repeating background melody remains the same. Headturns to the sound change are reinforced if they occur within the response interval. An equal number of no-change trials are presented during which the background melody continues to play and headturns are recorded. Performance on these no-change trials provides a measure of spontaneous headturns in the direction of the loudspeaker. Typical temporal parameters of the stimulus, response interval, and trial types are shown in Figure 4. A test phase consists typically of 30 trials: 15 change trials and 15 no-change trials.

Using this paradigm, we have shown that infants can discriminate a difference of one semitone in a music context, although we find no clear evidence that infants discriminate the major triad more easily than the augmented (Trehub et al., 1986). However, a study in which sequences were transposed suggested that infants' encoding of the major triad was more stable than the encoding of the augmented (Cohen, Thorpe, & Trehub, 1987). As well, the results of studies directed toward demonstrating the advantages of simple contour arpeggiations of the major triad as compared to more complex contours (see Figure 5) were not clearcut.

In one within-subject study, performance, as measured by the percentage of headturns on change trials, was significantly higher for the simple contour and the superiority was evident at every serial position tested. In a between-groups study,

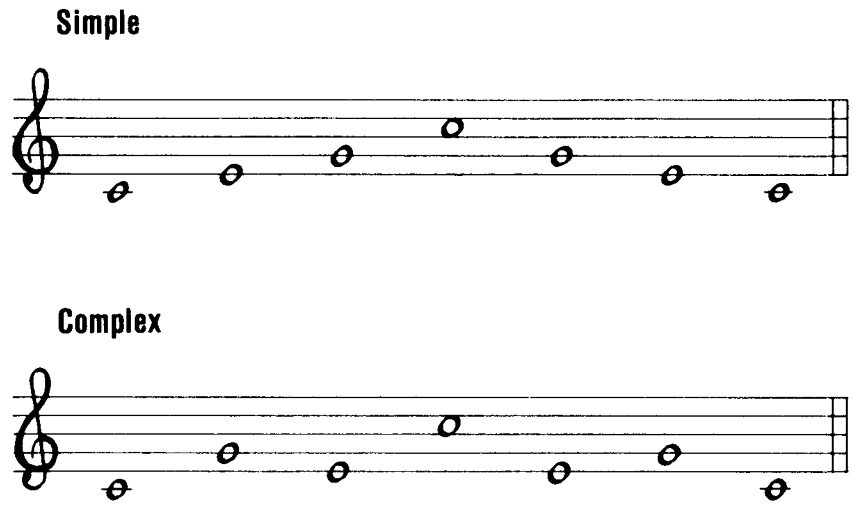

Figure 5. Arpeggiated major and augmented triads used in the conditioned headturn procedure.

however, the overall effect was not replicated although the majority of serial positions showed the superiority.

The role of contour complexity and the discriminability of a semitone in a music context are only now being studied in infants, and such studies are necessary given the considerable evidence of the ability of infants both to detect changes in melodic contour (Trehub, Morrongiello, & Thorpe, 1985), and to make other distinctions between sequences whose pitch composition is quasi-random (Chang & Trehub, 1977; Trehub et al., 1984). Using a small selection of sequences means that results or their absence cannot be attributable to confounding created by nonrandom stimulus variability.

In summary, the careful selection of a few sequences reduces possible extraneous factors and aids in the illustration of the effects of particular independent variables. The demonstration of the effect using one melody can be tested later for generality with other sequences. It may seem odd that of the infinite possible music stimuli, an experimenter would select only one or two to study. But we think it is more important to provide an initial demonstration of effects than to show a null result in a less controlled situation. The technique is economical with subject numbers and test time. This is a particular premium in research with infants and children. Potential disadvantages of lack of generality may be diminished if test sequences are selected judiciously on the basis of past research and theory.

Therefore, the researcher, in designing studies of melodic perception, does well to consider the fewest possible sequences required to demonstrate the effects of interest. When multiple sequences are employed, performance for each sequence deserves independent inspection.

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