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Constructing a Representation of a Melody: Transforming Melodic Segments into Reduced Pitch Patterns Operated on by Modifiers

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A reduced-pitch-pattern model for melodic processing is proposed. The model assumes that experienced listeners divide a melody into segments, derive a reduced pitch pattern from each segment, and then try to match each pattern to one of the prototypes stored in long-term memory. As a result, the melody is memorized accurately and quickly. This model and two competing models (the contour model and the harmonic progression model) make different predictions concerning what aspects of a melody would be preserved and what types of error in recall would appear. Recall data of a tonal melody of 12 measures in length were used to examine these predictions. The data were gathered from eight college music majors. Analysis of erroneous reproductions showed that reduced pitch patterns and harmonic progressions were preserved well and that errors predicted by the reduced-pitch-pattern model occurred more often than those predicted by the two competing models. It is concluded that the reduced-pitch-pattern model is the most tenable of the three.

Most pieces of music that we hear in everyday life are composed of several building blocks; that is, musically meaningful segments, that are arranged in a structured and coherent way. Previous studies on expertise in chess, showing that formation of higher order units facilitates memory for the positions of pieces (e.g., Chi, 1978), suggest that in music also, if many building blocks are stored in long-term memory and used as higher order units in memorizing a new melody, the melody would be easier to memorize.

Building blocks that are very distinctive and/or have been presented many times may be stored in long-term memory as they are. The number of building blocks, however, is extremely large, so it is impossible for us to store them all. What is possible is to encode new segments into "pro-

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totypes" that are quite limited in number, with or without modifiers. This was the case in a digit memory experiment reported by Chase and Ericsson (1982), in which a good long-distance runner encoded a long series of digits into a series of already-known running times with some additional characterizations. The prototypes may take the form of archetypal tone series, which are used in many musical works and are composed of structural notes of melodies (Meyer, 1973; Schenker, 1979). Deutsch and Feroe (1981) elegantly showed that series of notes could theoretically be decoded in terms of dominant notes and operators. This suggests that if the structural notes of a melody were selected as the dominant notes, then the melody could be decoded in terms of a series of structural notes and operators. With regard to the structural notes, musically experienced listeners have been found to identify these in the early stages of the processing of melodies (Pollard-Gott, 1983). This suggests that experienced listeners may represent melodies in terms of series of structural notes.

In the melodic processing model proposed by Oura and Hatano (1988a), a "melodic lexicon," which includes prototypes and modifiers, is assumed, in order to explain the rapid and accurate memory for melodies found among musically experienced listeners. The prototypes consist of series of several "structural notes," which are used frequently in musical pieces of a given style. Each of these prototypes represents a set of similar building blocks. The modifiers transform prototypes into the building blocks of a real melody. Prototypes do not contain information about pitches, except for those of the structural notes, nor about the rhythmic aspects of blocks. In order to reconstruct building blocks from prototypes, modifiers are needed.

In memorizing extended and realistic pieces of music, melodies or streams of notes are assumed to be segmented into groups. In order to enable listeners to grasp the structure of pitch relationships within a melody, the size of the unit to be processed should be as large as the capacity of working memory allows. In addition to the limitation of working memory, the size of the unit to be processed must also be sensitive to musical style, because the size of the meaningful unit of a melody sometimes differs among styles. Typical melodies written in the style of Western tonal music can be divided, we tentatively assume, into lengths of two measures each.

After segmentation, structural notes are abstracted from each segment, and the resulting series of pitches is matched to seemingly similar prototypes registered in the melodic lexicon in long-term memory. Then, if possible, each segment of the melody is encoded into a standard form (a prototype operated on by modifiers). In other words, an abstract prototype is expected to be reconstructed into a segment of a real melody through operations by modifiers specifying what rhythmic pattern and what instantiated tone series the segment will have. If not, for example, in the case of "irregular" building blocks, the segment may be stored separately as "an exception," or stored in standard form by the creation of additional modifiers. When this standard form of representation is constructed for (nearly) all the segments of a melody, people feel that they understand the melody, and tend to memorize it rapidly and accurately.

The melodic processing model described here will be termed the reduced-pitch-pattern model. This model appears to represent what musically experienced individuals do while listening to music and to explain why musically experienced listeners, who are expected to possess more prototypes and modifiers in long-term memory and to be more skillful in abstracting structural notes correctly from a melody, have melodic representations that are different from those of musically less-experienced listeners. That is, experienced listeners are able to form melodic representations in terms of prototypes and modifiers with ease, whereas less-experienced listeners are not able to do so.

This model includes an additional assumption: The prototypes are given priority over the modifiers in melodic processing, because prototypes represent the fundamental information in melodic segments. In other words, the prototypes are preserved more firmly than the modifiers. The linkages between prototypes and modifiers are not inevitable, so that musically experienced listeners can make erroneous reproductions caused by the omission of modifiers or the application of modifiers that have been associated with other prototypes.

The aim of this study was to examine whether or not the reduced-pitch-pattern model was tenable, through an analysis of experimental data concerning how accurately musically experienced subjects could reproduce a tonal melody in which the harmonic structure was easily detected. More specifically, this model was examined by investigating whether or not its predictions could be confirmed by the subjects' recall of a realistic and extended piece of music.

In addition to the reduced-pitch-pattern model, two competing models were examined. The first competing model is the contour model, which assumes that melodies are represented, not in terms of reduced pitch patterns, but of contours. As studies by Dowling (e.g., Dowling, 1978) have shown, contour can be used as one of the cues in memorizing a melody. Because contour is a feature apparently existing on the musical surface, it is easy even for less-experienced listeners to abstract contours from melodies, and contours abstracted by musically less-experienced listeners are expected to be the same as those abstracted by experienced listeners. Although this model has certain inherent limitations that will be discussed later, it is included here because it has often been invoked in previous studies on the psychology of music.

The second competing model is the harmonic progression model. Here a melody is assumed to be represented, neither in terms of the reduced pitch pattern nor by its contour, but by its harmonic progression (see, e.g., Schenker, 1979). Harmonic progressions are not as apparent on the musical surface, so a considerable amount of processing is needed in order to derive them from melodies. In addition, it should be noted that harmonic progressions do not fully constrain tone series. That is, many different melodies based on the same harmonic progression can be created. However, harmonic progressions may form one of the important bases of melodic memory, because they are basic and critical to tonal music.

These three models were examined by gathering experimental data on the types of errors musically experienced listeners make or do not make when they are asked to reproduce a tonal melody after auditory presentations. Each model makes different predictions about what aspects of a melody will be preserved and what types of error are probable in recall. That is, features that are contained in a representation are expected to be preserved more easily than those that are not contained in the representation. These features also give rise to specific erroneous reproductions, by constraining the subjects' attempts to reproduce the melody from its representation.

Each of these three models gives rise to two predictions. The first prediction, concerning the aspects of a melody that are preserved, is stated explicitly within each model. The three "first" predictions, each insisting that an aspect to be preserved more firmly will be the one by which the melody is represented, are mutually exclusive. The second prediction, although not stated explicitly within each model, concerns the types of error that can be expected to appear. Further, if such errors appear, they give strong support to the model from which the prediction derives, because such errors would otherwise be thought intuitively not to occur.

The reduced-pitch-pattern model predicts first that reduced pitch patterns will be retained more often than contours or harmonic progressions, even in erroneous reproductions. For example, reproductions are expected to appear often in which reduced pitch patterns are retained but contours are altered. The model also predicts that errors will often occur in which a reduced pitch pattern is operated on by modifiers that have been associated with other pitch patterns.

The contour model predicts first that contours will be retained more often than reduced pitch patterns or harmonic progressions and, second, that nontonal or out-of-tune reproductions will appear frequently, because contours do not contain information about tonality or specific pitches or intervals in a scale. If the contour model includes the additional assumption that the pitches of a tone series should be selected from those allowed by the style, this type of error will not be expected to appear. However, in the experiment to be described, the melodies presented to half the subjects included an atonal note. That is, the additional assumption was annulled for half the subjects, which may facilitate nontonal or out-of-tune reproductions containing atonal notes.

The harmonic progression model predicts first that harmonic progressions will be preserved best and, second, that errors in reproducing another note belonging to the same chord as the one presented will occur frequently. For example, the tone series D-G-E-C may be reproduced as B-D-E-C. Even if the harmonic progression model includes the additional assumption that the shape of a tone series should be smooth, many series can still be generated from the same harmonic progression, as will be shown later.

Method

In order to examine these three models, a list of erroneous reproductions was obtained from the experimental data on learning processes in melodic memory produced by musically experienced college students (Oura & Hatano, 1984). Eight undergraduate music majors who had had more than 13 years of piano training participated in this experiment. They were required to reproduce a melody whose style was familiar to them.

An unfamiliar commercial song of 12 measures that had been broadcast more than 25 years ago was selected as the stimulus melody. It had a clear tonality. The song had an ABC form, each composed of four measures. The same contour with the same rhythmic pattern appeared at the second, fourth, sixth, and eighth measures, so that it was easy to segment the melody into phrases. Harmonically, this song had a very simple structure, as will be shown later. The original version and a variant that differed from the original by one atonal note at the tenth measure, all without the accompaniment or the song text, were used as materials. These melodies were in C major, in $\frac{4}{4}$ time, and consisted of 64 notes each (Figure 1). They were played on a computer (Sharp Clean Computer MZ-80C) with a sound generator (Amdek CMU-800) in ♩ = 137 and were tape-recorded. The sounds heard were comparable to those produced by an electronic piano.

The original melody was presented to half the subjects and the variant to the remaining half. Each melody was presented 10 times. Each subject was required to reproduce it by singing or by playing a piano after each presentation. All subjects preferred to reproduce the melody by playing the piano. When each subject had made two successive correct reproductions, the experiment was terminated. The subject was not allowed to notate the melody, and no feedback was given. All reproductions were tape-recorded and transcribed.

Original

Variant

Fig. 1. The melodies used as experimental materials. (Copyright 1959 by T. Izumi. Used by permission JASRAC License No. 8972921.)

The transcribed reproductions were divided into blocks segmented by breaks in performance, and each block was superimposed on the presented melody so that a best match could be obtained. Reproductions were labeled according to which parts of the presented melody they corresponded to. Erroneous reproductions immediately followed by correct reproductions were regarded as slips of the finger and were ignored. Then, the reproductions were segmented into units of two measures each (the first and second measures, the third and fourth measures, etc.). Seven erroneous segments were excluded from analysis because they were shorter than a two-measure unit.

DATA ANALYSIS

In order to derive a reduced pitch pattern from each unit, the rules for time-span reduction by Lerdahl and Jackendoff (1983) were adopted. Although this theory is not complete, the rules are defined explicitly and clearly, so that it is very objective (Clarke, 1986). Each unit of the two melodies used, and of the erroneous reproductions made by the subjects, was reduced to a pitch pattern consisting of four half notes (or two half notes and one whole note in the unit of the ninth and tenth measures).

I now describe how the rules for time-span reduction were applied by taking the original melody as an example. The first stage of the time-span reduction analysis of the original melody was to determine its grouping structure (Figure 2). Grouping Preference Rule (GPR) 6 (parallelism) was applied to the second, fourth, sixth, and eighth measures because

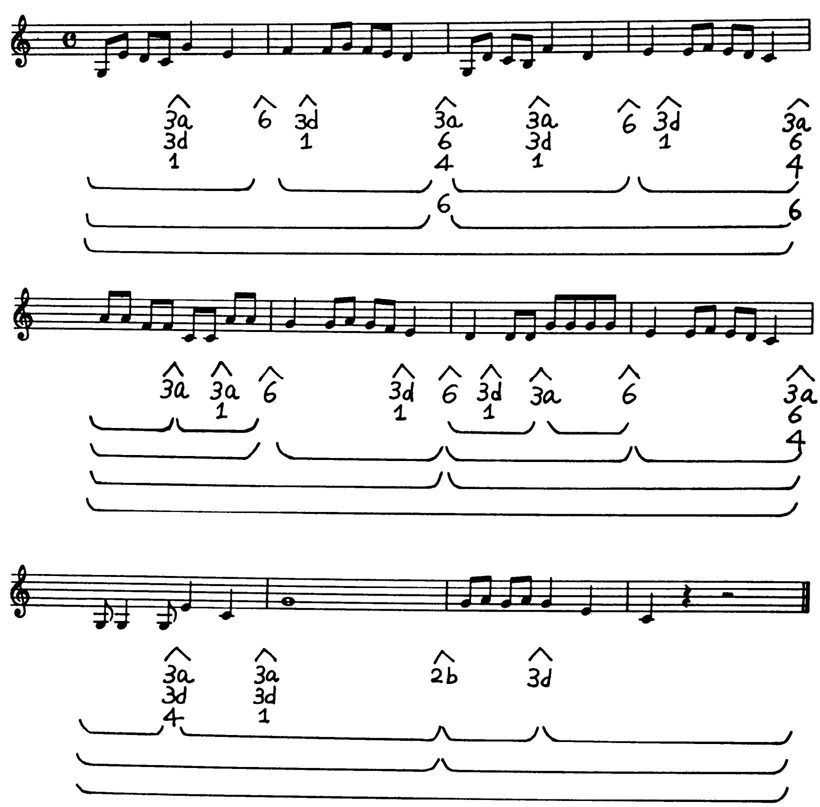

Fig. 2. Grouping structure of the original melody and rule applications for analysis.

of their motivic parallelism. GPR 6 was also applied at boundaries between the second and third measures, and between the fourth and fifth measures, because of the motivic parallelism of measures 1–2 and 3–4. GPR 2b (proximity of attack-point) was applied to the whole note, that is, to the boundary between the tenth and eleventh measures. Where an intervallic distance greater than the fourth appeared, GPR 3a (change of register) was applied. GPR 3d (change of length) was applied where a change in the length of notes occurred. However, some applications of GPR 3a and GPR 3d were overridden due to a conflict with GPR 1, which strongly avoided very small groups, that is, groups containing only one or two notes. For example, GPR 3a was applied between the first two notes of the melody because of the interval of the sixth between these notes. The first group, however, contained only one note. So this particular application of GPR 3a was overridden by GPR 1. Where more than two rules were applied, GPR 4 (intensification) was also applied. These preference rules strongly reinforced each other (i.e., as in the boundaries between the second and third measures, between the fourth and fifth measures, and between the eighth and ninth measures) implying a symmetrical melodic structure in the larger level grouping.

The second stage of analysis was to determine the metrical structure of the melody (Figure 3). At the eighth-note level, beats were assigned by metrical well-formedness rule (MWFR) 1 (attack point) and MWFR 4 (equal spacing). Beats coinciding with beginnings of notes were marked by metrical preference rule (MPR) 3 (event). MPR 5a (length of pitch event) marked the beginnings of the quarter notes and the whole note. Pitch prolongations into the next beat were marked by MPR 5e (length of duration) and by MPR 5f (length of harmony) marked where the harmony changed. At both the quarter-note and the half-note levels, a trochaic pattern was preferred because a combination of the preference rules intensified the first beats of the measures. At both the quarter-note and half-note levels of analysis, beats were also assigned by MWFRs 1 and 4, and marked by MPRs 3, 5e, and 5f. MPR 5a (length of pitch event) marked the beginnings of the quarter notes and the whole note at the quarter-note-level of analysis, and the beginning of the whole note at the half-note level of analysis.

The third stage was to determine the time-span segmentation. The grouping and metrical structures of the melody were in phase, so that a regular time-span bracketing was assigned (Figure 4).

The final stage of analysis was the time-span reduction (Figure 5). The quarter-note-level reduction was made by the time-span reduction preference rule 1 (TSRPR 1); that is, notes at the relatively strong metrical position were selected as most prominent. The first four eighth notes of the first and third measures each, however, were combined to a chord of a half note by time-span reduction well-formedness rule (TSRWFR) 3b (fusion). The quarter-note-level tone series of the fourth and eighth measures were checked by TSRPR 7 (cadential retention) and changed from E-E-E-C to E-E-D-C in order to produce a full cadential progression. Tone series of the second and sixth measures, which were parallel to those of the fourth and eighth measures, respectively, were changed from F-F-F-D to F-F-E-D at the second measure, and from G-G-G-E to G-G-F-E at the sixth measure by TSRPR 4 (parallelism). As to the half-note-level reduction, TSRPR 1 (metrical position) was applied first. Then, TSRPR 7 (cadential retention) was applied to the full cadences, that is, the fourth measure, the eighth measure, and from the eleventh to the twelfth measure, resulting in a change in the tone series. (For example, at the second half of the fourth measure, the metrically weak note C was preferred to the metrically strong note D, in order to produce a full cadential progression.) Accompanying these changes in the fourth and eighth measures, tone series of the second and sixth measures were changed by TSRPR 4 (parallelism). As to the indented tone series at the quarter-note-level reduction of the fifth and sixth measures, TSRPR 6 (linear progression) was applied. That is, at the second half of the fifth measure, the metrically weak note A was preferred to the metrically strong note C, and the resulting tone series of the fifth and sixth measures was changed from A-C-G-E to A-A-G-E.

In addition to reduced pitch patterns, contours were derived from units of the two materials and of the erroneous reproductions. Subjects made a large number of rhythmic

Fig 3. Metrical structure of the original melody and rule applications for analysis at the eighth-, quarter-, and half-note levels.

errors, which sometimes resulted in changes in contour, for example, an "up-up-down" series (e.g., C-E-G-E) was reproduced as an "up-up-unison (repetition of the same pitch as before)-down" (C-E-G-G-E) by the application of the rhythmic modifier "divide a duration of a note into two halves" to the third note G. In order to exclude contour errors that resulted from applying the wrong rhythmic modifiers, contours were encoded only by rises and falls within the tone series. In other words, unisons were not counted.

Fig. 4. Time-span segmentation of the original melody.

A harmonic structure for each measure was also obtained. Every inverted chord was rewritten as its basic chord. The harmonic implication of the original melody is as follows:

// I V⁷ / V⁷ I // IV I / V I // I I / I I //

The subjects produced 331 reproduction units, of which 67 were erroneous. As to these units, contours were encoded by rises and falls in the tone series; unisons were ignored. The harmonic implication of each unit was also obtained and written as its basic chord. In order to derive reduced pitch patterns for erroneous units, full-length reproductions that contained these erroneous units were analyzed according to the same procedure as for the original melody. The reduced pitch patterns for these units were thus determined.

Most of the time-span reduction analysis was achieved without difficulty. As to reproductions of one or two units in length, however, the grouping structures of these reproductions sometimes differed from those of the presented melodies because GPR 6 (parallelism) could not be applied to the second, fourth, sixth, and eighth measures. When only the first unit (i.e., the first and second measures) was reproduced, for example, the first four notes (G, E, D, and C) were grouped together by GPRs 3a, 3d, and 4. GPR 3d (change of length) was also applied between the seventh note F and the eighth note F. In other words, the first grouping of the melody was composed of the first four notes (G,

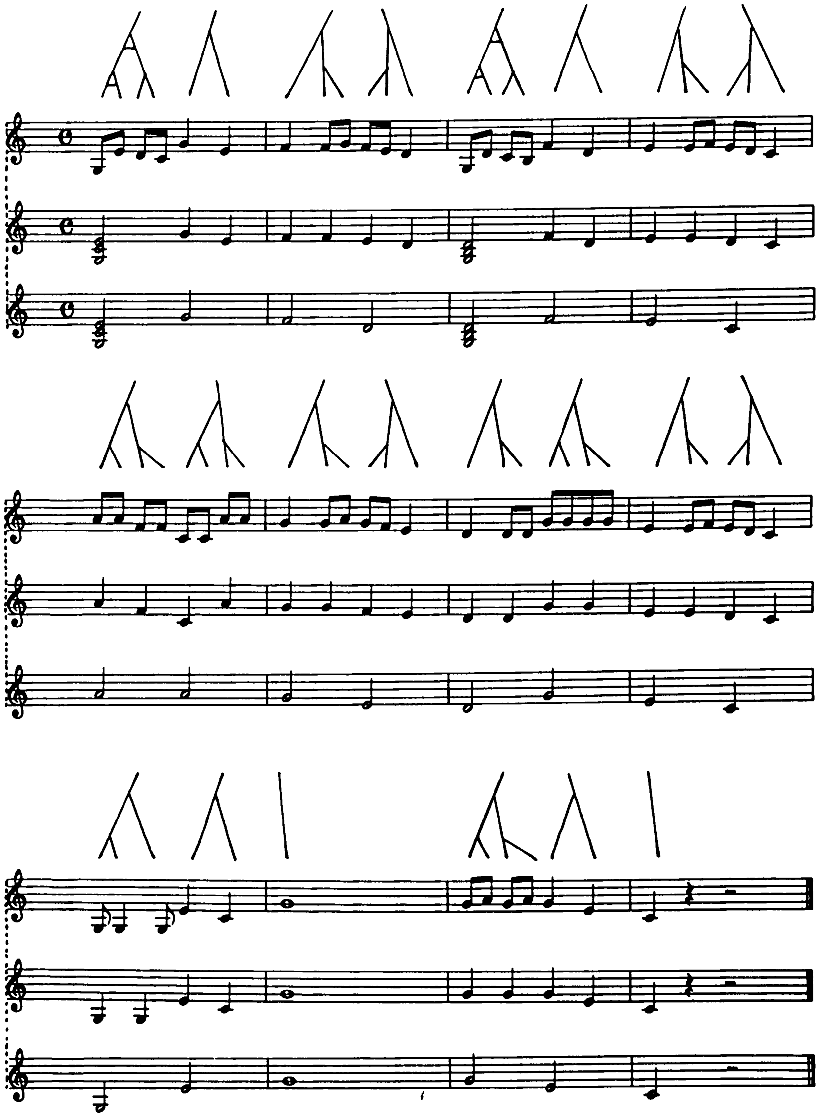

Fig. 5. Time-span reduction of the original melody.

E, D, and C), and the second grouping was composed of the three notes (G, E, and F). These applications made the grouping structure of the reproductions different from those of the original melodies. The time-span segmentation, however, was made by their metrical structure. Because metrical structure dominated over grouping structure in assigning smaller groupings, the resulting segmentations were the same as those for the original melodies.

Each unit containing erroneous reproductions was examined to determine whether or not it had the same contour/harmonic progression/reduced pitch pattern as the one originally presented had. When this was the case, the unit was judged to have preserved these properties.

Results

Contours were retained in 52 out of 67 units. Harmonic progressions were retained in 63 units. Reduced pitch patterns were preserved in 60 units. Thus reduced pitch patterns and harmonic progressions appeared to remain constant more often than the contours did. It seems unlikely that melodies were, in principle, represented in terms of contour. The first prediction of the contour model was therefore rejected and the predictions from the two remaining models were more or less supported.

No subject made a nontonal or out-of-tune reproduction predicted by the contour model. Therefore the second prediction from the contour model was rejected.

There were four erroneous units in which a different note belonging to the same chord as the presented one was played, which might be considered to support the harmonic progression model (see Figures 6a–c). However two of these appeared at the irregular unit of the variant as Figure 6c, although the irregular unit was presented to only half the subjects and was only one out of six units of the presented melody. In other words, this type of error occurred quite often in the irregular unit that contained an atonal pitch, and was expected to be stored as an exception. In regular units, however, errors of this type hardly ever appeared, suggesting that the second prediction from the harmonic progression model would not be tenable for ordinary melodies.

There were eight erroneous reproductions in which reduced pitch patterns were operated on by modifiers that had been associated with other pitch patterns. Figures 7a and 7b are examples of this type of error.

In sum, errors predicted by the reduced-pitch-pattern model appeared a number of times, whereas those predicted by the harmonic progression model or by the contour model did not do so. One can conclude that the reduced-pitch-pattern model is the most tenable among the three models examined.

Discussion

The above analysis of errors showed that contours tended to be missed more often than harmonic progressions or reduced pitch patterns were. Out-of-tune reproductions did not appear at all. On the basis of these results, it seems unlikely that musically experienced listeners represent a piece of music primarily in terms of contour. The reasons for this might be as follows: First, these listeners could use other musical cues such as reduced pitch patterns and harmonic progressions with ease. Second, con-

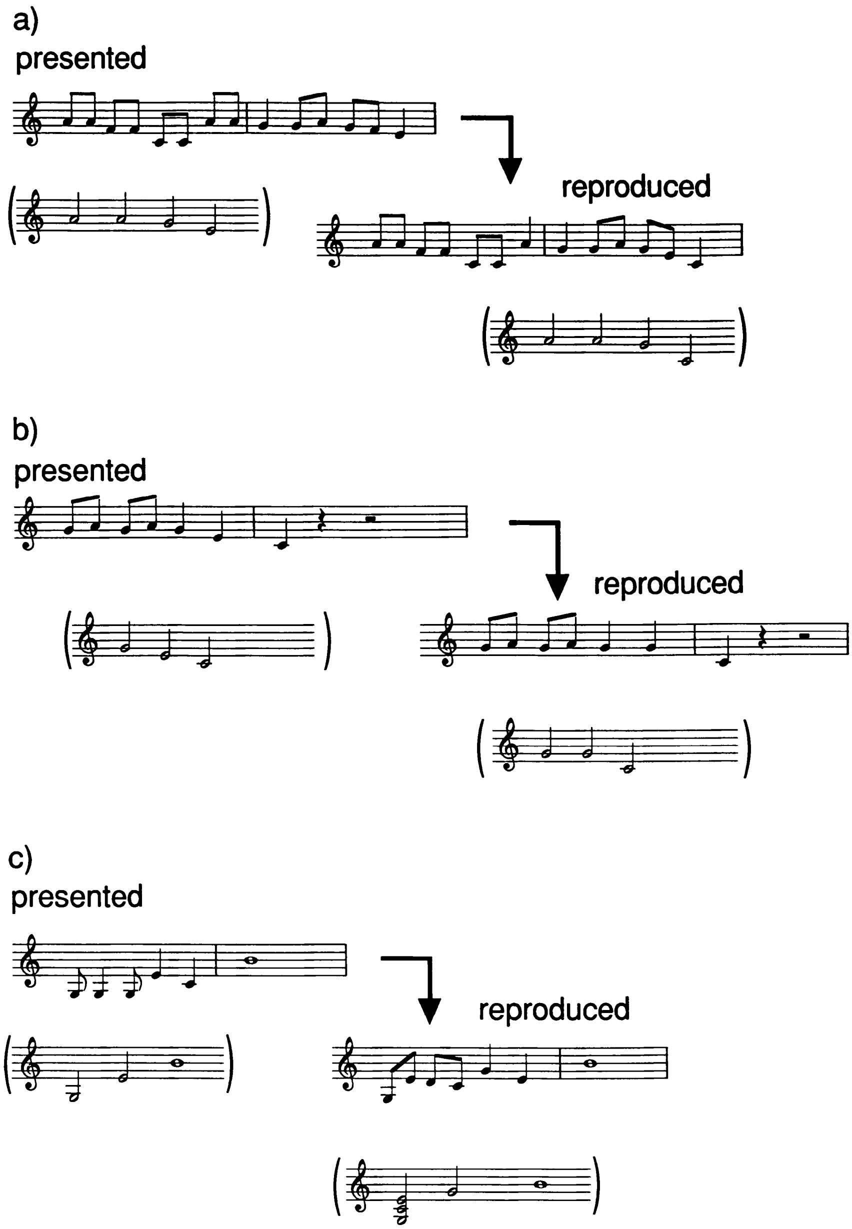

Fig. 6. Erroneous reproduction in which a different note belonging to the same chord as the one presented was used.

tours may not be effective for memorizing a melody because it is impossible to reconstruct the presented melody only from the contour information. Third, because of the limitations in working memory capacity,

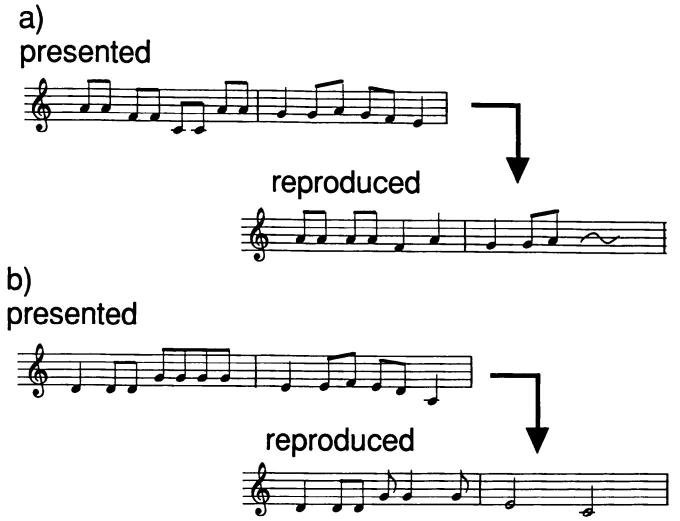

Fig. 7. Examples of erroneous reproductions in which reduced pitch patterns were operated on by modifiers that had been associated with other pitch patterns.

it is difficult for subjects to memorize the long series of rises and falls of a tone series. (This is normal in realistic and extended pieces of music.)

Both reduced pitch patterns and harmonic progressions were preserved well even in erroneous reproductions. The harmonic progression of a unit could be determined almost completely by its reduced pitch pattern. Thus reproductions that preserved reduced pitch patterns would probably retain the harmonic progressions. In other words, it is natural that harmonic progressions should be preserved as often as reduced pitch patterns.

The error of reproducing another note belonging to the same chord as the one originally presented occurred four times. However, this type of error appeared only twice in regular units in which the melodic segment was assumed to be transformed into a representation containing a prototype. Indeed, even if the range of pitches were fixed within an octave, a single harmonic progression composed of two chords can generate many "four half-notes series" in which the first two notes are selected from the first chord and the remaining two from the second chord. For example, the IV–I (i.e., [C, F, A, C]–[C, E, G, C]) progression that appeared in the fifth and sixth measures of the melody generates 256 "four half-notes" series. If alternatives in selecting the next pitch in a series are restricted to the same pitch and two proximal notes, of which one is higher and the other lower than the preceding note along a diatonic scale (in order to exclude series in which shapes are unnaturally indented), the IV–I progression generates 53 series. When having no information except for the harmonic progression for a unit, the probability of reproducing the correct melody is thus less than 2%. These results suggest strongly that even if the subjects derived a harmonic progression from the melody, they stored not only the harmonic progression but also the pitches of the structural notes and the orders of their appearance, that is, the reduced pitch patterns of the melody.

Harmonic progressions are very likely to be invoked in melodic memory. For example, they may be useful as fallback cues for reconstructing building blocks to satisfy the constraints of tonal music. However, harmonic progressions are not very powerful determinants because they do not fully constrain tone series.

Reduced pitch patterns were preserved well even in erroneous reproductions except for the reduced pitch pattern of the irregular unit. There were several erroneous reproductions in which reduced pitch patterns were operated on by modifiers that had been associated with other pitch patterns, resulting in changes in contour. This type of error was also made by the musically experienced subjects in the earlier study of Oura and Hatano (1988b), in which the materials and procedure were the same as those of this study. The entire pattern of results appears to support the reduced-pitch-pattern model.

There were some errors that retained only a portion of the reduced pitch patterns. Figure 6a shows an erroneous reproduction of this type. In this case, the modifier "decline successively along the diatonic scale" was replaced by the modifier "decline successively along the notes of the tonic chord," resulting in an alteration of a part of the reduced pitch pattern. Figure 6b appears to be another example of this principle. What was omitted here was the modifier of "decline successively along the notes of the tonic chord." These errors suggest that a reduced pitch pattern would be kept constant unless a portion of it was changed by omitting relevant modifiers and/or applying some other strong modifiers.

Accurate and fast memorization of a melody cannot be fully explained by the contour model or by the harmonic progression model. A model for melodic processing that assumes the use of knowledge not only of the basic constraints of some style (e.g., the rules for harmonic progressions) but that also employs examples of series made of several structural notes seems to be necessary. These series appear frequently among musical pieces within a given style, with or without ornamentations, and are expected to be accumulated in long-term memory through the learning of many melodies.

The reduced-pitch-pattern model needs to be formalized and specified in detail with regard to several points; for example, how modifiers specify prototypes and how many prototypes and modifiers are found in Western tonal music. In addition, the psychological reality of this model needs to be further examined experimentally; for example, by investigating the effectiveness of prototypes as cues in recall of melodies. Nevertheless, these results indicate that this model is a promising one.[1]

References

Chase, W. G., & Ericsson, K. A. Skill and working memory. In G. H. Bower (Ed.), *The psychology of learning and motivation,* vol. 16. New York: Academic Press, 1982, pp. 1–58.

Chi, M. T. H. Knowledge structures and memory development. In R. S. Siegler (Ed.), *Children's thinking: What develops?* London: Erlbaum, 1978, pp. 73–96.

Clarke, E. F. Theory, analysis and the psychology of music: A critical evaluation of Lerdahl, F. and Jackendoff, R., A Generative Theory of Tonal Music. *Psychology of Music,* 1986, ***14,*** 3–16.

Deutsch, D., & Feroe, J. The internal representation of pitch sequences in tonal music. *Psychological Review,* 1981, ***88,*** 503–522.

Dowling, M. J. Scale and contour: Two components of a theory of memory for melodies. *Psychological Review,* 1978, ***85,*** 314–354.

Lerdahl, F., & Jackendoff, R. *A generative theory of tonal music.* Cambridge, MA:MIT Press, 1983.

Meyer, L. B. *Explaining music.* Berkeley, CA: University of California Press, 1973.

Oura, Y., & Hatano, G. Learning processes in melodic memory by the musically experienced college students. *Ongakugaku,* 1984, ***30,*** 210–211. [Abstract in Japanese]

Oura, Y., & Hatano, G. The role of knowledge in melodic memory. *Ongakugaku,* 1988a, ***34,*** 205–207. [Abstract in Japanese]

Oura, Y., & Hatano, G. Memory for melodies among subjects differing in age and experience in music. *Psychology of Music,* 1986, ***16,*** 91–109.

Pollard-Gott, L. Emergence of thematic concepts in repeated listening to music. *Cognitive Psychology,* 1983, ***15,*** 66–94.

Schenker, H. *Free composition* [E. Oster, Trans.]. New York: Longman, 1979. (Original work published 1935)

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