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Memory for Melodies among Subjects Differing in Age and Experience in Music

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An unfamiliar commercial song of 12 measures was learned by four musically experienced college students and four 4th-grade children, who each had had about 5 years of piano training, and eight musically unexperienced college students. Each subject was presented the melody auditorily and required to reproduce it in singing ten times. The experienced students were far superior to the unexperienced ones, regardless of age, in the speed of acquisition as well as the eventual level of mastery of the melody. Additional experiments revealed that both musically experienced and unexperienced college students could learn a poem significantly faster than the 4th graders, and that these three groups of subjects were comparable in acquiring a non-tonal (modal) Japanese folk song. Tonal melodic memory of the experienced students seemed to be facilitated primarily by knowledge and strategies specific to tonal music.

The present study was aimed at investigating which would facilitate the storage and retrieval of a melody more greatly, age or general cognitive development on one hand, or experience of playing music on the other. More specifically, it examined relative contributions of (1) domain-general, (2) music domain-specific but style-general, and (3) music style-specific skills to memory of a real melody.

Most previous studies on melodic memory have dealt with stimulus variables, i.e., characteristics of melodies which facilitate or inhibit memory (for reviews, Dowling, 1978; Deutsch, 1982). Learner variables have been treated rather subsidiarily. Even when examined, it was not in an analytic fashion. For example, though Davidson, McKernon and Gardner (1981) showed that college students majoring in music were far superior to 4–5 years-old children in the speed of acquisition and the general understanding of songs, it remains an open question which factor was critical in memory of melodies, since the college students were more advanced in general cognitive development and also had had much more experience in music.

Recent research on understanding and memory of stories has suggested that both domain-specific substantive knowledge and domain-general knowledge play an important role (e.g., Bisanz & Voss, 1981). These two types of knowledge may be the bases for the memory of melodies as well. The latter knowledge functions as a control process which integrates various kinds of data bases and procedures, which constitute a body of domain-specific knowledge. Though the nature of this domain-general knowledge has not been specified in detail, part of it, for example, knowledge for selecting suitable mnemonic strategies and effective cues for memory, is metacognitive. It has been well established that metamemory development accompanying chronological age facilitates memory (Flavell and Wellman, 1977).

As to domain-specific knowledge, we propose that three types may contribute to melodic memory. Two of them are ordering rules and melodic prototypes suggested by Oura and Hatano (1984), to explain why musically experienced college students acquired a tonal melody of 12 measures so quickly. The ordering rules are pieces of knowledge concerning the form and construction of music, which can serve as a storage format and as a retrieval format. Melodic prototypes are sequences of several notes which are often used in actual melodies of tonal music, with or without pitch modifications such as inserting passing notes, ornamentation, repetition, etc. A melodic prototype may be used as it is, just as a melodic building block suggested by Sloboda and Parker (1985), or as a sequence of higher-order structural notes of a melody. With a rich set of melodic prototypes, one can code a novel melody into a series of units, each consisting of a prototype and a modification command, like the digit memory expert who coded a long series of digits into groups of 3 or 4 digits, each representing a running time and qualification (Chase & Ericsson, 1978).

The third type of domain-specific knowledge is a set of melodic memory strategies, which is supposed to be more critical in recall than recognition. In order to recall a melody in a familiar style, one may rely on strategies for utilizing the ordering rules and prototypes. One may also use strategies for recalling a melody in an unfamiliar style, e.g., assigning syllable names and/or chord names to each of the component pitches. We assume that those who have often performed music are good at those strategies, because, otherwise, they cannot perform music without the sight of musical notes.

A number of studies using realistic and extended pieces of music whose style was familiar to subjects have strongly suggested the importance of the experience, in other words, of having music domain-specific knowledge, in performing memory and other cognitive tasks (Sloboda, et al., 1985; Dowling, et al., 1981; Halpern, et al., 1982; Pollard-Gott, et al., 1983; Welker, 1982). Constraints governing music, such as syntactic rules, differ between styles or cultures (Meyer, 1979). Thus some pieces of music domain-specific knowledge is not style general but highly style specific.

Experiment 1

In this first experiment using a realistic piece of tonal music, we compared contributions of the domain-specific skills on one hand, and the domain-general skills on the other, by comparing musically experienced college students, musically experienced grade children, and musically unexperienced college students. Three competing predictions were made: 1) the two groups of musically experienced subjects would remember a melody much better than the less experienced subjects, with a negligible difference between the former two. This would hold when the contribution of the domain-specific was overwhelming; 2) the experienced college students would remember best and their unexperienced counterparts and the experienced grade-school children would be equally poor. This would be the case when both the domain-specific and the domain-general skills played an important role in memorizing melodies; 3) Both groups of college students would learn the melody equally well, and better than the grade-school children. This prediction presupposed that only the domain-general was critical.

Method

Subjects

Twelve undergraduate students from twenty to twenty three years of age and four elementary school children from nine to ten years of age participated in this experiment. All of the four children had had about five years of piano training. They will be called younger experienced students (YE). Four of the college students were majoring in vocal music, and were selected because they had had about the same amount of piano training as the children (older experienced students, OE). The remaining eight college students had no experience or a much shorter experience in playing tonal music except for general school music classes, nor were they great lovers of classical or popular music (unexperienced students, N). Six of them had had a half year piano playing class for beginners and a half year solfeggio class at the university as part of teacher training. None of the subjects had absolute pitch.

Materials

A commercial song "Shimazaki Koban Senbei no Uta", composed by T. Izumi and broadcast more than 25 years ago, was selected. It had clear tonality and was easy to sing. Its original version (O) and a variant (V), all without the song text, were used as materials (Figure 1). The variant differed by one note in the last part from the original. The song had an ABC form, each made of four measures. The same contour with the same rhythmic pattern appeared at the second, fourth, sixth, and eighth measures, making it easy to phrase the melody. Syncopation appeared only once at the ninth measure. These melodies were in C major, four-four time and consisted of 64 notes. They were played on a SHARP CLEAN COMPUTER MZ–80C with AMDEK (CMU–800) in crotchet = 137 and tape-recorded. The sound heard was like that of the electric piano.

Procedure

Each subject was given the experiment individually. O was presented ten times auditorily to each half of the groups, and V to the remaining half. After each presentation of the melody, the subject was required to reproduce it in singing. When he or she made two successive correct reproductions, the experiment was finished, his/her correct performance on later trials being assumed.

The subject was not allowed to write down the melody. He or she could, though not suggested, hum with it. No feedback was given to the subject.

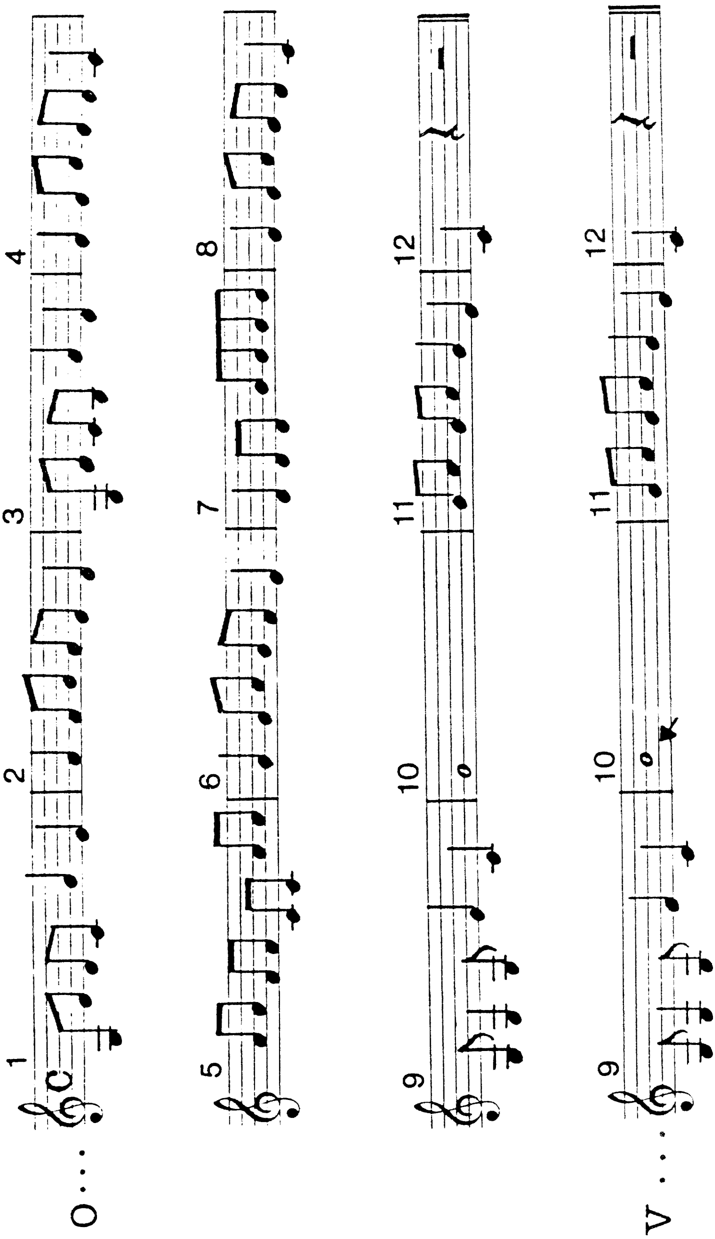

FIGURE 1
The tonal melodies used as the experimental materials.
Note. Copyright 1959 by T. Izumi.
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That is, he or she was not told explicitly what kind of mistakes had been made. All reproductions were tape-recorded and written down in C major even when subjects transposed the melody to a new key. Minor pitch deviations and rhythmic disorders in their reproductions were ignored.

Coding of recalled melodies. Each of the reproduced melodies was first examined for its relative key stability. Any portions which lacked the relative key stability, that is, the reproduction which was too out-of-tune to identify the key, or the rendition whose key was obviously different from that of the two preceding measures, were classified as *modulated* reproductions. The remaining key-stable reproductions were divided into blocks segmented by breaks in singing, and then each block was superimposed on the presented melody so that the best match could be obtained. If the contour (ups and downs in pitch) and/or rhythmic pattern of a reproduced half-measure (or a measure when a whole note appeared) was the same as the corresponding part of the presented melody, it was coded as *identifiable*, and then classified into a *correct* or *modified* reproduction. "Correct" means the reproduced half-measure was exactly the same as the corresponding part of the presented melody. "Modified" included both pitch error(s) and rhythm error(s), in other words, the reproduction was somewhat different from the most similar part of the presented melody. Some of the half-measures contained both pitch and rhythm errors. When the same (or almost the same) reproduction was repeated, one that was identical or more similar to the corresponding part of the presented melody was classified, and the other was ignored.

If a reproduced half-measure differed both in contour and rhythmic pattern from the matched part of the presented melody, it was coded as *unidentifiable*. They were counted only until the sum of the identifiable and unidentifiable reproductions reached 12 measures, even when more unidentifiable measures were reproduced. The length of modulated reproductions was measured in terms of the number of pulses involved. Similarly, they were counted until the sum of identifiable, unidentifiable and modulated reached 12 measures.

This method to code a reproduced melody in half-measures seemed to be compensatory to that by Sloboda and Parker (1985), in which coding was made separately in relation to several aspects of a melody.

Assigning IDs to subjects. The subjects were given identification numbers within each group according to how well their recall performances were, so that their relative status in the group could simply be indicated when we referred to them individually. The smaller numbers were assigned to those subjects who had a better overall performance. Thus, for example, OE–1 referred to the student who performed best among the older experienced students.

Results

Acquisition of the melody. The mean number of correctly recalled measures in each trial is plotted in Figure 2 for each of the three groups. A 3 (group × 10 (trial) ANOVA revealed a significant main effect for group ($F(2,13)=8.52$), $p<.01$), and for trial ($F(9,117)=21.91$, $p<.01$). Newman-Keuls analyses showed that recall performance differed only between either of the two experienced groups and the unexperienced group. The ANOVA also revealed a significant interaction effect of group by trial, reflecting larger group differences in later trials.

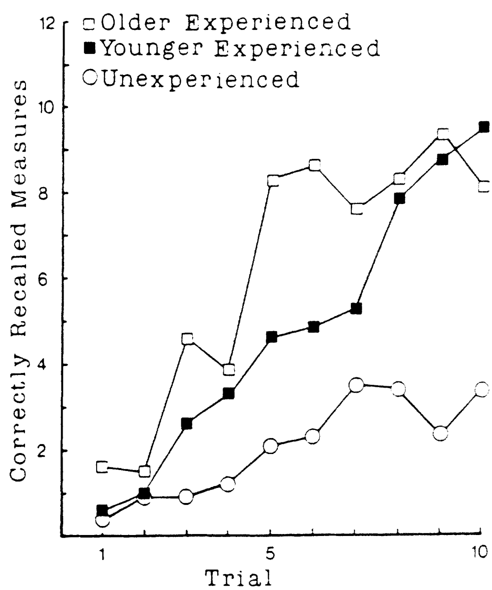

FIGURE 2
Acquisition of the tonal melody by three groups.

Though statistically not significant, there seemed to be a difference between the older experienced students and the younger experienced students up to the seventh trial, at which point the younger experienced students improved rapidly. Seventy-four percent of the classified half-measure segments throughout the trials by the older experienced students were correct and 8.4% of them were unidentifiable. In the case of the younger experienced students, 87.7% were correct and only 1.7% unidentifiable. These results may imply that the experienced children sung only when they were fairly sure about the accuracy of their reproductions, whereas the older experienced students attempted to reproduce the melody with much less confidence.

Types of Errors. The mean length of correct and erroneous reproductions for each group are shown in Table 1. Modified reproductions represented 75.4% of the erroneous reproductions for the experienced students (younger and older combined). Of them, 35.7% included pitch errors only, 32.7% rhythm errors only and 31.6% both pitch and rhythm errors. None of their reproductions lacked the key stability.

TABLE 1

Mean Length of Reproductions of the Melody in Measures Through Trials from the 1st to the 10th

Types of Reproductions	Group: Younger Experienced Students (n=4)	Older Experienced Students (n=4)	Unexperienced Students (n=8)
Identifiable			
Correct	4.83	6.19	2.05
Modified	0.98	1.48	0.91
Unidentifiable	0.10	0.70	0.88
Modulated	0	0	0.99

Two characteristics of their errors are noteworthy. First, 9.8% of their pitch errors were simplifications of a phrase to a series of structural notes. This seemed to imply that they divided and coded the melody into prototypes consisting of structural notes. Example made by YE–3 is shown in Figure 3a. Secondly, among their rhythm errors, many were wrong modifications of a part using a modifier that had been associated with another. For example, 32.5% of the rhythm errors applied [♪♩♪] pattern in other than the 9th measure. An example by YE–2 is shown in Figure 3b. This type of error suggested that the experienced students first separated the melody into prototypes and rhythmic modifications before storing.

Some errors other than these also suggested the use of prototypes. For example, YE–3 made errors to sing the first measure as G–G–E, a sequence of structural notes, at the ninth and tenth trial, and to sing the third measure as G–F–D at the tenth trial, though she made correct reproductions before. These errors suggested that she could retrieve both the prototype and pitch modifications at the eighth trial, but only the prototype at the ninth and tenth trial. An error by OE–2 at his fifth trial showed another example of the wrong modification and that of the prototype use. He sang the seventh measure as D–F–E–D. We interpreted this to mean that a modifier used at the first half of the first and the third measures, that is, to skip up to a note from a base note and then get down successively to a stable note, was slightly changed and applied to this measure. In fact a parallel sequence of C–E–D–C appeared at the first half of the first measure from the sixth to eighth trial and resulted in erroneous reproductions.

The unexperienced students fairly often revealed modulated and unidentifiable reproductions, which often extended over one, two or four measures.

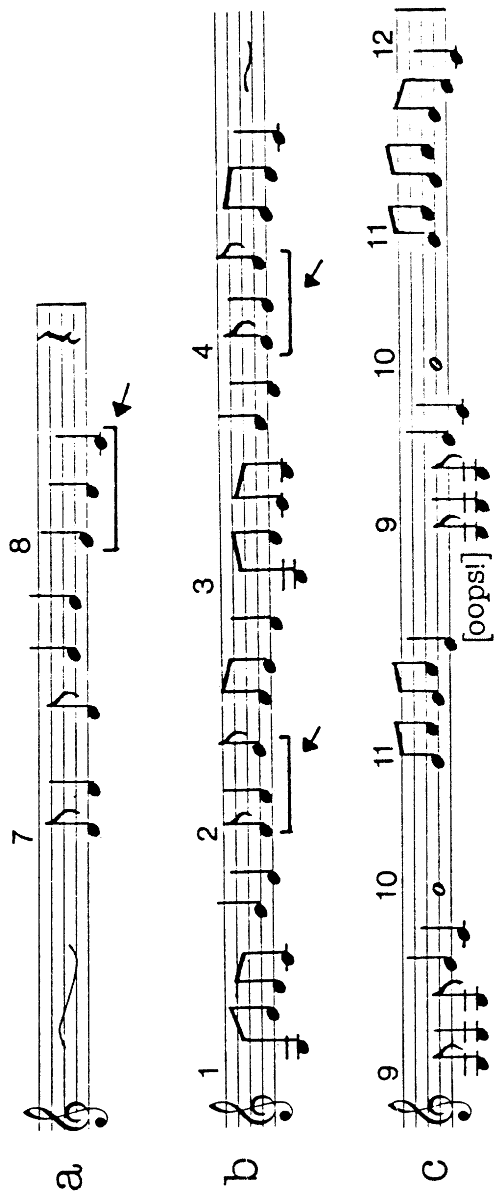

FIGURE 3
Examples of reproductions.

They generated modified reproductions, too. However, 85.5% of them involved pitch errors only. Among these pitch errors, simplification errors occupied only 1.6%.

Order of Acquisitions. The experienced students, regardless of age, reproduced the beginning and/or the ending phrase within the few initial trials, then several fragments, usually a measure or two, almost in a random order also within a few trials, and finally with suddenness, the whole melody in regular order with only a small number of erroneous and/or missing notes. For example, YE–3 made no reproductions during the first and second trial. She reproduced from the 11th to the 12th measure on the third trial, from the 9th to the 12th on the fourth trial, from the 1st to the 2nd and 5th to 6th on the fifth trial, from the 9th to the 10th and 5th to 6th on the sixth trial, from the 9th to the 12th on the seventh trial, and from the 1st to the 12th on eighth trial. This suggested that the experienced students segmented the melody into a number of parts, coded and stored those parts in long term memory (LTM), and assembled those parts at reproduction using ordering rules or melodic formats.

Two of the unexperienced students, N–4 and N–6, recalled always from the ending phrase, and could reproduce something only from the last four measures even on the tenth trial. See Figure 3c, which is all of what N–6 reproduced at the tenth trial. The other six of this group started with modulated or unidentifiable reproductions, but five of them could gradually regulate and approximate their reproductions. N–8, however, could not do any better at all.

To sum, this experiment showed that the performance of the two experienced groups was superior to that of the unexperienced group with no difference between the former two. In other words, it supported first of our competing predictions.

Experiment 2

Though the above results suggested that the contribution of domain-specific knowledge was critical for melodic memory, there can be an alternative interpretation: both groups of musically experienced students had better memory ability in general, i.e., could perform better on any memory tasks, than the unexperienced students. In order to exclude this interpretation, nonmusical material was used in this additional experiment.

Subjects and procedure

Because four students (N–8, OE–2, YE–1, and YE–4) missed this experiment, three additional students comparable to them were recruited. We could not find another new OE student who satisfied the requirement. Thus eight unexperienced college students, three experienced college students, and four experienced children served as subjects.

The material was the first stanza of a straightforward poem "Ich-nichi-wa Owaranai" by S. Tanigawa, consisting of four lines and of 16 sentence segments, each being made of a substantive word with or without functional word(s), or 54 characters. All the words involved in it seemed to be familiar to children. The poem was read aloud and tape-recorded. It was presented five times. After each presentation, the subject was required to orally reproduce it.

All the reproductions were recorded for subsequent analyses. The reproductions were divided into sentence segments, and then each segment was classified into a correct or incorrect reproduction according to whether or not it was exactly the same as any segment of the poem.

Results

The mean number of correctly recalled sentence segments at each of the five trials is plotted for each group in Figure 4. A two–way ANOVA revealed a significant main effect for groups (for the unexperienced college students, M=14.10, SD=2.99, for the experienced college students, M=15.27, SD=1.49, and for the younger experienced students, M=10.70, SD=4.21; $F(2,12)=7.76$, $p<.01$), and for trials, $(F4, 48)=28.41$, $p<.01$).

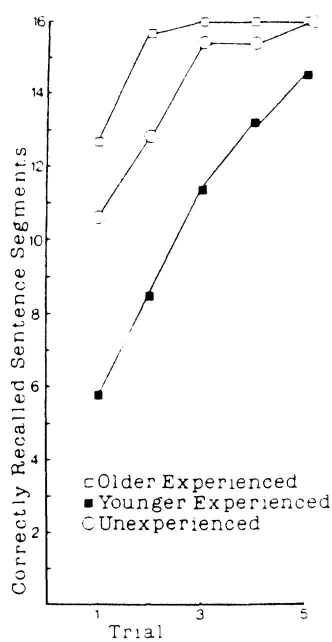

FIGURE 4
Acquisition of the poem by three groups.

Newman-Keuls analyses showed that recall performance differed only between either of the two college student groups and the children ($p<.01$). The interaction effect was not significant.

The musically experienced children had poorer memory capacity for this verbal material than either of the college student groups, and the experienced college students did not have any better capacity than the unexperienced. It is concluded that better performances of the experienced students in melodic memory were supported, not by memory ability in general, but by music domain-specific knowledge.

Experiment 3

Recall performance of the melody has proven to be facilitated by domain-specific knowledge in music. However, it is not clear whether the knowledge was specific to tonal music or to music in general. Throughout the present study, subjects were grouped in terms of the amount of their experience in playing tonal music. That is, the experienced students were expected to have lots of knowledge specific to the style of tonal music. Prototypes and ordering rules will be highly style-specific, i.e., specific to tonal music. However, there may be some strategic knowledge which is not specific to tonal music but useful for processing other kinds of music. Attaching syllable names, for example, is so helpful for coding of the acoustic sequence that it might assist to some extent recalling non-tonal (e.g., modal) melodies whose tone structure, nuclear tones, and syntactic rules are different from those of tonal music. We therefore ran this third experiment to examine how well the experienced in tonal music could memorize a non-tonal (modal) melody, a traditional Japanese folk song.

Subjects and procedure

Eight unexperienced college students, three experienced college students, and four experienced children served as subjects. Three students of each group (N–3, N–5, N–7, OE–1, OE–3, OE–4, YE–1, YE–3, and YE–4) had been the participants of Experiment 1. The subjects said that they had never listened to Japenese folk songs voluntarily and had little opportunity to hear that kind of music in everyday life. They, however, knew and could sing several traditional Japanese songs for children which had the same musical style as traditional folk songs.

The material chosen was "Owase-bushi", a folk song consisting of 26 measures or 50 notes (Shown in Figure 5). This melody was subdivided into two phrases (13+13). Rhythmic progression of it was so monotonous that it seemed to be rather difficult to find any characteristic patterns in it. Nuclear tones of it were B and E (B was the main nuclear tone). According to their report, none of the subjects had heard this song before.

It was played on the SHARP CLEAN COMPUTER MZ–80C with AMDEK (CMU–800) in crotchet = 120 and tape-recorded. Each of the subjects was presented with this melody ten times auditorily and asked to reproduce it after each hearing, as in Experiment 1. Their reproductions were tape-recorded, written down, and coded, as in Experiment 1.

Results

Figure 6 shows the mean number of correctly recalled measures at each trial for each group. A two-way ANOVA revealed a significant main effect for trials, $F(9,108)=5.43$, $p<.01$, but not for groups (for the unexperienced college students, $M=3.31$, $SD=2.47$, for the experienced college students,

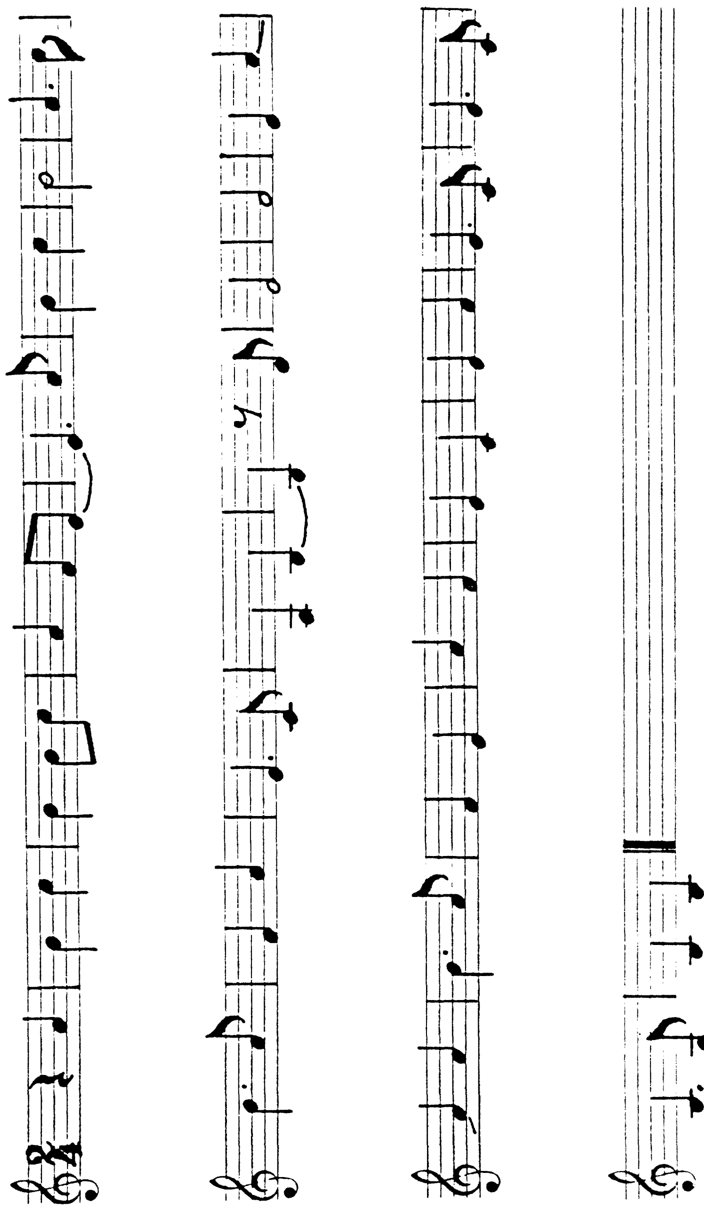

FIGURE 5
The non-tonal (modal) melody used as the experimental material.

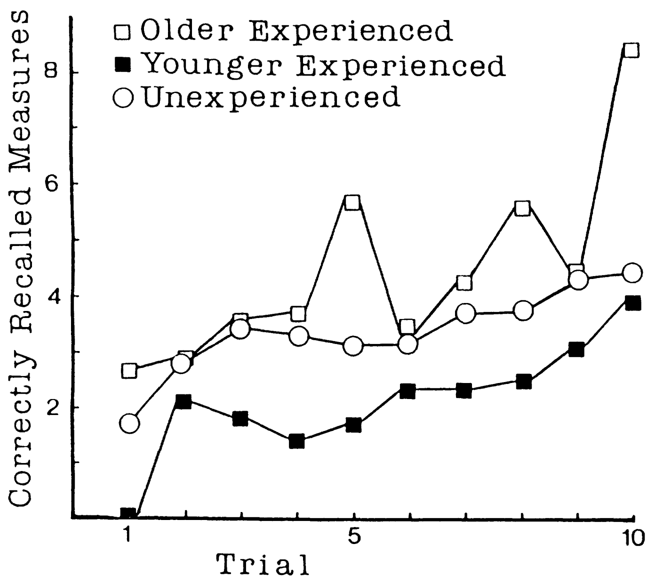

FIGURE 6
Acquisition of the non-tonal melody by three groups.

M=4.50, SD=2.39, for the younger experienced students, M=2.13, SD=1.81; $F(2,12)$=1.65, n.s.). The interaction effect was not significant, either.

All the subjects recalled some short pieces of the melody containing several notes. In addition, seven of the unexperienced college students, two of the experienced college students and one of the younger experienced students reproduced wrong tones extending several measures; the style of these errors was evidently 'traditional Japanese'. Out of the 64 wrong tunes produced by these 10 subjects, fifty-one had a few opening notes identical to those of the presented melody. Four reproductions had a phrase of another well-known song, whose tone sequence was different from any phrases of the presented one. Once these wrong tunes appeared, they were reproduced repeatedly for several trials without correction (One exception was the case of a younger experienced student who reproduced a phrase of another song but did not repeat it in later trials). Although the subjects had stored some melodic building blocks specific to traditional Japanese music, they seemed to have difficulty in using these blocks flexibly and effectively.

The mean number of correctly recalled notes on the 10th trial by the younger experienced students were 51.3 in experiment 1 and 6.8 in this experiment, and by the older experienced students 41.5 in experiment 1 and 16.5 in this experiment. These results suggested that the experienced students could not encode or chunk a non-tonal series of notes effectively.

This interpretation is reinforced by such an episode that YE–3 said to herself "I can't phrase notes" during the presentation of the song. In order to memorize any melody efficiently, a large amount of knowledge highly specific to that style of music seems to be needed.

General Discussion

Recall performance of the tonal melody of the musically experienced grade-school children was not only far superior to that of the unexperienced college students but also as good as that of the experienced college students (See Fig. 2). In the case of the poem recall task, on the contrary, the grade-school children showed a poorer performance (Fig. 4). Thus we can conclude that the superb memory of those children was restricted to the domain of music. These results of the domain-specificity of memory capacity corroborated Chi (1978). Experience in playing music was more important in memorizing melodies than general cognitive development or age.

The results of Experiment 3, however, showed that the experienced students were not always superior to the unexperienced college students even on a melody recall task (Fig. 6). The recall task of the non-tonal melody did not favor the experienced. Thus the domain-specific knowledge supporting memory of melodies must at least in part be highly specific to tonal music. For example, we assume, the prototypes and ordering rules acquired through piano playing are largely specific to tonal music. Although some strategies can be applied to non-tonal music as well, e.g., to assign to a non-tonal melody a series of syllable names, they cannot be very effective. These strategies make the melody presented not entirely new, and thus reduce the memory load, only with the stored prototypes and ordering rules. Style specific knowledge seems to be more critical in memorizing realistic melodies than style general knowledge.

The unexperienced students seemed to have difficulty in storage and/or retrieval. In order for one to be able to encode a melody so that it can easily be sent to LTM, one has to have the prototypes and ordering rules on one hand, and strategies for using them on the other. Those students may have had fewer prototypes and ordering rules than the musically experienced students, or their stored patterns may have been less established, though they have memorized a lot of popular songs and could sing them more or less accurately. Another likely interpretation is that they had as many established patterns as the experienced students, but did not use them because of the lack of strategies.

Because the unexperienced students could not give meaningful codes to the sequence of input information, they had trouble in retrieving the melody from LTM. Two of them could not reproduce it except for the ending phrase even on the tenth trial. These results suggest that their poor performance was primarily due to retrieval deficiency, that is, they could recall only information within the working memory. In fact, in the case of melody recognition, performance of unexperienced college students was only slightly inferior to that of experienced college students (Oura, 1983).

The unexperienced students may have had difficulty not only in storage and retrieval of melodic information but also in vocal performance. The possibility that a difficulty in vocalizing caused a poor performance of the unexperienced students in Experiment 1, however, seemed to be negligible, because 1) the melody used was easy to sing, 2) all the students had been taught singing for nine years at general music classes in elementary and junior high school, and six of them except for N–1 and N–2 had had a half year solfeggio class at the university, 3) they could refuse to participate in the experiment if they had a great difficulty in singing, and 4) their performance in Experiment 3 was comparable to that of the older experienced students majoring in vocal music.

Memory may often be supported by understanding (Bransford & Johnson, 1972). In the case of melodic memory, the much better performance of the more experienced students may have been based on their deeper understanding. For example, the experienced students may have been able to identify the structural notes and to relate other notes to them and thus to store parts of the melody as prototypes plus pitch modifications. Pollard-Gott (1983), showing that musically experienced subjects were superior to beginners in the abstraction of theme from its variations, suggests this possibility. This enables one to organize hierarchically the melody to be remembered. In addition, experienced students tend to understand a given melody by recognizing an underlying harmonic progression and meaningfully relating the melody to it (Sloboda & Parker, 1985). It would be rewarding to study how understanding and memory are related in the processing of melodies, both tonal and none-tonal.

Author Notes

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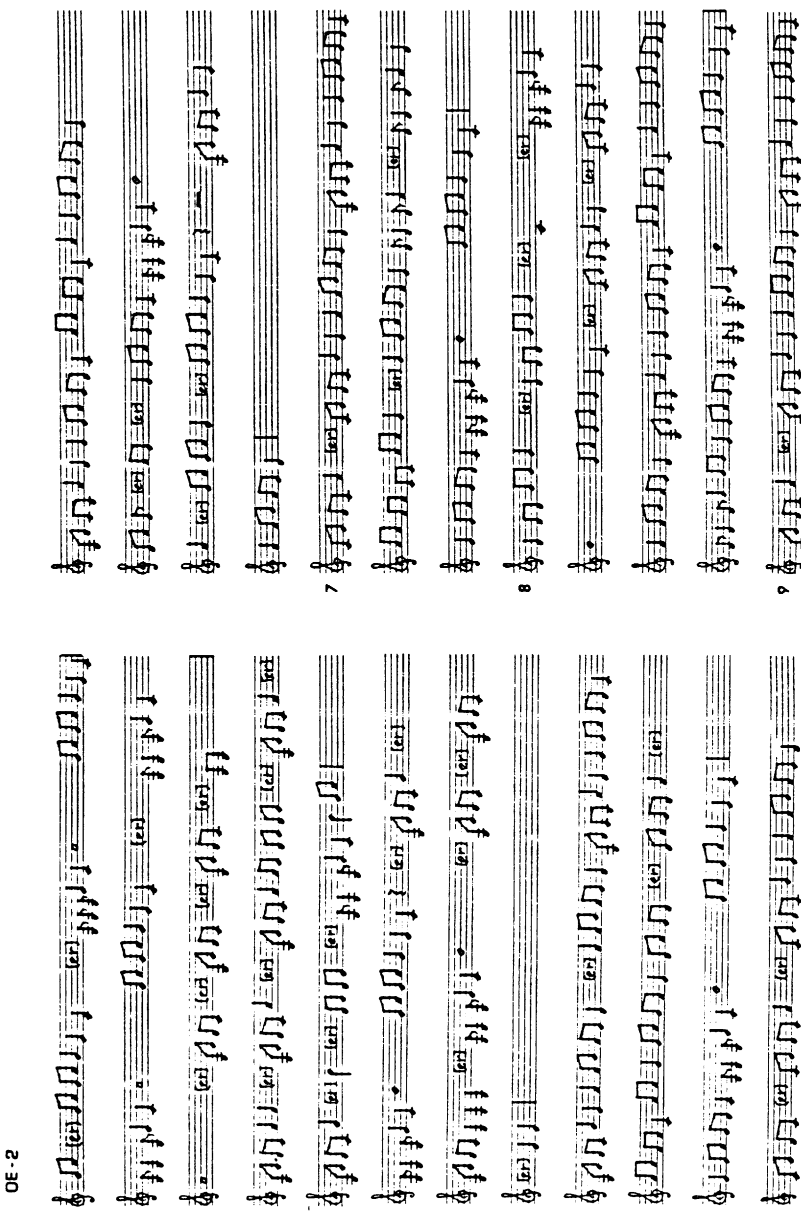
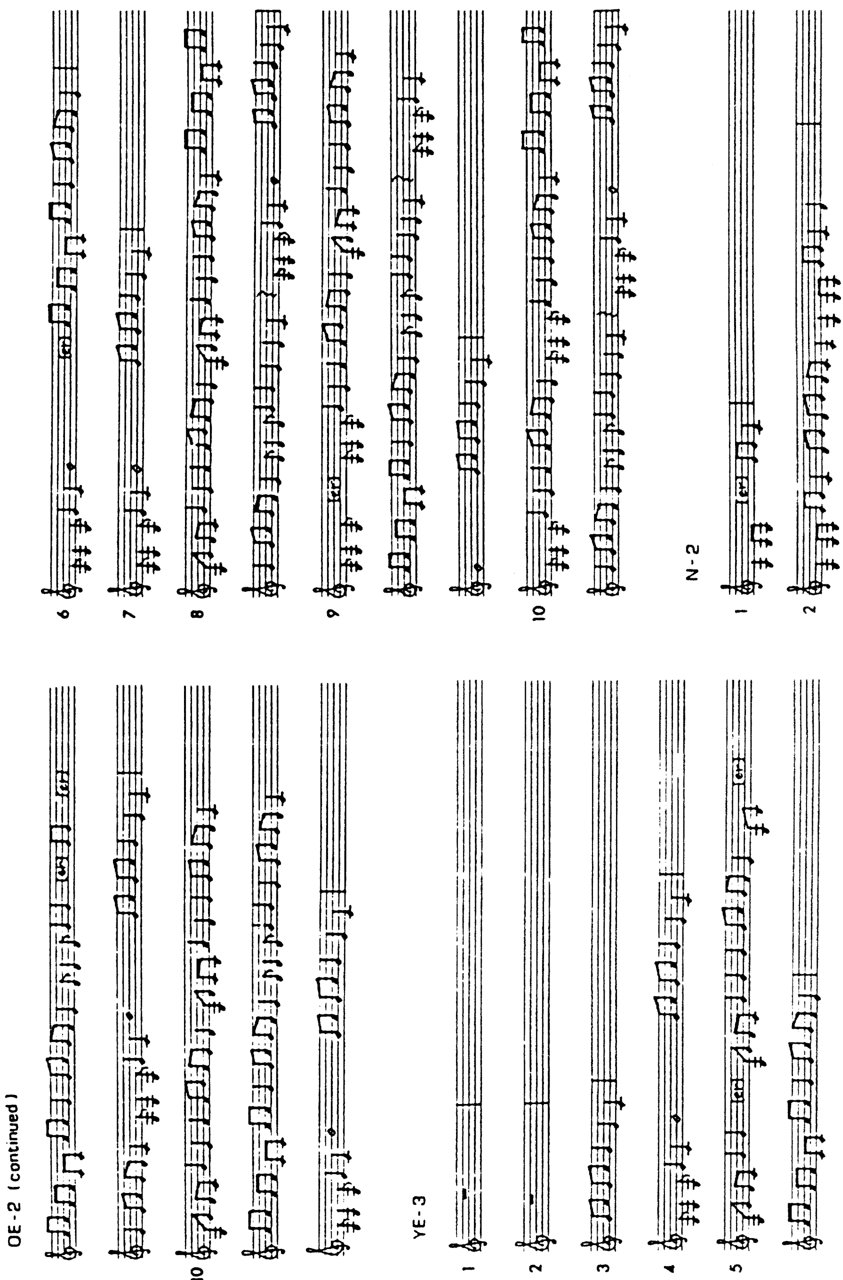
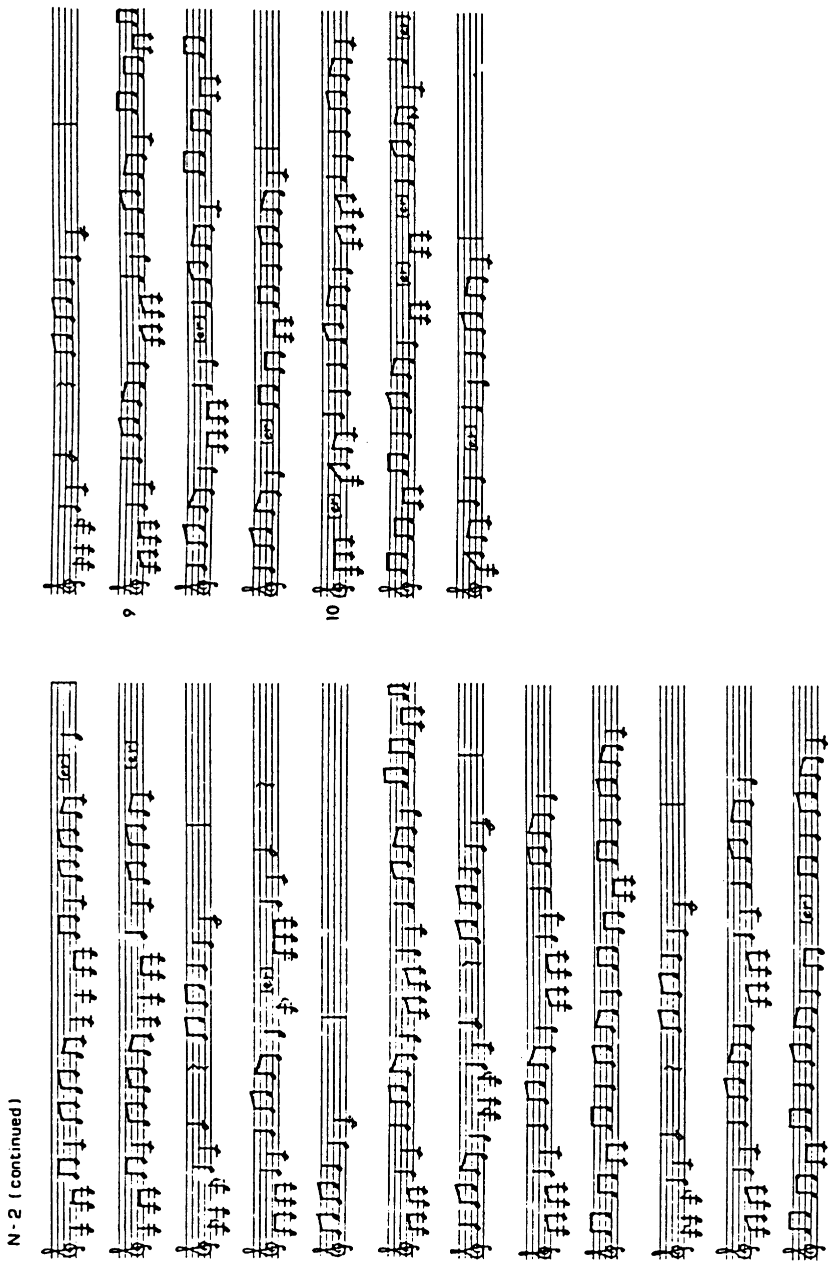
APPENDIX

Complete transcriptions of reproductions by OE–2, YE–3 and N–2.
The reproductions are numbered in sequence.




OE-2 (continued)
YE-3
N-2


N - 2 (continued)
3
4
5
6
7
8
9
10