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Context Effects on Melody Recognition: Scale-Step versus Interval Representations

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A basic question in cognitive psychology concerns ways in which sensory information is represented in memory. Listeners performed a long-term transposition recognition task in which brief melodies were presented with a chordal context that defined their scale-step interpretations. Context either remained constant or changed at test. In two experiments listeners with moderate amounts of musical experience performed well with constant context but at chance with shifting context. Inexperienced listeners (as well as professionals in one of the studies) performed equally well regardless of context. This result suggests that inexperienced listeners represented melodies as sequences of pitch intervals that remained invariant across context shifts. In contrast, moderately experienced listeners appear to have represented melodies as scale-step sequences that were affected by context. Professionals, while capable of scale-step representation, were able to use a flexible memory-retrieval system to avoid errors with changed context. A third experiment showed that moderately experienced listeners were able to base long-term recognition on either contour or scale-step information, depending on instructions. These results suggest that the scale-step representation used by moderately experienced listeners involved both contour and scale information.

LISTENERS differ in the ways they remember the pitch material of melodies. Perceptual learning in a specific stimulus domain such as music leads not only to increased efficiency in perceptual tasks but also to qualitative changes in *what* is perceived and remembered. For example, with increasing musical experience, Western listeners find it easier to remember tonal (versus nontonal) melodies (Francès, 1958), to distinguish tonal from nontonal melodies (Dowling, 1978), to reject lures from outside the tonal key in pitch recognition (Dewar, Cuddy & Mewhort, 1977) and melody recognition (Bartlett & Dowling, 1980), and to evaluate pitches in terms of

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their musical functions (Krumhansl & Shepard, 1979). These developments in perceptual learning are generally attributable to the more experienced listeners' interpretation of pitches in terms of the tonal scale patterns of their culture, as Francès (1958) described.

Melodies could conceivably be represented in memory in several ways. One way would be as a set of absolute pitches. Such a representation is implausible because people typically recognize familiar tunes immediately upon hearing them, even when transposed to new, arbitrary pitch levels at which they had never been heard before. People easily reproduce familiar melodies at novel pitch levels when asked (Attneave & Olson, 1971), and rarely reproduce them spontaneously at a consistent pitch level. (Otherwide *a cappella* choirs would not need pitch pipes.) Hence I will turn here to three more likely possibilities: representation by melodic contour, by intervals, and by relative pitches.

Melodic contour representations play an important role in memory for melodies, especially in immediate recognition memory for novel melodies (Dowling & Fujitani, 1971; Dowling, 1978, 1982). The melodic contour codes the ups and downs of the melody. For example, "Frère Jacques" would be represented by:

$$+ + - 0 + + -,$$

where the signs indicate up and down directions of melodic motion and the zero indicates unison. Although contour plays an important role in the immediate recognition of novel melodies, it is less important to the recognition of melodies stored in long-term memory (Dowling & Bartlett, 1981). In the latter case the function of melodic contour seems to be to "remind" the listener of the target melody. That is, the "index" of melodic memory may be set up in terms of melodic–rhythmic contour patterns, and the contour may provide access via that index to more precise memory representations (Dowling, 1983; Dowling & Harwood, 1986), including representations in terms of intervals and scale steps (relative pitches).

Interval representations encode a melody as a set of logarithmic interval sizes between successive notes (in semitones, for example). Here "Frère Jacques" would be represented as:

$$+2\ +2\ -4\ 0\ +2\ +2\ -4,$$

where the sign indicates direction. Unlike the absolute pitch representation, the interval representation has no difficulty explaining the immediate recognition of transpositions of familiar melodies at arbitrary pitch levels, since interval pattern remains invariant across transposition. An interval representation of a melody could easily arise from the type of processing envisioned in Deutsch's (1969, 1982) interval-abstracting channel.

Relative pitch representations encode melodies as sets of scale steps in a tonal scale framework, in a way analogous to their representation in a "movable *do*" system. Here "Frère Jacques" would be represented as: *do re* *mi do do re mi do*, where *do* is the tonic or key note of the scale, movable to any pitch level. An equivalent version would represent melody notes as scale-step numbers:

1 2 3 1 1 2 3 1 .

Such a representation could be easily matched to that of a test melody transposed to an arbitrary pitch level, as long as the listener was able to determine the tonic and scale pattern of the test item. That is, the pattern of scale steps in a familiar melody remains invariant across transposition.

Scale-step representations involve an additional complication that interval representations do not. While it is easy to imagine that interval representations arise from fairly direct sensory encoding in the auditory system, and that the memory representation of intervals remains close to that initial encoding, in contrast there appear to be several ways in which scale-step representations might be involved in transposition recognition. Scale steps might be encoded directly upon the input of a novel melody and remembered as literally as intervals. It is also possible that a scale-step representation might be generated at test, using information initially stored separately as melodic contour and as tonal scale framework. We will return to this issue following Experiment 2.

The first question addressed by these experiments was, which of the two sources of more precise pitch information—intervals or scale steps—do listeners use in long-term melody recognition? In these experiments brief novel melodies were presented to listeners, who were then tested for recognition of transpositions of those melodies following a filled time interval of about 40 sec. Listeners had to distinguish between exact transpositions of the target melodies and imitations in which one note had been changed. Under such conditions both musically inexperienced and moderately experienced listeners had been shown to be able to distinguish transpositions from imitations (Dowling & Bartlett, 1981). To determine which type of representation—scale step versus interval—listeners were using to solve this task, I surrounded each melody with a context that established the scale-step interpretation of its pitches, as shown in Figure 1. Figure 1A shows a six-note melody introduced by a sequence of four chords ending on the tonic chord (I). This tonal context determined the relative-pitch, scale-step representation of the target melody, which is shown below the melody notes in scale-step numbers. The interval representation of the target is shown in semitones above the melody. Shifts in context changed the scale-step interpretation of the melody, but not its interval pattern.

A melody like that in Figure 1A was tested in one of four possible ways. Test melodies were either exact transpositions or imitations, and both of those types were presented with either the same tonal context or a changed context. Test melodies were always presented at a different pitch level from the corresponding originals. The test melodies shown in Figures 1B and 1D are exact transpositions having the same interval pattern as the original melody in Figure 1A, while those in Figures 1C and 1E are imitations in which two intervals have been changed by changing one note. Listeners were supposed to respond positively to 1B and 1D and to reject 1C and 1E.

The melodies in Figures 1B and 1C are introduced by the same chord progression as that in Figure 1A. Thus the scale-step pattern of the original, as well as its interval pattern, is preserved in the transposition in Figure 1B. Scale-step pattern was changed by shifting the context so as to introduce the melody as beginning and ending on a different scale steps from the one on

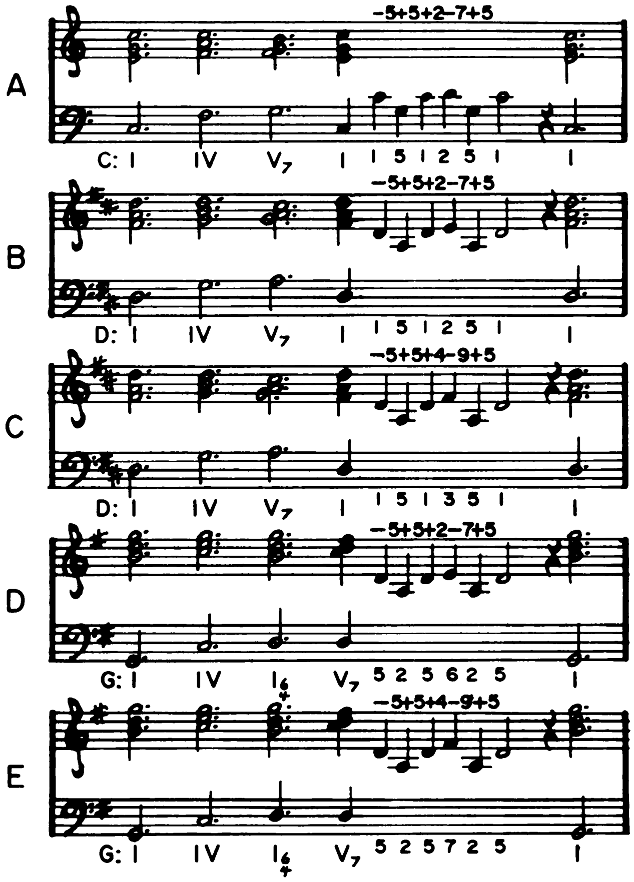

Fig. 1. Examples of stimuli in Experiment 1: (A) A novel melody introduced with chordal context ending with the tonic (I) chord; (B) a same-context transposition of A; (C) a same-context imitation of A; (D) a different-context transposition of A; (E) a different-context imitation of A. The Roman numerals under the staves indicate the chord labels in the context; the small numbers above the melodies indicate the interval pattern in semitones; and the small numbers below the melodies indicate the scale-step values of the pitches. Note that transpositions preserve interval pattern exactly, and that the chordal context determines the initial scale-step values.

which it was originally introduced. Figure 1D shows an exact transposition of the melody in Figure 1A introduced with a different context (a chord progression ending on the dominant chord—V), and Figure 1E shows an imitation introduced with that different context. (It was possible to transpose melodies exactly while shifting context between tonic and dominant as long as the original melody avoided scale step 7 in tonic context and scale step 4 in dominant context.) Context shifted equally often in the dominant–tonic direction (V–I) as in the tonic–dominant direction (I–V).

On each trial the listener attempted to respond positively to transpositions (as in Figures 1B and 1D) and to reject imitations (Figures 1C and 1E). In that task, of course, the scale-step representations were not always useful, being valid only for test trials on which chordal context remained the same. Interval representations were valid whether or not the context shifted. It seemed plausible that listeners with varying levels of musical training might rely to varying degrees on scale-step representations, since the use of such representations forms an implicit (if not an explicit) part of that training. Therefore, I tested listeners with three different levels of training (inexperienced, moderately experienced, and professionals).

Experiment 1

Listeners in Experiment 1 performed a continuous running memory task modeled on that of Shepard and Teghtsoonian (1961). This task consisted of a succession of 48 trials to which the listeners responded. Twenty-four of the trials introduced novel melodies differing in contour from every previous melody. Intermingled among the trials introducing novel melodies were trials on which those melodies were tested. An average of two trials (40 sec) intervened between the introduction of a melody and its corresponding test item. Figure 2 illustrates the structure of the running memory task. The listeners' task was to say on each trial whether or not the melody presented was an exact transposition of a previously presented melody. I expected this task to be relatively easy when it was a matter of rejecting new melodies being introduced, since they differed in contour from every melody heard before; but I expected it to be quite difficult when it was a matter of judging the test melodies, since then the listener had to distinguish between exact transpositions and imitations. Even so, inexperienced listeners usually perform at somewhat better than chance levels on such tasks.

The test items were of the four types illustrated in Figure 1. They were either transpositions or imitations, and the chordal context introducing them was either the same at test or different. The listeners' task was to respond positively to transpositions and reject imitations, ignoring context.

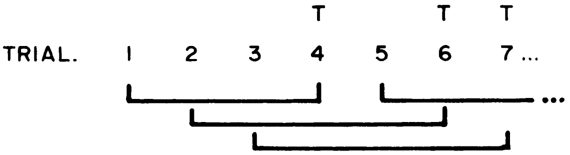

Fig. 2. The structure of the continuous running memory task. Trials 1, 2, 3, and 5 introduce new melodies. Trials 4, 6 and 7 are test trials (T). Brackets link new melodies with their corresponding test trials. There was a mean of two intervening items between introduction of a melody and its test.

Method

Subjects

Thirty-two listeners served in Experiment 1, of whom 25 were students at the University of Texas at Dallas receiving partial course credit for their participation (mean age = 29.6 years). Of those 25, 13 had had no individual music lessons in their lives and constituted the inexperienced group. Twelve had had 2 years or more of music lessons or instrumental ensemble experience (mean = 5.1 years) in their youth and were classified as moderately experienced. In addition to those 25, there was a group of 7 professional musicians, including a successful composer, two professional choir directors, one orchestra musician, one singer, and two advanced students of composition. All the professionals were currently performing music and all had at least 15 years of experience continuous with the present. The mean age of all the listeners was 31.2 years. (Three listeners were dropped from an initial group of 28 students: two for failing to follow instructions, and one for performing distinctly below chance overall—less than 40% correct–which can be interpreted as failure to understand the instructions.)

Stimuli

Each stimulus consisted of a six-note melody introduced by a chord progression and followed by a chord as shown in Figure 1. The melodies proceeded at a rate of 3 notes/sec with the third and sixth notes accented, while the chords proceeded at a rate of 1 chord/sec (that is, there were 60 dotted-half notes per minute). Timing was achieved with reference to an electronic metronome marking 1-sec intervals that was barely audible on the tape. Each trial was 16 sec in length: 8 sec for stimulus presentation, followed by a 6-sec response interval. The onset of the next trial was announced 2 sec in advance by the experimenter's voice giving the trial number. The stimuli were played on a freshly tuned Steinway piano, recorded on tape, and presented to listeners via loudspeakers in group sessions (except for the professionals, who served in individual sessions).

There were 48 stimuli presented in the session, consisting of 24 novel melodies and 24 test items. Each of the novel melodies had a different contour, randomly selected from the 32 possible up-and-down contours of six-note melodies, but excluding the uniformly ascending and descending contours. For each contour I constructed a melody that began and ended on the first, third, or fifth degree of the scale, avoided the seventh degree of the scale, and remained within the compass of seven pitches of the diatonic scale above and below the tonic. I tried to make the melodies strongly tonal and as attractive as possible within those constraints.

There were two types of test melodies. Transpositions were simply exact transpositions of the initial melodies. Imitations were derived from transpositions by altering one unaccented note by one diatonic step, in a way that did not alter the contour. Note positions 1, 2, 4, and 5 were altered about equally often.

The 24 test melodies were assigned randomly, six to each of four test-trial types: Same-context transposition; Same-context imitation; Different-context transposition; and Different-context imitation (illustrated in Figure 1). I prepared two counterbalanced lists such that melodies tested with a transposition in the first list were tested with an imitation in the second. The order of initial melodies in the first list was randomized, and the second list followed the reverse order. Approximately equal numbers of listeners in each group heard each list. The stimuli were distributed in the 48-item list so that the lag between the introduction of a melody and its test varied irregularly with a mean of two items intervening between the introduction of a melody and its test. For each of the four test types, four of the trials had two items intervening; one trial, one item; and one trial, three items.

There were two kinds of chordal context, one progressing to a tonic triad and the other progressing to a dominant-seventh chord. The chord sequence in the former was I–IV–V(7)–I, and for the latter was I–IV–I(6-4)–V(7). The melody started 0.33 sec after the onset of the fourth chord. Each stimulus ended with a tonic chord beginning 1 sec after the onset of the last note of the melody. The melodies either began and ended on members of the tonic triad (as they had been generated, above), or were moved so as to begin and end on members of the dominant triad, depending on context. That is, the melodies began and ended on pitches of the fourth chord in the context. Context (tonic versus dominant) was randomly assigned to initial introductions of melodies, with the constraint that each appear equally often and be tested equally often with same- and different-context test items.

Within the series of 48 trials, successive trials were never in the same key, and a melody and its test were always in different keys. Novel melodies were introduced equally often in the keys of F, C, or G major, randomly determined. Test melodies were in the keys shown in Table 1, with each alternative equally represented. Note that the pattern in Table 1 is counterbalanced for key distance and pitch proximity.

Procedure

The experimenter instructed listeners that they were going to hear a series of 48 brief melodies, and that their task was to respond to each melody, telling whether they had heard it before in the list. The experimenter explained that each melody would be introduced by a set of chords, and that they were to base their judgments on just the melodies, ignoring the chords. The experimenter emphasized that they were to respond positively only if the melody were *exactly* like an earlier one they had heard. The experimenter presented distorted and undistorted versions of "Twinkle, Twinkle, Little Star" to illustrate what was meant by "exactly like" (that is, to illustrate the transposition–imitation distinction). Even inexperienced listeners find it easy to distinguish between transpositions and imitations of a familiar tune like "Twinkle, Twinkle" (Bartlett & Dowling, 1980). Then the experimenter played

TABLE 1
Relationships Between Key of Initial Introduction of Melody and Key of Test Item in Experiment 1

Initial Melody			Comparison		
Key	Context	Notes of Chord	Key	Context	Notes of Chord
F	I	F–A–C	G	I	G–B–D
			C	V	G–B–D
	V	C–E–G	D	I	D–F♯–A
			G	V	D–F♯–A
C	I	C–E–G	D	I	D–F♯–A
			G	V	D–F♯–A
	V	G–B–D	F	I	F–A–C
			B♭	V	F–A–C
G	I	G–B–D	F	I	F–A–C
			B♭	V	F–A–C
	V	D–F♯–A	C	I	C–E–G
			F	V	C–E–G

the listeners four sample stimuli illustrating the different types of comparison involved and emphasizing again the need to respond to the melody and not the chordal context.

Listeners responded on each trial using a six-category confidence-level scale ranging from "very sure old" to "very sure new." The experimenter emphasized that listeners were to respond "old" only if the melody on a given trial was *exactly* like an earlier one they had heard. The experimenter also told the listeners that if a melody were going to recur in the sequence of trials, it would do so within three or four trials of being first introduced. Listeners responded on a single sheet of paper with blanks numbered from 1 to 48. At the end of the session listeners answered a brief questionaire concerning age, sex, and musical experience.

Data Analysis

The data consisted of listeners' responses on the six-category scale to each stimulus. These were analyzed in two ways. First, I calculated mean response ratings of the five types of stimuli and ran analyses of variance (ANOVAs) on the results. This analysis of ratings was used mainly as a check on the following analysis of area scores and will be cited only where it provides additional information. Second, I calculated area under the memory operating characteristic (MOC) to obtain an estimate of proportion correct in transposition–imitation discrimination for the same-context and different-context conditions, relative to a chance level of 0.50 (Swets, 1973). For each listener within each context condition I took the cumulative proportions of "old" responses to transposition trials at each confidence level as hits (counting, for example, "sure new" responses as "old" in comparison with "very sure new" responses). I took cumulative proportions of "old" responses to imitation trials at each confidence level as false alarms. Confidence levels corresponded to response criteria. Thus, each listener's performance was characterized by two area scores describing discrimination between transpositions and imitations for same- and different-context trials. These individual areas under the MOCs were analyzed by ANOVA.

Results

Figure 3 shows the mean areas under the MOC for the three groups and the two types of context condition in Experiment 1. Those results were subjected to a 3 Experience Levels × 2 Context Conditions ANOVA, in which there was a main effect of experience, $F(2, 29) = 7.61$, $p < .005$. The inexperienced and moderately experienced listeners performed better than chance and about equally well overall (areas of .58 and .60, respectively), whereas the professionals performed better (.70). The only other significant effect was the Experience × Context interaction, $F(2, 29) = 3.80$, $p < .05$. The inexperienced listeners performed equally well with same and different contexts. While those with moderate experience performed better than inexperienced listeners with same-context items; their performance fell to chance when context changed. The professionals' performance was about equal for the two context conditions.

Discussion

The most interesting aspect of the results of Experiment 1 is that while the performance of inexperienced and moderately experienced listeners was about equal overall, inexperienced listeners outperformed the more experienced on trials where context shifted. Moderately experienced listeners

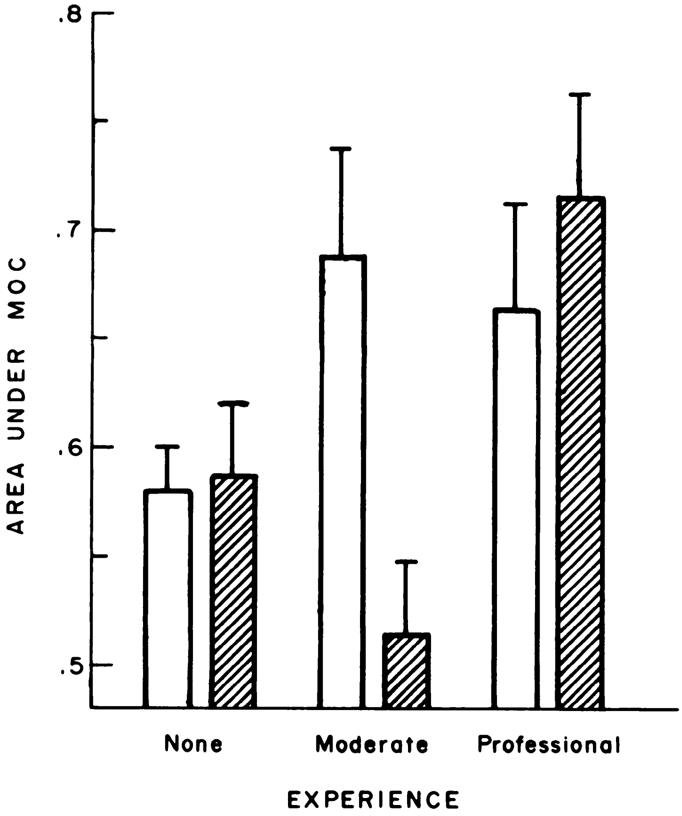

Fig. 3. Areas under the MOC for Experiment 1 with two contexts (same: open bars; different: cross-hatched) at three levels of experience. Chance was .50. (Brackets show standard errors.)

discriminated transpositions from imitations only with same context; with different context their performance was at chance. This strongly suggests that inexperienced listeners were using a memory strategy that was insensitive to context shifts; namely, a strategy involving pitch-interval representations. Moderately experienced listeners, in contrast, used a strategy affected by context shifts, most likely involving scale-step representations. That the professionals performed better than the other two groups, and about equally well with same and different context, suggests that they were able to adapt their strategies to cope with both same- and different-context items. In fact, their comments during the instructions generally indicated a good understanding of that aspect of the task.

One possible objection to the interpretation of these results as indicating that moderately experienced listeners use scale-step representations is that perhaps that group was rejecting different-context trials because of the global, holistic property of having a different harmonic pattern; that is, that those listeners were responding to the whole pattern on each trial, and not focusing on just the melody. One problem with that interpretation is that it is difficult to see why just the moderately experienced group should have been subject to that tendency. It seems a more likely tendency for the inexperienced group to display, lacking as they did any analytic training in music perception. A second reason for rejecting this interpretation based on holistic perception of different-context trials is that if it were true then we would expect the confidence-level ratings of both transpositions and imitations on the different-context trials to be depressed in comparison with the same-context trials. That is not the case. The ratings converged around the same mean rating for same- and different-context trials, with the latter ratings simply showing little transposition–imitation discrimination. (The mean ratings were 3.97 and 3.91 for same and different context, respectively, a nonsignificant difference by *t*-test.) Therefore I think it unlikely that the difficulties moderately experienced listeners had with different context trials stemmed from a tendency to respond globally to the context shift on those trials.

A second possible alternative explanation for the moderately experienced listeners' chance performance on different-context trials is that having to respond on every trial may have been distracting. Listeners' concentration on the difficult task of detecting minute alterations in test melodies may have been disrupted by the additional task of rejecting grossly different new melodies. To check on this possibility, I replicated the experiment with 30 new inexperienced and moderately experienced listeners using an answer sheet calling for responses only on the 24 test trials.

Experiment 2

Method

Subjects

There were 17 inexperienced and 13 moderately experienced listeners, as described in Experiment 1.

Stimuli and Procedure

The stimuli and procedure were the same as for Experiment 1, except that the answer sheet had response blanks only for the 24 test trials, and not for trials on which new melodies were introduced. The experimenter explained that procedure to the listeners.

Results

Areas under the MOC for Experiment 2 are shown in Table 2. The results closely parallel those of Experiment 1. In the 2 Experience Levels × 2 Contexts ANOVA the effects of context, $F(1, 28) = 4.81, p < .05$, and the Experience × Context interaction, $F(1, 28) = 5.10, p < .05$, were significant. As in Experiment 1 the moderately experienced listeners' perform-

TABLE 2
Areas Under the MOC for Transposition–Imitation Discrimination with Two Contexts for Listeners Responding Only to Test Items in Experiment 2

Group	Context	
	Same	Different
Inexperienced	.55	.56
Moderately Experienced	.67	.51

ance fell to chance with different contest test trials. Incidentally, the inexperienced listeners' performance declined slightly in comparison with Experiment 1 to a level barely above chance: .56 overall. This suggests that the task of responding on every trial may have in fact been easier for those listeners.

Discussion

Experiment 2 showed that the moderately experienced listeners' failure to discriminate transpositions from imitations with changed context was not due to task demands that required the simultaneous performance of contour and interval recognition tasks. This provides further support for the argument that the deficit is due to their reliance on a strategy of representing melodies in terms of tonal scale steps. We can now return to an issue that was raised in the Introduction; namely, whether these scale-step representations arise from scale steps' being directly encoded as such at the input of a novel melody, or whether they are generated at test by the combination of a melodic contour and a tonal scale framework. In the latter case the retrieval system, when confronted with a test melody with a recently heard contour, would generate a possible match by hanging the retrieved contour on the present scale framework (as suggested by Dowling, 1978). The contour would need to be remembered with some indication of where on the tonal scale it had been heard—that is, some memory for where the original melody lay in relation to the tonal center of the original key. Such a system would perform well when tonal context remained the same at test, but a shift of context would leave it without the means of effecting the kind of detailed match required by the transposition-recognition task.

In considering these two possibilities we should note that the first—direct encoding of scale steps—seems the less likely of the two with respect to prior evidence. For example, Deutsch (1979) showed that octave-scrambled repetitions of a melody that preserve its scale-step values—its chromas—but not its contour do not increase its memorability. And scale-step chromas alone, without some additional information such as familiar song title or contour, are insufficient retrieval cues in memory for melodies (Dowling, 1983). The second possibility, memory for contour combined with knowledge of the tonal scale framework, seems more plausible in terms of previous results. Knowledge of the tonal scale framework has been clearly demonstrated for moderately experienced listeners (Dowling, 1978). Regarding contour, even the experiments of Dowling and Bartlett (1981), which cast doubt on the strength of contour information in long-term memory, provided some indication of its use in a task closely resembling the present ones (their Experiment 4).

One consequence of the theory that scale steps are generated by combining a melodic contour with the tonal framework is that listeners should have access to contour information at test. Experiment 3 was designed to test that consequence. If moderately experienced listeners failed to recognize same-contour items under the same conditions as in Experiments 1 and 2, then we would have good reason to doubt whether they were using contour information in performing those tasks. Therefore Experiment 3 replicated Experiments 1, except that listeners were instructed to respond positively to all same-contour items, both transpositions and imitations.

Experiment 3

Method

Subjects

There were 16 inexperienced and 9 moderately experienced listeners, as described in Experiment 1.

Stimuli and Procedure

The stimuli and procedure were the same as for Experiment 1, except that the instructions were to respond "old" to all melodies having the same contour as a previous melody. Area under the MOC was calculated for the four types of test stimuli, taking positive responses to the four types of same-contour melodies as hits and positive responses to new melodies as hits and positive responses to new melodies as false alarms.

Results

Areas under the MOC for Experiment 3, evaluating same-contour responses to the four types of same-contour stimuli, are shown in Table 3. They were analyzed in a 2 Experience Levels × 2 Context Conditions × 2 Stimulus Types ANOVA. The only significant effect was that of experience, $F(1, 23) = 7.49, p < .02$, in which moderately experienced listeners performed at better than chance levels, while the inexperienced performed at chance. Moderately experienced listeners were able to recognize melodic

TABLE 3
Areas Under the MOC for Discrimination of Transpositions (T) and Imitations (I) from New Items, with Contour Instructions in Experiment 3

	Context				
	Same		Different		
Group	T	I	T	I	Mean
Inexperienced	.54	.53	.48	.50	.51
Moderately Experienced	.65	.60	.56	.66	.62

contours, but there was no indication that they distinguished involuntarily between transpositions and imitations when instructed not to do so.

Discussion

Experiment 3 showed that moderately experienced listeners were in fact able to retrieve contour information when instructed to do so. this fulfills a necessary condition for the contour-plus-tonal-framework system for generating scale-step melody representations to work. This, together with the doubts expressed above regarding the small likelihood of the direct use of scale-step representations in melodic memory, leads me to believe that these listeners were combining contour and scale information to evaluate test melodies in Experiments 1 and 2. Experiment 3 also demonstrated a certain amount of flexibility and conscious control on the part of moderately experienced listeners, in that they were able to follow instructions to recognize contours. Even though capable of using memory information to distinguish transpositions from imitations, they did not do that automatically and involuntarily (as was typical in the results of Dowling and Bartlett, 1981). Further, inexperienced listeners in Experiment 3 appear to have been unable to recognize contours—a result consistent with the supposition that they had been basing their judgments in Experiments 1 and 2 on interval information.

General Discussion

The results of these experiments indicate that listeners with different levels of musical training display individual differences in perception and memory for melodies. The shift of chordal context in Experiments 1 and 2 did not affect the performance of musically inexperienced listeners, presumably because when they first heard the melodies they represented them as patterns of intervals on a logarithmic pitch scale. The interval patterns of the melodies remained invariant across transposition, independent of context, and so could provide for accurate recognition in both context conditions. In contrast, context did affect the performance of listeners with moderate experience, and their performance fell to chance when context shifted. That result suggests that those listeners represented the melodies in terms of diatonic scale steps, a property that did not remain invariant with context shift. Experiment 1 provided evidence for three different levels of expertise in performing the transposition-recognition task. The professionals, of whom all had learned to verbalize scale-step representations during their training, demonstrated more flexibility than the moderately experienced listeners. When confronted with the task most of the professionals explicitly noted the context shifts as a potential source of difficulty, but according to the results they were generally able to cope with them. The professionals presumably had scale-step representations at their disposal, but were able to use other recognition strategies when the task demanded it.

One implication of these results is that different processes, best described by different theories, characterize performance at different levels of experience. The inexperienced listeners appear to have been relying on a process that was heavily dependent on something like Deutsch's (1969, 1982) interval abstracting channel—a process that was well suited to transposition recognition and that was independent of context. Moderately experienced listeners appeared to behave in a way closer to that characterized by Dowling's (1978) contour-plus-tonal-framework model. And professionals were able to use even more sophisticated strategies that probably included components of both the preceding schemes.

It is important to note that scale-step representation by moderately experienced listeners was done tacitly by the nervous system, and without conscious access (in the sense of not being verbalizable). The verbalization of this representation is one of the goals of first-year conservatory training, following about 10 years of active training. The explicit verbalization of scale-step representations is generally difficult for conservatory students to acquire. Thus it comes as some surprise that listeners who had had about 5 years of music lessons, followed by little active involvement in music for the subsequent 15 years or so, still retained the capacity for such representation. In general such representation is useful in melody recognition, and it is only in contrived conditions such as the context shifts of Experiments 1 and 2 that it becomes a liability.

Further, the scale steps of melodic pitches are inseparable from their tonal functions, which in the diatonic tonal system carry their musical meanings. Thus, it seems reasonable to suppose that the moderately experienced listeners have access via scale-step representation to deeper levels of musical meaning than inexperienced listeners using surface-level interval representations. Also, the contours that the moderately experienced were able to use are relatively global features of melodies, in contrast to the local sequence of note-to-note intervals (Deutsch, 1982). In making use of contours those listeners were demonstrating the use of organized pattern information over broader time spans than would be implied by the use of intervals.

These changes in melody-recognition performance with increased levels of musical experience parallels the improvement in reading skills that comes with an increase in "linguistic awareness." By linguistic awareness, Mattingly (1972) meant the sort of access to the phonological system (that maps the morphophonemic units of language onto speech sounds) demonstrated by abilities such as playing with rhymes, using pig latin, and counting the syllables and phonemes of spoken words. Children who demonstrate such access to the underlying structure of language are more effective readers than those who do not (Liberman, Liberman, Mattingly, & Shankweiler, 1980). The three groups in Experiement 1 had, presumably as a result of differences in training, different levels of access to the implicit structure of musical patterns. The inexperienced listeners encoded pitch intervals of melodies in a way that was accurate but that took little account of musical structure. More experienced listeners used representations that took account of musical structure in terms of contour and tonal functions, but that led to errors when the structural context shifted. Those listeners were, however, flexible in their ability to use melodic contour information when the task required it. Finally, professional musicians not only had the capacity for scale-step representation, but also explicit control over when and how to use it, with the result that they were able to perform accurately in transposition recognition even when tonal context shifted.[1]

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