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The influence of melodic context on pitch recognition judgment

DIANA DEUTSCH
University of California at San Diego, La Jolla, California

Subjects made delayed pitch comparisons between tones that were each preceded by tones of lower pitch. The pitches of these preceding tones were so chosen that in some conditions the melodic intervals formed by the standard (S) and comparison (C) combinations were identical, and in others they differed. A strong effect of melodic relational context was demonstrated. When the S and C combinations formed identical melodic intervals, there was an increased tendency for the S and C tones to be judged as identical. And when the S and C combinations formed different melodic intervals, there was an increased tendency for the S and C tones to be judged as different. These effects occurred both when the S and C tones were identical in pitch and also when these differed, and they occurred despite instructions to attend only to the S and C tones.

Pitch recognition judgment in a sequential setting has been found to be susceptible to a variety of influences. Recognition accuracy declines with increasing temporal separation between the tones to be compared (Bachem, 1954; Harris, 1952; Koester, 1945). The interpolation of an extra tone during the retention interval produces a further decrement in performance (Wickelgren, 1966, 1969). When several tones are interpolated, recognition accuracy varies as a function of the pitch relationships between the tones to be compared and the intervening tones (Deutsch, 1975), and also varies as a function of the pitch relationships between successive tones of the interpolated sequence (Deutsch, 1972, 1978; Olson & Hanson, 1977). It has also been found that pitch recognition judgments can be substantially affected by the relational context in which the standard (S) and comparison (C) tones are placed, when simultaneous tones are used to provide such context. That is, there is an increased tendency to judge the S and C tones as identical when they are placed in the context of identical harmonic intervals and as different when they are placed in the context of different harmonic intervals (Deutsch & Roll, 1974).

The present experiment was designed to determine whether melodic relational contexts affect pitch recognition judgments in the same way as harmonic contexts. Subjects compared the pitches of two tones that were each preceded by tones of lower pitch. The pitches of these preceding tones were so chosen that in some conditions the melodic intervals formed by the S and C combinations were identical and in others they differed. These patterns of relationship were present both when the S and C tones were identical in pitch and also when these differed. It was predicted that when the S and C combinations formed identical melodic intervals, there would be an increased tendency to judge the S and C tone pitches as identical, and that when the S and C combinations formed different melodic intervals, there would be an increased tendency to judge the S and C tone pitches as different. Furthermore, the S and C combinations were separated by a retention interval during which a sequence of extra tones was interpolated. In order to explore possible interactions between such repetition effects (Deutsch, 1972, 1975; Deutsch & Roll, 1974) and the effect of melodic context, the effects of including in this interpolated sequence tones of the same pitch as components of the C combination were examined.

METHOD

Procedure

The basic paradigm was as follows. Subjects listened to an S tone, which was followed by a sequence of six interpolated tones and then by a C tone, and they judged whether or not the S and C tones were identical in pitch. The S and C tones were both preceded by tones of lower pitch, which the subjects were instructed to ignore, and they were also instructed to ignore the interpolated tones. The subjects indicated their judgments by writing "S" (same) or "D" (different) on paper.

Temporal Parameters

All tones were 200 msec in duration. The interval between the S tone and its preceding tone was 300 msec, as was the interval between the C tone and its preceding tone. The interpolated tones were separated from each other by intervals of 300 msec. The interval preceding the first interpolated tone was 1 sec, and the interval following the last interpolated tone was 2 sec.

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Conditions

In all sequences, the tone preceding the S tone was 4 semitones lower than the S tone. However, the tone preceding the C tone varied depending on the experimental condition.

There were three conditions in which the S and C tones were identical in pitch. In Condition S1, the tone preceding the C tone was identical in pitch to the tone preceding the S tone, so that the melodic intervals formed by the S and C combinations were also identical in size. In Conditions S2 and S2(i), the tone preceding the C tone was a semitone removed from the tone preceding the S tone, so that the melodic intervals formed by the S and C combinations differed in size by a semitone. In both these conditions, on half of the sequences the tone preceding the C tone was a semitone higher than the tone preceding the S tone, and on the other half it was a semitone lower. Furthermore, in Condition S2(i), a tone of pitch identical to that of the tone preceding the C tone was included in the second serial position of the interpolated sequence.

There were six conditions in which the S and C tones differed in pitch by a semitone. In Conditions D1 and D1(i), the pitch of the tone preceding the C tone was identical to that of the tone preceding the S tone, so that the melodic intervals formed by the S and C combinations differed in size by a semitone. Furthermore, in Condition D1(i), a tone of pitch identical to that of the C tone was included in the fourth serial position of the interpolated sequence. In Conditions D2 and D2(i), the tone preceding the C tone was a semitone removed from the tone preceding the S tone. This difference was always in the same direction as the difference between the S and C tones. That is, when the C tone was higher than the S tone, the tone preceding the C tone was also higher than the tone preceding the S tone. And when the C tone was lower than the S tone, the tone preceding the C tone was also lower than the tone preceding the S tone. Thus, although the S and C tones differed in pitch, the melodic intervals formed by the S and C combinations were identical in size. Furthermore, in Condition D2(i), a tone of pitch identical to that of C tone was included in the fourth serial position of the interpolated sequence, and a tone of pitch identical to that of the tone preceding the C tone was included in the second serial position. In Conditions D3 and D3(i), the tone preceding the C tone was again a semitone removed from the tone preceding the S tone; however, the direction of this shift was opposite to the direction of shift between the S and C tones. That is, when the C tone was higher than the S tone, the tone preceding the C tone was lower than the tone preceding the S tone. And when the C tone was lower than the S tone, the tone preceding the C tone was higher than the tone preceding the S tone. Thus, the melodic intervals formed here by the S and C combinations were different in size. Furthermore, in Condition D3(i), a tone of pitch identical to that of the C tone was included in the fourth serial position of the interpolated sequence, and a tone of pitch identical to that of the tone preceding the C tone was included in the second serial position.

Each condition consisted of 12 sequences, so that there were 108 sequences in all. These were presented in random order in groups of 12, with 10-sec pauses between sequences within a group and 2-min rest periods between groups. The subjects listened to the entire set of sequences on two separate days, and the results were averaged.

Tonal Stimuli

These were taken from an equal-tempered scale (International Pitch; A = 435 Hz). The following frequencies were employed as S tones: F = 345; G = 388; A = 435; B = 488; C# = 548; D# = 615. Each of these S tone frequencies was employed twice in all conditions. In the conditions in which the S and C tones differed in pitch, on half of the sequences the C tone was a semitone higher than the S tone, and on the other half the C tone was a semitone lower. The tones preceding the S and C tones were as specified by the experimental condition, and thus ranged from C = 259 to C = 517. The interpolated tones were taken from the same scale, and ranged from the A below middle C to the E over an octave above. The frequencies employed, therefore, were: A = 218; A# = 230; B = 244; C = 259; C# = 274; D = 290; D# = 308; E = 326; F = 345; F# = 366; G = 388; G# = 411; A = 435; A# = 461; B = 488; C = 517; C# = 548; D = 581; D# = 615; and E = 652. The tones were chosen at random from this set except for the following restrictions. No interpolated sequence contained repeated tones or tones that were separated by octaves. Furthermore, no interpolated sequence contained tones that were identical in pitch to the S tone, the C tone, or their preceding tones, or that were a semitone removed from the S tone. Tones were also excluded that were exactly an octave removed from such tones.

Subjects

Twenty-six undergraduates at the University of California at San Diego served as subjects in this experiment and were paid for their services. They were selected on the basis of obtaining a score of at least 85% correct on a short tape containing similar sequences, but on which the S and C tones were not paired with preceding tones of lower pitch.

Apparatus

Tones were generated by a Wavetek oscillator controlled by a PDP/8L computer, and the output was recorded on high-fidelity tape. The tape was played to subjects through speakers on a Revox tape recorder, the output of which was passed through a Crown amplifier.

RESULTS

The results of the experiment were analyzed separately for sequences in which the S and C tones were identical in pitch and for sequences in which they differed.

S and C Tones Identical

The error rates in the three conditions in which the S and C tones were identical in pitch are shown in Table 1. It can be seen that, as predicted, the error rates were higher for sequences in which the S and C combinations formed melodic intervals of different size than for sequences in which they formed melodic intervals of the same size. This effect was found to be significant, both when comparing Conditions S1 and S2 ($p < .005$, one-tailed, on a Wilcoxon test) and also when comparing Conditions S1 and S2(i) ($p < .01$, one-tailed, on a Wilcoxon test). Conditions S2 and S2(i) did not differ significantly from each other.

S and C Tones Different

The error rates in the six conditions in which the S and C tones differed in pitch are also shown on Table 1. Separate comparisons were made between

Table 1
Percent Average Error in the Different Conditions of the Experiment

Condition								
S and C Tones Identical			S and C Tones Different					
S1	S2	S2(i)	D1	D2	D3	D1(i)	D2(i)	D3(i)
9.0	14.6	12.5	11.2	18.8	13.1	30.6	47.9	31.6

conditions in which the components of the C combination were excluded from the interpolated sequence (Conditions D1, D2, and D3) and between conditions in which components of the C combination were included [Conditions D1(i), D2(i), and D3(i)]. It can be seen that, for both sets of conditions, the error rates were higher for sequences in which the S and C combinations formed identical melodic intervals than for sequences in which these melodic intervals differed. This effect was highly significant for all comparisons [Conditions D1 vs. D2; Conditions D3 vs. D2; Conditions D1(i) vs. D2(i); Conditions D3(i) vs. D2(i); $p < .005$, one-tailed, on Wilcoxon tests for all comparisons]. There were no significant differences between Conditions D1 and D3 or between Conditions D1(i) and D3(i).

The effect of including in the interpolated sequence tones of pitch identical to that of components of the C combination was also analyzed. This effect was found to be highly significant for all comparisons [Conditions D1 vs. D1(i); Conditions D2 vs. D2(i); Conditions D3 vs. D3(i); $p < .005$, one-tailed, on Wilcoxon tests for all comparisons.

DISCUSSION

The results obtained in this experiment confirm the hypothesis that errors in pitch recognition judgment are influenced by the melodic context in which the S and C tones are placed. When the S and C tones were identical in pitch but placed in different melodic contexts, there resulted a significant increase in the tendency to judge them as different. And when the S and C tones differed in pitch but were placed in identical melodic contexts, there resulted a significant increase in the tendency to judge them as identical. These results parallel those found with the use of harmonic intervals as relational context (Deutsch & Roll, 1974).

One question that arises concerns the possible mediation of verbal labeling in these effects. Although musical intervals were not mentioned in the instructions, and the subjects were asked to ignore all but the S and C tones, one might argue that labeling of the melodic intervals could still have taken place. To find out, the subjects were asked at the end of the experiment whether they were able to attach verbal labels to musical intervals and whether they had been doing so during the experiment. Five of the 26 subjects replied that they could name intervals to some extent, although none reliably, and none of the subjects reported having engaged in labeling during the experiment. The error patterns for these five subjects did not differ discernibly from those of the others. An explanation in terms of verbal labeling can therefore be effectively ruled out.

A second question that arises concerns the involvement of memory for the absolute pitches of the preceding tones. In sequences in which the S and C tones were identical in pitch, differences between the intervals formed by the S and C combinations were, of necessity, produced by differences between the pitches of their preceding tones. In such sequences, therefore, one might argue that the increased reports of "different" were due to a recognition of such pitch differences between the preceding tones. Some slight support for this argument comes from the finding that the tendency to judge the S tones as different was lower in Condition S2(i) than in Condition S2. In Condition S2(i), a tone of pitch identical to that of the tone preceding the C tone was included in the interpolated sequence, and this manipulation would be expected to counteract the perceived newness of this preceding tone (Deutsch, 1972, 1975). However, since the difference between Conditions S2 and S2(i) did not reach statistical significance, a strong argument cannot be made here.

In sequences in which the S and C tones differed in pitch, the effect of relational context is not subject to an alternative interpretation in terms of the absolute pitches of the preceding tones, since this effect is obtained when comparison is made both with sequences in which the preceding tones differ in pitch [Conditions D2 and D2(i) vs. D3 and D3(i)] and also with sequences in which the preceding tones remain the same [Conditions D2 and D2(i) vs. D1 and D1(i)]. In the latter case, judgments based on the pitches of the preceding tones should produce higher error rates in Conditions D1 and D1(i) than in Conditions D2 and D2(i). However, the reverse effect was in fact obtained, as predicted from the hypothesized effect of relational context.

It should be noted that, in sequences in which the S and C tones differed in pitch, a substantial increase in errors resulted from including, in the interpolated sequence, tones of pitch identical to that of components of the C combination. This effect is as expected from previous studies (Deutsch, 1972, 1975; Deutsch & Roll, 1974) and is hypothesized as due to loss of temporal or order information. That is, the subject correctly recognizes that components of the C combination had occurred, but, due to a loss of temporal or order information, he incorrectly assumes that these had been components of the S combination. The cumulation of this misrecognition effect with the effect of relational context results in a very substantial increase in errors of misrecognition. In Conditions D1 and D3, in which neither source of confusion was present, the error rates were 11.2% and 13.1%, respectively. However, in Condition D2(i), in which both sources of confusion were present, the error rate, in contrast, was 47.9%.

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