Recognition of transposed melodies by absolute-pitch possessors

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Melody recognition experiments were performed to investigate how absolute-pitch listeners deal with musical pitch in tonal context. In each trial, a short standard melody was presented auditorily with piano sounds in Experiment 1 and visually in the format of musical notation in Experiment 2, and a comparison melody followed always with piano sounds. Listeners were required to determine whether the two melodies were the same or different with respect to relative pitch. The listeners having absolute pitch performed more poorly in comparing transposed melodies than in comparing untransposed melodies and their performance for transposed melodies was significantly poorer than the listeners having no absolute pitch. These results suggest that absolute pitch may work to a serious disadvantage to musicians in dealing with melodies in different tonal contexts.

It is commonly accepted that musical pitch information is essentially of relative nature, so that in music melodic or harmonic figures are represented in structural relationships among tones (see, e.g., Krumhansl, 2000). A melodic or harmonic sequence preserves its musical identity so long as pitch relations among the constituent tones are maintained even if the sequence is transposed to a different pitch level so that all its constituent tones are changed in absolute pitch, but two musical passages sound different if a portion of one of the passages has altered and the sequence of pitch intervals among the tones is not the same. In this sense, absolute pitch (AP), strictly linked with frequencies of tones, is not essential in music. Because of the relative nature of musical pitch, processing melodies has often been investigated in a paradigm of transposed melody recognition, in which listeners hear a standard melodic sequence followed by a comparison melody transposed to a different pitch level and try to judge whether the two melodies are the same or different (e.g., Bartlett & Dowling, 1980; Cuddy & Cohen, 1976, 1979; Dowling & Fujitani, 1971; Dowling, 1986; Takeuchi & Hulse, 1992). In this task, of course, the listeners should make their decision as to the melodic identity on the basis of the relative pitch, not on AP.

In spite of the irrelevance of AP in music, AP has been commonly believed as a highly valued musical ability. Presumably, this belief seems to come from the fact that the proportion of AP possessors is significantly greater among musicians than among nonmusicians and well-known musicians often have AP. In fact, AP has several advantages in performing and composing music. For example, AP may be highly useful in sight-reading a musical score in that musicians with AP are able to easily have a representation of musical passages when reading a musical score, and AP may also assist musicians when writing down heard or imagined musical phrases in musical notation. However, AP is simply an ability to identify musical pitch categories of isolated tones without regard to tonal contexts, neither more nor less than that, although it may be a rare ability. Considering that essential in music is relative pitch not AP, it could be argued that the belief respecting AP as an amazing musical talent is misleading.

Contrary to the common belief favoring AP, previous experiments (Miyazaki, 1993, 1995) demonstrated evidence for a drawback of AP. In those experiments, two tones were presented successively in different tonal contexts (musical keys) that were established by a preceding cadential chord sequence, and listeners were asked to identify the relative pitch name of the second tone relative to the tonic note (the first tone) in a given key context. Listeners not having AP performed this task fairly well regardless of the key context. By contrast, AP listeners were strongly influenced by the key context; they had more difficulty in naming musical intervals beginning with non-C references (F#, out-of-tune C, and out-of-tune E) than beginning with the C reference, and, moreover, their performance with the non-C references was significantly poorer than that of the no-AP listeners. The poorer performance of the AP listeners in identifying relative pitch stands in striking contrast to their nearly perfect accuracy in naming AP.

These results could be interpreted as demonstrating a weakness of AP listeners in perceiving pitch relations in a tonal context. Although the decrement of performance of the AP listeners was quite striking, the experiment had only a small significance to music because the task employed tapped simply identification of a musical interval, a very basic musical element. Moreover, it may be argued that the poorer performance of the AP listeners may be due to their lack of training to name relative pitch in the movable-*do* system (Miyazaki, 1995). The purpose of the present experiments was to investigate further the suggested weakness of AP listeners in dealing with musical pitch in different tonal contexts by employing a paradigm of melody recognition.

EXPERIMENT 1

In this experiment, processing of musical pitch relationship was examined by using the paradigm of the transposed melody recognition that had been commonly used in studies on melody recognition. Listeners compared two melodies; the first was a novel short melody and the second was a transposed version of the preceding melody, either an exact transposition or a lure melody a single tone of which is changed in pitch. Listeners are required to decide whether the two melodies are exactly the same in terms of pitch relationship. The present experiment focuses on the possible difference in performance between AP listeners and no-AP listeners. If the AP listeners had a high reliance on a coding strategy based on AP and had difficulty in perceiving tonal relationships, as suggested from the results of the previous experiments, they would exhibit a similar disadvantage in recognizing transposed melodies.

METHOD

Stimulus. Examples of stimuli presented are shown in Figure 1. In each trial, participants heard a pair of short melodies successively. Both melodies consisted of 7 tones belonging to the diatonic major scale tuned to equal temperament (A4=440 Hz). The first melody (the standard melody) was played always in the C major, and the second melody (the comparison melody) was either in the same key as the standard (the C major) or transposed to two different keys: the F# major and a slightly shifted major key with a quarter-tone lower E as a tonic (designated the E– major, hereafter). Both the standard and the comparison melodies were preceded by a pair of two successive chords, which formed the conventional cadence (V7-I) of the same key as the melody. This chord sequence was introduced to enable the subjects to establish the key context for the melody. Each melody began with the tonic note (*do*) and was constructed according to the musical practice so as to be a natural melody by arranging the diatonic tones from the lower fifth degree note (*so*) to the upper sixth degree note (*la*). The interval size between successive tones within the melodies ranged from 1 to 9 semitones. The comparison melody was either exactly the *same* as or *different* from the standard. The different comparison melody had one of 5 middle tones shifted to a lower or upper adjacent tone in the major scale; the shift could be either a semitone or a whole tone depending on its location in the scale. Melodic contour (the sequence of directions of pitch progression in a melody) of the comparison melody was kept the same as the standard in spite of the pitch shift.

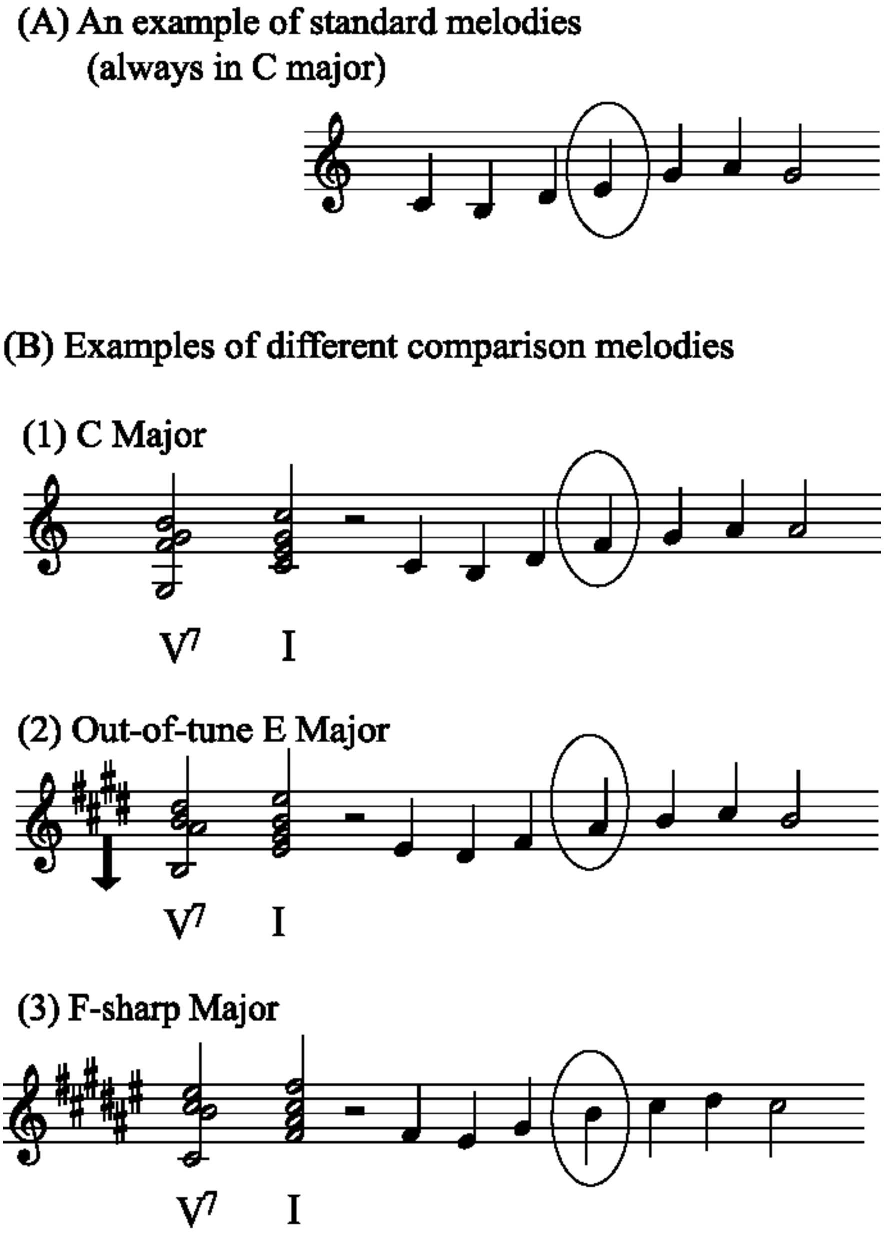

Figure 1. Examples of a standard melody and comparison melodies used in Experiment 1. The standard melody (A) was presented always in the C major key, and the comparison melody was presented either in the same key as the standard melody (untransposed) or in transposed key (shifted upward by 3.5 or 6 semitones). Note that the comparison melody in the same pair is exactly the same in relative pitch, and that in the different pair includes one tone shifted upward or downward by one scale step; the shifted tones are circled.

The chord sequence and the melodic sequence were presented at a tempo of 180 quarter notes per minute; each chord was 667-ms in duration and there was a 667-ms silent interval between the last chord and the first note of the standard/comparison melody. Constituent tones of the melodies were about 300 ms in duration and the onset-to-onset time intervals were

333-ms. There was a 700-ms pause between the offset of the last tone of the standard melody and the beginning of the first chord of the cadence leading to the comparison melody. There was a 4-s time interval between the end of the comparison melody and the beginning of the stimulus of the next trial, during which listeners were allowed to respond. Thirty standard melodies were constructed and the same melody set was used in the three key conditions. Sixteen standard melodies were paired with exactly the same comparison melodies and fourteen were paired with the different comparison melodies in terms of relative pitch.

Apparatus. Generating and presenting stimulus melodies, registering participants' responses, and measuring response times were carried out by an Apple Macintosh IIci computer and a MIDI system interfaced to the computer with a MIDI interface (Mark of the Unicorn, MIDI TimePiece II). The melody and the preceding chord sequence were composed and played using a sequencing software (Mark of the Unicorn, Performer) with sampled piano-tones generated from a tone generator module (Yamaha, TX-1P). All the stimulus tones were presented to participants through a loudspeaker (Yamaha, NS-1000M) located in front of the listener at a comfortable level. The listeners made a response as quickly as possible by pressing one of two keys labeled "Same" and "Different" on a musical keyboard (Yamaha KX-88). Responses were recorded as MIDI signals by using the sequencing software (Performer), and response times as well as response accuracy were read from the MIDI data. Measurements of response times are not so straightforward. In this task that require listeners to differentiate whether the two melodies were the same or different, it might be more justified to measure response time from the onset of the critical tone for determining whether the two melodies were the same or different; the critical tone could be the altered tone for the *different* comparison melody and the penultimate tone for the *same* melody. Nevertheless, response time was defined here as the time interval from the onset of the last tone of the comparison melody and the listener's keypress. The response time defined in this manner would be negative, if listeners made a response before the last tone of the comparison melody. However, this may not be a problem, because the primary interest of the present experiment was the comparison of response speed between transposed and nontransposed conditions and between AP group and no-AP group. Actually, most listeners made a response after hearing the comparison melody to the end and compared the whole shapes of melodies.

Procedure. Listeners were asked to determine whether the two melodies successively presented were exactly the same or slightly different in terms of relative pitch and to press a corresponding key as fast as possible. They were particularly instructed that the two melodies should be judged as “same” if the two melodies had the same pitch relationship among the constituent tones even if they were played at the different pitch levels (they were different in terms of AP). After the instruction, a practice session including five same trials and five different trials was given. The experimental session consisted of 90 trials, 30 in each key condition. The three key conditions appeared in random order with the constraint that any two successive trials were not in the same key condition.

Participants. Twenty-eight students in the Department of Music Education of Niigata University participated in the experiment. On the basis of the results of an AP test conducted prior to the melody experiment, they were classified as the AP group of 17 listeners and 12 no-AP (NAP) group; the former gave more than 80% correct responses (average, 94.3 %) and the latter gave less than 65% (average, 41.7%), with octave errors permissible.

RESULTS

Response accuracy of melody comparison is displayed in bars in Figure 2 for the AP group and NAP group separately. Chance level is 50%. In the C major (nontransposed) context where the two melodies were compared at the same pitch level, both the AP and the NAP group gave the highest level of performance, whereas, in the E– and F# context where the comparison melody was transposed to the different pitch level from the standard melody, both groups performed markedly worse. Notably, the AP group performed more poorly than the NAP group. All these differences were confirmed by an overall 2-way analysis of variance (ANOVA) with the between-subject factor of AP possession and the within-subject factor of key context; both the main effects of AP possession and key context were significant [$F(1, 27) = 5.95$, $p<.025$, and $F(2, 54) = 13.96$, $p < .001$, respectively]. The AP Possession x Key Context interaction was also significant [$F(2, 54) = 4.06$, $p<.025$],

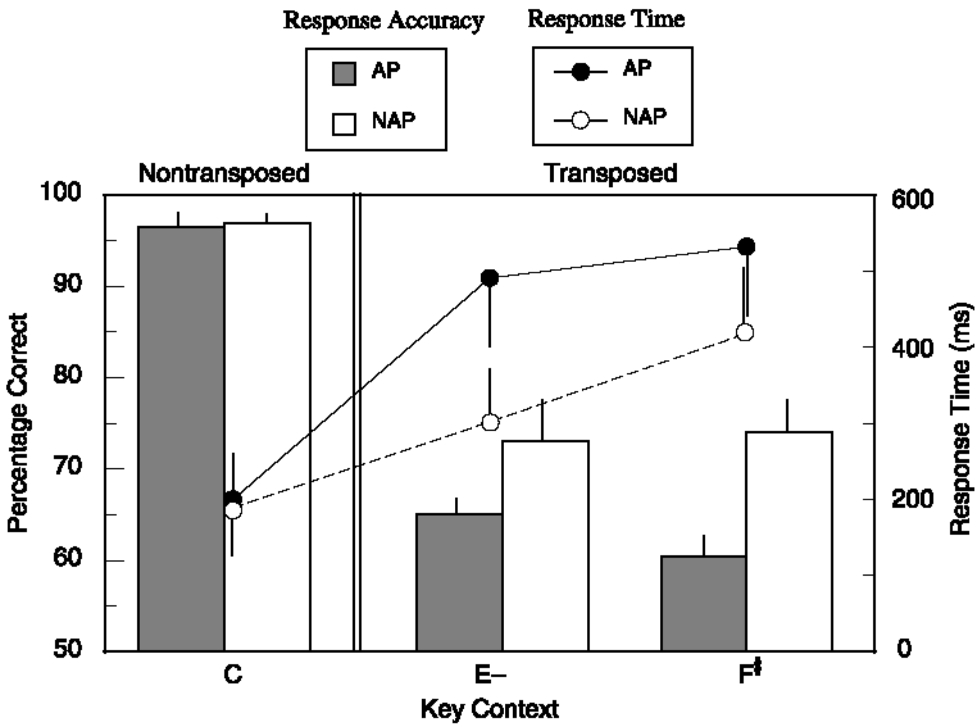

Figure 2. Response accuracy (columns) and speeds (lines) as a function key context of the comparison melodies for the absolute-pitch listeners (AP) and the no-absolute-pitch listeners (NAP), obtained in Experiment 1

The primary interest of this experiment is in the comparison of performance between the AP and NAP groups in the transposed condition where listeners had to compare the melodies at different pitch levels (keys). Hence, an additional 2-way ANOVA was carried out only on the data in the transposed conditions. There was a significant main effect of AP possession [$F(1,27) = 6.84$, $p<.02$], but neither main effect of key context [$F(1, 27) = 0.93$] nor interaction between these two factors [$F(1, 27) = 0.93$] emerged. This analysis indicated that the NAP group performed better than the AP group in discriminating transposed melodies, and that both groups showed no difference in performance between the E– and F# conditions.

To examine these differences in more detail, the correlation between the accuracy of melody recognition (melody scores) and the accuracy of AP (AP scores) for individual listeners is graphically represented in Figure 3 as a scatterplot. Dots plotted in the scattergrams represent the individual participants whose melody scores are plotted on the ordinate and the AP scores on the abscissa. Melody scores of the NAP listeners (represented by open circles) were widely distributed from the lowest (near chance) to the highest, whereas those of the AP listeners (represented by closed circles) were tightly clustered in the range of relatively low performance. There was a significant negative correlation between the melody scores and the AP scores when calculated for all the listeners (r = -.458, n=28, p<.02).

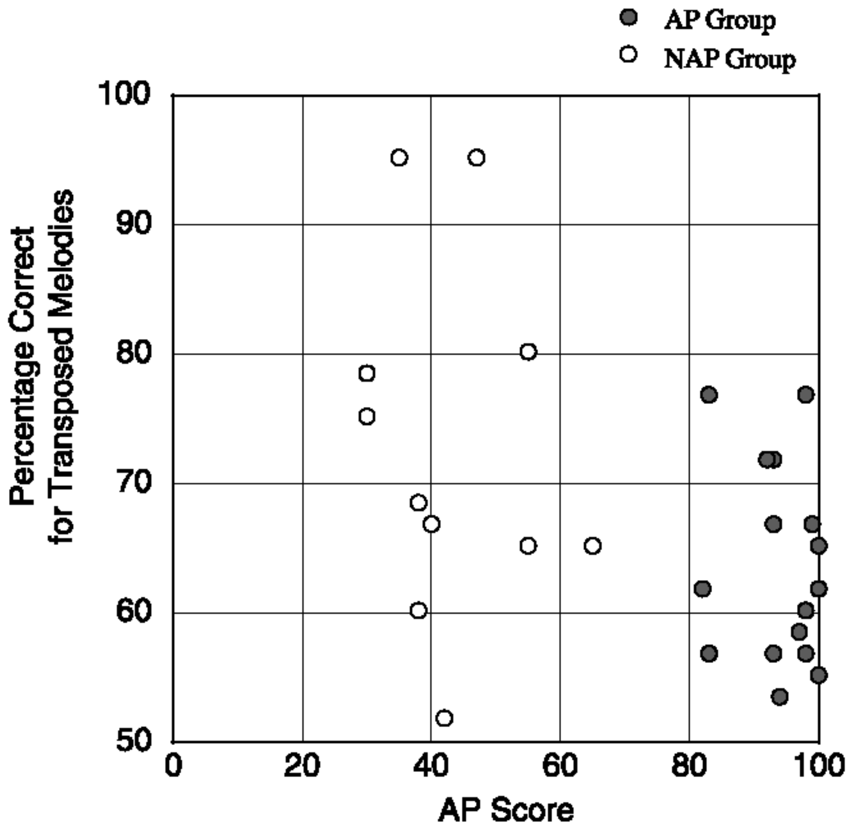

Figure 3. Scatterplot showing the correlation between the accuracy of absolute-pitch identification (abscissa) and transposed melody recognition (ordinate). Closed circles represent absolute-pitch listeners and open circles represent no-absolute-pitch listeners.

Averaged response times (RTs) displayed by lines in Figure 2 showed the similar features as the accuracy data. In the nontransposed key context (C major), responses were the fastest and there was no difference in RTs between the AP and the NAP groups. As compared with this, responses were slower in the transposed context and the AP group responded even more slowly than the NAP group. An overall 2-way analysis of variance (ANOVA) with the between-subject factor of AP possession and the within-subject factor of key context revealed a significant main effect of Key Context [$F(1,27) = 39.47$, $p<.001$] and a significant interaction between Key Context and AP Possession [$F(2,54) = 3.73$, $p<.05$], but a main effect of AP Possession was not significant [$F(1,27) = 0.93$] mainly because RTs were widely dispersed among listeners. The significant interaction reflects that RTs were longer for the AP group than

NAP group in the transposed context, whereas RTs were very similar for the two groups in the nontransposed context. An additional ANOVA on RTs for the transposed conditions showed that only a main effect of Key Context was significant [$F(1,27) = 9.65$, $p<.005$], but a main effect of AP possession and a Key Context x AP Possession interaction was not significant [$F(1,27) = 1.47$, $p>.1$, and $F(1,27) = 2.22$, $p>.1$, respectively].

DISCUSSION

In the nontransposed (C major) condition in which the comparison melody begins at the same pitch level (or key) as the standard melody, the *different* version of comparison melody has a new tone that is not in the standard melody, and so it should be very easy to judge *same* or *different* by directly comparing APs between the two melodies in short-term memory. The finding that both the AP and NAP groups performed very well in the nontransposed condition indicates that short-term memory for pitch is a general ability independent of AP (long-term memory for pitch).

In contrast, in the transposed (E– or F# major) condition in which the comparison melody is presented at the different pitch levels from the comparison melody, all the corresponding tones of the melodies differ in AP. The direct comparison of AP that was useful in comparing untransposed melodies should be useless in this condition, and so listeners have to compare the melodies in terms of relative pitch (musical intervals) of tones. Thus, the comparison of melodies in the transposed condition needs completely different processing from that needed in the nontransposed condition. It seems that whereas encoding AP in short-term memory is relatively easy and independent on musical experience, encoding relative pitch is a more difficult task that entails a higher level of abstraction and is dependent on musical experience.

The most important result is that the AP group produced a significantly poorer performance for transposed melodies than the NAP group. It would be argued here that the groups to be compared must be equal in the degree of ability and experience in music in order to establish the validity of the comparison between the groups. However, in the present case, the two groups are inevitably more or less different in the musical experience, because most AP listeners have acquired AP through extensive musical training beginning early childhood (Takeuchi & Hulse, 1993; Ward, 1999), resulting in an unintended confound between the factor of AP accuracy and of the degree of musical experience or musical ability. This confound is expected to yield better performance in the AP group than the NAP group. However, contrary to the prediction, the obtained results indicated that the AP group was less accurate in discriminating transposed melodies than the NAP group. Thus, the possible difference in musical experience between the AP and NAP listeners, if any, makes the observed difference in accuracy between them more impressive. Along with the previous findings obtained from the interval-identification experiments (Miyazaki, 1993, 1995) demonstrating that some AP listeners can't tell the name of musical intervals, the present results provide additional evidence for the disadvantageous aspect of AP.

EXPERIMENT 2

When listeners are required to compare melodies presented auditorily as in Experiment 1, the nontransposed condition in which the melodies are played at the same pitch level is not considered to be a control condition with which performance in the transposed condition is compared. The problem of Experiment 1 is that in the nontransposed condition comparisons could not be made on the basis of melodic identity but short-term memory for pitch. Then, a new experimental task was devised for Experiment 2, in which standard melodies were displayed visually in the form of musical notation and comparison melodies were presented auditorily. Listeners were required to judge whether the comparison melody was identical to the notated standard melody. This paradigm is expected to enable to make meaningful comparisons between the transposed and nontransposed conditions. Specifically, listeners who continue to adopt the AP coding strategy are predicted to perform worse for transposed melodies than for nontransposed melodies, because the AP strategy may be ineffective in comparing transposed melodies whereas it may work well at any rate for comparing nontransposed melodies. In contrast, listeners having AP who can adopt the AP or RP strategy flexibly and those having no AP are expected to perform equally well in the transposed and nontransposed conditions.

METHOD

Stimulus. A pair of melodies (a standard melody and a comparison melody) was presented successively. The standard melody was in a format of musical notation as a sequence of quarter notes placed on a C-major musical staff with a treble clef and displayed in the center of the monitor screen in front of listeners. The melody consisted of 5 tones of the diatonic major scale from F3 to C5 beginning with the central C4, and had intertone intervals within 5 semitones. The comparison was presented auditorily in a sampled-piano timbre either in the same key as the notated standard or in transposition (the F# major and the E– major). There was an authentic cadence (V7-I) in the key of the comparison melody to establish the key context in which the melody was to be heard. The cadence started 5 sec after the onset of the display of the standard melody that remained on the screen until a response was made. The cadence and the comparison melody were played at a tempo of 150 quarter notes per minute; thus, each chord in the cadence was 800 ms and each tone in the melody was 400 ms (only the last tone was 600 ms); there was an 800-ms silent interval between the cadence and the melody and no silent gap between chords and between melodic tones. The different version of the comparison melody had one of 3 middle tones shifted to a lower or upper adjacent tone in the scale with the constraint that melodic contour was never changed.

Twenty pairs of the standard/comparison melodies were prepared for each key condition, resulting in 60 experimental trials per participant. Of 20 melody pairs, 8 pairs were the same and the other 12 pairs were different.

Procedure. The listeners' task was to determine whether the comparison melody was exactly the same as the notated standard with respect to relative pitch. Listeners sat in front of a music keyboard used for responding and a computer monitor placed behind it, and were instructed to respond as fast and as accurately as possible by pressing one of the two keys labeled as "same" and "different." There were 18 practice trials including the same number of the *same* and *different* trials for each key condition, and then 60 experimental trials followed. The comparison melody was randomly assigned to one of the three keys with the constraint that any two successive trials were not in the same key condition.

Apparatus. Generating and presenting stimulus melodies, registering participants' responses, and measuring response times were carried out by a computer (Apple, Macintosh) and a MIDI system interfaced to the computer with a MIDI processor (Mark of the Unicorn, MIDI

Timepiece II). Musical notation of the standard melody was presented in the center of the computer display (Apple, 13-inch color display). The sounds of the comparison melody and the preceding chord sequence were generated from a tone generator module (Yamaha TX-1P) and presented to participants through a pair of loudspeakers (Bose, 501X) at a comfortable level. The participant used a musical keyboard (Kurzweil, K-1000) for responding. A HyperCard software (Apple) with a programming language HyperTalk was used for controlling the experimental setup, and HyperMIDI external commands (EarLevel Engineering) were used for controlling the MIDI system and measuring response times (Miyazaki, 1998).

Participants. Twenty-seven students in the Department of Music Education of Niigata University participated in the experiment. No one had participated in Experiment 1. Before the experiment, listeners had an AP test that used 60 chromatic piano-tones spanning from C2 to B6. According to the results of the AP test, they were classified into three groups; the AP1 group (9 accurate AP listeners), the AP2 group (9 inaccurate AP listeners), and the NAP group (9 listeners not having AP). The percentage correct was more than 90%, 50-86%, and less than 40%, respectively, with octave errors permissible.

RESULTS

Response Accuracy. Response accuracy was shown in bars in Figure 4. A two-way ANOVA with AP level as a between-participants factor and Key as a within-participants factor was performed on the accuracy data. There was a significant main effect of AP level [$F(2,24) = 26.01$, $p<.001$], and of Key [$F(2,48) = 55.05$, $p<.001$]. There was also a significant interaction between AP level and Key [$F(2,48) = 10.29$, $p<.001$]. The significant interaction indicates that the effect of Key was different among the groups of different AP levels, that is, the NAP group showed little effect of Key, giving nearly equal level of performance in any key conditions. This is quite natural because NAP listeners can make comparisons of melodies equally well irrespective of the key in which melodies are played. In contrast, the AP groups (AP1 and AP2) showed a marked effect of Key, that is, although the AP listeners were very accurate in discriminating the nontransposed melodies and so achieved slightly better performance than the NAP listeners, their performance decreased in the transposed conditions, thereby showing lower performance than the NAP listeners; notably, in the F# major condition, the percentage of correct responses of the AP listeners dropped to near chance (50%). Such inaccuracy the AP listeners exhibited in recognizing transposed melodies as compared with the untransposed melodies is inconsistent with the prediction from the principle of equivalence of melodies under transposition.

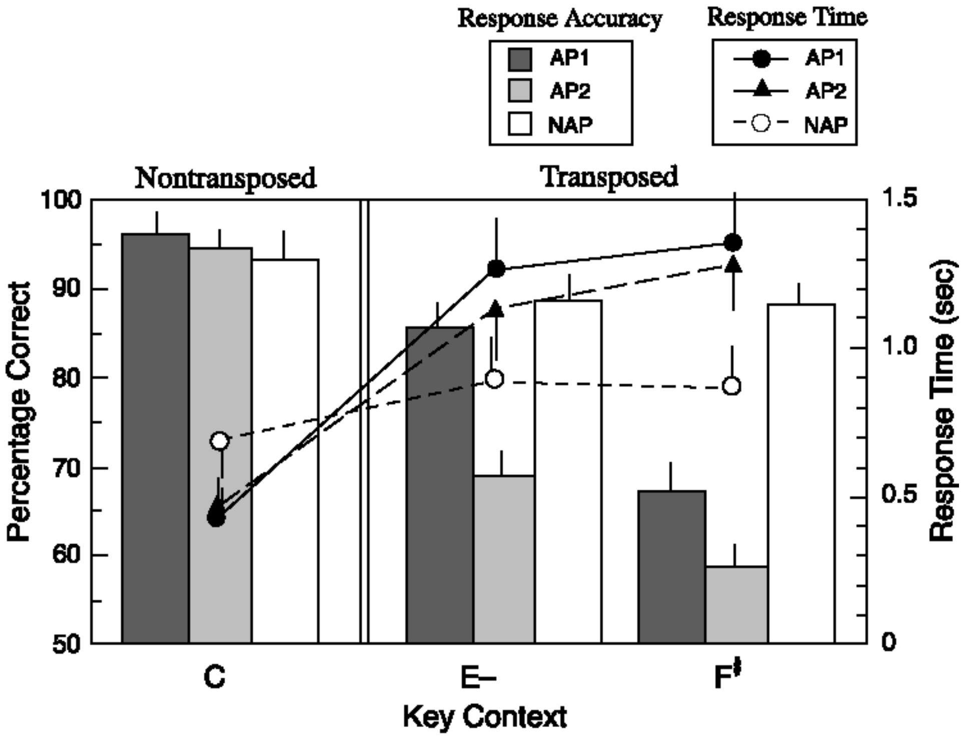

Figure 4. Response accuracy (columns) and speeds (lines) as a function key context of the comparison melodies for the accurate absolute-pitch listeners (AP1), the inaccurate absolute-pitch listeners (AP2), and the no-absolute-pitch listeners (NAP), obtained in Experiment 2.

Subsequent analyses showed that simple main effects of Key were significant for both the AP1 and AP2 groups [$F(2, 48) = 29.00$, $p<.001$, and $F(2, 48) = 45.63$, $p<.001$, respectively], and pairwise comparisons (Tukey's HSD) showed all the differences among the Key conditions were also significant ($p<.05$), indicating that, of the transposed conditions in which performance was poorer than the nontransposed condition, the F# major condition was even worse than the E– condition. In contrast, the simple main effect of Key was not significant for the NAP group [$F(2, 48) = 1.02$], suggesting that the NAP listeners did not differ in performance among the key conditions.

Simple main effects of AP Level were significant for both the E– and F# major conditions [$F(2, 72) = 15.48$, $p<.001$, and $F(2, 72) = 31.06$, $p<.001$, respectively]. Pairwise comparisons revealed that, for the E– major condition, the AP2 group was significantly less accurate than the AP1 and NAP groups ($p<.05$), but the AP1 and NAP groups did not differ significantly; for the F# major condition, both the AP1 and AP2 groups were significantly less accurate than the NAP group ($p<.05$) and were not significantly different from each other. The simple main effect of AP Level was not significant [$F(2, 72)=0.26$] for the C major condition, indicating that performance was not different among the participant groups of different AP levels.

Individual accuracy is shown in Figure 5 for each participant group. The pattern of results of most listeners in each group is consistent with that of the group averages. Performance of most listeners of the AP1 and AP2 groups declined sharply in the transposed key conditions compared with the nontransposed condition. Notable is near chance performance of some of the AP listeners for transposed melodies. In contrast, NAP listeners showed no marked difference between key conditions.

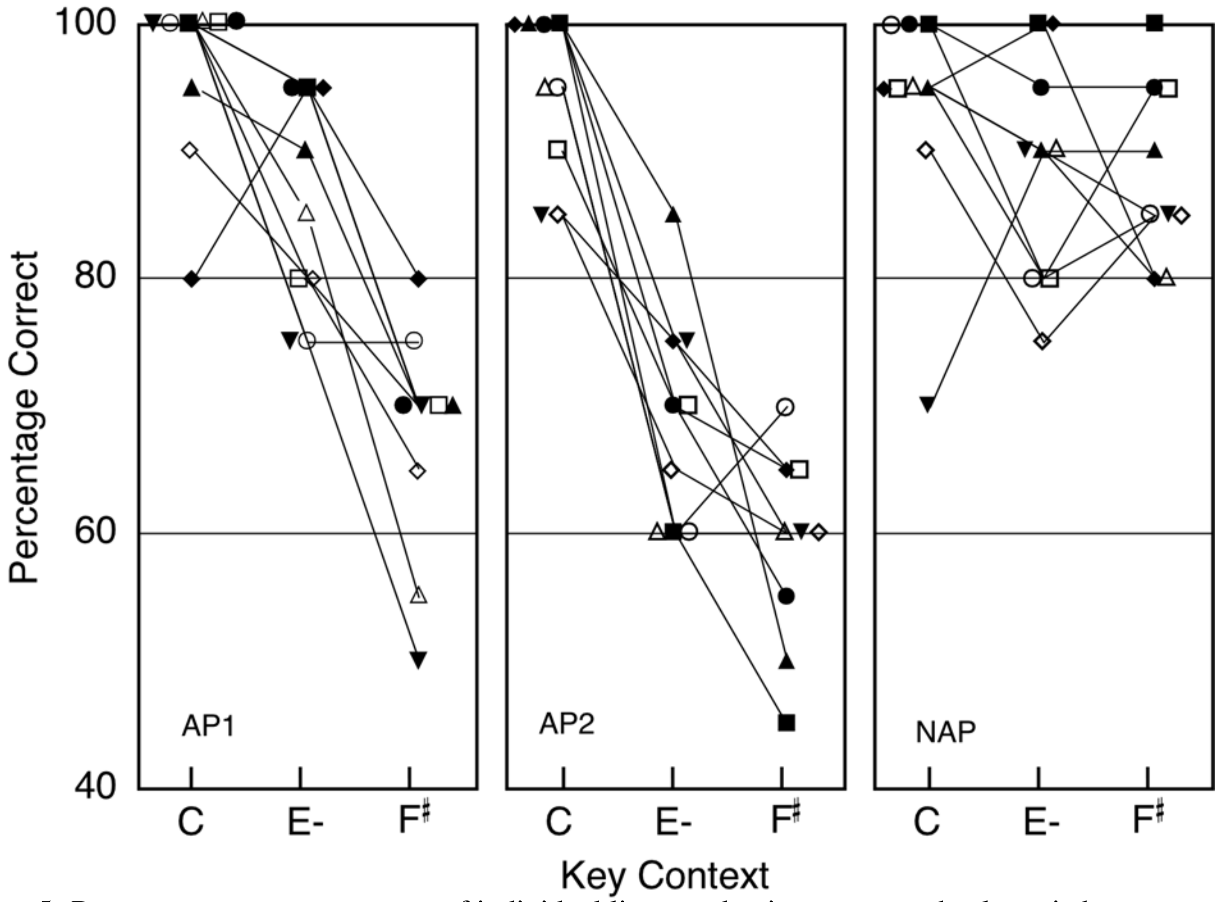

Figure 5. Percentage correct responses of individual listeners having accurate absolute pitch (AP1), having inaccurate absolute pitch (AP2), and having no absolute pitch (NAP). Different symbols connected denote different listeners.

Response Times. Averaged response times are presented by lines in Figure 4. The AP listeners showed longer RTs in the transposed condition than in the untransposed condition, whereas the NAP listener showed similar RTs in all the key conditions. This pattern of results confirmed by a two-way ANOVA with AP Level as a between-participants factor and Key as a within-participant factor. The main effect of Key and the interaction between Key and AP Level were significant [$F(2, 48) = 32.05$, $p<.001$, and $F(4, 48) = 4.11$, $p<.01$, respectively], but a main effect of AP level was not significant [$F(2, 24) = 0.96$].

As the significant interaction was found, simple main effects were further analyzed. Both the AP1 and AP2 groups showed significant simple main effects of Key [$F(2, 48) =22.67$, $p<.001$, and $F(2, 48) =16.59$, $p<.001$, respectively], and multiple comparisons (Tukey's HSD) between the key conditions revealed significant differences between the C major and the other two conditions ($p<.05$) but no significant difference between the E– and the F# major conditions, for both the AP1 and AP2 groups. However, the simple main effect of Key was not significant for the NAP group [$F(2, 48) = 1.01$], suggesting that the NAP listeners did not differ in response speed among the key conditions.

Simple main effects of AP Level were significant only for the F# major condition [$F(2, 72) =3.65$, $p<.05$], but not significant for the C major condition [$F(2, 72) =0.92$] and for the E– major condition [$F(2, 72) =1.89$, $p>.05$]. Multiple comparisons for the F# major condition revealed a reliable difference only between the AP1 and the NAP groups.

DISCUSSION

In Experiment 2, listeners compared a notated standard melody visually displayed and a comparison melody auditorily presented and judged whether the two melodies were the same or different regardless of the key differences (differences in AP). The NAP listeners showed fairly good performance irrespective of whether or not the comparison melody was played at the same key as the standard melody, indicating that they performed mainly on the basis of relative pitch. The most important result, however, was that the AP listeners exhibited considerably lower performance and longer response times when the comparison melody was played in different keys from the standard melody, and, furthermore, the AP listeners' performance in comparing melodies presented in different keys was significantly poorer than the NAP listeners' performance. This suggests that the AP listeners had considerable difficulty in processing relative pitch information in melodies. This pattern of results is consistent with that of Experiment 1 where the two melodies to be compared were presented auditorily.

The present experiment differed from Experiment 1 and other previous experiments in that the standard melody was presented as a musical score. On the surface, the conventional musical notation system represents AP information of musical passages; melodies are written in the score as AP sequences. However, musicians who do not have AP are insensitive to AP in the musical score but are able to read relative-pitch information within a certain tonal context. Therefore, in the present experiment, the discrepancy in AP information between the standard melody in notation and the comparison melody in sound should not interfere with performance of the NAP listeners, and so they were able to perform equally well in all key conditions by using relative pitch.

On the other hand, for AP listeners, the musical score would be, first of all, a representation of AP, and so it may be easier for them to read AP information than to read relative pitch information from the score, because they have strong associations between perceived pitch and pitch names or notated notes and presumably reading AP information from the score may be more or less automatic for them. Therefore, when the comparison melodies are presented in the same key as the notation of the standard melody, the AP listeners have only to decide whether or not there is a tone whose pitch is different from the standard melody notation in an ongoing comparison melody. Hence, the melody discrimination task given in the present experiment may actually be comparable to a simple odd-tone detection task for the AP listeners. In fact, they performed near perfect in this condition.

However, this strategy based on AP should not work in comparing transposed melodies. As demonstrated in the present experiment, performance of the AP listeners declined in the transposed condition compared with the untransposed condition. Presumably, this poorer performance is caused by the conflict between the written pitches of the notated standard melody and the perceived pitches of the comparison melody. Such degraded performance would not have occurred, if the AP listeners completely suppressed the AP strategy and switched to the relative pitch strategy. Acturally the opposite result was observed suggesting that the AP listeners persisted in relying on the AP coding strategy.

Practically, the AP listeners seemed to devise various tricky strategies exploiting AP to surmount the difficulty in comparing transposed melodies. For example, according to introspective remarks obtained from some of AP listeners after the experiment, one tried to read the standard melody written in the C major on a staff with the treble clef as if it were written in E major on a staff with the bass clef (see Figure 6A), and the other tried to read the C major melody in E major by mentally shifting notes upward by one line in the notation (see Figure 6B). Such a strategy would be useful to compare comparison melody played in the E– major with the standard melody written in the C major notation; small pitch deviation of the E– major melody from the standard pitch seems to be less interfering.

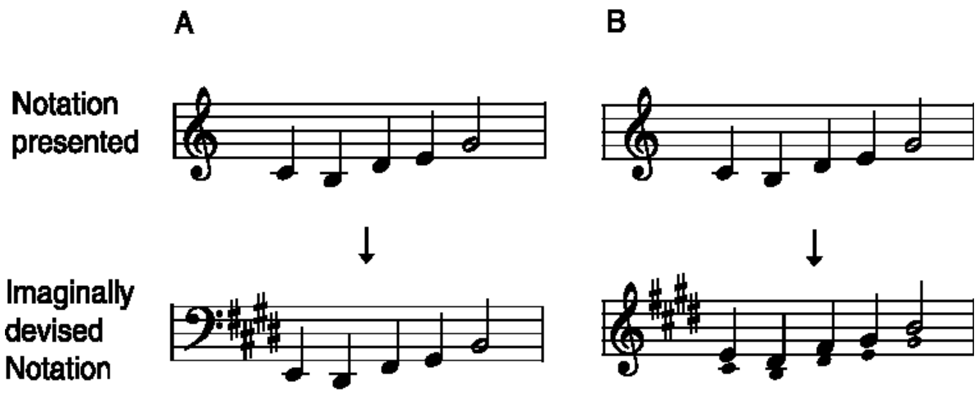

Figure 6. Examples of imaginal notations devised by absolute-pitch listeners in recognizing transposed melodies.

On the two transposed conditions, performance of the AP listeners was even poorer in the F# context than in the E– context in the present experiment. This is partly accounted for by the fact that the tricky strategies mentioned above were useful in the E– context but not in the F# context. Alternatively, it may be more difficult for the AP listeners to compare the comparison melody played in the F# context with the standard melody written in the C major notation, because the F# context was more distant key from the C major than the E context both in the pitch-class circle and in the fifth circle.

CONCLUSION

Converging evidence for the disadvantage of AP in recognizing transposed melodies was obtained both in Experiment 1 where melodies to be compared were both presented in sound and in Experiment 2 where comparison melodies presented auditorily were compared with notated standard melodies. The results were consistent with the previous findings obtained from experiments on musical interval identification where musical intervals were presented at different pitch levels (Miyazaki, 1993, 1995). The poorer performance of the AP listeners in recognizing transposed melodies could be accounted for by their high reliance on the AP coding strategy. The strong tendency of AP listeners to use AP even when it is ineffective as in the case of recognizing transposed melodies suggests that the AP mode may be so automatic for AP listeners that they are not able to switch to the relative pitch mode suppressing AP. Supposedly, they may have not developed relative pitch to the full. Considering that relative pitch is essential in musical activities, such inadequacy of AP listeners in processing relative pitch would entail a serious drawback of AP in music.

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