American Psychological Association

Psychomusicology: Music, Mind, and Brain

0275-3987/18/$12.00

2018, Vol. 28, No. 3, 178–188
http://dx.doi.org/10.1037/pmu0000219

A Cross-Cultural Comparison of Tonality Perception in Japanese, Chinese, Vietnamese, Indonesian, and American Listeners

Rie Matsunaga
Kanagawa University and Hokkaido University

Toshinori Yasuda
Waseda University

Michelle Johnson-Motoyama
Ohio State University

Pitoyo Hartono
Chukyo University

Koichi Yokosawa and Jun-ichi Abe
Hokkaido University

We investigated tonal perception of melodies from 2 cultures (Western and traditional Japanese) by 5 different cultural groups (44 Japanese, 25 Chinese, 16 Vietnamese, 18 Indonesians, and 25 U.S. citizens). Listeners rated the degree of "melodic completeness" of the final tone (a tonic vs. a nontonic) and "happiness–sadness" in the mode (major vs. minor, YOH vs. IN) of each melody. When Western melodies were presented, American and Japanese listeners responded similarly, such that they reflected implicit tonal knowledge of Western music. By contrast, the responses of Chinese, Vietnamese, and Indonesian listeners were different from those of American and Japanese listeners. When traditional Japanese melodies were presented, Japanese listeners exhibited responses that reflected implicit tonal knowledge of traditional Japanese music. American listeners also showed responses that were like the Japanese; however, the pattern of responses differed between the 2 groups. Alternatively, Chinese, Vietnamese, and Indonesian listeners exhibited different responses from the Japanese. These results show large differences between the Chinese/Vietnamese/Indonesian group and the American/Japanese group. Furthermore, the differences in responses to Western melodies between Americans and Japanese were less pronounced than that between Chinese, Vietnamese, and Indonesians. These findings imply that cultural differences in tonal perception are more diverse and distinctive than previously believed.

Keywords: music perception, tonality perception, cultural differences

In the late 19th century, a group of Japanese musicians created the Japanese national anthem, "Kimigayo." Their work was composed in a "key" in traditional Japanese music, namely, D[1]-E-G-A-C being D the tonal center (i.e., a tonic in Western music) and ending tone. Japanese audiences clearly perceive the key for Kimigayo, meaning that their perceived tonal center for the song is D. A German musician, Franz Eckert (1852–1916), was asked to provide harmonic accompaniment to Kimigayo. However, it is said that Eckert appeared unable to feel the same key for the song as most Japanese did (Toukawa, 2007). For that reason, he did not provide any harmony for the beginning and ending phrases of the song. Moreover, another anecdote states that Eckert added a novel tone C (which he felt was the tonal center) following the ending tone D. These stories about the creation of Kimigayo illustrate the differing perception of tonality between Japanese listeners and the German musician. Such anecdotes regarding cultural differences have been reported in a variety of literature in the fields of music and ethnomusicology. However, the concept that underlies these stories has seldom been tested in a rigorous experimental way. The goal of the present study is to empirically assess the actual states of cultural differences in tonality perception.

Rie Matsunaga, Department of Human Sciences, Kanagawa University and Faculty of Health Sciences, Hokkaido University; Toshinori Yasuda, Faculty of Education and Integrated Arts and Sciences, Waseda University; Michelle Johnson-Motoyama, College of Social Work, Ohio State University; Pitoyo Hartono, School of Engineering, Chukyo University; Koichi Yokosawa, Faculty of Health Sciences, Hokkaido University; Jun-ichi Abe, Department of Psychology, Hokkaido University.

We gratefully acknowledge Shiho Yamada, Hiroki Motoyama, Elyse Motoyama, Yuta Sugino, Yuya Takeshita, Tami Wakebe, International Student Center of Hokkaido University, Hamamatsu Japan Language College, and Fukuroi International Friendship Association for help in running the experiment. A part of data appearing in this article were presented at the 6th Conference of the Asia-Pacific Society for the Cognitive Sciences of Music. This research was supported by the following grants awarded to Rie Matsunaga: grant-in-aid for Scientific Research (B) 23300079 and grant-in-aid for Challenging Exploratory Research 26590182 from the Japan Society for the Promotion of Science.

Correspondence concerning this article should be addressed to Rie Matsunaga, Department of Human Sciences, Kanagawa University, 3-27-1 Rokkakubashi, Kanagawa-ku, Yokohama-shi, Kanagawa 221-8686, Japan. E-mail: rm@kanagawa-u.ac.jp

[1] In music theory, the absolute pitch name (i.e., the pitch class name) of a tone is expressed as C, D . . . , A, B, and the relative pitch name of a tone is expressed as syllables *do, re,* . . . , *la*, *ti*.

Listeners perceive a certain tonality when pitches of individual constituent notes of a tone sequence are organized in a coherent structure on the basis of their "tonal schemas" (Abe, 1987; Krumhansl, 1990). Tonal schemas reflect implicit knowledge about the tonal structure of music of a listener's own culture, including knowledge of musical scale and mode.[2] As with the acquisition of language schemas, listeners gradually acquire tonal schemas through long-term and everyday exposure to music in their own cultures (Corrigall & Trainor, 2010; Krumhansl & Keil, 1982; Trainor & Trehub, 1992, 1994). Thus, the tonal schemas of listeners differ from culture to culture. Consequently, listeners from different cultures should be biased to perceive respectively different tonalities for the same melody. However, the extent of these differences versus similarities in tonal perception between cultures remains unclear.

As far as we know, only two studies have experimentally investigated tonal perception of listeners from different cultures. One study compared tonal perception of North Americans with those of Indians for traditional North Indian music (Castellano, Bharucha, & Krumhansl, 1984). A second study conducted a comparison of tonal perception of North Americans with those of Balinese for the same set of Western and Balinese music (Kessler, Hansen, & Shepard, 1984). Castellano et al. (1984) used "the probe tone task" (Krumhansl & Shepard, 1979) to compare tonal sensitivities of Indian and North American listeners. All listeners were provided various musical segments generated from musical scales of North Indian music, and both groups of listeners rated how well, in a musical sense, each probe tone fit with the preceding segment. Results revealed that for each musical segment, the probe tone with the highest rating was basically common to both Indian and North American listeners. It is generally assumed that the probe tone with the highest rating is interpretable as a tonal center perceived by listeners. Thus, Castellano et al. concluded that Indian and North American listeners perceived the same tonal center for the same musical segment. However, at the same time, there were differences between these two groups with respect to their sensitivity to other scale tones. Indian listeners showed clear sensitivity to the underlying Indian scale, whereas North American listeners did not. Similar results were found in a study by Kessler et al. (1984). Both studies focused on the comparison of tonal perception between two different cultures. The present study explores a relatively broad range of cultural differences by enlisting listener groups from several different cultures.

The purpose of the current study was to experimentally assess the extent to which five different cultural groups were similar versus different in their tonal percepts of different test melodies (from Western and Japanese cultures). The groups of listeners were selected from five different cultures (Japan, China, Vietnam, Indonesia, and the United States). We used the following methodology to obtain comparable response data among the cultures. We gave the same melody materials to all five groups and then required participants in the groups to perform the same tasks. The five cultural groups, Japanese, Chinese, Vietnamese, Indonesian, and American were chosen for two reasons. First, generally these cultural groups can be assumed to differ in music cultural environments, and second, we needed a feasible method to collect participants for the experiment. Needless to say, America (the United States) has cultural environments of Western music. In the contemporary Japanese society, Western music is deeply embedded into the culture, society, economy, and education, although many opportunities for exposure to traditional Japanese music are maintained (Koizumi, 1984; Kojima, 1997; Shibata, 1978; Tokita, 2014). Accordingly, the contemporary Japan society is known as bimusical cultures of Western music and traditional Japanese music. In China, Vietnam, and Indonesia, the respective traditional music (traditional Chinese music, traditional Vietnamese music, and traditional Indonesian music) are widely prevalent (Wakabayashi, 2006), and, at the same time, due to globalization, there appear to be various opportunities for listening to Western music in these three cultures.

The fundamental criterion for selecting melodic materials for this study was that the materials should be able to convey high tonal stability for native listeners of the corresponding culture. This means that, for example, if we use traditional Japanese melodies as our materials, the traditional Japanese melodies must convey high Japanese tonal stability for listeners enculturated to traditional Japanese music. The same is true for Western music, Chinese music, Vietnamese music, and Indonesian music. The use of melodies from all the five cultures would be the best-case scenario. However, for the sake of ease of preparation and our confidence in materials, we focused on Western music and traditional Japanese music as melodic materials. Specifically, we used melodies generated from each of the major and minor modes of the Western diatonic scale and those from each of the YOH and IN modes of traditional Japanese scales.

Tonality perception implies a listener's ability to identify a tonal center (i.e., a tonic in Western music) and to ascribe a mode. For the sake of task simplicity, we used two distinct tasks to separately measure listeners' perceptions of a tonal center and mode (note: a tonal center and a mode are not separated, as the tonal center forms a constituent of the mode). First, we used "the tonal finality task" to measure the perception of a tonal center. This task is based on the very well-known phenomenon that a listener feels the greatest strength for the sense of tonal finality when a melody ends with the tonal center he or she feels. In this study, we prepared two conditions that differed only in pitches of tones occurring in the final position of a melody. Then, we asked participants to rate how well the final tone functioned as a good ending of a given melody. In one of the two conditions, the pitch of the final tone corresponded to the tonal center that would be perceived by most native listeners of the corresponding culture. In the other condition, the pitch of the final tone corresponded to a noncentral tone.

Second, we used the "affective valence task" to measure listeners' mode perception. It is well known that mode perception is closely associated with the perception of emotional characteristics suggested in a given melody (Bowling, 2013). For example, North American listeners tend to feel that the Western major mode is happier than the Western minor mode (Gagnon & Peretz, 2003), and Japanese listeners tend to feel that the Japanese YOH mode is happier than the Japanese IN mode (Hoshino, 1996). In this study, we presented the major and minor melodies or the YOH and IN

[2] In music theory, the definition of *musical scale* and that of *musical mode* are different. A scale is, by definition, a collection of pitches arranged in order from lowest to highest or from highest to lowest. On the other hand, a mode is used in describing a scale system with a tonal center. Thus, a scale often includes different modes having different tonal centers. In these sense, we basically used the two terms in this article.

melodies to participants, and then we asked the participants to rate how happy or sad a given melody sounded.

For the Western melodies, we expected to find the following results involving responses of the five cultural groups. American and Japanese listeners have been enculturated to Western music, and it has been experimentally shown that they have Western tonal schemas (for Americans, see Krumhansl, 1990; for Japanese, see Matsunaga & Abe, 2005, 2012). Therefore, we expected that for the Western melodies, both American and Japanese participants would give higher tonal finality ratings to the center condition than the noncenter condition, and they would rate the major mode as happier than the minor mode. By contrast, it is unclear to what extent Western music is prevalent in China, Vietnam, and Indonesia. In addition, there are no empirical data demonstrating that listeners of these three cultures have Western tonal schemas. Thus, we did not have predictions for the responses of Chinese, Vietnamese, and Indonesian participants in the tonal finality task and the affective valence task.

For the Japanese melodies, we expected to observe the following responses for the five cultural groups. Modern Japanese society offers many opportunities for listening to not only Western music but also traditional Japanese music. In line with this, previous studies indicate that most Japanese listeners have not just Western tonal schemas but also tonal schemas of traditional Japanese music (Fukui & Matsukubo, 1992; Matsunaga, Yokosawa, & Abe, 2012, 2014; Ogawa, Kimura, & Mito, 1995/1996). Therefore, we expected that for the Japanese melodies, Japanese participants would give higher tonal finality ratings to the center condition than to the noncenter condition, and that they would rate the YOH mode as happier than the IN mode. By contrast, we did not know the extent to which traditional Japanese music is prevalent in each of the other four cultures. In addition, there has been no research reporting that listeners from the other four cultures have tonal schemas of traditional Japanese music, as Japanese listeners have. Accordingly, we did not have predictions for the responses of American, Chinese, Vietnamese, and Indonesian participants in the tonal finality task and the affective valence task.

Before this experiment, we sought to determine the target sample size to ensure adequate power to detect effects of musical culture in tonality perception. Using an effect size (d) of .81 calculated from a test statistic reported by a previous study that tested the effects of musical enculturation (Trehub & Hannon, 2009), we performed a power analysis. Results showed that a sample of 11 had .80 power, a significant magnitude for one-sample t test (Analysis 1). In addition, other similar previous studies had eight to 27 participants (Castellano et al., 1984; Kessler et al., 1984; Schellenberg & Trehub, 1999; Trainor & Trehub, 1994). On the basis of the abovementioned, we determined that 11 was the minimum required size for each cultural group.

Method

Participants

We targeted participants who were born and raised in their respective native countries and who had no experience of special music training or education. On the basis of these criteria, we recruited Japanese, Chinese, Vietnamese, Indonesian, and American or U.S. citizen participants by distributing flyers at the International Student Center of Hokkaido University, Hamamatsu Japan Language Center, and the University of Kansas. In total, 44 Japanese (21 female; M_{age} = 20.3, SD = 1.2), 25 Chinese (19 female; M_{age} = 25.3, SD = 6.0), 16 Vietnamese (three female; M_{age} = 23.6, SD = 3.7), 18 Indonesians (10 female; M_{age} = 22.4, SD = 2.7), and 25 Americans (15 female; M_{age} = 28.1, SD = 12.0) voluntarily participated in this experiment. All Japanese, Chinese, Vietnamese, and Indonesian participants took part in experiments held in Japan. Although the Chinese, Vietnamese, and Indonesian participants resided in Japan for a short time (mean length of stay in Japan = 1 year and 8 months), they had spent much of their lives in their own countries. Thus, they qualified as native listeners from their respective countries. None spent any notable length of time in foreign countries aside from their home country and Japan. On the other hand, all American participants took part in experiments at the University of Kansas. None of these participants had spent any significant amount of time in foreign countries. All participants and experimenters communicated well in either Japanese or English. All participants signed informed consent forms approved by the Research Ethics Committee of Shizuoka Institute of Science and Technology.

Stimuli and Apparatus

Twenty-four melodic materials were prepared in the present experiment (Figure 1). Twelve of the 24 melodies were generated from the Western diatonic scale and 12 from the Japanese traditional scales. Western melodies were created by a musician proficient in Western music. Half of the 12 Western melodies were in the major mode (e.g., C-D-E-F-G-A-B with C as a tonal center) and the other half in the minor mode (e.g., C-D-Eb-F-G-Ab-Bb with C as a tonal center). Japanese melodies were brief excerpts from existing music in books of "Nihon Komoriuta Senkyoku" (which contains traditional Japanese children's songs and traditional Japanese lullabies). Half of the 12 Japanese melodies were in the YOH mode[3] (C-Eb-F-G-Bb with C as a tonal center) and the other half in the IN mode (C-Db-F-G-Ab with C as a tonal center).

Before the main experiment, we conducted a pilot experiment designed to verify the nature of these melodies. In the pilot experiment, each of 20 Japanese nonmusician participants who did not serve in the main experiment was presented with the 12 Western melodies and 12 traditional Japanese melodies. As noted earlier, most Japanese have both Western and Japanese tonal schemas (Matsunaga et al., 2012, 2014; Ogawa et al., 1995/1996). Participants were asked to rate the extent to which each melody reflected Western music or traditional Japanese music (using a scale from −3 to +3, where −3 reflects a strong sense of traditional Japanese music and +3 reflects a strong sense of Western music). Results showed that the Japanese participants recognized all the Western melodies as Western music (M = 0.82, SD = 0.63) and all the Japanese melodies as traditional Japanese music (M = −1.43, SD = 0.71). The ratings for the Western melodies and those for the Japanese melodies each differed significantly from the chance level (i.e., a difference score = 0)—for the Western melodies, $t(19)$ = 5.83, $p < .001$, d = 1.30; for the

[3] In this article, the descriptions of YOH and IN modes are in accordance with a theory by Toukawa (1990). Koizumi (1958) called the YOH and IN modes of this study as Minyo and Miyakobushi modes, respectively.

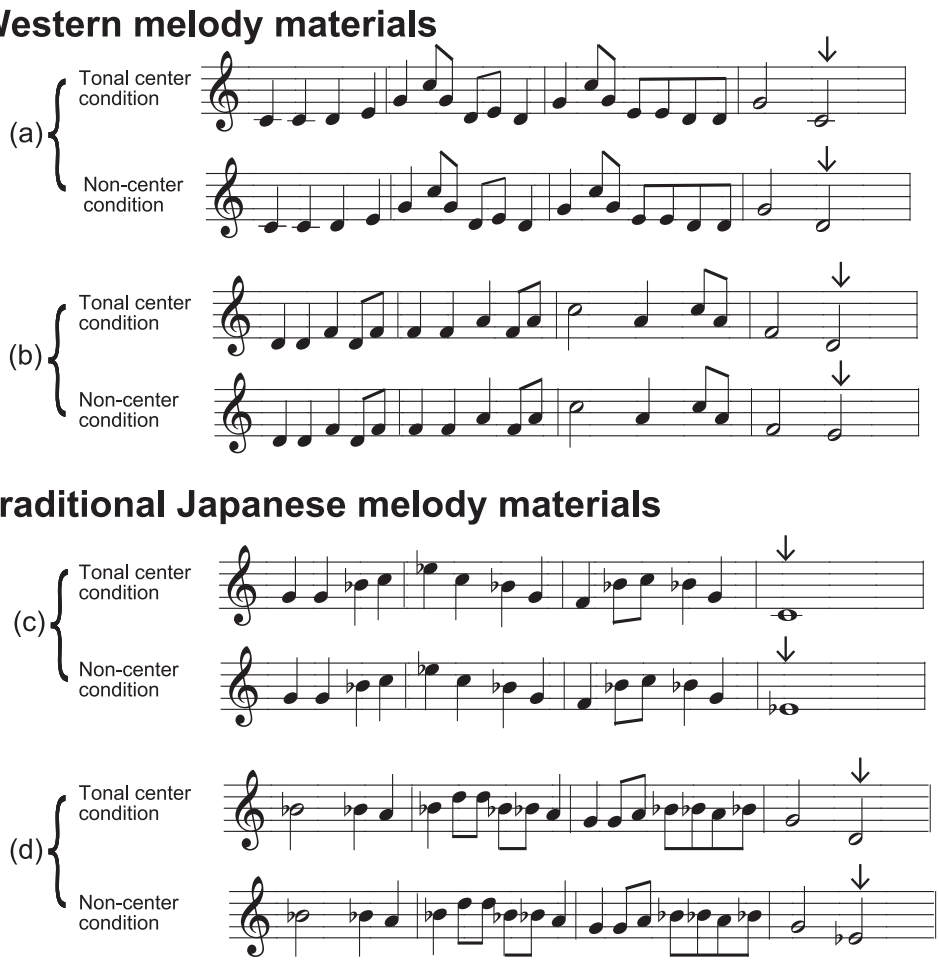

Figure 1. Examples of Western melody materials and Japanese melody materials, respectively. Specifically, (a) a melody in the major mode, (b) a melody in the minor mode, (c) a melody in the YOH mode, and (d) a melody in the IN mode. The results of the pilot study showed that these four melodies were given the mean ratings of + 0.7, +1.05, −1, and −1.45, respectively. In tonal center conditions, the final tones correspond to the tonal centers: C in (a) and (c) and D in (b) and (d). In noncenter conditions, the final tones correspond to the second scale degrees: D in (a), E in (b), and Eb in (c) and (d). All melodies are notated in the key that was actually presented to the participants.

Japanese melodies, $t(19) = 8.97$, $p < .001$, $d = 2.01$. These results confirm that for most Japanese people (i.e., bimusical listeners of Western music and traditional Japanese music), our prepared Western melodies sounded like Western music and our prepared Japanese melodies sounded like traditional Japanese music.

The results of the pilot study can be also interpreted as an indication of the degree of "tonal clarity" (i.e., how clear tonality sounded in each melody). The interpretation is supported by the empirical data of Hoshino and Abe (1981), which report that Japanese participants showed a positive correlation between subjective ratings of "melodic" and those of "tonal clarity" for the Western melody stimuli. According to the findings of Hoshino and Abe, melodic material conveys "tonal clarity" when it sounds very much like a "(Western or Japanese) melody" for most Japanese; conversely, melodic material does not convey "tonal clarity" when it does not sound like a "(Western or Japanese) melody" for most Japanese. Thus, the results of the pilot study can be interpreted as suggesting that our Western melodies could clearly convey Western tonality and the Japanese melodies could clearly convey traditional Japanese tonality.

On the basis of the 12 Western melodies and the 12 Japanese melodies, we created 48 types of stimulus tone sequences. Specifically, by manipulating pitches of the final tones of these melodies, we prepared a tonal center condition and a noncenter condition for each melody. In other words, two conditions based on one melody shared all the constituent tones except the ending tone. The first scale tone of each mode was used as a final tone for the center condition; conversely, the second scale tone of each mode was prepared as a final tone for the noncenter condition (Figure 1). We also checked whether melodies ending in the center condition versus the noncenter condition matched in terms of the pitch distance between the penultimate tone and the final tone, and then we found no significant difference between these two conditions, $t(23) = .189$, $p = .85$, $d = .04$; the mean of pitch distance was 3.3

and 3.4 semitones for the center and noncenter conditions, respectively. Melodies were presented in several different keys, whereas the same key was used between stimulus tone sequence pairs. The total number of tones per individual sequence ranged from 12 to 28 tones, and all tone sequences had the same tempo (120 bpm), metrical structure (meters of 4/4), and timbre (acoustic piano). Equal temperament was used in all stimulus tone sequences. The stimuli were created using Tux Guitar (SourceForge) and presented though iTunes (Apple Inc.).

Procedure

Before the experiment, participants completed a questionnaire assessing educational and family backgrounds (the environment in which they were raised) as well as any history of musical training. Instructions for the experiment were given in Japanese or English. Participants were tested individually or in small groups (two to five), and they listened to each stimulus tone sequence via speakers in front of a computer. After listening to each stimulus tone sequence, participants were required to conduct two tasks in order. First, they rated how well the final tone of a tone sequence could make the good ending on a 7-point scale, where a rating of 1 indicated "incomplete" and "lacking a sense of closure" and 7 meant "fully complete" and "having a sense of finality." Second, participants rated how well a given stimulus tone sequence expressed happiness or sadness on a 7-point scale, with 1 referring to sad, melancholy, and dark and 7 meaning happy and bright. Participants were not told that they were hearing Western or traditional Japanese melodies. The main experiment consisted of 48 trials (about 30 min). The two melody types were mixed together. To ensure participants understood these tasks, before the experiment, they were given two practice trials. Trial order was fully randomized and was counterbalanced across participants or small groups.

Results and Discussion

All analyses were conducted separately for the Western melodies and the traditional Japanese melodies. In other words, we did not directly compare the participants' rating data between the two types of music. This was because we were not able to ensure equivalence between the Western and traditional Japanese melodies. For example, we could not ensure that the Western materials and the Japanese materials were comparable in terms of easiness of differentiation between tonal center tones and noncenter tones.

Analysis 1: Did Each Cultural Group Differentiate a Tonal Center From a Noncenter Tone? (The Tonal Finality Task)

For each cultural group, ratings of the tonal center condition were compared with those of the noncenter condition. Specifically, difference scores were calculated by subtracting ratings of the noncenter condition from those of the corresponding center condition. Figure 2 shows the average difference scores of each cultural group for the two types of music (Western and traditional Japanese). If participants could correctly identify the tonal center of the corresponding melody, then the difference scores should show positive values that significantly exceed the chance level of 0 (i.e., an equal rating of the center and noncenter conditions). To test this, one-sample t tests were conducted separately for each cultural group. Results for the Western melodies revealed that difference scores of Japanese, Chinese, and American groups significantly exceeded the chance level—Japanese: $M = 1.18$, 95% confidence interval (CI) [.91, 1.46], $t(43) = 8.74$, $p < .001$, d[4] $= 1.32$; Chinese: $M = .45$, 95% CI [.16, .74], $t(24) = 3.19$, $p = .004$, $d = .64$; and Americans: $M = .74$, 95% CI [.40, 1.07], $t(24) = 4.56$, $p < .001$, $d = .91$. In contrast, the difference scores of Vietnamese and Indonesian groups did not exceed the chance level—Vietnamese: $M = .19$, 95% CI [−.25, .63], $t(15) = .92$, $p = .371$, $d = .23$; Indonesians: $M = .11$, 95% CI [−.18, .40], $t(17) = .82$, $p = .425$, $d = .19$. The results for the traditional Japanese melodies revealed that difference scores of Japanese and American groups significantly exceeded the chance level—Japanese: $M = .62$, 95% CI [.35, .89], $t(43) = 4.61$, $p < .001$, $d = .69$; Americans: $M = .66$, 95% CI [.35, .97], $t(24) = 4.39$, $p < .001$, $d = .88$. In contrast, difference scores of Chinese, Vietnamese, and Indonesian groups did not significantly exceed the chance level—Chinese: $M = .23$, 95% CI [−.08, .55], $t(24) = 1.50$, $p = .148$, $d = .30$; Vietnamese: $M = -.02$, 95% CI [−.37, .34], $t(15) = -.09$, $p = .93$, $d = -.02$; and Indonesians: $M = .10$, 95% CI [−.16, .37], $t(17) = .81$, $p = .43$, $d = .19$.

As mentioned in the "Method" section, sample sizes across the five groups were uneven. In particular, the sample size ($N = 44$) of the Japanese group was larger than the other four groups. This led to a concern that the Japanese group might have a greater tendency than the other groups to exhibit statistically significant results in significance tests such as the t test. The analysis results confirm that the rank order of effect sizes (which do not depend on the sample size) among the five cultural groups is consistent with that of p values of t tests. This means that the effect size of a cultural group showing a significant result was larger than that of a group showing a nonsignificant result. Moreover, effect sizes of the cultural groups with significant results were large according to Cohen (1969). These results of effect sizes indicate that the unevenness of sample size did not influence the outcomes of the t tests. Thus, the results of t tests were reliable and sufficiently meaningful to be used as a basis of discussion.

Figure 2 shows that the average difference scores were not equal among those cultural groups, with difference scores significantly exceeding the chance level. To pursue these differences further, we conducted a one-way independent analysis of variance (ANOVA) with group (Japanese, Chinese, Vietnamese, Indonesian, and American) as a factor. The results of the Western melodies showed a main effect of group, $F(4, 123) = 8.67$, $p < .0001$, and its effect size (η_p^2) of .22 was large (Cohen, 1969). Post hoc multiple comparisons (Shaffer's modified sequentially rejective Bonferroni procedure, here and throughout) showed that the average difference score of the Japanese group was significantly higher than those of Chinese, Vietnamese, and Indonesian groups (adjusted $p < .001$). In addition, the average difference score of the American group was also marginally significantly higher than that of the Indonesian group (adjusted $p = .08$). Results of the traditional Japanese melodies also showed a main effect of group, $F(4,$

[4] In reference to Lakens (2013), we used a formula provided by Rosenthal (1991) when calculating an effect size for a one-sample t test.

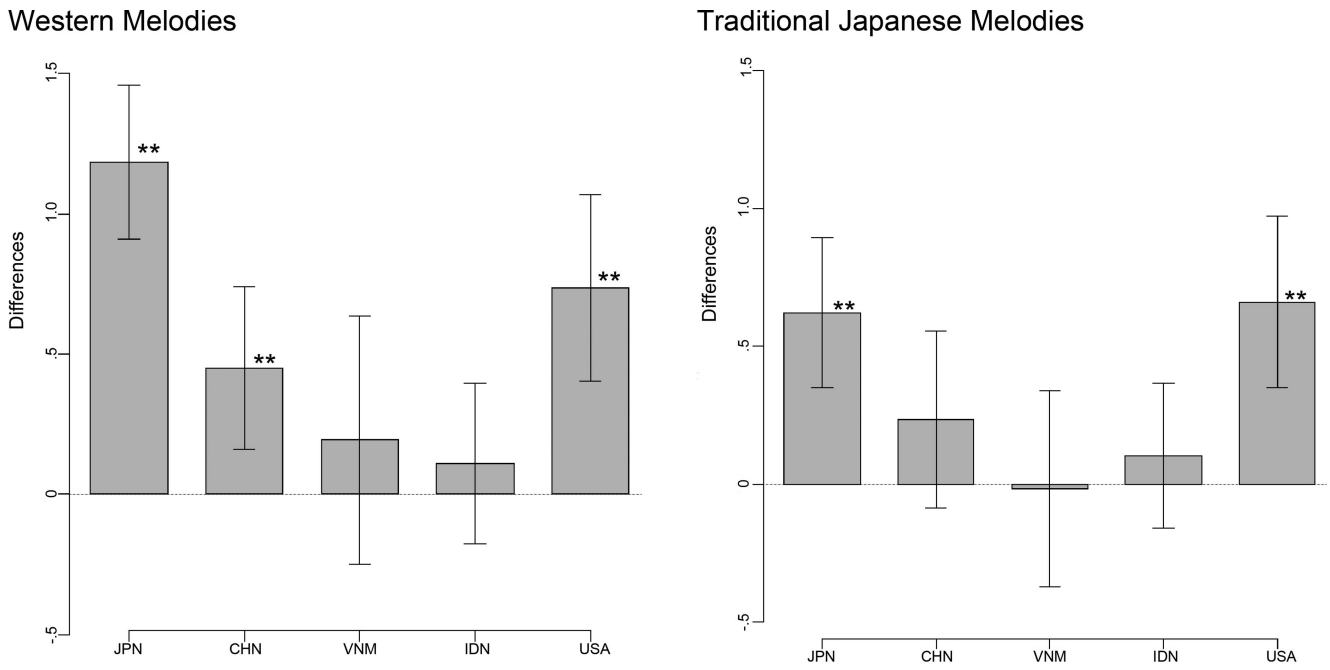

Figure 2. Mean differences of Japanese (JPN), Chinese (CHN), Vietnamese (VNM), Indonesian (IDN), and American (USA) groups for the Western melodies and the traditional Japanese melodies, respectively. Differences were calculated by subtracting ratings of noncenter conditions from those of center conditions. The dotted line indicates chance level (0), and asterisks indicate the significant differences from the chance level. Error bars shows 95% confidence interval. Asterisks indicate differences that were significantly above chance level.

123) = 3.69, $p = .007$, and its η_p^2 of .11 was medium. Post hoc multiple comparisons showed that the average difference score for the Japanese group and that of the American group were marginally higher than that of the Vietnamese group (adjusted $p = .06$ and $p = .06$ for the Japanese and American groups).

To summarize the results for the Western melodies, the Japanese, Chinese, and American groups could differentiate the tonal centers from noncenter tones, with best differentiation performance shown by Japanese, followed by Americans, and then Chinese. The Vietnamese and Indonesian groups were not able to differentiate between the tonal centers and noncenter tones. For the traditional Japanese melodies, both Japanese and American groups could differentiate the tonal centers from the noncenter tones, and the differentiation performances did not differ between these two groups. The Chinese, Vietnamese, and Indonesian groups could not differentiate between the tonal centers and noncenter tones.

Analysis 2: Did Each Cultural Group Differentiate Between Two Modes of Each Music Type? (The Affective Valence Task)

In Analysis 2, only the happy–sad ratings for stimulus tone sequences of center conditions were used (i.e., we excluded ratings for tone sequences of noncenter conditions).[5] Figure 3 shows the results for the major and minor modes of Western music and those for the YOH and IN modes of traditional Japanese music. Ratings for the Western melodies were submitted to a 5 (Group: Japanese, Chinese, Vietnamese, Indonesian, American) × 2 (Mode: major, minor) mixed-design ANOVA. This revealed a significant interaction, $F(4, 123) = 7.77$, $p < .0001$, $\eta_p^2 = .20$. There were no main effects of mode, $F(1, 123) = 1.94$, $p = .17$, $\eta_p^2 = .02$, and group, $F(4, 123) = 0.42$, $p = .79$, $\eta_p^2 = .01$. Significant simple main effects of mode were observed in the Japanese and American groups. Both Japanese and American groups rated the major mode as happier than the minor mode—Japanese: for the major mode, $M = 4.80$, 95% CI [4.62, 4.99]; for the minor mode, $M = 4.28$, 95% CI [4.10, 4.47]; $F(1, 43) = 30.58$, $p < .0001$, $\eta_p^2 = .42$; Americans: for the major mode, $M = 4.87$, 95% CI [4.68, 5.05]; for the minor mode, $M = 4.56$, 95% CI [4.37, 4.74]; $F(1, 24) = 4.55$, $p = .04$, $\eta_p^2 = .16$. In contrast, the Chinese, Vietnamese, and Indonesian groups did not differentiate between the major and minor modes—Chinese: for the major mode, $M = 4.53$, 95% CI [4.34, 4.71]; for the minor mode, $M = 4.71$, 95% CI [4.53 4.90]; $F(1, 24) = 2.99$, $p = .10$, $\eta_p^2 = .11$; Vietnamese: for the major mode, $M = 4.57$, 95% CI [4.34, 4.76]; for the minor mode, $M = 4.71$, 95% CI [4.52, 4.89]; $F(1, 15) = .73$, $p = .41$, $\eta_p^2 = .05$; and Indonesians: for the major mode, $M = 4.51$, 95% CI [4.32, 4.69]; for the minor mode, $M = 4.61$, 95% CI [4.43, 4.80]; $F(1, 17) = .67$, $p = .42$, $\eta_p^2 = .04$. Incidentally, it was confirmed that the rank order of effect sizes among the five cultural groups corresponded exactly to that of p values of simple main effects of mode.

[5] Note that the stimulus tone sequences of this study were not designed to correspond to each other in terms of the major versus minor modes (or the YOH vs. IN modes), unlike the center condition versus the noncenter condition.

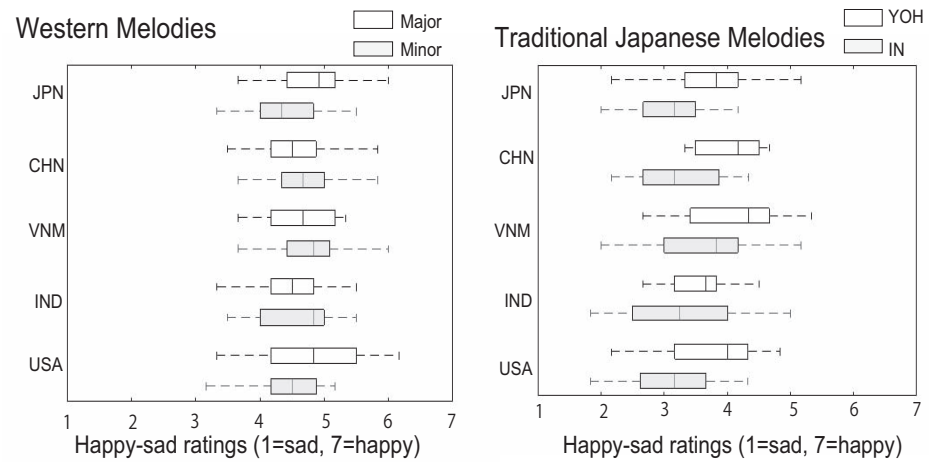

Figure 3. The box plots show happy–sad ratings of Japanese (JPN), Chinese (CHN), Vietnamese (VNM), Indonesian (IND), and American (USA) groups for the Western melodies and the traditional Japanese melodies, respectively. The vertical lines inside rectangles indicate the medians, the rectangles span the first quartile to the third quartile, and the dotted lines indicate the full ranges.

Ratings for the Japanese melodies were submitted to a 5 (Group) × 2 (Mode: YOH, IN) mixed-design ANOVA. This revealed a significant main effect of mode, $F(1, 123) = 60.47$, $p < .001$, $\eta_p^2 = .33$, a marginally significant main effect of group, $F(4, 123) = 2.20$, $p = .07$, $\eta_p^2 = .07$, and a nonsignificant interaction, $F(4, 123) = 1.24$, $p = .29$, $\eta_p^2 = .04$. Overall, all groups significantly rated the YOH mode as happier than the IN mode.

Analysis 3: How Similar Were Tonal Responses Across the Five Cultural Groups? (Multidimensional Scaling Analysis)

The aims of Analyses 1 and 2 were to examine whether participants in the five cultural groups could identify a "correct" tonal center and a "correct" mode for the Western and traditional Japanese melodies, respectively. The aim of Analysis 3 differed from those of the preceding analyses. This analysis aimed to estimate the degree of similarity in "tonal responses" (i.e., a combination of the tonal center response and mode response; more concretely, a combination of performances in the tonal finality task and those in the affective valence task) among the five cultural groups for the Western and Japanese melodies.

Analysis 3 entailed four steps. First, separately for each of the five cultural groups, individual melodies were plotted in two dimensions, where one dimension represented the tonal finality ratings that reflected the degree of tonal center perception, and another dimension represented the affective valence ratings that reflected the degree of mode perception. Concretely, each melody was plotted according to the average difference scores of the tonal finality task and the average ratings of the affective valence task. The Western music and the Japanese music consisted of 12 melodies, so that 12 melodies were plotted in both dimensions. Second, we calculated 66 (= 12 × 11/2) types of distances between all possible melody pairs for each cultural group (this procedure was adapted from Saji, Asano, Oishi, & Imai, 2015). Here, let $\mathbf{E}_j^i$ be the jth melody of the ith group. The distance δ_{jk}^i between the jth melody and the kth melody in the ith group is written as $\delta_{jk}^i = \|\mathbf{E}_j^i - \mathbf{E}_k^i\|$. In the current article, a list of the 66 distances of the ith group in a given order was referred to as a feature vector, $\boldsymbol{\phi}^i = \{\delta_{jk}^i\}$. Third, we calculated the degree of dissimilarity among the five cultural groups. The dissimilarity index, d_{mn}, between the mth and the nth groups is defined as follows:

$$d_{mn} = 1 - \mathrm{cor}(\phi^m, \phi^n) \quad (1)$$

In Equation (1), $\mathrm{cor}(\boldsymbol{\phi}^m, \boldsymbol{\phi}^n)$ is the correlation between the feature vectors $\boldsymbol{\phi}^m$, $\boldsymbol{\phi}^n$. On the basis of d_{mn}, we calculated a 5 × 5 dissimilarity matrix; finally, we submitted the dissimilarity matrix to a multidimensional scaling (MDS) analysis. The MDS map can visually indicate the degree of similarity in tonal responses among the five cultural groups.

Figures 4 and 5 plot the five groups in a two-dimensional space for the Western and Japanese melodies, respectively. The validity of two-dimensional space for each type of music was ensured by eigenvalues derived from the correlation matrix. Moreover, we checked variances and their covariance for each dimension in the Western music map; variances for Dimensions 1 and 2 were 0.14 and 0.12, respectively, whereas their covariance was 5.55×10^{-17}. In the Japanese music map, the variances for Dimensions 1 and 2 were 0.12 and 0.05, respectively, whereas their covariance was 2.76×10^{-17}. On the basis of the similarity of variances and the very low covariance, we can argue that both dimensions had approximately equal importance in expressing differences among the five groups, meaning that interpretations of distances between the groups must be based on both Dimensions 1 and 2. Here two important points should be noted regarding interpretations of MDS maps: First, MDS analysis does not explicitly provide an interpretation of the dimensions. Second, if MDSs are conducted separately for distinct data sets (i.e., Western and Japanese music in this study), the dimensions of each MDS representation do not necessarily correspond.

Distances between cultural groups in MDS maps indicate the degree of similarity in tonal responses among the groups. Cultural groups are closely clustered together if the groups provided similar

tonal responses. Conversely, cultural groups are further removed from each other if the groups provided different tonal responses.

In the Western melody map (Figure 4), the Japanese and American groups are located very close to each other,[6] whereas the Chinese, Vietnamese, and Indonesian groups are further removed from the other four groups. These results imply that, for the Western melodies, the Japanese and American groups provided similar tonal responses, whereas the Chinese, Vietnamese, and Indonesian groups provided different tonal responses from the other four groups. In the Japanese melody map (Figure 5), the Japanese, Chinese, Vietnamese, Indonesian, and American groups are located at a distance from each other, indicating that tonal responses for Japanese melodies are dissimilar among the five cultural groups.

General Discussion

The present study investigated the extent to which the five cultural groups were similar versus different in their tonal percepts of different melodies (from Western and Japanese cultures). First, we discuss differences and similarities in tonal perception for the Western melodies among the five cultural groups. American participants could differentiate the tonal centers from noncenter tones. In addition, they differentiated between the major and minor modes; specifically, they felt the major mode was happier than the minor mode. The same results were shown in Japanese participants. Like American participants, Japanese participants could identify both the tonal center and the mode. Moreover, the Western MDS map indicated that the American and Japanese groups provided quite similar tonal responses. A number of previous studies have shown that American listeners have the Western tonal schemas (Cuddy, Cohen, & Mewhort, 1981; Krumhansl, 1990; Trainor & Trehub, 1992, 1994). Likewise, many studies have demonstrated that unlike Japanese who lived a century ago, modern-day

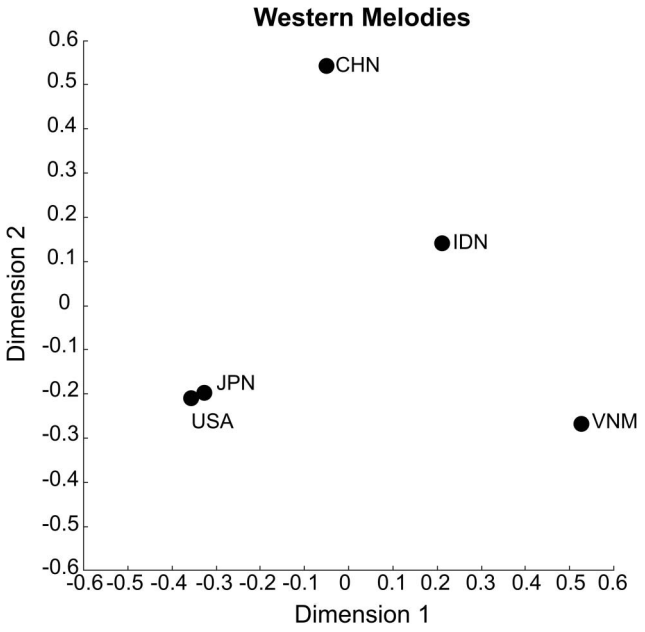

Figure 4. Multidimensional scaling solutions for the Western melodies.

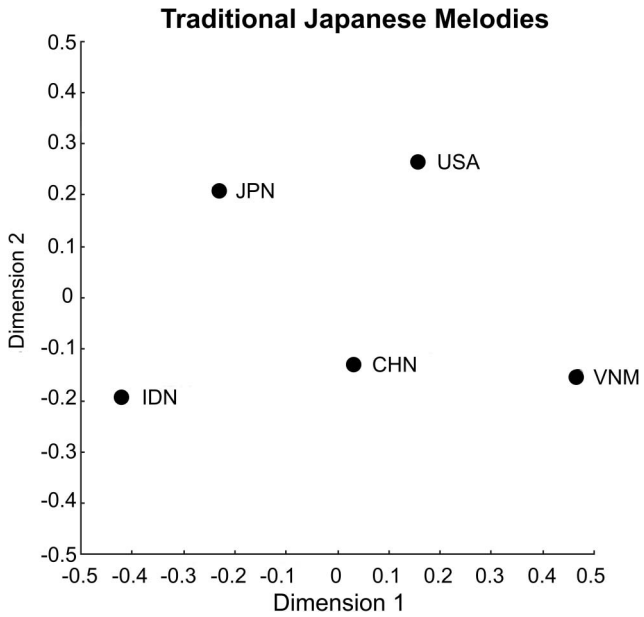

Figure 5. Multidimensional scaling solutions for the traditional Japanese melodies.

Japanese listeners have sufficient Western tonal schemas (Matsunaga & Abe, 2005, 2012). Considering these previous findings, as well as the present results, it is quite likely that both American and Japanese listeners perceived the Western tonalities for the Western melodies.

Basically, our results showed that the American and Japanese groups exhibited very similar tonal perception for the Western melodies. A more detailed examination of these results reveals the following tendency: For the Western melodies, performances of the Japanese group appear to be superior to those of the American group for the tonal finality task (Figure 2), but this difference was not statistically significant. One explanation for such an outcome maintains that the better performance of the Japanese group may result from their bimusicality. Presumably, most Japanese people may have developed both Western and Japanese tonal schemas in a manner that facilitates explicit distinctions of these two schemas. Consequently, Japanese participants might be able to use the Western tonal schemas more effectively for the Western melodies than American participants.

On the other hand, Chinese participants could differentiate the tonal centers from noncenter tones for the Western melodies, but they could not distinguish between the major and minor modes. Vietnamese and Indonesian participants were unable to differentiate the tonal centers from noncenter tones, and they also could not differentiate between the major and minor modes. Together, the results of the Chinese, Vietnamese, and Indonesian groups were considerably different from those of the American and Japanese groups. This shows that the Chinese, Vietnamese, and In-

[6] By plotting average ratings of Japanese and those of Americans for each Western melody stimulus in a two-dimensional space (the degree of tonal finality and affective valence), we confirmed that the plot of average ratings of Japanese and that of Americans were similar.

donesians did not perceive the Western tonalities as the Americans and Japanese did. Moreover, the Western MDS map reveals that tonal responses of the Chinese, Vietnamese, and Indonesian groups were dissimilar with respect to each other.

Second, we discuss differences and similarities in tonal perception for the traditional Japanese melodies among the five cultural groups. The results of Analyses 1 and 2 showed that Japanese participants could differentiate the tonal centers from noncenter tones, and that they could distinguish the YOH from IN modes. These performances of participants in the Japanese group are consistent with findings of previous studies, which have shown that most Japanese people have Japanese tonal schemas (Fukui & Matsukubo, 1992; Matsunaga et al., 2012, 2014; Ogawa et al., 1995/1996). It is thus very likely that Japanese participants perceived the Japanese tonalities for the Japanese melodies.

Surprisingly, performances of Americans in both the tonal finality task and the affective valence task were very similar to those of Japanese. A simple interpretation of this result might be that the American group perceived the Japanese tonality just as the Japanese group did. However, this view is incongruent with the results of MDS analysis. The MDS analysis for the Japanese melodies indicates that tonal responses of the American group differed from those of the Japanese group. This analysis implies that Americans were unlikely to perceive the Japanese tonality for the Japanese melodies as Japanese did.

This raises the following question: "Why does the American group show the same outcomes in the two tasks (tonal finality, affective valence) as the Japanese group?" Unfortunately, no study has reported empirical data about tonal perception of Westerners for traditional Japanese music. Thus, it is difficult to offer a definitive answer to this question. However, one possible explanation of the Americans' performance in the tonal finality task should be pursued. The Japanese YOH mode used in the present study can be represented as, for example, C-Eb-F-G-Bb (with C as a tonal center), and the Western (natural) minor mode can be represented as, for example, C-D-Eb-F-G-Ab-Bb (with C as a tonal center). In actuality, the YOH mode and the minor mode appear to share both a tonal center and a (sub)set of scale tones. In the above instance, C is a tonal center of both the two modes, and C, Eb, F, G, and Bb overlap between the two modes. On the other hand, as for the IN mode, there is no Western mode that parallels the relationship between the YOH mode and the minor mode. If the structural similarity of the Western and Japanese modes improves American participants' ability to identify the tonal center for the Japanese melodies, then this difference between the YOH and IN modes might reflect their performances in the tonal finality task. That is, Americans' performances for the YOH mode would be better than those for the IN mode. To test this possibility, we compared difference scores in the tonal finality task between the YOH melodies and the IN melodies. The results showed that difference scores did not significantly differ between the two modes, $t(24) = 1.40$, $p = .17$, $d = .28$. Thus, the performance of American participants in the tonal finality task may not simply be explained by the concept of structural similarities, such as the overlapping scale tones between Western and Japanese modes. In any case, the results of the American group are puzzling. In the future experiments, more detailed data of listeners' tonal perception, in addition to the essentials (tonal center and mode) focused on in the current study, will be needed. For example, the probe-tone method may be useful because it can provide a granular quantitative assessment of tonal relations within a melody.

The results for the Japanese melodies showed that the Chinese, Vietnamese, and Indonesian groups were not able to differentiate the tonal centers from noncenter tones. In addition, these three groups could differentiate the YOH mode from the IN mode as Japanese group could. These results of the Chinese, Vietnamese, and Indonesian groups were not identical to those of the Japanese group. This means that the three cultural groups did not perceive the Japanese tonality as the Japanese group did. Moreover, the MDS analysis reveals that tonal responses of the Chinese, Vietnamese, and Indonesian groups were dissimilar from each other.

In summary, the present study documents the extent of differences in the tonal percepts among listeners of five different cultures, namely, Japanese, Chinese, Vietnamese, Indonesian, and American listeners. Roughly speaking, the largest difference we observed emerged with Chinese/Vietnamese/Indonesian listeners and American/Japanese listeners. Moreover, differences between American and Japanese listeners were smaller than those between Chinese, Vietnamese, and Indonesian listeners; however, this is limited to only Western music.

What are the general implications of these findings for cultural differences in tonal perception? One possible implication concerns the extent of cultural differences. In general, the closer countries are geographically and socially, the greater the cultural exchange between these places and people, and as a result, the music prevalent in each of the countries adapts to musical features of the other culture. Thus, tonal perception of listeners should be similar between those countries that are close geographically and socially. In addition, during the 1950s–1960s, two musicologists, Koizumi (1958) and Shibata (1967), proposed that musical scales in many countries can be roughly divided into two groups: In one group that includes Western music, the first scale tone (e.g., *do* in a movable *do* system) and a scale tone *sol* are important in the scales; in another group including traditional music found in East and Southeast Asian countries, a scale tone *do* and a scale tone *fa* are important in the scales. The results of the present study demonstrate that the actual states of cultural differences in tonal perception between the five cultures are more diverse and distinctive than these musicologists estimated. Our results revealed only one pair of cultural groups whose tonal perception could be interpreted as expressing "equivalence": the Japanese and American groups for the Western melodies. From a different perspective, this result indicates that almost all of the cultural groups differed, to a greater or lesser extent, in their tonal perception. Moreover, the extent of such differences was more diverse than the musicologists estimated. Almost half a century has passed since Koizumi (1958) and Shibata (1967) proposed the musical scale theory. Especially, over the past few decades, musical and cultural information has spread widely and rapidly due to the rise of the Internet. Worldwide, it is much easier to start new friendships regardless of geographical distance, and people can easily enjoy music of foreign cultures in their own homes. Such drastic changes might bring more diversity to tonal perception of listeners.

Another possible implication concerns the influence of Western music on listeners in non-Western cultural regions. Recently, the globalization of Western music has been repeatedly noted in the field of music sociology (Bratus, 2014). Due to this social change, two music scholars have proposed that biases in music perception

of listeners in non-Western music cultures may have gradually become similar to those of listeners in Western music cultures (Huron, 2008, 2012; Stevens, 2012). We know that Western music is deeply prevalent in modern Japanese culture, whereas we do not know the degree to which Western music is prevalent in the modern Chinese, Vietnamese, and Indonesian cultures. Nevertheless, at the same time, we believe that listeners in Chinese, Vietnamese, and Indonesian cultures have a certain degree of exposure to Western music. The results of the present study clearly demonstrate that tonal perception of the Chinese, Vietnamese, and Indonesian groups for the Western melodies differed substantially from those of the American and Japanese groups. This suggests that tonal schemas of Chinese, Vietnamese, and Indonesians are less "Westernized" than tonal schemas of Americans and Japanese. Presumably, listeners need longer and more active learning experiences to acquire not only the tonal schemas of their own culture but also the Western tonal schemas, although we do not argue that this activity would be to the extent needed for second language acquisition.

A final implication concerns the process of learning a novel tonal schema associated with an unfamiliar music tradition. The present results show that there are cultural differences in tonal processing when listening to unfamiliar foreign music. Such findings can extend findings of previous studies addressing the question of how adult listeners learn the tonal schemas of unfamiliar music traditions. Previous findings have shown that when listening to music generated from unfamiliar scales, adults depend on statistical distributions of occurrence frequency of pitch classes to learn the corresponding tonal schema (Loui, Wu, Wessel, & Knight, 2009; Oram & Cuddy, 1995). We agree with the concept of statistical learning. However, we believe that this concept alone is insufficient because statistical learning on its own, by default, supposes that adult listeners from different cultures should be equivalent with respect to the difficulty of learning a novel tonal schema. Our results suggest that listeners engage in tonal processing on the basis of their own culture-specific tonal schemas even when listening to foreign music. This means that the learning of a new tonal schema is influenced by listeners' previously acquired tonal schemas. Adult listeners from different cultures have different tonal schemas. Therefore, if adult listeners from different cultures simultaneously start learning the same foreign music, they should show differences in tonal schema learnability. The explanation is in line with the general understanding regarding the concept of "accommodation of a schema" as outlined by Piaget (1952).

In conclusion, the current study provides the first empirical data addressing the differences/similarities in tonal perception among a broad collection of different cultures, including American, Japanese, Chinese, Vietnamese, and Indonesian listeners. Our empirical data indicate that cultural differences in tonal perception are more diverse and distinctive than previously believed. Moreover, the empirical data reveal that despite advances in the globalization of Western music, listeners' tonal perception still varies considerably across cultures.

References

Abe, J. (1987). Senritsu ha ikani syori sareruka? [How is a melody processed?] In G. Hatano (Ed.), *Music and Cognition* (pp. 41–68). Tokyo, Japan: Tokyo University Press.

Bowling, D. L. (2013). A vocal basis for the affective character of musical mode in melody. *Frontiers in Psychology, 4,* 464. http://dx.doi.org/10.3389/fpsyg.2013.00464

Bratus, A. (2014). Globalization. In W. F. Thompson (Ed.), *Music in the social & behavioral sciences: An encyclopedia* (pp. 517–521). Newbury Park, CA: SAGE Publication.

Castellano, M. A., Bharucha, J. J., & Krumhansl, C. L. (1984). Tonal hierarchies in the music of North India. *Journal of Experimental Psychology: General, 113,* 394–412. http://dx.doi.org/10.1037/0096-3445.113.3.394

Cohen, J. (1969). *Statistical power analysis for the behavioral sciences*. New York, NY: Academic Press.

Corrigall, K. A., & Trainor, L. J. (2010). Musical enculturation in preschool children: Acquisition of key and harmonic knowledge. *Music Perception, 28,* 195–200. http://dx.doi.org/10.1525/mp.2010.28.2.195

Cuddy, L. L., Cohen, A. J., & Mewhort, D. J. (1981). Perception of structure in short melodic sequences. *Journal of Experimental Psychology: Human Perception and Performance, 7,* 869–883. http://dx.doi.org/10.1037/0096-1523.7.4.869

Fukui, H., & Matsukubo, Y. (1992). Onkai kankaku no hattatsu ni kansuru kenkyu [A developmental study of a sensitivity to scale structure]. *Bulletin of Nara University of Education: Cultural and Social Science, 41,* 75–86.

Gagnon, L., & Peretz, I. (2003). Mode and tempo relative contributions to "happy-sad" judgements in equitone melodies. *Cognition and Emotion, 17,* 25–40. http://dx.doi.org/10.1080/02699930302279

Hoshino, E. (1996). The feeling of musical mode and its emotional character in a melody. *Psychology of Music, 24,* 29–46. http://dx.doi.org/10.1177/0305735696241004

Hoshino, E., & Abe, J. (1981). *Tonality and the coherence in melody cognition*. (*Hokkaido Behavioral Science Report Series P No.* 23). Sapporo, Japan: Hokkaido University, Department of Psychology.

Huron, D. (2008). Science & music: Lost in music. *Nature, 453,* 456–457. http://dx.doi.org/10.1038/453456a

Huron, D. (2012). Two challenges in cognitive musicology. *Topics in Cognitive Science, 4,* 678–684. http://dx.doi.org/10.1111/j.1756-8765.2012.01224.x

Kessler, E. J., Hansen, C., & Shepard, R. N. (1984). Tonal schemata in the perception of music in Bali and the West. *Music Perception, 2,* 131–165. http://dx.doi.org/10.2307/40285289

Koizumi, F. (1958). *Nihon dentou ongaku no kenkyu: Minyo kenkyu no houhou to onkai no kihon kouzou* [A study of Japanese traditional music: Methodology of folk music and a basic structure of scale]. Tokyo, Japan: Ongaku no tomo sha.

Koizumi, F. (1984). *Otama jakushi muyou ron* [Western musical scores are unnecessary]. Tokyo, Japan: Seido sya.

Kojima, T. (1997). *Ongaku kara mita Nihon-jin* [A discussion of Japanese from a viewpoint of music]. Tokyo, Japan: NHK Publishing, Inc.

Krumhansl, C. L. (1990). *Cognitive foundations of musical pitch*. New York, NY: Oxford University Press.

Krumhansl, C. L., & Keil, F. C. (1982). Acquisition of the hierarchy of tonal functions in music. *Memory and Cognition, 10,* 243–251. http://dx.doi.org/10.3758/BF03197636

Krumhansl, C. L., & Shepard, R. N. (1979). Quantification of the hierarchy of tonal functions within a diatonic context. *Journal of Experimental Psychology: Human Perception and Performance, 5,* 579–594. http://dx.doi.org/10.1037/0096-1523.5.4.579

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for *t*-tests and ANOVAs. *Frontiers in Psychology, 4,* 863. http://dx.doi.org/10.3389/fpsyg.2013.00863

Loui, P., Wu, E. H., Wessel, D. L., & Knight, R. T. (2009). A generalized mechanism for perception of pitch patterns. *The Journal of Neuroscience, 29,* 454–459. http://dx.doi.org/10.1523/JNEUROSCI.4503-08.2009

Matsunaga, R., & Abe, J. (2005). Cues for key perception of a melody: Pitch set alone? *Music Perception, 23,* 153–164. http://dx.doi.org/10.1525/mp.2005.23.2.153

Matsunaga, R., & Abe, J. (2012). Dynamic cues in key perception. *International Journal of Psychological Studies, 4,* 3–21. http://dx.doi.org/10.5539/ijps.v4n1p3

Matsunaga, R., Yokosawa, K., & Abe, J. (2012). Magnetoencephalography evidence for different brain subregions serving two musical cultures. *Neuropsychologia, 50,* 3218–3227. http://dx.doi.org/10.1016/j.neuropsychologia.2012.10.002

Matsunaga, R., Yokosawa, K., & Abe, J. (2014). Functional modulations in brain activity for the first and second music: A comparison of high- and low-proficiency bimusicals. *Neuropsychologia, 54,* 1–10. http://dx.doi.org/10.1016/j.neuropsychologia.2013.12.014

Ogawa, Y., Kimura, T., & Mito, H. (1995/1996). Modification of musical schema for Japanese melody: A study of comprehensible and memorable melody. *Bulletin of the Council for Research in Music Education, 127,* 136–141.

Oram, N., & Cuddy, L. L. (1995). Responsiveness of Western adults to pitch-distributional information in melodic sequences. *Psychological Research, 57,* 103–118.

Piaget, J. (1952). *The origins of intelligence in children*. New York, NY: International Universities Press. http://dx.doi.org/10.1037/11494-000

Rosenthal, R. (1991). *Meta-analytic procedures for social research*. Newbury Park, CA: SAGE Publications. http://dx.doi.org/10.4135/9781412984997

Saji, N., Asano, M., Oishi, M., & Imai, M. (2015). *How do children construct the color lexicon? Restructuring the domain as a connected system*. In D. C. Noelle, R. Dale, A. S. Warlaumont, J. Yoshimi, T. Matlock, C. D. Jennings, & P. P. Maglio (Eds.), *Proceedings of the 37th Annual Meeting of the Cognitive Science Society*. Austin, TX: Cognitive Science Society.

Schellenberg, E. G., & Trehub, S. E. (1999). Culture-general and culture-specific factors in the discrimination of melodies. *Journal of Experimental Child Psychology, 74,* 107–127. http://dx.doi.org/10.1006/jecp.1999.2511

Shibata, M. (1967). *Seiyou ongaku no rekishi (ue)* [A history of Western music (Vol. 1)], Tokyo, Japan: Ongaku no tomo sha.

Shibata, M. (1978). *Ongaku no gaikotsu no hanashi* [A skeleton of music]. Tokyo, Japan: Ongaku no tomo sha.

Stevens, C. J. (2012). Music perception and cognition: A review of recent cross-cultural research. *Topics in Cognitive Science, 4,* 653–667. http://dx.doi.org/10.1111/j.1756-8765.2012.01215.x

Tokita, A. (2014). Bi-musicality in modern Japanese culture. *The International Journal of Bilingualism, 18,* 159–174. http://dx.doi.org/10.1177/1367006912458394

Toukawa, S. (1990). *Nihon no onkai wo saguru* [An exploration of traditional Japanese musical scales]. Tokyo, Japan: Ongaku no tomo sha.

Toukawa, S. (2007). *Kimigayo kou* [A discussion of Kimigayo]. Tokyo, Japan: Shunjusga.

Trainor, L. J., & Trehub, S. E. (1992). A comparison of infants' and adults' sensitivity to Western musical structure. *Journal of Experimental Psychology: Human Perception and Performance, 18,* 394–402. http://dx.doi.org/10.1037/0096-1523.18.2.394

Trainor, L. J., & Trehub, S. E. (1994). Key membership and implied harmony in Western tonal music: Developmental perspectives. *Perception and Psychophysics, 56,* 125–132. http://dx.doi.org/10.3758/BF03213891

Trehub, S. E., & Hannon, E. E. (2009). Conventional rhythms enhance infants' and adults' perception of musical patterns. *Cortex, 45,* 110–118. http://dx.doi.org/10.1016/j.cortex.2008.05.012

Wakabayashi, T. (2006). *Sekai no minzoku ongaku jiten* [A dictionary of ethnomusicology]. Tokyo, Japan: Tokyo do shuppan.

Received January 25, 2018
Revision received August 6, 2018
Accepted August 17, 2018 ■