1. INTRODUCTION

In recent years, there are opportunities to watch and listen to a lot of multimedia data including pictures, sound clips, and video clips. Multimedia data give various impressions to human beings. For example, many people feel fresh and clear in a scenery picture.

As people in different countries have different education and cultural background, the people in different countries have different feelings to the same object. Cultural and gender differences in the impression of pictures have been well studied [1-3]. Common and different factors for people having different nationalities have been revealed. Although the impression factors of sound clips were obtained [4], cultural and gender differences of the impression of sound clips are not studied well. These are required to be clarified in order to satisfy the emotional requirements of people in different countries.

We have experimentally clarified cultural and gender differences of the impression of sound clips [5]. It was shown that the brightness factor appeared for Japanese males, Chinese males, and Chinese females. The other factors of Japanese and Chinese males are quite different. Although the activity factor commonly exists for Chinese males and females, the other factors could not be said to be the same.

It was also shown that the factors of Japanese males and those of Chinese females were similar [5]. This tendency is, however, not quantitatively clarified. It is not confirmed that this tendency appears for other types of media data either.

After cultural and gender differences of the impression of sound clips are experimentally clarified, we quantitatively clarify the tendency appearing in the impressions of sound clips of Japanese males and Chinese females. It is also shown that this tendency appears in the impression of pictures.

The remainder of the paper is structured as follows. Section 2 describes the related works. Section 3 describes the experiment. Section 4 shows the experimental results. Section 5 gives some considerations to the experimental results. Section 6 clarifies the similarities of Japanese males and Chinese females. Finally, Section 7 concludes the paper.

2. RELATED WORKS

2.1 Cultural comparison of the impression of pictures

Cultural comparisons of the impression of pictures have been conducted. Yang et al. elaborated on the similarities and differences of the impression of pictures between Japanese and Chinese [1]. Yang et al. obtained the factor loading matrixes of Chinese males and females, which are shown in Appendix. They revealed the following differences:

• Compared with Chinese males, Japanese males are easily affected by the factors “Potency” and “Activity.”
• In comparison with Japanese males, Chinese males are more affected by the factor “Naturalness,” that is, Chinese males pay more attention to the natural sense.

Du et al. compared the cultural difference of the influence on the impression by images having different...
resolutions [2]. They conducted subjective experiments with Japanese and Chinese participants. They obtained three factors from the experimental results for both Japanese and Chinese participants. As the three factors obtained from the Japanese results corresponded to those obtained from Chinese ones, the factors could be compared with each other. They placed factor scores in the two-dimensional space of each two factors for Japanese and Chinese results. As the distribution of the factor scores of the second and the third factors of Japanese people is quite different from that of Chinese ones, Du et al. concluded there are some cultural differences in the third factor named “Naturalness.”

2.2 Impression of sound clips

Hochin and Tsuji clarified the impression factors of multimedia data including sound clips [4]. Twelve Japanese students evaluated forty sound clips. These are songs of birds, the sound of a stream, etc. The average length of a sound clip is about ten seconds.

By applying factor analysis to the scores obtained from the experiment, four factors are obtained. Table 1 shows the factor loading matrix. The factor loadings whose absolute values are more than 0.75 are hatched. If there is no such factor loading in a factor, the factor loadings, each of whose absolute value is the largest one in those of the word pair and is in the top 10% largest ones in those of the factor, are hatched. Four factors obtained are of naturalness, brightness, potency, and sharpness.

| Impression Word Pair | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
|----------------------|----------|----------|----------|----------|
| Beautiful - Ugly     | -0.52    | -0.51    | -0.41    | 0.40     |
| Natural - Artificial | -0.49    | -0.45    | 0.11     | 0.01     |
| Wet - Dry            | -0.47    | -0.24    | -0.34    | 0.01     |
| Glad - Sad           | -0.27    | -0.85    | -0.22    | 0.06     |
| Hot - Cold           | -0.18    | -0.85    | -0.10    | -0.11    |
| Bright - Dark        | -0.06    | -0.84    | -0.27    | 0.30     |
| Tense - Relaxed      | 0.27     | 0.71     | 0.39     | 0.47     |
| Simple - Complex     | -0.06    | -0.53    | -0.10    | 0.00     |
| Strong - Weak        | -0.03    | 0.27     | 0.92     | 0.09     |
| Large - Small        | 0.05     | 0.31     | 0.86     | -0.10    |
| Bold - Delicate      | 0.21     | 0.07     | 0.77     | -0.18    |
| Heavy - Light        | -0.25    | 0.51     | 0.71     | -0.36    |
| Active - Passive     | 0.23     | -0.05    | 0.63     | 0.21     |
| Pure - Impure        | -0.32    | -0.38    | -0.55    | 0.54     |
| Hard - Soft          | 0.18     | 0.13     | 0.20     | 0.86     |
| Fresh - Stale        | -0.28    | -0.08    | -0.25    | 0.63     |

3. EXPERIMENTAL METHOD

3.1 Purpose

The purpose of the experiment is to clarify cultural and gender differences in the impression of sound clips. The impression factors of Japanese and Chinese are compared.

3.2 Experimental environment

The experiment was conducted in a calm room on the fifth floor of a building of the Kyoto Institute of Technology. A participant sat on a chair and listened to the music pieces with an earphone (Apple EarPods).

3.3 Stimuli

The stimuli used in the experiment are 40 audio clips used in the previous study [4]. These are songs of birds, the sound of a stream, etc.

3.4 Design

The presenting order of sound clips is decided at random for each participant. After a participant listened to a sound clip, he/she evaluated it through the Semantic Differential (SD) method in five steps (-2, -1, 0, 1, and 2). The impression word pairs shown in Table 1 [4] are used.

3.5 Procedure

14 male and 14 female Chinese university students joined this experiment.

The experimenter explained the personal information management, data management, and the experimental procedure. A participant listened to sound clips and evaluated them.

The study was approved by the Institutional Review Board of Kyoto Institute of Technology. All participants agreed to the experimental procedure and protection of their data.

4. RESULTS

The mean scores were obtained for male and female participants. The factor analysis was applied to them to obtain the factors of sound clips for males and females. A cumulative contribution ratio was calculated in descending order of the eigenvalues of factors obtained. From the first factor to the factor whose cumulative contribution ratio exceeding 80% were adopted as the factors of sound clips.

4.1 Result of males

Eigenvalues, contribution ratios, and cumulative contribution ratios of the first four factors are shown in Table 2.
As the cumulative contribution ratio of the third factor exceeds 80%, three factors are adopted as the factors of sound clips for males.

The factor loadings of males are shown in Table 3. The factor loadings are hatched as described in Section 2.2. The first factor is of potency because the impression word pair of “Active - Strong” has the large factor loadings. The second factor is brightness because the factor loadings of the impression word pairs of “Glad - Bright,” “Full - Large,” “Fast - Fast,” “Bright - Light” have large absolute values. The second factor may be of brightness because the factor loadings of the impression word pairs of “Glad - Bright,” “Hot - Cold,” and “Bright - Dark” are large. It is considered that the third factor is an activity factor because the impression word pair of “Active - Passive” has the largest factor loading.

### 4.2 Result of females

Eigenvalues, contribution ratios, and cumulative contribution ratios of the first four factors are shown in Table 4. As the cumulative contribution ratio of the fourth factor exceeds 80%, four factors are adopted as the factors of sound clips for females.

The factor loadings of females are shown in Table 5. The factor loadings are hatched as described in Section 2.2. The first factor is considered to be of brightness because the factor loadings of the impression word pairs of “Glad - Sad,” “Hot - Cold,” and “Bright - Dark” are large. The second factor is of potency because the factor loadings of the impression word pairs of “Strong - Weak,” and “Large - Small” are large. It is considered that the third factor is of naturalness because the impression word pairs of “Passive - Natural” and “Wet - Dry” have the large factor loadings. The fourth factor is an activity factor because the impression word pair of “Active - Passive” has the largest factor loading.

### 5. CONSIDERATIONS

#### 5.1 Cultural difference

Here, factors of Japanese males and Chinese males are compared. Factors and the corresponding impression word pairs are shown in Table 6. The brightness factor appears both in Japanese and Chinese males. Their impression word pairs are also the same. Although the potency factor also appears in Japanese and Chinese males, the impression word pairs of Japanese males are included in those of Chinese males. The naturalness and the sharpness of Japanese males are not included in the factors of Chinese males, while the activity of Chinese males is not included in the factors of Japanese males.
The brightness factor is the same, while the other factors are quite different in those of Japanese and Chinese males.

5.2 Gender difference

Factors of Chinese males and females are compared. Factors and the corresponding impression word pairs are shown in Table 7. The brightness, the potency, and the activity factors commonly appear both in Chinese males and females. The impression word pairs of the brightness and the activity are the same. The impression word pairs of the potency factor of Chinese males are different from those of Chinese females. The naturalness factor appears in the Chinese female factors, while it does not appear in the Chinese males’ factors.

Although some differences exist in the factors of Chinese males and females, these are very similar to each other.

5.3 Cross-sectional difference

Here, factors of Japanese males and Chinese females are compared. Factors and the corresponding impression word pairs are shown in Table 8. The brightness factor of Japanese males is the same as that of Chinese females, which is also the same as that of Chinese males. The naturalness and the potency factors are very similar. On the other hand, the sharpness factor does not appear in Chinese females’ factors, while the activity factor does not appear in Japanese males’ factors.

Factors of Chinese females may be more similar to those of Japanese males than those of Chinese males.

6. EVALUATION

We have seen the factors of Japanese males and Chinese females are remarkably similar. Here, we try to evaluate this tendency by using the transformation matrix [6]. After the transformation method is briefly explained, the tendency is evaluated.

6.1 Transformation matrix

Let a matrix of \( p \) variable data (impression word pairs) of \( n \) observation targets (pictures, sounds, and moving images) be the matrix \( Z \) of experimental data. Let \( F \) be an \( n \times m \) matrix of factor scores. Let \( A^T \) be a \( p \times m \) transpose matrix of factor loadings. Let \( E \) be an \( n \times p \) matrix of residuals. Then the factor analysis is represented in Equation (1).

\[
Z = FA^T + E \tag{1}
\]

The matrixes \( F \) and \( A \) are obtained so that \( m \) is as small as possible, and \( E \) is sufficiently small. Potential factors are obtained by using \( m \) sufficiently smaller than \( p \), which is the number of variables.

As a residual matrix \( E \) is small and negligible, matrix \( E \) in Equation (1) can be omitted to obtain Equation (2). The matrixes \( Z_1, F_1, \) and \( A_1 \) are the experimental data, the factor score matrix, and the factor loading matrix in a
study, respectively. The matrixes \( Z_1, F_2, \) and \( A_2 \) are the experimental data, the factor score matrix, and the factor loading matrix in another study, respectively.

\[
\begin{align*}
Z_1 &= FA_1^T \\
Z_2 &= FA_2^T
\end{align*}
\]  
(2)

Assume that the matrix \( A^T \) can be expressed in Equation (3) by using a matrix \( P \), which transforms the factor loading matrix [8]. The transformation matrix \( P \) can be obtained by using the Moore-Penrose generalized inverse matrix [7] as shown in Equation (4). Here, it is denoted as \( A_1^T \).

\[
A_1^T = PA_1^T
\]  
(3)

\[
P = A_1^T A_1^T +
\]  
(4)

In Equations (3) and (4), the order of the data, the impression word pairs and the factor names may be exchanged so that these correspond to each other.

### 6.2 Evaluation of the factors

#### 6.2.1 Factors of sound clips of Japanese males and Chinese females

Here, the factor loading matrix of the Japanese male shown in Table 1 and the factor loading matrix of the Chinese female shown in Table 5 are considered.

We assume the transposed matrix of the factor loading matrix of the Japanese male for sound clips \( A_{JM}^T \) is obtained from that of the Chinese female \( A_{CF}^T \) by using the transformation matrix \( P_{JMfromCF} \) as shown in Equation (5).

\[
A_{JM}^T = P_{JMfromCF} A_{CF}^T
\]  
(5)

The matrix \( P_{JMfromCF} \) is obtained as shown in Equation (6) by using the Moore-Penrose generalized inverse matrix of the matrix \( A_{CF}^T \).

\[
P_{JMfromCF} = \begin{bmatrix}
-0.12 & -0.28 & -0.64 & 0.13 \\
-0.86 & -0.07 & 0.01 & 0.09 \\
-0.02 & 1.01 & 0.19 & 0.42 \\
-0.03 & -0.39 & -0.13 & 1.03
\end{bmatrix}
\]  
(6)

The matrix \( P_{JMfromCF} \) shows that the second (fourth, respectively) factor of the Chinese female corresponds to the third (fourth) factor of the Japanese male because the \((3, 2)\) element \((4, 4)\) element of \( P_{JMfromCF} \) is almost one. It also shows that the first (third, respectively) factor of the Chinese female is inversely correlated to the second (first) factor of the Japanese male because the \((2, 1)\) element \((1, 3)\) element of \( P_{JMfromCF} \) is negative, and its absolute value is large. These correspondences and correlations in the factors of the Japanese male and the Chinese female can be confirmed by referring Table 1 and Table 5.

The matrix \( P_{JMfromCF} \), which is shown in Equation (7), is obtained from \( P_{JMfromCF} \) by changing the columns so that the \(i\)th factor of the Chinese female corresponds to the \(i\)th factor of the Japanese male.

\[
P_{JMfromCF} = \begin{bmatrix}
-0.64 & -0.12 & -0.28 & 0.13 \\
0.01 & -0.86 & -0.07 & 0.09 \\
0.19 & 0.02 & 1.01 & 0.42 \\
-0.13 & -0.03 & -0.39 & 1.03
\end{bmatrix}
\]  
(7)

Here, we calculate the mean and the standard deviation of the differences in the absolute values of the matrix \( P_{JMfromCF} \) and the elements of the four-dimensional unit matrix. The mean value and the standard deviation are 0.15 and 0.14, respectively.

#### 6.2.2 Factors of pictures of Japanese males and Chinese females

Yang et al. experimentally clarified the cultural and gender differences of pictures [1]. The factor loading matrixes of Japanese males, Chinese males, and Chinese females are shown in Appendix.

The transformation matrix \( P_{JMfromCF} \) is used to obtain the transposed matrix of the factor loading matrix of the Japanese male for pictures \( A_{JM}^T \) from that of the Chinese female \( A_{CF}^T \) as shown in Equation (8).

\[
A_{JM}^T = P_{JMfromCF} A_{CF}^T
\]  
(8)

The matrix \( P_{JMfromCF} \) is obtained as shown in Equation (9).

\[
P_{JMfromCF} = \begin{bmatrix}
-0.94 & -0.08 & -0.30 & 0.21 \\
0.04 & 0.89 & -0.09 & -0.01 \\
0.07 & 0.03 & -0.56 & 0.26 \\
0.03 & -0.09 & 1.11 & -0.22 \\
0.19 & 0.31 & -0.16 & 0.32
\end{bmatrix}
\]  
(9)

As for pictures, the matrix \( P_{JMfromCF} \) shows that the second (third, respectively) factor of the Chinese female corresponds to the second (fourth) factor of the Japanese male. It also shows that the first factor of the Chinese female is inversely correlated to the first factor of the Japanese male. These correspondences and correlations in the factors of the Japanese male and the Chinese female can be confirmed by referring Table A.1, and TableA.3 described in Appendix.

As the matrix \( P_{JMfromCF} \) is not a square matrix, we calculate the difference between it and the matrix, whose \((i,i)\) element is one, and the other elements are zero. The mean and the standard deviation of differences are 0.17 and 0.16, respectively.
6.2.3 The other factors

The mean and the standard deviation of differences between the transformation matrix of the other combinations of the factors for sound clips and pictures and the unit matrix could be obtained. These are the transformation matrixes for obtaining the transposed matrixes of the factor loading matrixes of the Japanese male (Chinese male, respectively) for sound clips and pictures from those of the Chinese male (Chinese female). These with those obtained in 6.2.1 and 6.2.2 are shown in Table 9.

The mean differences between the transform matrixes for obtaining the factor loading matrix of Japanese males from that of Chinese females for sound clips, that of Japanese males from that of Chinese females for pictures, and that of Japanese males from that of Chinese males for pictures and the corresponding unit matrixes are smaller than the other mean differences. These show the transformation matrixes are similar to the corresponding unit matrixes. Therefore, it can be said that the factor loading matrix of Japanese males and that of Chinese females seem to be similar, and so on.

### Table 9: Mean and standard deviation of differences between a transformation matrix and a unit matrix

| Media    | Transformation Matrix | Mean | S. D. |
|----------|-----------------------|------|-------|
| Sound clips | JM from CF 4x4       | 0.15 | 0.14  |
|          | JM from CM 4x3       | 0.25 | 0.22  |
|          | CM from CF 3x4       | 0.28 | 0.19  |
| Pictures | JM from CF 5x4       | 0.17 | 0.16  |
|          | JM from CM 5x5       | 0.18 | 0.13  |
|          | CM from CF 5x4       | 0.21 | 0.20  |

7. CONCLUSION

This paper tried to experimentally clarify cultural and gender differences of the impression of sound clips. It was shown that the brightness factor commonly appeared for Japanese males, Chinese males, and Chinese females. The other factors of Japanese and Chinese males were quite different. Although the activity factor commonly existed for Chinese males and females, the other factors could not be said to be the same.

The factors of Japanese males may be similar to those of Chinese females. We tried to clarify this tendency quantitatively by using the transformation matrix, which maps a factor loading matrix to another. We showed that two factor loading matrixes were similar by examining the similarity between the transformation matrix and a unit matrix corresponding to it. We also showed that this tendency appeared in the impression of pictures.

The cultural differences of pictures and sound clips were clarified. Clarifying those of video clips and music clips is included in future work. Confirming the similarity of the impression of Japanese males and Chinese females is also included in future work.

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APPENDIX

A.1 Factor Loading Matrixes for Pictures

The factor loading matrix of Japanese males (Chinese males and Chinese females, respectively) is shown in Table A.1 (A.2 and A.3).

Table A.1: Factor loadings of Japanese males for pictures

| Impression Word Pair | Factor 1  | Factor 2  | Factor 3  | Factor 4  | Factor 5  |
|----------------------|-----------|-----------|-----------|-----------|-----------|
| Bright - Dark        | -0.90     | -0.06     | 0.06      | 0.03      | 0.25      |
| Blad - Sad           | -0.90     | -0.05     | 0.02      | 0.28      | 0.01      |
| Hot - Cold           | -0.88     | -0.05     | 0.15      | 0.12      | -0.20     |
| Tense - Relaxed      | 0.65      | 0.08      | 0.08      | -0.41     | 0.43      |
| Clear - Hazy         | -0.59     | -0.12     | -0.09     | 0.56      | 0.35      |
| Large - Small        | 0.05      | 0.98      | 0.09      | -0.03     | 0.00      |
| Strong - Weak        | -0.06     | 0.88      | 0.14      | -0.22     | 0.17      |
| Heavy - Light        | 0.47      | 0.83      | -0.10     | -0.12     | -0.05     |
| Active - Passive     | -0.14     | 0.15      | 1.20      | 0.00      | 0.01      |
| Beautiful - Ugly     | -0.40     | -0.07     | -0.09     | 0.85      | 0.00      |
| Fresh - Stale        | -0.36     | -0.26     | 0.00      | 0.69      | 0.28      |
| Wet - Dry            | -0.31     | -0.30     | -0.04     | 0.66      | -0.16     |
| Natural - Artificial | -0.20     | -0.22     | 0.04      | 0.66      | -0.26     |
| Bold - Delicate      | -0.23     | 0.52      | 0.07      | -0.66     | 0.03      |
| Simple - Complex     | -0.03     | -0.21     | -0.08     | -0.46     | 0.04      |
| Sharp - Dull         | -0.02     | 0.08      | 0.01      | -0.07     | 0.90      |

Table A.2: Factor loadings of Chinese males for pictures

| Impression Word Pair | Factor 1  | Factor 2  | Factor 3  | Factor 4  | Factor 5  |
|----------------------|-----------|-----------|-----------|-----------|-----------|
| Bright - Dark        | 0.90      | 0.06      | -0.14     | 0.05      | 0.11      |
| Blad - Sad           | 0.84      | 0.24      | -0.20     | -0.08     | 0.17      |
| Hot - Cold           | 0.68      | -0.03     | -0.22     | -0.28     | 0.46      |
| Tense - Relaxed      | -0.33     | -0.56     | 0.02      | 0.62      | -0.23     |
| Clear - Hazy         | 0.69      | 0.53      | -0.18     | 0.20      | -0.13     |
| Large - Small        | -0.05     | 0.03      | 0.88      | 0.01      | 0.14      |
| Strong - Weak        | 0.23      | -0.19     | 0.23      | -0.34     | -0.17     |
| Heavy - Light        | -0.23     | -0.40     | 0.71      | 0.06      | -0.01     |
| Active - Passive     | 0.03      | 0.05      | 0.06      | -0.01     | 0.43      |
| Beautiful - Ugly     | 0.39      | 0.57      | -0.30     | -0.08     | 0.59      |
| Fresh - Stale        | 0.46      | 0.56      | -0.34     | 0.30      | 0.11      |
| Wet - Dry            | 0.18      | 0.66      | -0.30     | 0.16      | -0.02     |
| Natural - Artificial | 0.08      | 0.80      | -0.05     | 0.10      | 0.21      |
| Bold - Delicate      | -0.24     | -0.22     | 0.48      | 0.09      | -0.17     |
| Simple - Complex     | 0.49      | 0.34      | 0.03      | -0.14     | -0.07     |
| Sharp - Dull         | 0.06      | 0.13      | 0.11      | 0.50      | -0.05     |

Table A.3: Factor loadings of Chinese females for pictures

| Impression Word Pair | Factor 1  | Factor 2  | Factor 3  | Factor 4  | Factor 5  |
|----------------------|-----------|-----------|-----------|-----------|-----------|
| Bright - Dark        | 0.93      | -0.10     | 0.02      | 0.35      |
| Blad - Sad           | 0.86      | -0.18     | 0.42      | 0.04      |
| Hot - Cold           | 0.71      | -0.26     | -0.07     | -0.05     |
| Tense - Relaxed      | -0.26     | 0.35      | -0.38     | -0.19     |
| Clear - Hazy         | 0.69      | 0.10      | 0.32      | 0.48      |
| Large - Small        | -0.17     | 0.70      | -0.30     | -0.07     |
| Strong - Weak        | -0.10     | 0.85      | -0.04     | 0.03      |
| Heavy - Light        | -0.23     | 0.74      | -0.23     | -0.26     |
| Active - Passive     | 0.01      | 0.07      | -0.21     | 0.12      |
| Beautiful - Ugly     | 0.13      | -0.31     | 0.63      | 0.23      |
| Fresh - Stale        | 0.61      | -0.15     | 0.58      | 0.29      |
| Wet - Dry            | 0.15      | -0.04     | 0.7       | 0.18      |
| Natural - Artificial | -0.01     | -0.38     | 0.47      | 0.57      |
| Bold - Delicate      | -0.18     | 0.75      | -0.18     | -0.15     |
| Simple - Complex     | 0.40      | -0.25     | 0.13      | 0.71      |
| Sharp - Dull         | 0.11      | 0.25      | 0.00      | 0.20      |