

PSYCHOLOGICAL EVALUATION AND THE APPLICABILITY OF THE IMPRESSION TRANSFER VECTOR METHOD FOR SYNTHESIZING HIGHER-ORDER FACIAL IMPRESSIONS

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ABSTRACT

We developed a facial image generating technique that can manipulate facial impressions. The present study applied this impression transferring method to higher-order impressions such as “elegance” or “attractiveness” and confirmed the psychological validity of this method using the semantic differential method. Subsequently, we applied this method to two types of cognitive experiments. First, we examined the contributions of texture and shape on the facial impressions by using those face images for which the impressions have already been quantitatively manipulated based on this method. Second, we used such stimuli to examine the effect of facial impressions and attractiveness on the “mere exposure effect.” Thus, we concluded that the impression transfer vector method is an effective tool to quantitatively manipulate the facial impressions in various cognitive studies.

Keywords: Principal component analysis, semantic differential method, face, higher-order impressions, impression transfer vector

1. INTRODUCTION

The human face plays an important role in interpersonal communication. When we look at a person’s face, we readily perceive whether or not we know the person; further, we also estimate gender, age, personality, or physical attractiveness. Moreover, people perceive or form subjective facial impressions such as “elegant or inelegant” and “masculine or feminine.” In our research, we define *impressions* as “subjective or affective images perceived from various objects that reflect the viewer’s feelings, past experiences, knowledge, or an affective evaluation”. Some impressions are simple and directly perceived from physical information, such as gender or age. Others are more subjective, such as attractiveness. The latter are considered to be a higher level of impressions than the former.

In this paper, we focused on higher-level impressions such as attractiveness or elegance and manipulated the physical properties that contribute to them. The impressions were measured by using the semantic differential method [1]. This method was originally developed by Osgood and colleagues to measure the affective meanings of words. Recently, this method has been broadly employed for quantitatively measuring various impressions from different stimuli such as face,

color, music, aroma, and so on. Osgood posited that semantic differential data can generally be summarized into the following three primary factors: “Activity,” “Potency,” and “Evaluation.” In many studies, these factors have been confirmed among many materials and by people belonging to various cultures or countries.

1.1 Purpose of this study

In the current research, we manipulated facial impressions by using a newly suggested image processing method based on the principal component analysis (PCA); this method is referred to as the impression transfer vector method [2][3]. We then evaluated the psychological validity by using the semantic differential method. In particular, we focused on the impressions related to the “Evaluation” factor. Since Evaluation typically contains affective appraisals or reflections of values, such as “beautiful or ugly” or “elegant or inelegant,” it represents integrative higher-order impressions more than the other factors do. Investigating relationships between higher-order impressions, such as “elegant” or “likable,” and physical features as a mathematical model is useful for creating systems that can recognize and generate affective information regarding faces in order to develop, for example, user-friendly and attractive human interfaces.

The basic concepts of the impression transfer vector method and its application to higher-order impressions will be described in the first half of this paper. Thereafter, two experiments that apply the impression transfer vector method to the cognitive studies have been presented.

1.2 Impression transfer vector method based on the PCA

Kobayashi and colleagues generated impression-transferred images by using the impression transfer vector method [2][3]. In this method, facial patterns are first represented by multiple high-dimensional vectors that separate the shape and texture information of the face. The shape vectors indicate the x and y coordinates of the corresponding feature points defined on the face, and the texture vectors indicate the gray level values of the corresponding pixels of the pattern. We built a separated shape and texture morphable model, which describes the variations of faces with diverse attributes in terms of a small number of shape and texture parameters, by applying the PCA independently to the sets of the shape and texture vectors [4]. Thus, shape/texture vector \mathbf{X}_m ($m=1,2, \dots, M$)

of an arbitrary face image is represented by low-dimensional feature vector \mathbf{f}_m defined in the parameter space for shape/texture information.

Subsequently, we applied Fisher’s linear discriminant method to two groups of faces yielding opposite impressions, such as masculine and feminine for an impression dimension related to gender. The impression transfer vector was then defined as a unit vector on Fisher’s projection axis, which indicates the direction in which the target impression would most likely change.

Finally, for original feature vector \mathbf{f} which corresponds to an arbitrarily input face, the transformation by impression transfer vector \mathbf{e} was formulated as

$$\mathbf{f}_c = \mathbf{f} + q_c \delta \cdot \mathbf{e}, \quad (1)$$

where δ denotes the distance defined in the parameter space between the average vectors of the two groups, and q_c is a coefficient of magnification given to the term of the impression transfer vector. In our previous studies, we have successfully manipulated lower-order impressions such as gender- or age-related impressions [2][3].

2. APPLYING THE IMPRESSION TRANSFER VECTOR METHOD TO HIGHER- ORDER IMPRESSIONS

In this chapter, the procedures of applying the impression transfer vector to higher-order impressions have been presented. The principal components (Experiment 1) and training samples (Experiment 2) were chosen using the semantic differential method; thereafter, the impression transfer vector was generated based on the results of Experiments 1 and 2, and its psychological validity was evaluated in Experiment 3.

2.1 Experiment 1: Choosing the components used for the impression transfer vector based on the impression ratings of composite faces

Using the semantic differential method, we conducted impression ratings on a set of composite faces that were artificially generated by shifting the shape/texture parameters along the orthogonal axis corresponding to each principal component of the shape/texture feature space. Subsequently, we chose several potent principal components that were found fairly sensitive to the impressions of Evaluation, which mainly comprised “elegance,” “excellence,” or higher-order impressions related to attractiveness (Please refer to our previous studies for more details [5]).

2.1.1. Method

Participants. One hundred undergraduate and graduate students (50 males and 50 females) from Tohoku University participated in this experiment.

Stimuli. Two hundred and eighty-two composite face images were generated based on the PCA with 200 training samples taken from the ATR face database.

The 282 face images were then divided into four sets, and each participant was required to rate one set (72

Table 1: Top 10 components that contributed to impressions regarding Evaluation factor

| Rank | Component | Rank | Component |
|------|--------------|------|--------------|
| 1 | Shape 2nd | 6 | Shape 10th |
| 2 | Texture 14th | 7 | Shape 6th |
| 3 | Texture 34th | 8 | Shape 9th |
| 4 | Shape 1st | 9 | Shape 17th |
| 5 | Shape 7th | 10 | Texture 33rd |

images including two standard faces). The dimension of each image was 128 x 128 pixels; it was printed in the center of an A6-sized piece of paper and placed in clear files. With regard to the presentation order, five patterns were prepared for each set to eliminate the possible order effect.

Procedure. Impression ratings were conducted based on the semantic differential method. Rating adjective pairs were chosen based on previous studies [6]-[8] and were reduced to the following 10 pairs; “bright-dark,” “extraverted-introverted,” “powerful-weak,” “hard-soft,” “elegant-inelegant,” “excellent-incompetent,” “mild-violent,” “attractive-unattractive,” “distinctive-non distinctive,” “old-young,” and “feminine-masculine.” Each participant was provided with a file that contained 72 face images and a questionnaire; the participants were required to rate the impressions of each face image using the abovementioned 10 adjectives on a 7-point scale at their own pace. All the adjectives were presented in Japanese.

2.1.2. Results and discussion

A factor analysis was conducted on the semantic differential data using the principal factor method and varimax rotation. Based on the commonalities and the contribution ratio, the following three factors were extracted: “Activity (contribution ratio: 22.35%),” “Evaluation (17.45%),” and “Potency (11.41%).”

Thereafter, factor scores were calculated for all the stimuli. Using the factor scores, two-way analysis of variances, factors (3: Activity, Potency, and Evaluation) x degree of weight (P_c) (5: -3.0, -1.5, 0, +1.5, +3.0), were performed on each shape and texture dimension. The 10 dimensions in which the Evaluation factor scores of faces largely changed along the degree of the weight (P_c) were chosen for shape and texture; each as the important dimension that would particularly contribute to the impressions regarding Evaluation. The top 10 components that contributed to the impressions regarding Evaluation have been presented in Table 1.

Thus, we confirmed that synthesized images induce various impressions that change along the gradual transformation of shape and texture components. Moreover, dimensions with bigger contribution ratios defined by the PCA did not necessarily have a larger effect on the impressions related to Evaluation. Therefore, we selected and used the dimensions that greatly affected Evaluation, regardless of their eigenvalues, in order to produce synthesized face images in the following experiments.

2.2. Experiment 2: Choosing training sample

faces based on the impression ratings of real faces

In this experiment, the same impression ratings were conducted on the real face samples that were used to generate the composite faces. Based on the results, we formed two groups of faces with high Evaluation (e.g., elegant) and low Evaluation (e.g., inelegant) impressions to synthesize the impression transfer vectors corresponding to Evaluation.

2.2.1 Method

Participants. One hundred undergraduate and graduate students (50 males and 50 females) from Tohoku University participated in this experiment and received some amount of remuneration. Further, they did not participate in Experiment 1.

Stimuli. Two hundred face patterns, including 10 facial expressions x 20 models (10 males and 10 females), were chosen from the ATR face database. The dimension of all the stimuli was 128 x 128 pixels, and they were printed on A6-sized pieces of paper.

The 200 faces were divided into five groups of 40 faces each. Thereafter, five patterns of deviation were made by varying the combinations of stimulus people and facial expressions. Each participant was assigned to one of the groups and was required to rate 40 patterns of faces. In addition, the following two rules were implemented to create more variations of the stimulus groups: (1) each stimulus group must contain two men and two women per expression, and (2) each model must appear twice with different expressions in a stimulus group.

Procedure. Impression ratings were conducted based on the semantic differential method using the same 10 adjective pairs that were used in Experiment 1. One of the combinations of the 25 stimulus groups and three types of questionnaires were randomly assigned to the same number of male and female participants.

2.2.2 Results and discussion

The results of the factor analysis with the principal factor method and varimax rotation were almost identical to the results of Experiment 1. The following three factors were extracted: "Activity (contribution ratio: 22.38%)," "Evaluation (21.13%)," and "Potency (14.27%)."

Factor scores were calculated for each factor. We chose 40 faces based on the magnitude of the factor scores. Twenty faces with high Evaluation scores and another twenty with low Evaluation scores were chosen to construct two classes with opposite Evaluation impressions in order to obtain the impression transfer vector.

2.3. Experiment 3: Examining the validity of the impression transfer vector method

In Experiment 3, we tested the validity of the impression transfer vectors generated based on the results

of Experiments 1 and 2. In our previous studies, the vectors were synthesized from the major principal components chosen in the order of larger eigenvalues (*Method A*). In the current research, we employed a new method (*Method B*) for choosing the appropriate dimensions. In *Method B*, the principal components with larger effects on the impressions pertaining to Evaluation were selected to synthesize the impression transfer vector. We then compared the effectiveness of *Methods A* and *B*.

2.3.1 Method

Participants. One hundred and eight undergraduate and graduate students (54 males and 54 females) from Tohoku and Hosei Universities participated in this experiment. Since the data homogeneity of the two groups of participants was confirmed, we combined the data obtained from both the groups. None of the participants had been involved in Experiments 1 and 2. Further, each participant received a small remuneration.

Stimuli. Face stimuli were synthesized by varying the q_c parameter in Equation (1) on nine steps from -4.0 to +4.0 (varied by 1.0) for *Method A* and from -2.0 to +2.0 (varied by 0.5) for *Method B*. We employed these different ranges to equate the appearance variations of the faces generated in both the methods without including unnatural faces. The faces were synthesized using the nine steps of q_c for both shape and texture; thus, a total of $9 \times 9 = 81$ face patterns were synthesized. All the stimuli were printed on A6-sized pieces of paper and divided into four sets; each participant rated 41 face images including 20 images from those synthesized by *Method A*, 20 images synthesized by *Method B*, and a standard face. The standard face was created by averaging the shape and texture vectors of 200 face patterns in the ATR face database.

Procedure. Impression ratings were conducted based on the semantic differential method in the same manner as in Experiments 1 and 2. Stimulus sets and the questionnaires were randomly assigned to an equal number of male and female participants.

2.3.2 Results and discussion

As the result of the factor analysis with the principal factor method and varimax rotation, the following three factors were extracted based on the adjectives: Activity (contribution ratio: 23.37%), Evaluation (17.34%), and Potency (14.08%). The factor structure was almost identical to the ones obtained in Experiments 1 and 2.

Factor scores were calculated for the three factors and averaged for each image. To test the validity of the impression transfer vector method in terms of Evaluation, the following analyses were performed only on the Evaluation factor. First, to compare the validity of *Method A* with that of *Method B*, we performed linear regression analyses using the Evaluation factor scores as the dependent variables and the 9-step changes of q_c in Equation (1) as the independent variables for both methods. In the analyses, the nine stimuli, whose shape and texture

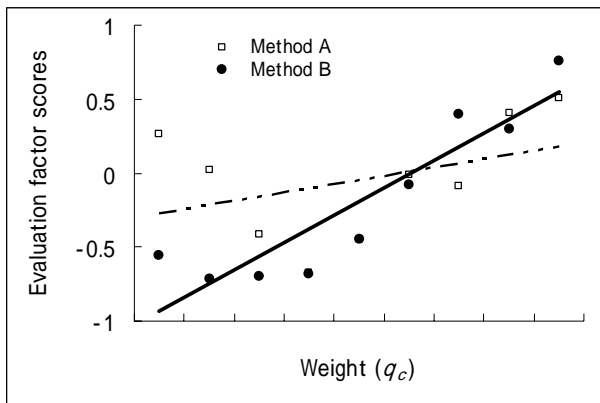


Fig. 1: Scatter plots and regression lines of the Evaluation factor scores for the images synthesized based on *Methods A & B*. The dotted line indicates the regression line pertaining *Method A*, and the linear regression equation is $y = 0.06x - 0.05$. The bold line indicates the regression line regarding *Method B*, and the linear regression equation is $y = 0.37x - 0.19$.

were transformed together (i.e., the q_c s of shape and texture were the same), were used by both *Methods A* and *B*. If the factor scores linearly increased along the growth of q_c , we conclude that the validity of the method was confirmed. Fig. 1 shows the factor scores for the images synthesized based on *Methods A* and *B*.

In the results for *Method A*, the scatter plot of the Evaluation factor score appeared to be U-shaped. Thus the regression equation was not significant (adjusted $R^2 = .03$, $p = .31$). On the other hand, *Method B* produced a significant regression equation (adjusted $R^2 = .81$, $p < .001$) with a positive slope. That is, *Method B* increased the perceived impressions in the Evaluation factor as a function of the impression transfer vector for the Evaluation factor. Thus, we confirmed the psychological efficacy of *Method B* for choosing parameters regarding Evaluation impressions.

While *Method A* has been used in previous research [2][3], this method does not consider particular impressions. Hence, the impression transfer vector

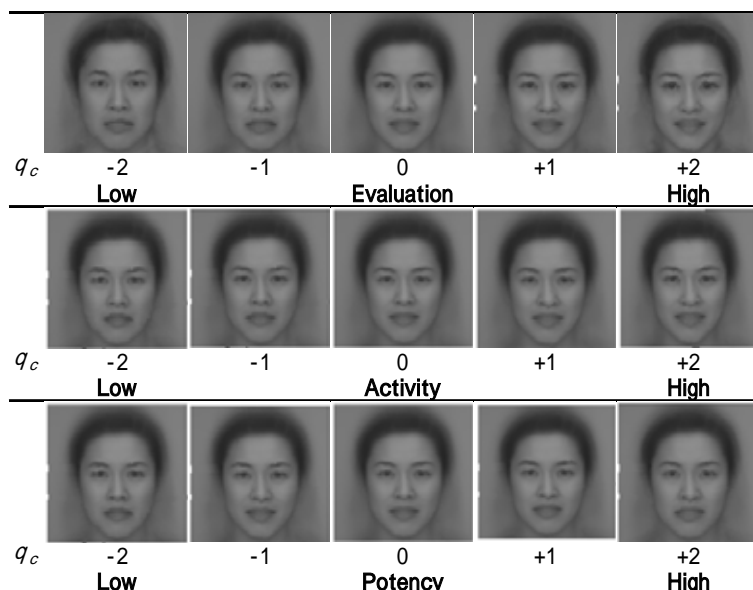


Fig. 2: Samples of the face images generated based on the impression transfer vector method. q_c indicates the degree of manipulation.

generated using *Method A* did not strongly affect the transfer of impressions in terms of Evaluation. In contrast, in *Method B*, only those dimensions considered to have a larger effect on Evaluation impressions were chosen. Thus, the impression transfer vector generated using *Method B* had a stronger effect on the transfer of the impressions in terms of Evaluation. Therefore, effectively utilizing psychological factors (such as impression ratings) is important to efficiently transfer the target impressions.

3. APPLICATIONS FOR THE COGNITIVE STUDIES

In this chapter, we present some of the applications of the impression transfer vector method. Recently, more and more psychologists have focused on the effects that first impressions or affective judgments of faces have on subsequent judgments or behaviors. However, previous studies have not systematically manipulate such impressions. If a specific impression can be manipulated or controlled by the impression transfer vector method and such controlled face images can be used in psychological experiments, the effects of impressions on face recognition can be examined more systematically and precisely.

In this chapter, we introduce two studies ([9][10]) that have attempted to use the impression transfer vector method to manipulate the impressions of stimuli. First, we examined the contributions of a face's shape and texture of face on the facial impressions with those face images for which the impressions have already been quantitatively manipulated based on this method (3.1). Second, we employed the manipulated stimuli to examine the effects of the impressions on the "mere exposure effect [11]." (3.2). We were able to successfully transfer the impressions of an average face by using the impression transfer vector method not only with regard to the Evaluation factor but also in terms of Activity and Potency [12] (Fig. 2). The manipulated stimuli were used in the following experiments.

3.1. Contributions of shape and texture on the facial impressions

Osgood and colleagues suggested a "pessimistic evaluative stickiness" tendency with regard to the Evaluation factor [1]. When two words are combined, the impression of the combined word tends to be negative if one word has a negative meaning. For example, a TREACHEROUS NURSE and a SINCERE KILLER are not to be trusted. This tendency has also been confirmed using color-form combinations [13]. It was shown that Activity and Potency factor have additive characteristic whereas Evaluation factor has a non-additive characteristic, based on the regression analysis. Thus, we attempted to examine this tendency using the shape and texture of impression-transferred faces.

3.1.1 Method

Stimuli. Eighty-one patterns of images for which the impressions were manipulated in terms of Evaluation (see 2.3) and forty-nine patterns of images for which the impressions were manipulated in terms of Activity and Potency [12] were generated and printed on A6-sized pieces of paper. The impressions of the face images have been rated [9][12].

Procedure. The semantic differential data obtained in our previous study [9][12] were re-analyzed in this section.

3.1.2 Results and discussion

Factor scores were calculated on each stimulus. Thereafter, linear regression analyses were performed using the factor scores as the dependent variables and the q_c s of texture as the independent variables on each q_c of shape. As the result, all adjusted R^2 and the standardized partial regression coefficient (β) were significant on those stimuli for which the impressions were manipulated with respect to Activity or Potency. However, the adjusted R^2 and standardized β were not significant when the q_c of shape was -2 (adjusted $R^2 = -.08$, *n.s.*) or -1.5 (adjusted $R^2 = -.10$, *n.s.*) for Evaluation. In other words, when the impression of shape was negative in terms of Evaluation, the entire impression of the face was not changed by the positive impression of texture (Fig. 3).

Thus, the pessimistic evaluative stickiness tendency was confirmed with regard to the Evaluation factor.

3.2. Mere exposure effect

Many literatures have shown that an individual's preference for a particular stimulus object is enhanced when the individual is repeatedly exposed to the object (mere exposure effect) [11]. However, the manner in which the subjective factors such as affective impressions or physical attractiveness affect the mere exposure effect have not been sufficiently discussed. In our research, we used face images and manipulated the facial impressions quantitatively on various dimensions (e.g., elegant, strong, etc) in order to compare the preference ratings between the repeated and novel stimuli.

3.2.1 Method

Experimental design. This experiment consisted of a three factorial design: manipulated impressions (Activity, Potency, or Evaluation) x repetition (0, 1, or 10 times) x attractiveness (high or middle). All of them were within-subject factors.

Participants. Eighteen undergraduate and graduate students from Waseda University participated in this experiment.

Stimuli. Thirty-one face images for which the impressions had been manipulated by the impression transfer vector method were used. The perceived facial attractiveness had already been measured in our previous study [7].

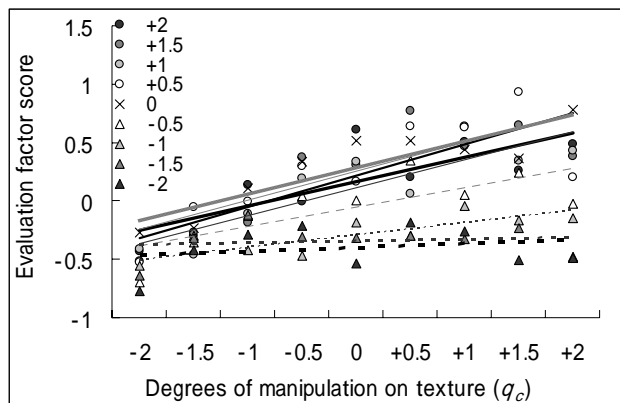


Fig. 3: Scatter plots and regression lines of the Evaluation factor scores for the impression-transferred images. The factor scores were plotted on the degrees of manipulation (q_c) of texture, and regression lines were drawn for each of the q_c s of shape.

Procedure. In the exposure phase, the fixation point (1000 ms), stimulus (6 ms), mask (100 ms), and blank screen (2000 ms) were presented in that order. Ten stimuli were presented only once, and the other ten were presented 10 times; the remaining eleven stimuli (including the average face) were not presented in the exposure phase. Thereafter, the participants were required to estimate their mood using the PANAS questionnaire as a filler task. Subsequently, all the 31 stimuli were presented, and a preference judgment was performed using a 6-point scale (1: do not like at all ~ 6: extremely like).

3.2.2 Results and discussion

A three-way ANOVA (impressions x repetition x attractiveness) was performed on the preference ratings. The main effect of the number of repetitions was significant, $F(2,204) = 9.3$, $p < .001$.

It was suggested that the patterns of the exposure effect were different among the impression dimensions. The preference ratings were increased by repeated exposure only on the faces for which the “elegant” impression was manipulated and for those that have relatively high attractiveness. Therefore, it is possible that the mere exposure effect is mediated by the impression dimension pertaining to the elegance or attractiveness of the stimuli. Thus, the mere exposure effect would be mediated by the impression dimension pertaining to the elegance or attractiveness of a stimulus.

4. GENERAL DISCUSSION

In previous studies [2][3], the impression transfer vector method was applied to simpler impressions, such as gender or age impressions, which were primarily judged based on relatively simple facial features. In this paper, we proposed that the impression transfer vector method could be applied to more complicated and subjective higher-order impressions such as elegance or attractiveness. Therefore, we confirmed that even complicated and subjective impressions are, in fact, derived from a combination of the

appropriate principal components of face images.

Moreover, it was suggested that the impression transfer vector method could be applicable as an effective tool to manipulate facial impressions in psychological experiments. Thus, the impression transfer vector method can contribute to the development of basic research on impressions or attributes and the recognition of faces.

Many extended applications are possible for the impression transfer vector method. First, in the current paper, we focused on higher-order impressions represented by the Evaluation factor. In addition, we applied the impression transfer method with a new method for choosing parameters to other kinds of impressions, such as Activity or Potency [12]. The proposed method enables us to modulate the facial impressions in a more dynamic manner by simultaneously or separately manipulating several impression transfer vectors.

Second, we only used two-dimensional (2D) images in this research. The impression transfer vector method has already been applied to 2D faces; however, gender impressions were transformed based on the 3D impression transfer vector method [3][14]. Thus, we need to confirm the psychological validity of the impression transformation for 3D data with higher-order impressions as well as those used in the current study.

Finally, this can help to increase desirable impressions depending on different situations. For example, we can suggest creating human-machine interfaces that offer desirable impressions. If the users are young children, the desirable impressions might be “friendly” or “approachable,” whereas if the users are business people, “intelligent” or “sophisticated” might be more desirable impressions. Moreover, it could also be possible to suggest makeup techniques to induce elegant impressions based on the analysis using impression-transferred images. Thus the impression transfer vector method has considerable potential in many fields.

4.1. Conclusion

We confirmed the validity of the impression transfer vector method for modulating higher-order impressions by using psychological judgments. To manipulate facial impressions based on the impression transfer vector method and to use the manipulated faces in psychological research will considerably help in quantitatively examining the effects of impressions on face processing. In addition, many practical applications of the impression transfer vector method are also expected.

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5. REFERENCES

- [1] C. E. Osgood, & G. Suci, et al., “*The Measurement of Meaning.*” Urbana: University of Illinois Press, 1957.
- [2] T. Kobayashi, & M. Ozu, et al., “Impression transformation of a face based discriminant analysis on separately coded representations of facial shape and texture,” *Proceedings of the 6th IEEE International Conference on Automatic Face and Gesture Recognition (FGR04)*, pp. 711-716, 2004.
- [3] Y. Okada, & M. Ohzu, et al., “Automatic impression transformation of faces in 3D shape- A perceptual comparison with processing on 2D images -.” *Proc. of the 7th IEEE International Conference on Automatic Face and Gesture Recognition*, pp.535-540, 2006.
- [4] T. Vetter & N. Troje, “A separated linear shape and texture space for modeling two-dimensional images of human faces,” *Max-Planck-Institute fur biologische Kybernetik, TR*, No. 15, 1995.
- [5] T. Sakurai & T. Akita, et al., “Automatic face image generation system for higher-order impression transformation,” *Proc. of IWAIT2007*, pp.572-577, 2007.
- [6] M. K. Yamaguchi, & T. Kato, et al., “Relationships between physical traits and subjective impressions of faces -age and gender information-,” *Electronics and Communications in Japan, Part 3*, 79, pp.279-287, 1996. (in Japanese)
- [7] Y. Sakuta & J. Gyoba, “Facial Impressions and facial memory: Evidence for potential factors mediating the effects of distinctiveness and attractiveness,” *Tohoku Psychologica Folia*, 62, pp. 75-85, 2003.
- [8] J. A. Sarno, & T. R. Alley, “Attractiveness and the memorability of faces: Only a matter of distinctiveness?” *American Journal of Psychology*, 110, pp. 81-92, 1997.
- [9] Y. Sakuta, & H. Ishi, et al., “Additive or non-additive characteristics of the facial impressions examined by the impression transfer vector method,” *Kaogaku*, 7, pp. 65-76, 2007. (in Japanese)
- [10] Y. Sakuta, & H. Ishi, et al., “Role of facial expressions and attractiveness on the mere exposure effect,” *Perception*, 37 *ECVP Abstract Supplement*, p. 35, 2008.
- [11] R. B. Zajonc, “Attitudinal effects of mere exposure,” *Journal of Personality and Social Psychology*, 9, pp. 1-27, 1968.
- [12] H. Ishi, & Y. Sakuta, et al., “A face image generation system for transforming three dimensions of higher-order impression transformation,” *IWAIT2009*, in press.
- [13] T. Oyama, & H. Yamada, et al., “Synesthetic tendencies as the basis of sensory symbolism: a review of a series of experiments by means of semantic differential,” *Psychologia*, 41, pp. 203-215, 1998.
- [14] M. Ohzu, & D. Yano, et al., “Morphable model of composite 3-D faces that transforms gender impression,” *Technical Report of IEICE*, IE2004-136 (2005-1), pp. 101-106, 2005.