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Effects of Affective Impressions on Recognizing Upright and Inverted Faces

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The purpose of this study was to examine the subjective impressions of upright and inverted faces and their effects on face recognition. We measured the impressions of inverted faces and compared them to those of upright faces using Semantic Differential (SD) method. Based on factor analysis, three factors were extracted and named Activity, Potency, and Evaluation. The magnitude of impressions, especially the impressions related to Evaluation, was found to be reduced when the faces were inverted. Then we examined the differences between recognition performances on the inverted faces and upright faces. As the results, the recognition performances were largely decreased when the faces containing negatively strong impressions on Evaluation or the faces with an intermediate rating on Potency were inverted. These results were discussed with focusing on the differential processing of featural information (individual facial features) and configural information (spatial layout of these features) in relation to the characteristics of the three factors.

Key words. impression, recognition, inverted face

Introduction

The reduced ability to recognize accurately faces that have been inverted, known as the "inversion effect" has been well studied (see Valentine, 1988 for a review). One possible reason for the inversion effect is that face recognition relies on processes unique for faces. The exact mechanisms are unknown, however, researchers have proposed different theories to explain the phenomenon.

Yin (1969) suggested that facial expressions had an important role on the face inversion effect. When faces were inversed, we cannot accurately judge what kind of expressions were on the faces. Yin proposed that disruption in judging facial expressions also disrupted face recognition. The Thatcher illusion (Thompson, 1980), where the famous prime minister of Great Britain Margaret Thatcher's face is upside down but the eyes and mouth are inverted relative to the face, supports Yin's claim. People fail to realize the strange expression on Thatcher's face created by the inverted eyes and mouth when the whole face is inverted.

Another possible explanation for the face inversion effect is that people use a "face schema" in order to process faces efficiently and quickly (Goldstein & Chance, 1980). Goldstein and Chance argued that face schema has little flexibility, thus impairment arises when processing

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extremely unfamiliar faces, such as inverted faces or other race faces. The face inversion effect and the race effect increased with age and development of the face schema help support schema theory (Goldstein & Chance, 1980). However, other studies failed to replicate Goldstein & Chance's results. Flin (1985) suggested that the increase in the effect of inversion with age could be a result of floor effects. Some studies did not show any interactions between the age and race effect (Cross, Cross, & Daley, 1971; Feinman & Entwisle, 1976; Kagan & Klein, 1973). Thus the relationships between age and race or inversion effect are unclear (for a review, Valentine, 1988).

A more plausible account involves the effect of familiarity or expertise in recognizing stimuli within an object class. Diamond and Carey (1986) assumed that inversion effect required three premises; items within a class share a common configuration, stimuli can be discriminated based on distinctive relations among elements, and experts are adept at using these relations. They found that dog experts showed a larger inversion effect on recognizing dogs than non-experts did. Other studies have also reported that not only human faces but also other extremely familiar stimuli can cause inversion effect (e.g., Tanaka & Farah, 1993). Valentine (1988) concluded that high familiarity and homogeneity of the stimuli must be important for the inversion effect. Most researchers believe now that the inversion effect is not unique to human faces and does not necessarily indicate the special process of face recognition.

Configural and featural information processing

Many studies have suggested that both of featural and configural information are involved in recognizing upright faces. Physical information of each feature inside face, such as eyes, mouth or nose is considered as "featural information" and their allocation or spatial relationships in the face is called as "configural information." The processing of configural information is disrupted severely in upside-down faces (e.g., Carey & Diamond, 1977; Diamond & Carey, 1986; for a review, Farah, Wilson, Drain, & Tanaka, 1998; Murray, 2004). According to this view, people have to recognize inverted faces depending mainly on the featural information. However, interpretations of the different studies are difficult because of the lack of consensus in terminology and manipulation of stimuli. For example, distance between the eyes (Tanaka & Sengco, 1997), or layout of all the features inside a face (Tanaka & Farah, 1993) were manipulated as configuration, whereas Cabeza and Kato (2000) created combined faces as "configuration prototype" using a morphing technique. Tanaka and Sengco (1997) suggested that featural and configural information interact each other. When configural information is changed, featural information is also interfered. Cabeza and Kato (2000) indicated that featural and configural information had similar effect on recognizing upright faces, whereas the effect of configural information was declined on inverted faces. Although there are some problems regarding the featural and configural information as described above, we would focus on the roles of these kinds of information play in face recognition.

The semantic differential studies of the affective impression

Recently, a number of studies have focused on affective aspects in cognitive processes. They have mainly examined the affective value of the stimuli-- the emotional states of participants or the interaction between them. People may systematically process or store affective information that is important for them so that it can be efficiently remembered and used at a later time. For example, the studies of mood congruency effects (Bower, 1981; Isen, Shalker, Clark, & Karp, 1978) or negativity bias (Hamilton & Zanna, 1972; Kanouse & Hanson, 1972; Pratto & John, 1991) have been well known as the studies that indicate such effects of affective aspects on memory. According to mood congruency effects, when affective value of a stimulus (e.g., negative or positive) is congruent with a person's mood, the stimulus can easily be recognized by the person (Bower, 1981; Isen, Shalker, Clark, & Karp, 1978). Negativity bias suggests that people tend to remember negative things better than positive things (Hamilton & Zanna, 1972; Kanouse & Hanson, 1972; Pratto & John, 1991). Thus many studies have discussed the effect of affective values on memory processes.

In our research, we would like to deal with impressions rather than affective values or personality traits, which people can visually perceive from the facial appearance. When people see human faces, they receive various information from the faces, such as "male or female," "adult or child," "familiar or unfamiliar," and so on. Moreover, they also (sometimes automatically) perceive or judge subjective facial impressions, such as "good or bad," "masculine or feminine," and so forth. We define impression as a "highly subjective image that a person affectively receives from a stimulus" in our study. Such impressions are a type of subjective or holistic information and reflect particular affective feelings or responses. It is important to understand how such various impressions affect recognition since people always see faces displaying various subjective impressions in daily life. To study the relationships between various impressions and facial features can help understanding the face processing regarding affective aspects. For example, that kind of research can be applied to develop friendly or attractive man-machine-interface or humanoid design. In many studies, Semantic Differential (SD) method has been used to measure the affective impressions.

The Semantic Differential (SD) method was originally developed by Osgood and his collaborators in order to measure the affective meanings of words on the basis of the hypothesis that words include both literal and affective meanings (Osgood, Suci, & Tannenbaum, 1957). As a general procedure, participants are asked to rate their impressions of various stimuli, such as words or pictures, along several bipolar adjectives (e.g., 'active-passive', 'hard-soft', 'beautiful-ugly', etc.) on a 5 or 7 point scales. Factor analysis reveals which main factors provide the bulk of the information from which impressions can are derived. Osgood et al. (1957) posited that semantic differential data can generally be summarized using the three main factors: "Activity," "Potency," and "Evaluation." According to Osgood et al. (1957), Activity factor is concerned with "quickness, excitement, warmth, agitation, and the like (Osgood et al., 1957)," represented by adjectives such as "active-passive" or "cheerful-cheerless." Potency factor is concerned with "power and things associated with it, size, weight, toughness, and the like (Osgood et al., 1957)," often contains "powerful-weak" or "hard-soft." And Evaluation factor is considered as an "attitudal variable in human thinking, based as it is on the bedrock of rewards and punishments both achieved and anticipated, appears to be primary (Osgood et al., 1957)," and consists of highly subjective adjectives such as "beautiful-ugly" or "likable-unlikable." In a considerable number of studies, these factors have been confirmed among many materials (concepts or objects) and people belonging to various cultures or countries. Recently, SD method has been widely used to examine the impressions derived from visual stimuli (e.g., Oyama, 2003).

In some previous studies, different characteristics among the three factors have been indicated (Hogg, 1969; Osgood et al., 1957; Oyama, 2003). The Activity and Potency factor scores of combined stimuli can be more accurately predicted from the factor scores of individual stimuli whereas overall impressions of combined stimuli could not be accurately predicted from the individual stimuli in terms of Evaluation factor. For example, when a color with active impression (e.g., bright red) is combined with a shape with active impression (e.g., star-like shape), the combined stimulus of colored shape would have more active impression. In contrast, a colored shape with both a color and a shape with good impressions would not have much better impression than individual color and shape. Moreover, when a color with good impression is combined with a shape with bad impression, the impression of the colored shape tends to be worse. Osgood called this phenomenon as "pessimistic evaluative stickiness." Oyama (2003) suggested that Evaluation had a nonadditive property whereas Activity and Potency had additive properties. In this study, we would also focus on the different characteristics among the three factors.

As described above, there have been many studies which have investigated the impressions of various stimuli. Surprisingly, however, few studies have examined how the impressions affect memorability or recognizability. Sakuta and Gyoba (2003) found that the faces that were rated positively on the Activity dimension and those rated negatively on the Evaluation dimension were significantly more recognizable compared to the faces with the opposite characteristics. Evaluation factor had the largest influence on the recognition performance among the three factors, while in the impression ratings Activity had the highest , Potency had second highest, and Evaluation had the lowest contribution ratio. Therefore, it is suggested that the impression factors have a different effect on memorability of faces and that some cognitive processes might be involved in recognizing faces differently among the three factors. In this study, we would analyze the relationships between the affective impressions and memorability in detail and discuss the mechanism underlying such effect.

Purpose of this study

In this study, we examined whether the inversion effect occurs on subjective impressions. That is, we focused on how the various facial impressions (e.g., "bright," "elegant," etc.) would be influenced and changed when the faces are inverted. We supposed that the subjective impressions would be attenuated because it has been reported that people have difficulty in judging the impressions on the inverted faces.

Most of the previous researches on inverted face have mainly focused on facial identification, recognition, or perceptual decision. There are other studies that have investigated how subjective and affective impressions and attractiveness affect face recognition. Facial attractiveness facilitates recognizability of the face (Shepherd & Ellis, 1973; Sakuta & Gyoba, 2003). Subjective impressions also affect the facial recognition (Sakuta & Gyoba, 2003). Especially, faces with negatively rated on Evaluation factor showed the highest recognition performance. These results indicate that such impressions can modify the recognition performances even when the participants were not aware of facial impressions during the experiment. Based on those findings, we hypothesized that subjective impressions would significantly influence on recognition for both upright and inverted faces.

Sakuta and Gyoba (2003) have found that Evaluation factor has the largest influence on recognizability while the contribution ratio of Evaluation is lower than Activity and Potency. We have suggested that such unique characteristics of Evaluation on face recognition, which is different from the other two factors, would partly be caused by the basis of impression judgment (Bower & Karlin, 1974 ; Sakuta & Gyoba, 2003, 2006). The impressions in terms of Activity are likely related mainly with sensory or physical information, for example, "hard-soft," "dark-light." On the other hand, it is quite plausible that subjective, self-relevant, or affective judgments, which are not necessarily dependent upon physical features, might be important for the impression judgment related to Evaluation, such as "beautiful-ugly" or "likable-unlikable." The impressions in terms of Potency could be related to both kinds of information (c.f. "powerful-weak" or "masculine-feminine"). Considering these points, it can be thought that the impressions related to Activity or Potency are relatively stable even when the faces are inverted because such impressions are more easily judged by physical feature of the faces. On the contrary, Evaluation might be less affected by such physical features but be comprehensively judged based on global figures. In consequence, it is highly likely that the impressions related to Evaluation would be easily changed or attenuated and the factor score of Evaluation would be moved toward zero (we call it "neutralized" in this article) by inversion. Moreover, it is also highly probable that the "neutralization" of the impressions would decrease the recognition performances because the impressions might work as one of a cue for recognition (Sakuta & Gyoba, 2002, 2003, 2006). If so, recognition performances for the faces, whose impressions are largely neutralized by inversion, might also be largely decreased.

The present study was conducted in order to assess the following two predictions: (1) the impressions related to Evaluation would be easily neutralized by inversion whereas the impressions related to Activity would not be so largely neutralized, (2) the neutralization of the impressions would decrease the recognition performances producing the different decrements depending on the three factors. This study will reveal the relationships between the subjective impressions and physical information. Furthermore, it will also be addressed that the difference among the impression factors in terms of the basis of the impressions.

Experiment 1: Impression ratings for upside-down faces

There has been little study on the effect of subjective or affective factors on recognizing inverted face, although it would appear that people might have some subjective feelings or images on human faces, such as "He looks warm." Bäuml (1994) examined the facial attractiveness on upright and inverted faces. He suggested that facial attractiveness was generally reduced by inversion and that usage of featural information for the attractiveness judgment would be disrupted by inversion as well as configural information. However, only eight faces were used in his study and attractiveness of those faces was equated to be medium degree. So his study could have some limitations. As mentioned above, we would like to consider subjective impressions in terms of affective factors of Activity, Potency and Evaluation (Osgood, et al., 1957). We hypothesized that the strong impressions related with Evaluation (e.g., "beautiful-ugly") could largely be attenuated by inversion. That is because such impressions were assumed to be mainly based on configural information. According to Diamond and Carey (1986), processing of configural information would easily be disrupted comparing to featural information when a face was inverted.

In this section, multiple impressions for all the faces were rated using multiple adjective scales, and then the main factors were extracted from the data by factor analysis. We compared the factor scores between upright faces and upside-down faces. We hypothesized that the impressions related to Evaluation would be easily neutralized by inversion whereas the impressions related to Activity would not be so largely neutralized.

Methods

Participants. The participants comprised a total of 47 (29 male and 18 female) college students at Sendai Iryohukushi Senmon Gakko (mean age: 18.7 years old). Participants were given class credit. All of them were native Japanese speakers.

Stimuli. The stimuli consisted of 48 adult Japanese male monochromatic photographs which were used in our previous study (Sakuta & Gyoba, 2003) and have already been measured their impressions derived from upright faces. Experimenters chose the faces which did not display any expressions and were devoid of memorable decorations, such as pierced earrings or showy hairstyles. Eight men wore glasses. All faces were presented from a frontal view. Photographs were scanned into a personal computer; sizes and contrast of the photographs were equated as much as possible. They were printed out on A6 size of gloss photo paper and placed into transparent cases.

All the stimuli were divided into 4 sets. Each set consisted of 12 faces. The individual participants rated only one out of the 4 sets, in other words, only a quarter of all stimuli (12 male faces).

Procedure. Based on a previous study (Inoue & Kobayashi, 1985), 30 Japanese adjective-pairs were chosen as 7-point scales by experimenters, which were considered to be suitable for the impression judgment of faces. In order to choose appropriate adjectives for measuring facial impressions from the 30 adjective pairs, preliminary study was performed on a small number of participants (12 university students). A pilot factor analysis was performed for the faces in terms of the principal factor method using the varimax rotation. Based on the communality and factor loadings obtained, 18 adjective pairs were chosen and used in the impression ratings. These 18 adjective pairs have also been used in our previous study for measuring the impressions for the upright faces (Sakuta & Gyoba, 2003). In sum, the stimuli and adjectives in the current research were identical to the ones used in the previous research (Sakuta & Gyoba, 2003) except for the face direction.

The participants rated the presented faces one by one using the SD method in Japanese. The orders of presentation of stimuli set were counterbalanced. The face photographs were presented to the participants in such a manner that similar facial features of faces were not presented in succession. There were three different patterns containing a different order of the adjectives and their polarities were prepared and assigned to an equal number of participants. The rating data for upright faces have been obtained in the previous research (Sakuta & Gyoba, 2003).

Results

At first, it was found that the factor analysis on the data for the inverted faces revealed almost the same factor structure as those for the upright faces (Sakuta & Gyoba, 2003).

Then, further factor analysis was performed on the combined data of inverted and upright faces to confirm the general impressions shared within all the stimuli. Consequently, three factors were extracted in terms of the principal factor method with varimax rotation (Table 1). The factors were named "Activity" (contribution ratio: 25.88%), "Potency" (10.44%), and "Evaluation" (10.23%) referring to the previous studies (Osgood et al., 1957; Sakuta & Gyoba, 2003). The representative adjectives for each factor were as follows: "active-passive" and "light-dark" for Activity; "hard-soft" and "round-square" for Potency; and "excellent-incapable" and "calm-nervous" for Evaluation.

Next, comparisons between the factor scores of the inverted and those of upright faces revealed that the impressions were weakened and neutralized by the inversion (Figure 1). Moreover, such shift of impressions was less on the stimuli which original impressions of the upright orientation were neutral (near to the zero), while the faces with extreme impressions (e.g., high Activity, low Evaluation, etc.) tended to be largely changed by the inversion. These results correspond to the fact that the inversion made the impression judgment difficult.

To analyze the differences between the impressions of upright and inverted faces, the stimuli were divided into three groups (each comprising 16 faces) for each factor following the magnitude of factor scores (high, middle, or low levels) of Evaluation, Activity, and Potency for the upright face. In other words, faces were ranked and grouped according to their factor scores for upright faces (The faces with rank 1st-16th were grouped as "high," rank 17th-32nd were "middle," and rank 33rd-48th were "low") and this grouping was common to upright and inverted faces. That is, inverted faces were also grouped based on the factor scores for the faces with upright presentation. For example, in terms of Activity factor scores, "face A" would be included in the group "high" when the upright "face A" has high Activity. In order to compare the differences between factor scores for upright and inverted "face A" (and also on the other faces), two-way ANOVA, [face orientation (upright or inverted) × factor score (low, middle, or high)], were performed on each factor.

With regard to Evaluation, the main effect of face orientation was significant, $F\,(1,89) = 8.30, p < .005$. The factor scores were higher for inverted faces than upright faces in Evaluation. The interaction between face orientation and factor score was also significant, $F\,(2,178) = 7.47, p < .001$. The factor scores of the faces with low and middle Evaluation were significantly increased by inversion, $F\,(1,267) = 17.23, p < .001$; $F\,(1,267) = 6.68, p < .05$, respectively.

In contrast, it was revealed that the main effects of face orientation was only marginally significant in Activity, $F\,(1,89) = 3.41, p < .10$. The interaction between face orientation and factor score was also marginally significant, $F\,(2,178) = 2.94, p < .10$.

Table1 Factor loadings after varimax rotation

Factor	Adjectives	Activity	Potency	Evaluation
Activity	bright-dark *(akarui-kurai)*	**0.730**	0.059	0.101
	soft-hard *(yawarakai-katai)*	**0.661**	-0.363	-0.080
	free-unfree *(jiyuuna-hujiyuuna)*	**0.661**	0.072	-0.014
	friendly-unfriendly *(shitashimiyasui-shitashiminikui)*	**0.659**	-0.096	0.278
	extaverted-introverted *(gaikoutekina-naikoutekina)*	**0.649**	0.268	0.048
	showy-plain *(hadena-jimina)*	**0.611**	0.123	-0.164
	cheerful-dismal *(katsudoutekina-mukiryokuna)*	**0.611**	0.338	0.140
	light-heavy *(karui-omoi)*	**0.607**	-0.213	-0.105
	modern-traditional *(gendaitekina-dentoutekina)*	**0.590**	-0.092	-0.051
	tidy-untidy *(sukkirisita-sukkirisinai)*	**0.559**	0.115	0.284
	mild-violent *(yasashii-kibishii)*	**0.469**	-0.349	0.160
Potency	powerful-weak *(chikaraduyoi-yowayowashii)*	0.257	**0.676**	0.133
	masculine-feminine *(danseitekina-joseitekina)*	-0.109	**0.583**	0.053
	promising-unreliable *(tanomoshii-tayorinai)*	0.307	**0.521**	0.408
	grown-up-childish *(otonappoi-kodomoppoi)*	-0.201	**0.411**	0.397
Evaluation	sedate-exciting *(ochitsuita-ochitsukinonai)*	-0.218	0.152	**0.591**
	excellent-incompetent *(yushuna-munouna)*	0.088	0.115	**0.545**
	elegant-inelegant *(hin'noaru-hin'nonai)*	0.125	-0.021	**0.468**
	Eigen value	4.658	1.879	1.842
	Contribution of each factor	25.879	10.438	10.233
	Cumulative contribution	25.879	36.317	46.550

Note: All adjectives were presented in Japanese as indicated under the English words.

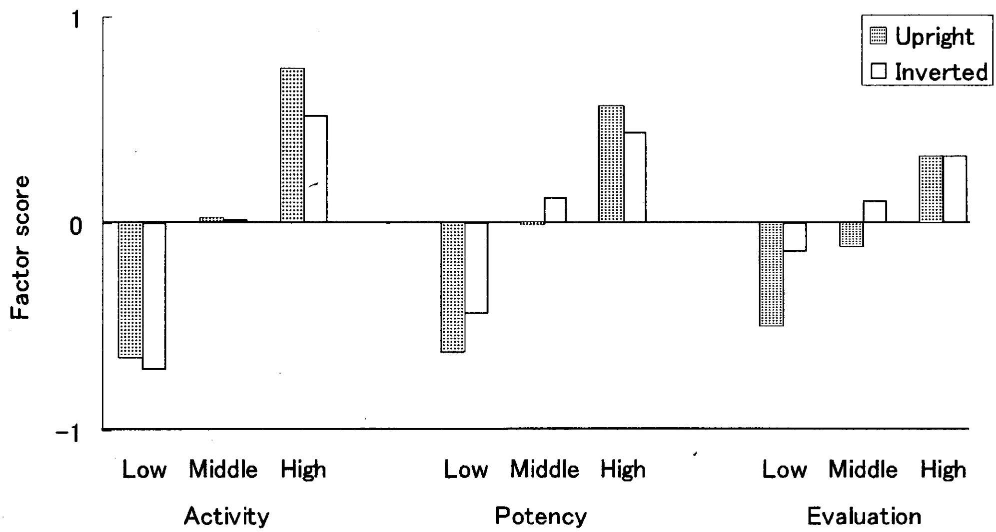

Figure 1. Impression ratings for upright and inverted faces, in relation to the three impression factors and the magnitude of factor scores.

As for the Potency factor, the interaction between face orientation and factor score was significant, $F\,(2{,}178) = 4.42$, $p < .05$. The factor scores of the faces with low Potency were significantly increased by inversion, $F\,(1{,}267) = 5.75$, $p < .05$.

Discussion

As indicated in Figure 1, the factor scores of the inverted faces were generally moved toward zero comparing to that for the upright faces. That is, inverted faces were judged as more "excellent" and relatively "passive" than upright faces. In terms of the interactions between face orientation and factor score, inversion had larger influence on the impressions regarding Evaluation, Potency, and Activity in this order. Thus our prediction that the whole impressions were generally neutralized was supported. More importantly, the prediction that the impressions related to Evaluation would be most easily neutralized was also supported. We predicted that the impressions related to Activity and Potency wouldn't largely be neutralized. The impressions related to Potency were significantly neutralized, yet the effect of inversion was relatively weaker than that on Evaluation. Therefore we considered that our prediction on Potency was also supported.

Experiment 2: Recognition tests

In Experiment 1, the facial impressions, especially related to Evaluation factor, were attenuated and neutralized when the faces were inverted. Next, we examined the effect of impressions on recognizing inverted faces. Based on the findings of Yin (1969), we predict that face recognition performance would decrease. And it was also predicted that the recognition performances would be decreased depending on the magnitude of neutralization of the impressions.

Methods

Participants. The participants comprised a total of 22 (12 male and 10 female) students at Tohoku University (mean age: 20.5 years old), who had not participated in the first experiment. All of them were native Japanese speakers.

Stimuli. The same photographs from Experiment 1 were used for this experiment. The stimuli were presented on a 15-inch computer display using slide-display software. All the stimuli were adjusted to the same dimensions (10.0 × 10.0 cm). The screen resolution was 1024 × 768 pixels. The viewing distance was approximately 40 cm. Four types of slide order were prepared for both study and test phase in order to reduce any possible effect of the presentation order.

Based on our previous study (Sakuta & Gyoba, 2003), target faces were chosen in terms of the factor scores on each factor. For example, four faces which have particularly strong positive impressions on Evaluation were selected as target with high Evaluation. Other four faces which have particularly strong negative impressions on Evaluation were selected as target with low Evaluation. We chose eight faces for each in the same manner as described above regarding Activity and Potency. Thus we chose 24 faces in total as targets and the other 24 faces were used as distracters. All the targets and distracters were identical to the ones which used in our previous study (Sakuta & Gyoba, 2003).

Procedure. In the study phase, the participants were presented with the 24 target upside-down faces for 2 sec each on the computer display in succession, and instructed to memorize them. Immediately after that, 48 stimuli (24 targets and 24 distracters) were presented with upside down. The participants were asked to response whether the stimulus was presented in the study phase or not. Participants made responses verbally and a experimenter recorded them. Each of the stimuli was presented on the screen for 4 seconds, and a blank slide was inserted between them to provide a 2 second inter stimulus interval. In the test phase, another slide was inserted for 2 seconds after the recognition judgment.

Recognition data for the upright faces have been obtained in our previous research (Sakuta & Gyoba, 2003). The previous research and this study were conducted on same procedure except for the face direction.

Results

The hit rates are shown in Figure 2a. Stimuli were divided into three groups based on the results of impressions (Experiment 1). Two-way ANOVAs [face orientation (upright or inverted) × factor score (low, middle, or high)] were performed on each factor.

As a result, main effects of face orientation were significant, $F(1,41) = 4.66, p < .05$, in all of the three factors. Upright faces were better recognized than inverted faces. In line with the previous studies (e.g., Yin, 1969), this result confirmed that inversion made recognizing faces more difficult.

With regard to the Evaluation factor, it was revealed that an interactions of face orientation and factor score was significant, $F(2,82) = 4.18, p < .05$. The faces with low and middle Evaluation showed the differences between recognition performances for upright and inverted faces, $F(1,123) = 8.98, p < .005$; $F(1,123) = 3.87, p < .10$. As for the Activity factor, there was neither main effect nor interaction. Finally, in respect of the Potency factor, there was a significant interactions of face orientation and factor score, $F(2,82) = 3.28, p < .05$. The faces with low and middle Potency showed the significant differences between recognition performances for upright and inverted faces, $F(1,123) = 4.09, p < .05$; $F(1,123) = 7.71, p < .01$.

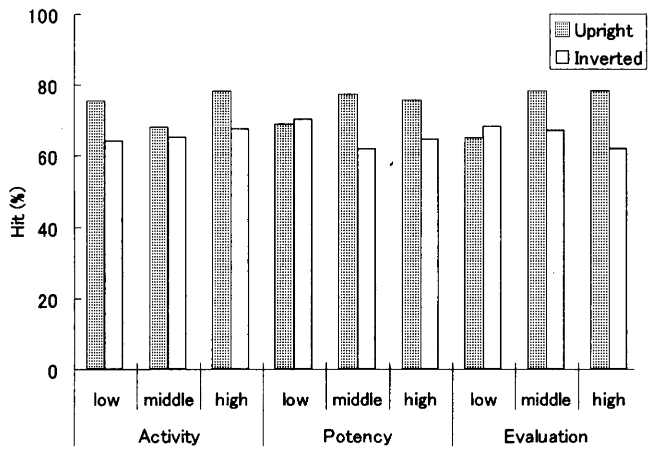

Figure2a

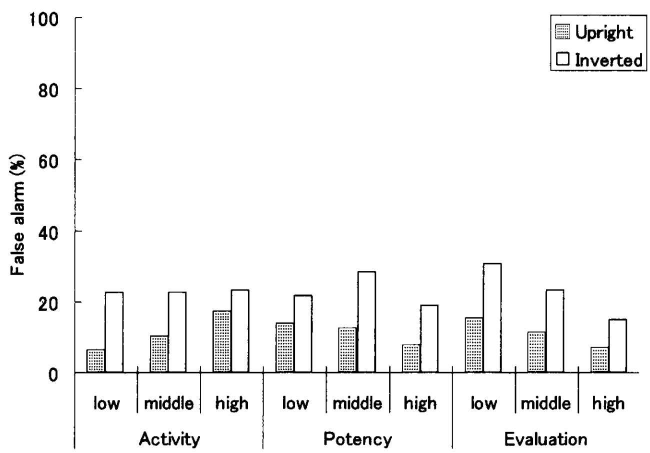

Figure2b

Figure 2. Recognition performance for upright and inverted faces, in relation to the three impression factors and the magnitude of factor scores. Figure2a indicates the percentages of hit, and Figure2b indicates the percentages of false alarm.

Next, false alarms were analyzed as well as hits (Figure 2b). Main effects of face orientation were significant again in all factors, $F(1,41) = 14.38, p < .001$. More false alarms were obtained on inverted faces than upright faces. However, there were no significant interactions between face orientation and factor scores in all factors. As to the main effect of factor scores, there was a largest difference with regard to the Evaluation factor, $F(2,82) = 9.55, p < .001$. The faces with lower Evaluation showed significantly smaller false alarms than those with middle or higher Evaluation, $MSe = 0.02$. The main effect of factor scores was also significant on Potency, $F(2,82) = 3.11$, $p < .05$. The faces with low Potency showed significantly smaller false alarms than those with middle Potency, $MSe = 0.02$.

Thus, most of our predictions about recognition performances were supported. The decrease of the recognition performance due to inversion was mostly obvious in the faces with low Evaluation. Impressions regarding to Potency also had an influence on recognition performances. Detailed discussions are given below.

General Discussion

In the present study, we extracted three factors representing the impression ratings of face stimuli by SD method. These factors can be classified as "Evaluation," "Activity" and "Potency" according to the main three factors proposed by Osgood et al. (1957) as well as our previous study (Sakuta & Gyoba, 2003). Even when the faces were inverted, the impressions could be represented by the same factors as the upright faces. However, it was found that overall impressions of faces were reduced and neutralized by the inverse presentation in line with our predictions. It can be said that "inversion effect" occurs in the various subjective impressions, and the impressions related to Evaluation are largely reduced in particular. Bäuml (1994) compared the facial attractiveness on upright and inverted faces and suggested that facial attractiveness was generally neutralized by inversion. Our results are in line with this result, except for the impressions related to Activity factor.

We found similar results on recognition performances. Recognition performances were also generally decreased by the inversion, replicating the previous studies (e.g., Yin, 1969). Moreover, the recognition performances for the faces with low Evaluation were mostly decreased. These results are also in line with our prediction as discussed below.

Thus, the present research showed the largest neutralization in the impression and the largest decrease of memory performances regarding to Evaluation factor. The adjectives regarding to Evaluation factor are not necessarily dependent on such physical features but are related with more affective, subjective or self-related judgment, such as "sedate-restless", or "elegant-inelegant." Consequently, it is highly likely that more complicated and integrated process is necessary for Evaluation judgments. Such processing would be easily disrupted by inversion.

In contrast, there are less effects of inversion both on the impressions and recognition performances in terms of Activity. As described in Introduction, we assumed that Activity is judged mainly based on the featural information, since most of the adjectives included in Activity factor (such as "bright-dark," or "hard-soft") are strongly related with physical features or modalities. In contrast, we assumed that Evaluation is assessed based on the configural information rather than on the individual features because adjectives included in Evaluation factor (such as "sedate-exciting," or "excellent-incompetent") would not directly be associated to particular physical features.

With regard to Potency, the impressions and the recognition performance were significantly reduced by inversion. But the effects of inversion were smaller than ones in terms of Evaluation. Potency would be based on both kinds of information (e.g., "powerful-weak," or "masculine-feminine").

These assumptions would be supported by the current results. It has been suggested that configural information would be largely disrupted by inversion, comparing to featural information (e.g., Carey & Diamond, 1977). Considering these findings together, it is highly likely that Evaluation is related more with configural information rather than featural information.

The faces with low and middle Evaluation or Potency were more accurately recognized than the faces with high Evaluation or Potency in upright presentation. We had argued in our previous study that low evaluation refers to impressions described by adjectives such as incompetent or exciting. It is thought that such faces might include a sign of possible violence or some negative behavior. Consequently, it is likely that participants tend to pay a great deal of attention to such faces (Sakuta & Gyoba, 2003). As to Potency, as well as Evaluation, it is also possible that people pay more attention to "powerful" and "masculine" faces for the reason of possible influence for them. We should directly examine such negative image, attention and the impression factors.

However, the recognition performances were declined and such tendency was disappeared when the faces were inverted. Consequently, it can be thought that the participants might have difficulty in recognizing the faces and in judging the impressions especially related to Evaluation or Potency when the faces are inverted.

These results could be interpreted by the subjectivity of the impressions. As we have already mentioned, Evaluation mainly contains subjective impressions, while Activity seems to contain featural or superficial impressions. Potency could be related to both types of impressions. The impressions in terms of Activity factor, which has the highest contribution ratio in the result of factor analysis, would be the most easily judged among the three factors because such impressions are derived from physical features. The contribution ratio of Potency and Evaluation are almost same levels. It can be thought that the effect of configural and featural information on face recognition depends on the involvement of subjective impressions to some extent. So configural information has the largest effect on Evaluation, next largest effect on Potency, and relatively small effect on Activity. In contrast, featural information might have the largest effect on Activity, next largest on Potency, and small effect on Evaluation. In future study, we would need to control the levels of "subjectivity" of the impressions and discuss the effect on memorability.

Most of the previous studies, which considering the basis of facial impression judgment, had examined the relationships between some kinds of impressions and facial features, such as sizes, shape, or proportions (e.g., Cunningham, 1988; Cunningham, Barbee, & Pike, 1990; McArthur, & Apatow, 1983-1984). These studies had been interested only in the relationships between impressions and physical features, however, they did not suggest that what the differences among the impressions could yield, and how such impressions influence on the other cognitive processes. The current research suggested that the different bases of the impressions have different effect on recognition performances. Our research will provide a new perspective in the field of face recognition. We do believe that such subjective impressions play a significant role on recognizing various objects including faces. Several studies have reported that affective information affects subsequent judgments or behavior (Willis & Todorov, 2005; Winkielman, Berridge, & Wilbarger, 2005). We also consider that the impressions can automatically affect recognition processes without intentional judgment. That is, recognition pattern would be different depends on what kind of impressions stimuli particularly have, even when people did not intentionally make impression judgment both on encoding and remembering (Sakuta & Gyoba, 2003, 2006). Our study would help understanding the relationships between the subjective impressions and physical information, and also the difference among the impression factors in terms of the basis of the impressions. Further research on the impressions and the physical information may provide insight into affective and subjective recognition of faces.

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