How does the transformation of an avatar face giving a favorable impression affect human recognition of the face?

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Abstract *We investigated how different appearances in the favorable impressions of 3D avatar faces affect face-recognition performances by humans. We conducted an encoding and testing experiment using synthesized facial images and artificially manipulated the strength of the perceived impressions in three different dimensions. We also subjectively assessed the favorability of the synthesized faces that were used as visual stimuli in face-recognition tests and found that facial transformation, which decreased the favorability impressions, generally deteriorates human face-recognition performance.*

Keywords *Social impression of face, morphable 3D face model, facial impression manipulation, Thurston's paired comparison, face memory*

I. INTRODUCTION

Faces play an important role in person-to-person communication as a kind of media that convey a variety of information that involves both personal identity and a person's emotional state and social impressions. This idea also applies to visual communication between humans and synthesized avatar faces based on virtual reality technologies. It remains unclear, however, how the transformation of the appearance of 3D faces actually affects people's identification of such faces. In this work, we investigated the relationship between the favorability of a face and human recognition performance.

II. OUR PREVIOUS WORK

In our previous work [1], we examined whether subjects can identify faces when their specific social impressions have been modulated between encoding and recognition phases.

The Todorov Face Database [2][3] is a set of computer-generated faces based on the morphable 3D face model that was implemented by Facegen Modeler [4], which is an extension of Blanz and Vetter's work [5]. It includes impression-transformed faces in three different dimensions: trustworthy, dominant, and threatening. For each dimension, impression manipulations were made at several intensity levels. Some examples of impression-manipulated faces are shown in Fig. 1. Subjective scrutiny of the perceived impressions of these stimuli has already been published [2].

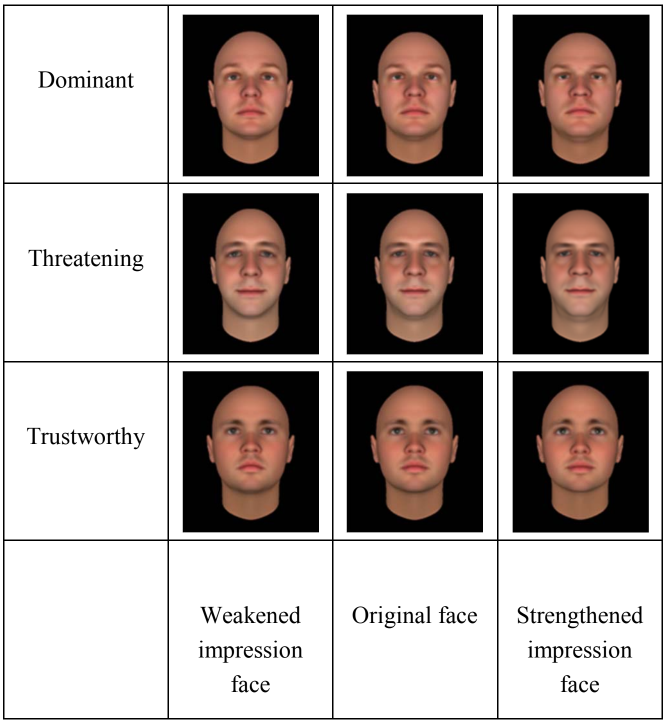

Fig 1. Examples of impression-manipulated faces

Our face identification experiment consisted of encoding and recognition phases, and in both we used a set of images provided by the Todorov Face Database as target and distractor stimuli. In the encoding phase, 11 face images (including two dummy stimuli that appeared at the test phase's beginning and ending) were presented one by one for seven seconds. All of the face images were neutral and no impressions were manipulated. We asked the participants to memorize them. In the recognition phase, we conducted an old-new recognition test and made judgments on a 6-point scale: "I've definitely seen it (1)" to "I've never seen it before (6)". For this test, we presented 18 face images one by one for seven seconds each. Three of the images were the same neutral faces presented in the encoding phase, three had weakened impressions, and three had strengthened impressions. The remaining nine were distracters. We provided three sets of images that depended

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on one of the three dimensions assigned for impression manipulations: trustworthy, dominant, and threatening.

For the analysis method, we introduced hit rates, which are indexes of the correct recognition performance achieved by humans, to represent the probability of the target face that was previously presented in the encoding phase that was correctly judged as an already "seen” face. Note that answering "I’ve seen it" to face images that were newly synthesized from the target face during its impression manipulation was also counted as a hit.

We identified three intensity levels of each impression manipulation (i.e., strengthened, no change, and weakened) with three semantic direction classes (i.e. positive, neutral, and negative) (Table 1). Fig. 2 shows the hit rates under the manipulation of the original faces with respect to three types of social impressions in either positive/negative directions. We confirmed a significant difference in the category of negative impression manipulations. Participants generally failed to properly recognize the encoded faces as previously “seen” ones when the impression manipulation was made in a semantically negative direction (e.g., more threatening).

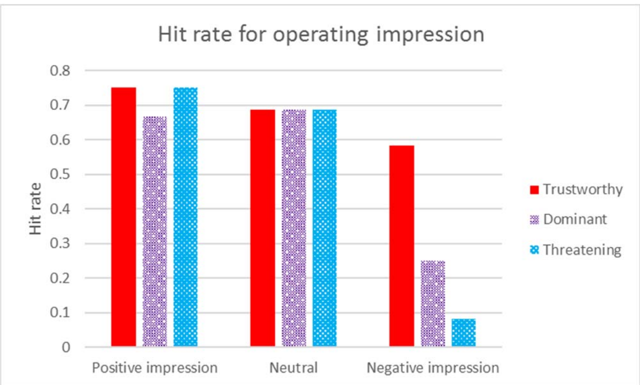

Fig. 2 Hit rate for operating impressions

Table 1 Positive/negative categorization of impression manipulations

Social impressions	Strengthened	No change	Weakened
Trustworthy	Positive	Neutral	Negative
Dominant	Negative	Neutral	Positive
Threatening	Negative	Neutral	Positive

Ⅲ. EXPERIMENTAL METHOD

Our subjective assessment assigned favorability ratings to each synthesized face used in our previous work [1] as the visual stimuli of the “seen” faces. This procedure was

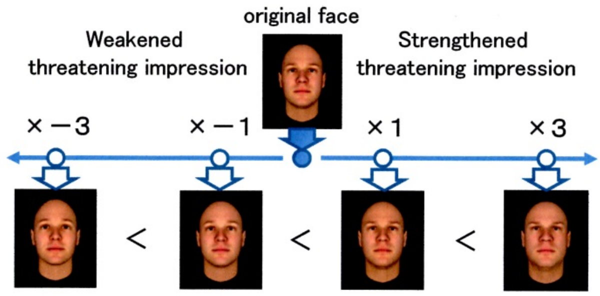

Fig. 3 Examples of impression-manipulated faces directed to paired comparison

Fig. 4 Display of two stimuli for Thurston’s method of paired comparison

achieved with 120 university participants with Thurston’s method of paired comparison[7] for each set composed of four synthesized faces (Fig. 3). Two faces in the set were synthesized by weakening and two others by strengthening the impression manipulation degree along each of three dimensions: trustworthy, dominant, and threatening. Each pair of facial images was presented on a 12.5-inch computer display (Fig. 4), and subjects selected relatively favorable faces.

Ⅳ. EXPERIMENTAL RESULTS

Based on the favorability rating results, we classified the face stimuli made by impression manipulation into two classes: relatively favorable and unfavorable faces. Table 2 shows the average hit rates achieved with faces that belong to each favorability class manipulated in terms of specified impression dimensions and in comparison to the average scores achieved with the original faces without impression manipulation.

When the faces were manipulated within the trustworthy dimension that generally projects a positive image to recipients, the difference in the hit rate, caused by the difference in the perceived favorability, was small. But when the faces were manipulated within the dominant and threatening dimensions that generally project negative feelings, the difference in the hit rate, caused by the difference in favorability, was large. Since unfavorable faces among those strengthened with negative impressions are less favorable than those with positive impressions, it

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Table 2 Hit rates achieved in seen-unseen tests

Dimension of impressions manipulation	Favorability of synthesized faces		
	Decreased	Original	Increased
Trustworthy	58%		75%
Dominant	25%	69%	67%
Threatening	8%		75%

Table 3 Results of analysis of variance

Table of Analysis of Variance

source	SS	df	MS	F	p
A:strength of the impression	0.6371528	2	0.3185764	4.238	0.0251 *
error[WC]	2.0295139	27	0.0751672		
Total	2.6666667	29			

+ p<.10, * p<.05, ** p<.01, *** p<.005, **** p<.001

seems difficult to recognize faces that have already been seen before.

Table 3 shows the result of a one-way analysis of variance (ANOVA) conducted for the hit rate in which the three levels for the strength of impression manipulation were analyzed. The main effect of the strength of the impression manipulations was significant ($F(2, 29) = 4.238$, $p < .05$). Thus we found that the hit rate is affected by differences in the strength of impression manipulations.

V. CONCLUSION

We found that people generally failed to properly recognize encoded faces as previously “seen” ones when impression manipulation reduced their favorability. We expect that such findings will contribute to designing avatars with higher communicative competence, especially in people-search applications. Based on the results obtained by a pairwise comparison method, our future work will investigate whether gaze movements during recognition tests differ depending on the face’s favorability.

ACKNOWLEDGMENT

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