An Experimental Consideration on "Mona Lisa Gaze Effect"

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AN EXPERIMENTAL CONSIDERATION ON "MONA LISA GAZE EFFECT"

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"Mona Lisa gaze effect" was confirmed from four experiments with 12 adult *Ss*, which is the apparent stable eye contact despite the slant of facial pictures. It was found that the turning aside of apparent gaze direction disappeared only at the facial eyes with eye contact in the slant condition (Mona Lisa effect). All the other cases showed the obliquity to the slant in the direction of gaze or the facial orientation, which were the eye's proper gaze (measured in the reduced eyes), the orientation of a face without pupils, and the apparent gaze of facial eyes without eye contact. As an explanation of the apparent eye contact, it was hypothesized that gaze anchoring effect would occur not to turn aside the apparent gaze.

Key words: Mona Lisa gaze effect, gaze, face perception.

Introduction

People say that Mona Lisa seems to gaze them in the observation of any angle. She gives us the impression that her gaze follows our passing movement in front of her. This effect will now be refered as "Mona Lisa gaze effect", where her apparent gaze is always contact with the observer's eyes even in the different observational angles to the figure when a pictorial or a photographic face has eye contact with the observers. Could it be confirmed that such an effect usually exists in our circumstances? How does it occur? Which mechanism does trigger the effect?

Our purpose of the following experiments is to investigate these problems with the technique of "estimation of the apparent direction of gaze" we have used in previous researches.

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Fig. 1. A photographic face equivalent to "Mona Lisa" with respect to a facial orientation and a direction of gaze used in Expeiment I.

Experiment I

Mona Lisa gaze effect in the photographic face equivalent to Mona Lisa

We will test the existence of Mona Lisa gaze effect by making subjects observe a photographic face (a cover of a magazine for women) which is equivalent to Mona Lisa with respect to facial orientation and direction of gaze, as shown in Fig. 1.

The apparatus for estimation of the apparent gaze-direction in this series of experiments is the same as we used in previous studies (Maruyama & Endo, 1983; 1984) except that the stimulus plate holder is able to roll with the frontoparallel vertical axis of subjects. Subjects observed the photographic face of Fig. 1 in a transparent plastic envelope (pass-case, inner size; 9.4 cm × 13 cm) set in the holder of apparatus, through a round-shaped transparent acrylic belt. And they were instructed to indicate the point on the belt where the apparent gaze are crossing, using an indicator (indicating stick or needle). The indicated point could be read on a video monitor as an angle of a protoractor which was orthogonally fixed under the holder.

Subjects observed the stimulus pattern monocularly with a right eye through most of the experiments. The chin rest was adjusted to fix the subject's head in order that his line of vision overlapped the central line of a protoractor according to Maruyama & Endo (1983). Apparent direction of gaze was estimated five times in each face,

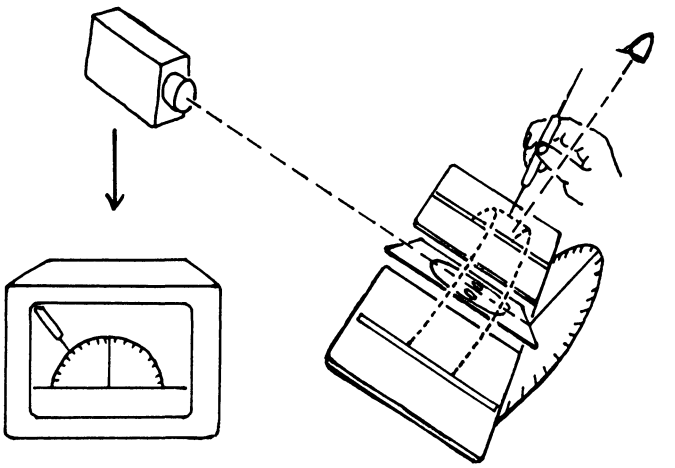

Fig. 2. The apparatus for estimation of the apparent direction of gaze. The stimulus plate holder can roll with the frontoparallel vertical axis of a subject.

adding a few more times when large variance has taken place. The data with the large variances were taken out and five values were averaged. The number of measurement was the same in following experiments. When the apparent direction of gaze was obviously parallel to the line of subject's vision, trials were ended in several times.

Twelve adult subjects took part in this experiment under two conditions and the results were as follows.

(1) *Presentation of the photographic face on the frontoparallel plane of a subject, which is equivalent to Mona Lisa ; A right angle viewing of a Mona Lisa-like face*: A half of twelve *S*s estimated the apparent gaze to be almost near to 0°. However each *S* of the rest half pointed the right-hand direction and the mean angle was 12.6° (see the first row in the Table 1).

(2) *Presentation of the photographic face slanted in 45°, which is equivalent to Mona Lisa* (*Fig. 1*); Observation of a slanting Mona Lisa-like face: The second condition of the present experiment was the slanting presentation of the photographic face by rolling it to the right in 45° with an vertical axis on the subject's frontoparallel plane, as showen in Fig. 2.

The apparent direction of gaze was also estimated by the same procedures in order to investigate how the apparent gaze direction changed.

The first row in Table 1 also shows the results of the second condition. Seven *S*s estimated that the apparent gaze direction oriented to themselves, six of whom were the same *S*s in the previous condition and one had been in the rest half.

Table 1. Results of Exp. I, Exp. II-(1), and Exp. III.

	Frontoparallel				45° slanting to the right			
	Reports of eye contact		Reports of no eye contact		Reports of eye contact		Reports of no eye contact	
	Number of *Ss*	Indicated apparent direction of gaze (Obliquity to the right)	Number of *Ss*	Indicated apparent direction of gaze (Obliquity to the right)	Number of *Ss*	Indicated apparent direction of gaze (Obliquity to the right)	Number of *Ss*	Indicated apparent direction of gaze (Obliquity to the right)
Photographic face equivalent to Mona Lisa (Exp. I)	6/12	$\bar{x}$: 1.4° (*SD*: 4.87°)	6/12	$\bar{x}$: 12.1° (*SD*: 7.94°)	7/12	$\bar{x}$: 0.8° (*SD*: 4.66°) (Six of them are the same *Ss* as in the right-angled viewing)	5/12	$\bar{x}$: 13.4° (*SD*: 7.27°)
Pictorial face equivalent to Mona Lisa (Exp. II-1)	12/12	—	0/12	—	6/12	0.7° (4.45°)	6/12	Right: 4/12 30.2° (17.67°); (Five of them are the same *Ss* as in Exp. I); Left: 2/12 −11.6° (1.00°)
Photographic full face (Exp. III-1)	11/12	−1.0° (3.51°)	1/12	2.6° (—)	11/12	2.7° (3.49°)	1/12	6.60° (—)
Pictorial full face (Exp. III-2)	12/12	—	—	—	4.5/12	−0.4° (3.28°)	7.5/12	Right: 6.5/1235.2° (13.91°); Left: 1/12 −20.6° (—)
Photographic eyes cut out of a full face (Exp. III-3)	11/12	−0.4°(3.60°)	1/12	2.40 (—)	6/12	3.4° (2.17)°	6/12	14.4° (11.31°)

Each of the rest five *S*s showed the right-hand direction and its mean obliquity was 13.4°. This value is almost equal to the results in the first condition.

Mona Lisa gaze effect was observed in more than half of *S*s with the photographic face equivalent to Mona Lisa. So the existence of this effect was confirmed.

Experiment II

Mona Lisa gaze effect on the pictorial face equivalent to Mona Lisa

The same experiment as Experiment I was carried out not with the photographic face but with the simplified pictorial face equivalent to Mona Lisa, as used our previous studies (Maruyama & Endo, 1983; 1984). According to Maryuama & Endo (1983), it was clarified that the apparent direction of gaze is markedly affected by the frame of facial orientation, being towed toward the facial orientation. Thus, the apparent direction of gaze is mainly decided by two factors: one is apparent facial orientation, the other is eye's proper gaze direction concerning the simplified pictorial face used in this experiment. We intend to make Mona Liza gaze effect clear with regard to the two factors. The experiment was constructed from three sessions.

(1) *Mona Lisa gaze effect on the pictorial face equivalent to Mona Lisa*: With pictorial face whose pupils were movable horizontally (Fig. 3(A)), each of the same twelve *S*s as in Experiment I adjusted the pupils to their eyes.

The second row in Table 1 shows the results of this experiment with an right-angled pictorial face. All *S*s estimated that the apparent gaze was directing to

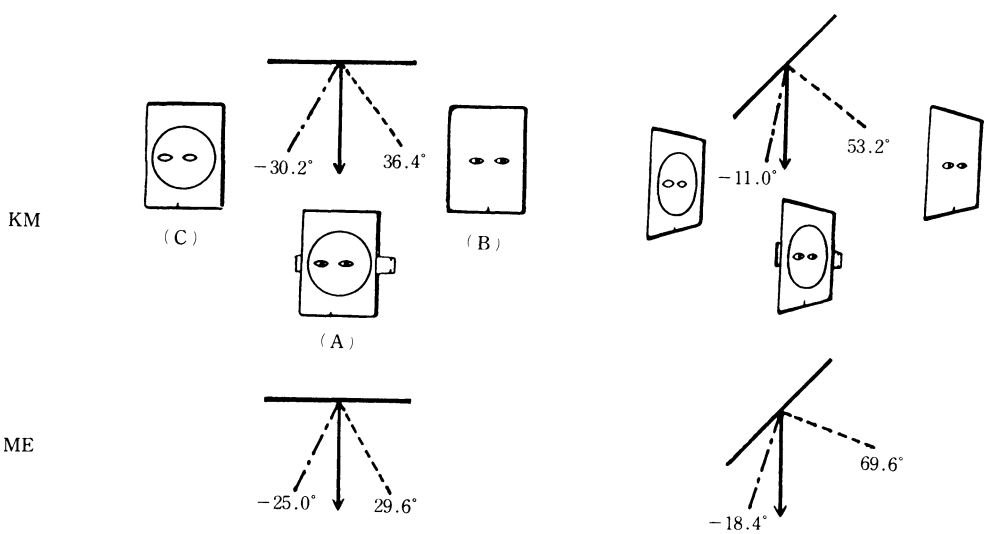

Fig. 3. Illustrations of the two subjects' results of Exp. II, which contain the apparent direction of gaze, the eye's proper direction of gaze and the apparent orientation of a face without pupils.

themselves. Then, the pictorial face was set in the holder of the apparatus with an slant angle of 45° to the right, and was presented to *S*s. Which direction will the apparent gaze take in the observation of the slanting pictorial face equivalent to Mona Lisa ?

The results are shown in the right two columns of the second row in Table 1 as the angles pointed by an indicator and their directions. Half of twelve *S*s reported that the gaze was directed to themslves and the mean pointed angle was 0.7° to the right (nearly O°). Five of them were the same *S*s as in Experiment I. The rest half reported that the apparent gaze was not directed to themselves. Four of them including a same one in Experiment I pointed to the right (mean angle ; 30.2°), two of them left (mean angle ; 11.0°)

Half of the *S*s showed the same tendency as in Experiment I. Therefore Mona Lisa gaze effect was confirmed also in the simplified pictorial face.

(2) *The measurement of an effect of the face-frame on the direction of gaze (I)*: According to the conclusion of Maruyama & Endo (1983), the apparent direction of gaze, which is in a pictorial face with the discrepancy between eye's proper direction of gaze and apparent facial orientation, seems to result from the eye's proper line of gaze resisting and being towed by the apparent facial orientation (Fig. 3(c)) affected itself by the line of eye's gaze.

Therefore the apparent direction of gaze will be interpreted by these two factors, and will be the result from the interactive mutual towing. The effect of apparent facial orientation plays an important role as a frame for decision of apparent gaze direction (face-frame effect). Could the schema of such explanation be applied to the 45° slanting pictorial face equivalent to Mona Lisa ? This problem will be investigated by the measurement on the two of six *S*s (KM & ME) who reported that the apparent gaze directed to themselves in Exp. II-(1) with respect to a right-angled pictorial face. Subjects adjusted the position of pupils in a left-oriented pictorial face in Fig. 3 (A) in order that the apparent gaze directed to them. And the apparent direction of gaze was measured again without the circlic out-line of the pictorial face, that is, with only eyes as shown in Fig. 3 (B). Fig. 3 shows the results that KM estimated it 36.4° to the right and ME 29.6°.

A subsequent measurement of the apparent facial orientation was carried out on the face without pupils (Fig. 3 (C)). Subjects adjusted the left visual line to the O° line on the protoractor in the pevious manner. The indicator was operated left-handedly. The results were −30.2° to the left in KM and −25.0° to the left in ME. These two *S*s were also employed in the experiments of Maruyama & Endo (1983), both of whom showed one-way-like (face - eye) interaction without the effect of the eye's proper direction of gaze on the apparent facial orientation. So the self-directed gaze will be explained by the facial orientation's towing the apparent gaze direction into the facial orientation itself.

Next, in the 45° slanting condition of the right-angled pictorial face, the reports

were that the apparent direction to the observer was kept constant in this condition (Mona Lisa gaze effect). In these results of Fig. 3, both *S*s changed the angle of eye's proper direction and facial orientation to the facial slant, that is, to the right (eye's proper direction of gaze ; KM : 36.4°→53.2°, ME : 29.6°→69.6° ; apparent orientation of face ; KM : −30.2°→−11.0°, ME : −25.0°→−18.4°).

It is supposed that the change of eye's proper gaze and facial orientation is based on the mechanisms as follows. One of the rules in human perception, shape constancy takes place for the slant of an object, and the distal oriented perception will be at work according to the notion of Brunswik. The explanation for the distal oriented perception is that the eye's proper gaze direction without eye contact and the apparent facial orientation seems to be perceived, being consistent with the oblique of an object. In other words, perceptual organization of constancy mode (Rock, 1977) becomes dominant on the patterns which are reduced to facial parts as only eyes or a face without pupils.

If the perceptual organization of constancy mode was also applied to the slanting facial pattern, the apparent direction of gaze are expected to turn aside to the right from "the principle on the prospect of gaze direction", that is, the combination of eye's proper direction of gaze and facial orientation on the reduced pattern because both gaze direction and facial orientation turned aside to the right in the results of previous measurements.

However, the apparent gaze direction of a facial pattern was kept constant to the observers in spite of the facial slant. It should be thought that a special effect would occur not to turn aside the apparent gaze. Such effect will be referred to as "the gaze

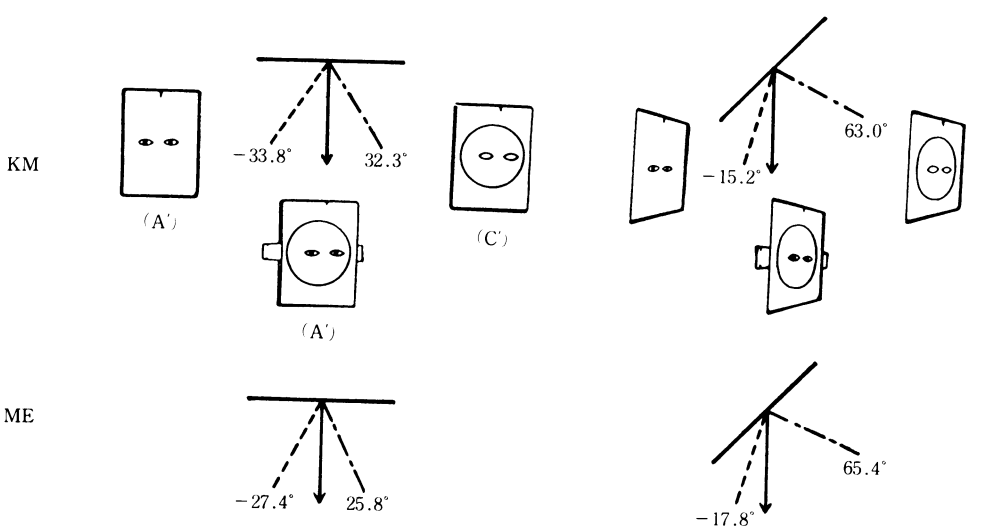

Fig. 4. The illustrated results (of the two subjects) of Exp. II, which contain the apparent direction of gaze, the eye's proper direction of gaze and the apparent orientation of a face without pupils.

anchoring effect".

Being without the effect, the existence of the other special effect should be considered, where the towing effect of facial orientation (face-frame effect) markedly affects to the slanting pattern.

(3) *The measurement of face-frame effect on the gaze (II)*: Eye's proper direction of gaze and apparent facial orientation were exchanged each other in this experiment with roughly equivalent procedures. Fig. 4 shows the results of two *S*s.

These results have the same tendency as in the previous experiment; Mona Lisa gaze effect has occurred.

It should be considered that the facial orientation's towing effect would be weakened on eye's proper direction of gaze unless gaze anchoring effect on this mechanism. But the way of towing effect mentioned above is in contradiction with the case of Exp. II-(2). If the towing power to the left would be strengthened according to the notion without contradiction, some power should be considered, which strengthen the tendency of directing to the left, that is, the gaze anchoring effect.

Experiment III

Mona Lisa gaze effect on a full face

The preceding experiments were performed with Mona Lisa-like facial pictures,

Fig. 5. A photographic full face used in Experiment III.

whose orientation was slightly oblique and whose gaze was fixed at observers as the painting of Mona Lisa. Next, we will test the Mona Lisa gaze effect with full faces.

(1) *An experiment with a full face of photograph*: Twelve *S*s observed a photographic face as Fig. 5 (made from a magazine cover) on their frontoparallel plane, and indicated the apparent direction of gaze. Eleven of them reported the gaze toward them. The rest one reported the slight oblique to the right and its angle was 2.6°.

The reports on the 45° slanting face were also same in eleven of them. And the rest one who was different from the rest above, estimated the oblique angle to the right at 6.6, little wider than above.

These results are shown in the third row of Table 1. Mona Lisa gaze effect was observed in most of *S*s. The main reason of the obvious effect would depend on the clarity of gaze in the photographic face. It is difficult to observe the effect in the pictorial face with unclear gaze as the following.

(2) *An experiment with a pictorial full face*: Only 4.5 *S*s in twelve reported the gaze toward them on the 45° slanting pictorial full face. Other 6.5 *S*s pointed to the right and the rest one to the left. Each indicated angle is in the fourth row of Table 1. The one subject was divided into two 0.5 *S*s for each group, who had shown the change indicated direction in his observation. A lot of subjects insisted on the considerable difficulty for the estimation of gaze direction in the present experiment.

A modified full face was applied here, whose eyes were adjusted to the center of a face in Fig. 3(A). Supposing the reason of these results from our other observations on some photographic faces, it is considered to be unclearness of an apparent gaze in a pictorial face.

(3) *Some tests in the eyes of a photographic and a pictorial full face*: The apparent direction of gaze was measured on the pictorial eyes made by covering other parts of a face in Fig. 5. The lowest row in Table 1 represents the results that eleven of twelve *S*s estimated the apparent gaze toward them on a full face. However, the number of subjects with such estimation decreased to a half of them on the 45° slanting face to the right. And the rest half showed that the apparent gaze direction turned aside to the right in 14.4°, that is the same direction as the stimulus slant.

Gaze anchoring effect is weakened by the dominance of the constancy mode perception when the frame of a facial pattern has reduced, even though the gaze is clear.

This tendency becomes obvious in the pictorial eyes whose gaze was not clear. The results of two *S*s are as follows. For the 45° slanting pictorial eyes, KM indicated 54.0° and ME gave 12.9° as an obliquity of gaze to the right.

Comparing with the obliquity of these two *S*s for the photographic eyes, which are 25.0° and −2.5° (the zero point angle of ME was −8° and he reported that the obliquity was to the right though it was a minus value) respectively, the obiliquity to the right became wider in the pictorial eyes.

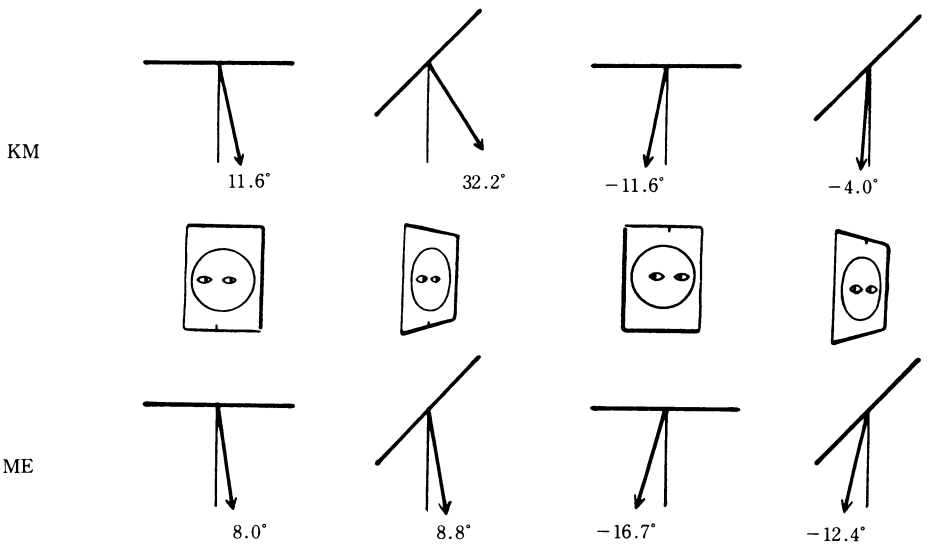

Fig. 6. The illustrated results of Exp. IV-(1) on a pictorial face without eye contact.

Above mentioned results of Exp. III made the following three points obvious. First, Mona Lisa gaze effect was observed in the full-faced stimulus. Second, the clarity of gaze was an important factor which strengthen the gaze anchoring effect. Finally, a frame of a face is also one of the factors because eye's proper direction of gaze is easy to turn aside in the eye-only measurement even though there was eye contact in the right angled observation.

Experiment IV

Gaze anchoring effect in the pictorial face without eye contact

All of the previous experiments were the cases with eye contact. Mona Lisa gaze effect has been explained by a hypothesized perceptual inclination of gaze anchoring. However, any case of no eye contact has not been investigated. So we will study this point with pictorial faces.

(1) *A pictorial face with a Mona Lisa- like facial orientation*: Two *S*s of KM and ME observed a pictorial face with no eye contact, whose facial orientation was the same as Mona Lisa. Fig. 6 shows the results of both facial patterns with right and left gaze direction. The results of KM clearly reveal that the apparent gaze direction without eye contact has a tendency of obliqueness in concert with the 45° slant of a face to the right.

On the ther hand, the results of ME show the slight obiquity on the left-oriented face. But the results of a right-oriented face have a tendency similar to that of KM who showed the gaze obliqueness to the direction of slant.

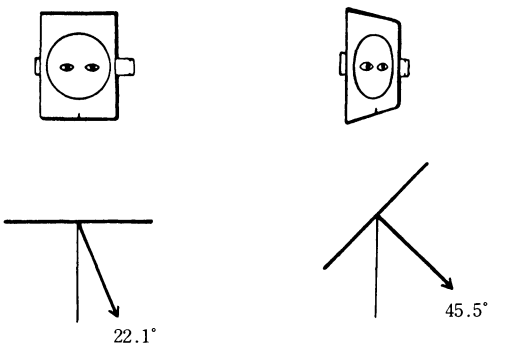

Fig. 7. The illustrated results of Exp. IV-(2).

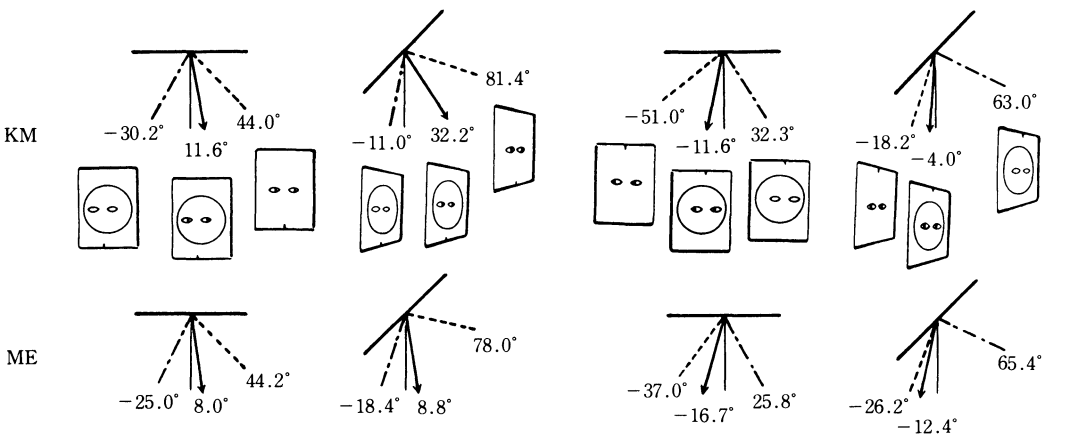

Fig. 8. The illustrated results of Exp. IV-(3).

(2) *A pictorial full face*: Fig. 7 shows the results of the seven subjects' observations on a pictorial full face whose direction of gaze turns aside. The obliquity of gaze, which is 22.1° in the right-angled observation, has increased 45.5° on the 45° slanting of the pictorial face to the right.

Considering the results of (1) and (2) come together, the distal oriented perception with a constancy phenomenon become dominant and the gaze anchoring effect is not observed when the gaze turns aside.

(3) *The eye's proper direction of gaze and the apparent facial orientation when the gaze turns aside*: Probably the eye's proper direction of gaze and the apparent facial orientation will oblique to the same direction with the slants, considering from the results shown in Fig. 3 and 4. As the results, it may be said that only a pictorial face with eye contact does not turn aside its gaze, and all of the rest patterns appear to turn aside their orientations (a pictorial face with no eye contact and the reduced patterns with only eye's proper direction or only apparent facial orientation). It is obvious

that a special perceptual effect is at work on a pictorial face with eye contact. Therefore the following experiment will finish this series of experiments.

The measurement have been done on a same pictorial face of Experiment IV-(1) in Fig. 6 with KM and ME. The obliquity of the eye's proper direction of gaze(B) in Fig. 3 and that of gaze (B') in Fig. 4 were enlarged for construction of a left-oriented pictorial face and of a right-oriented one, respectively, being with the same facial orientation. The purpose of this experiment is the estimation of eye's proper direction of gaze because the apparent facial orientation and the apparent gaze direction have already been measured.

The results shown in Fig. 8 confirmed our expectation. It has revealed a tendency that the eye's proper direction took the large obliquity by the slant of patterns in both a left- and a right-oriented face. It can be concluded that the rule for prospection of gaze direction should fit the case of no eye contact according to the increase of obliquity in facial orientation, and to the change of the gaze direction expected from the eye's proper direction and facial orientation. The rule cannot be applied in the case of eye contact. So a special perceptual organization should be considered in this case. We will discuss on this point in the following.

Discussion and Conclusion

A series of four experiments revealed the existence of "Mona Lisa gaze effect", where the apparent gaze direction of facial pictures with eye contact is kept constant to the observer in spite of the slant of the stimulus patterns.

This effect seems to be obvious on a photographic face whose gaze is clear. Mona Lisa gaze effect would occur even on the eyes with no other facial parts, if the eye had clear gaze. But the effect is not observed on pictorial eyes without clear gaze. It should be said that the face frame is one of the factors for Mona Lisa gaze effect, because the effect did not appear in the half of twelve subjects and in the rest the gaze turned aside by taking out the face frame (Exp. III).

In the results on the pictorial face or the patterns in Exp. II-(2) and (3), Exp. III-(2), and Exp. IV, the turning aside of apparent gaze direction did not appear only at the facial eyes with eye contact in the slant condition (Mona Lisa effect). All the other cases showed the obliquity to the slant in the direction of gaze or the facial orientation, which were the eye's proper gaze (measured in the reduced eyes), the orientations of a face without pupils, and the apparent gaze of facial eyes without eye contact.

In other words, the rule for prospection of gaze direction never be applied to the face with eye contact, which can anticipate the apparent direction of gaze from the angle of the eye's proper direction of gaze and from that of the facial orientation. This is nothing but Mona Lisa gaze effect. Therefore, a special perceptual organization should be considered in this case.

The perception of a slanting plane should be discussed firstly concerning the perceptual organization. As we noted above, it is well known as a general discipline of perception that the way of perception for the slant pattern i.e. the constancy mode perception. The constancy mode perception became evident from the results on the reduced patterns, where the eye's proper direction and the facial orientation obliqued the subjective directions to the same orientation with the slant. The constancy mode perception also takes place in a pictorial face as the total configuration without eye contact, as described in Exp. IV-(3). However on a face with eye contact, because of its stability, it should be thought that the constancy mode perception becomes dominant or that the gaze anchoring effect takes place in spite of such perceptual mode.

If the other perceptual solution, for instance, the orthographical perception would be hypothesized contrary to the constancy mode perception, the gaze anchoring effect should be considered as a clue to such solution. So the hypothesis of gaze anchoring effect is necessary on this problem.

References

Maruyama, K. & Endo, M. **1983** The effect of face orientation upon apparent direction of gaze. *Tohoku Psychologica Folia*, *42*, 126-138.

Maruyama, K. & Endo, M. **1984** Illusory face dislocation effect and configurational integration in the inverted face. *Tohoku Psychologica Folia*, *43*, 150-160.

Rock, I. **1977** In defense of unconscious inference. In W. Epstein (ed.), *Stability and constancy in visual perception : Mechanisms and processes*. New York : John Wiley & Sons.

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