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# THE EFFECT OF FACE ORIENTATION UPON APPARENT DIRECTION OF GAZE[1]

By

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The effect of the face orientation upon the perception of the gaze direction was examined with such stylized picture faces that the eyes were embedded in a circular face contour.

As the results of four different types of examination by 3 *S*s, it was introduced that the apparent gaze has its direction determined in such a manner that the apparent face orientation in some degree towed toward it the eyes' proper line of gaze. The eyes made a stand against the towing force of the face, and in consequence the perceived direction of the gaze in the eye-face pattern was intermediate between the eyes' proper direction of gaze and the face orientation, when these two lines were not aligned.

A marked interaction between the eyes and the face was offered by an *S* in whom the face orientation pulled the eyes' proper gaze with its force being reduced enough for an amount of interaction, and consequently the face-frame effect reduced so much.

The other two *S*s gave a one-way-like interaction (from face to eyes) where the distinct effect of the face orientation took place.

Thus, the face orientation played an important role as a frame in the perception of the gaze direction.

Further evidence supporting these properties of the face-frame was offered by an extreme reduction of faceness.

Such a striking effect of the face-frame was observed across the conditions where the discrepancy in direction between the eyes and the face was large and the full face did not affect so much.

**Key words**: face perception, apparent gaze direction.

Summarizing the data on mutual glance from Gibson & Pick(1963), Cline(1967), v. Cranach & Ellgring (1973), and the like, Argyle & Cook made a conclusion in their monograph (1976) that the perceived direction of gaze is intermediate between the orientation of eyes and head. In other words, the head tows the eyes' proper gaze toward its orientation ; the perceived direction of gaze is settled not solely by the eyes, but it is an outcome of interaction between the eyes and the head (face) orientation. Hence, it is assumed that the face works effectively as a frame in the perception of gaze.

To inquire systematically into the frame effect or the eye-face interaction, the following experiments were carried out not with real faces but with stylized pictures.

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1. This experiment was carried out in cooperation with Kanako Takahashi (高橋加奈子), an undergraduate student of the Department of Psychology at Tohoku University.
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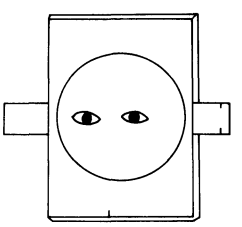
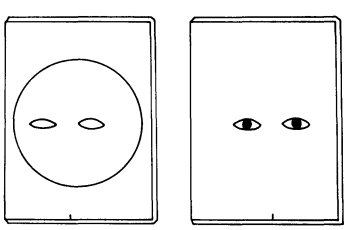
## Experiment I

The picture face employed throughout the series of experiments was in such a concise style as shown in Fig. 1-(A), which was constructed on a paper with pen and black-ink, and held in a pass-case. The contour of face was a circle of 8 cm in diameter and at its center level, the contours of the eyes (major axis : 1.8 cm × minor axis : 0.8 cm, distance between eyes : 1.8 cm) were drawn with the irises of 5.5 mm in diameter. These sizes were common to the experiments.

The irises in Fig. 1-(A) were so drawn on a bar, that the direction of gaze was turnable right to left smoothly with a manipulation of it. An initial task called upon three *S*s was to adjust the irises with his manipulation of the bar so as to turn the gaze toward him. Fig. 1-(C) is just the eyes adjusted through the above procedure, in which the face contour was veiled with a cover. The next task of *S*s was to indicate the direction where the line of vision apparently directed along a horizontal plane at a center level of face, by use of a measuring apparatus for gaze-direction.



(A)



(B) (C)

Fig. 1. Stimulus patterns for Exp. I. (A) : Eye-face pattern in which the irises were movable right and left with the manipulation of a bar. (B) : Face pattern without the irises for measurement of face orientation. (C) : Eyes pattern, in which the face circle of (A) was taken off.

The apparatus is illustrated in Fig. 2 by a sketch as well as in Photos. 1 and 2. The observers looked at the face (or eyes) pattern through a transparent acrylic plane which was made into the shape of an arch, and indicated a point where the apparent line of gaze was crossing.

It could be easily done by every observer by a way of aligning the indicator with a perceived line of gaze. The indicated point was displayed on a TV screen as if the observer was indicating a certain angle along a semicircular arc of the protractor as seen in Photo. 2, since the transparent acrylplane appeared as arching over the

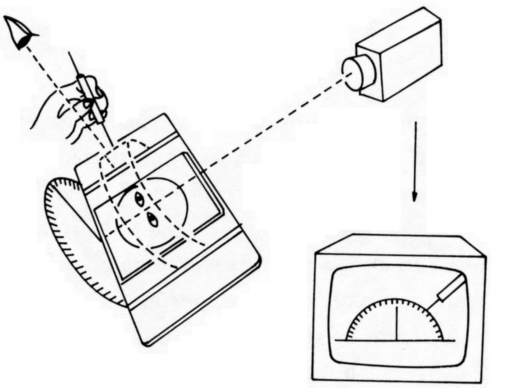


Fig. 2. Sketch of the measuring apparatus for gaze-direction.

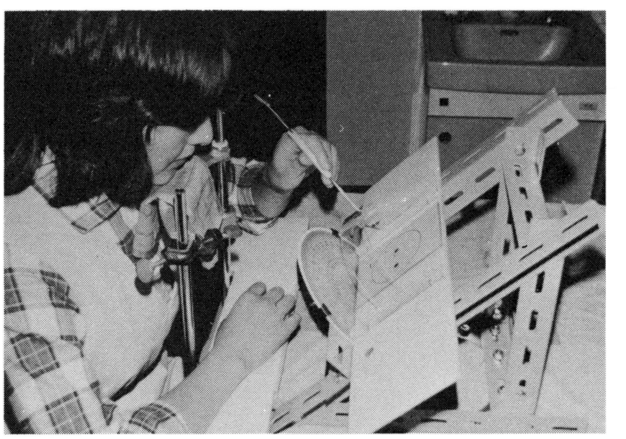


Photo. 1.

Photo. 2.

protractor from the view angle at a video-camera. The protractor was fixed in approximately parallel to the observer's view line, and at a right angle to the protractor, the pass case with a face picture was so put that the center of the eyes would be intermediate between the video-camera and the center of the protractor on a straight line.

The observer kept his head on a chin-rest with his eyes apart approximately 40 cm from the pass case, and looked into the face picture held in the pass case. In an experimental series in which the observer perceived the gaze on his right, he should fix his head so that his line of view with the right eye kept at 0° toward the protractor. This head-protractor adjustment was easily achieved in such a way that the observer located his head at a given position from where he could view the full face pattern and its direction of gaze was indicated at 0° by his right hand. While the observer was operating the indicator with his right hand, his right eye dominated over his view on the face pattern, and his observation was conducted under this mode of vision as long as he concerned himself with the estimation from 0° to 90° on his right.

In the series on the observer's left, he did his observation under the head-protractor arrangement for left corresponding to the above for right, thus the gaze indication was done with his left hand.

The procedure was so arranged that the 0°-indication with the right hand would hold the same position on the protractor as the 0°-indication with the left hand.

The subject gave five indications for each stimulus pattern, adding two or more when wide variation has taken place. The number of measurements was the same in every series throughout the experiment. And a mean and *SD* in terms of degrees in angle averaged over these. The subject's task on Fig. 1-(A) preceded each measurement of Fig. 1-(C).

Fig. 1-(B) is a picture by omitting the irises from Fig. 1-(A). The orientation of face (head) was measured about the Fig. 1-(B) by the same manner as gaze-measurement with the help of the apparatus shown in Fig. 2.

*Results and Discussion :*

The procedure thus mentioned above was enjoined on each of three *S*s for five kinds of face condition and the results are presented in Fig. 3.

As seen with half an eye, the results from Fig. 3 obviously show that the eyes turned their perceived direction of gaze to the opposite side of the perceived orientation of the face when they were presented without the face-frame, while they had been adjusted by the *S*s to direct at a right angle to him at the eye-face (the face patterns with the eyes) condition where the face oriented sideways. Namely, the apparent direction of gaze was intermediate between the direction of the eyes themselves and the perceived orientation of the face. That is to say, the eyes and the face pulled the line of gaze against each other, keeping in an equilibrium. The force relationship between them, however, was unbalance, here. The pulling force of the face-frame seems to be

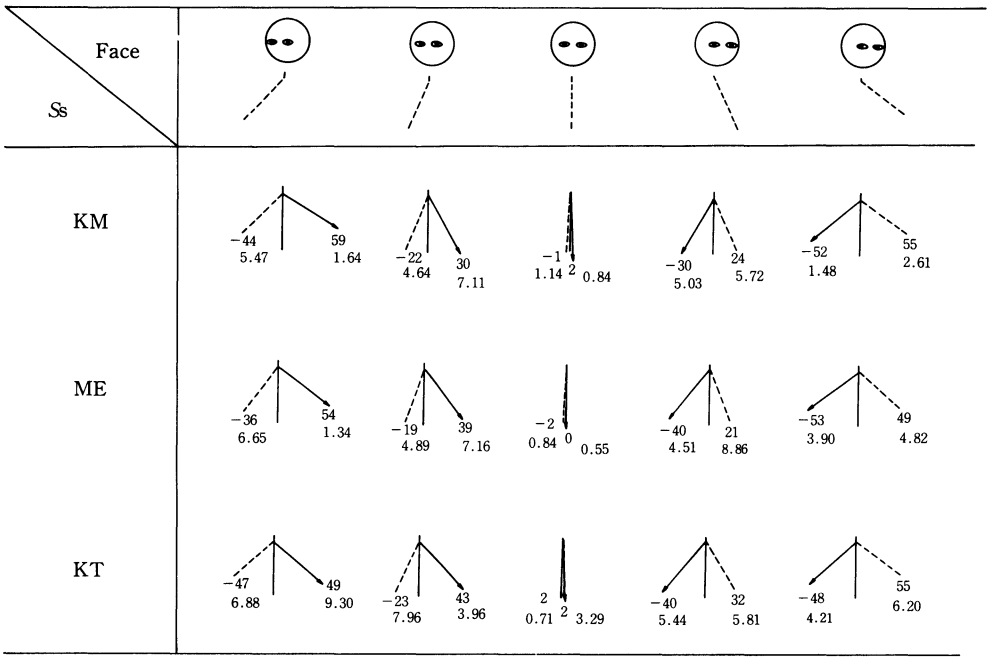



Fig. 3. Results of Exp. I. |, gaze direction in the eye-face patters of Fig. 1-(A); ↓, gaze direction of the eyes (without face- contour) on Fig. 1-(C); ⋮, face orientation of Fig. 1-(B). Numerical values are mean and *SD*.

more powerful than that of the eyes. This can be read clearly at the conditions of moderate angle, whereas not so clear at the extreme angular conditions.

Every *S* could easily adjust a right angle to him with a little variation.

## Experiment II

Experiment I, as stated above, examined the eye-face interaction in the determination of the gaze direction under the particular condition that the eyes and the face directed right and left separately from each other. Next examination, then, should be concerned in whether or not the above results might be applicable to the other conditions. To resolve this problem, Experiment II was conducted under the condition that both the eyes and the face oriented to the same, right or left, though not exactly parallel.

Five different patterns in the direction of gaze as shown in Figs. 4, 5, and 6 were provided for the eyes, as well as five patterns for the orientation of the face. The first task of Experiment II was to measure the apparent angular direction of gaze for the eyes and also to measure the orientation for the face. These were done through the same method as Experiment I and the three *S*s of Experiment I participated in this

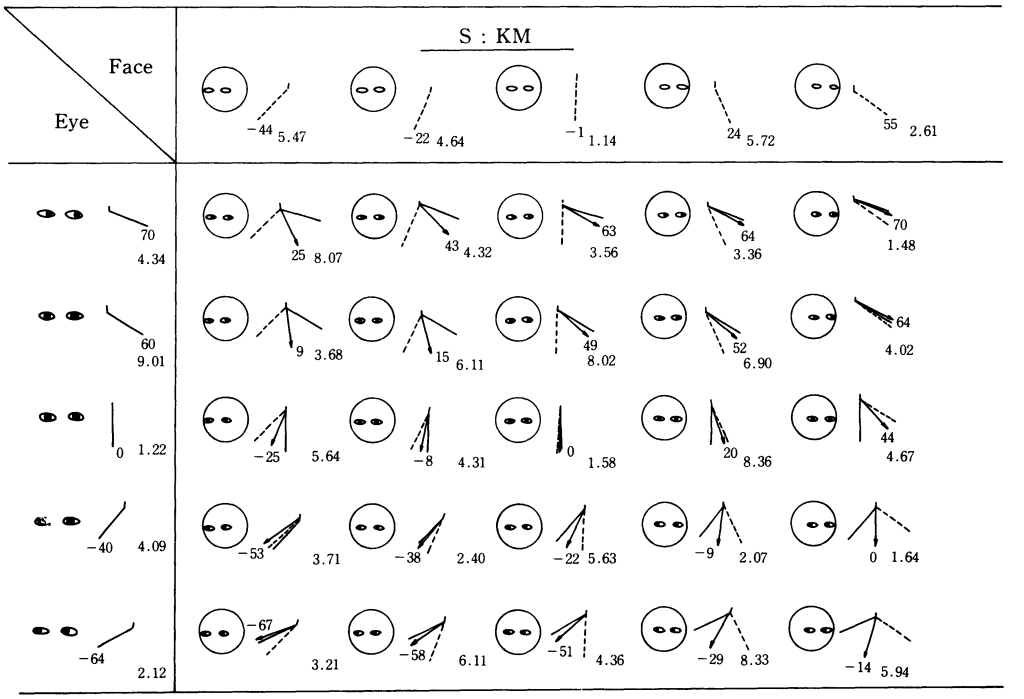



Fig. 4. Results from KM at Exp. II. ↓, gaze direction in the eye-face pattern with mean and *SD*; |, gaze direction of the eyes alone; ⋮, face orientation.

experiment as well.

In the next stage, these patterns were factorially combined to form 25 patterns of eye-face types as seen in Figs. 4, 5, and 6, and for each of these the apparent direction of gaze was estimated.

*Results and Discussion :*

In Figs. 4, 5, and 6 are described these individual results added to those of the first task.

As is read from the figures, the trend of results is as a whole in essential agreement across the *S*s. That is to say, it may be concluded that the apparent direction of gaze in the eye-face patterns is not the same as that of the eyes' own, but it is a product of the eye-face interaction; the face tows the eyes' own gaze toward its orientation.

The frame effect of the face was obvious under the conditions of marked discrepancy between the two directions. With the eye-face pattern, however, the face-frame effect worked little. Depending on the *S*s, the effect varied to some degree in magnitude. KT gave an apparently weak effect compared with the other two *S*s as seen in Fig. 6.

The essence of the results may be summarized as follows: When the directions

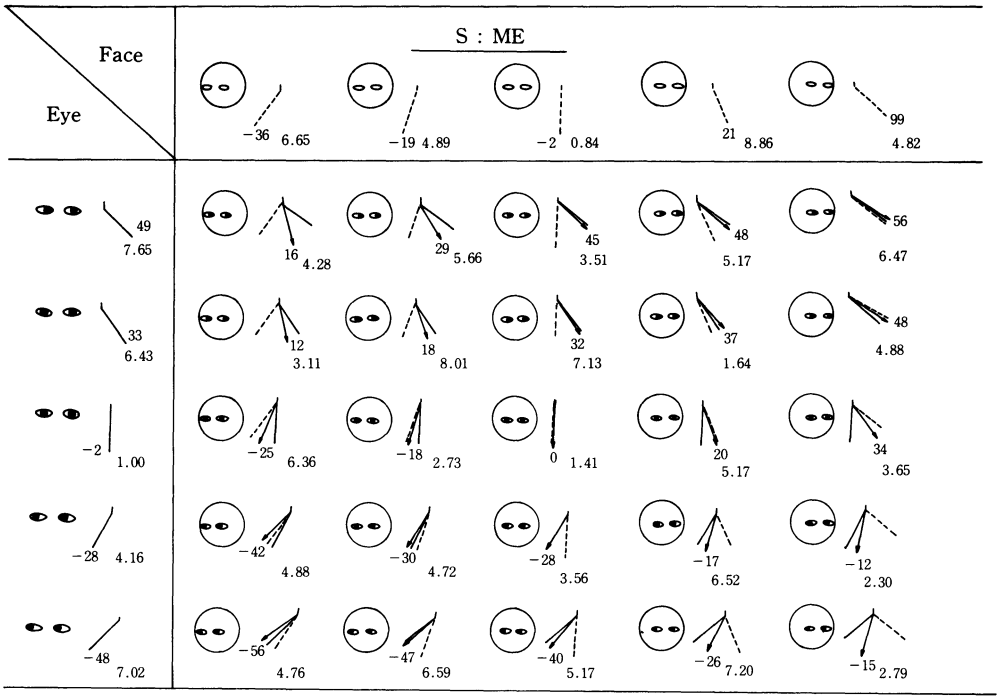



Fig. 5. Results from ME at Exp. II.

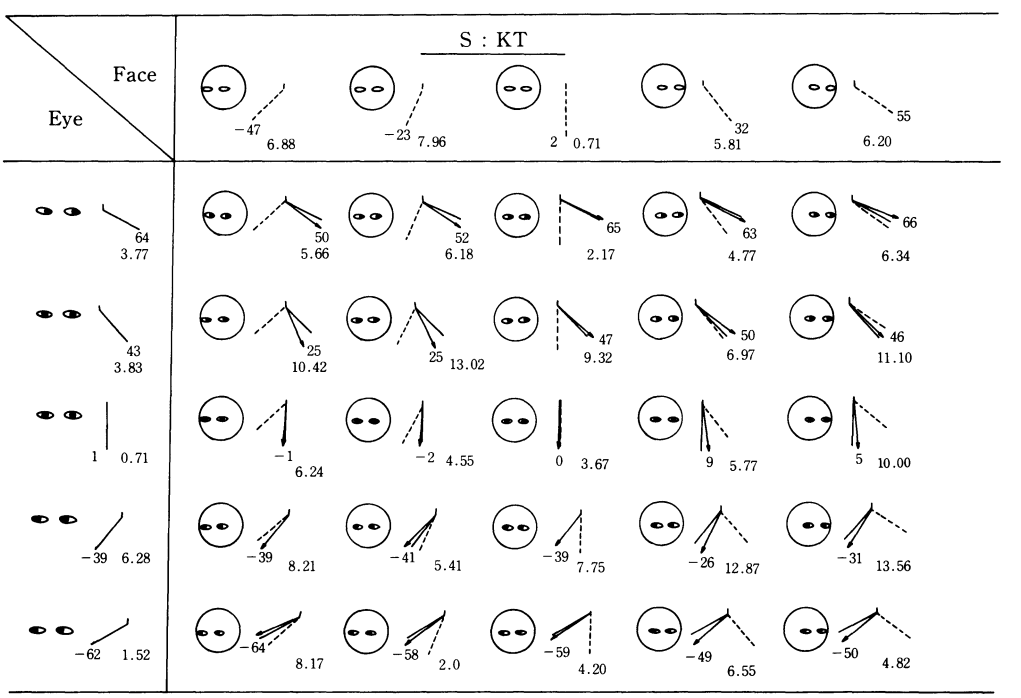



Fig. 6. Results from KT at Exp. II.

of the gaze and the face were not perceived the same, the apparent line of gaze in the eye-face pattern was intermediate between them. These results are in good accordance with that provided by Argyle & Cook (1976).

## Experiment III

The line of gaze originally inheres in the eyes themselves. It was, consequently, the matter of examination in both Experiments I and II to what extent this eyes' line of gaze is attracted toward the facc orientation by its frame organization. That is, the manner of influence from face to eyes (face→eye) was investigated in the preceding experiments, but that of the reverse (eye→face) has been ignored there. Where the interaction is concerned, both sides of influence should be taken up. Thus, Experiment III was set up to inquire into the effect of the gaze direction upon the face orientation.

Four patterns were provided for the face orientation as shown in Figs. 7, 8, and 9, and three patterns for the gaze direction. The direction measurement was done for each of the three patterns and also for the different 12 face patterns with the eyes embedded (eye-face pattern) which were made by the factorial combination of the eyes and the face. In the latter measurement, the *S*s judged not about the direction of the gaze but about the face orientation. The measuring procedure and *S*s were the same as the preceding experiments.

*Results and Discussion :*

The results are given in Figs. 7, 8, and 9, which are the individual descriptions for three *S*s, respectively.

The *S*s may be classified in to two types ; one is for KM and ME, the other for KT. The former is a type in which the eyes had little influence upon the face and the latter a little. KM and ME are the ones who gave a striking result in Experiment II with respect to the frame effect of the face. From all accounts of the results of Experiments II and III, it may be concluded that, in the case of these two *S*s, the orientation of face was so firm as a frame that it hardly changed its orientation when accompanied by the gaze. So, the perceived gaze direction in the eye-face pattern was the outcome of such a one-way-like interaction from the face to the gaze that the face took the gaze in tow toward its own direction.

The data from KT, on the contrary, showed that the perceived orientation of the face in the eye-face pattern was towed a little toward the gaze direction, except for four examples of right-directed gazing faces (of the estimated face orientations : 17°, 30°, 16° , and 31° in the eye-face pattern). She has gave a more feeble face-frame effect than the other two male *S*s in Experiment II. It may, hence, be summarized that, in the case of such an *S*, the gaze could tow the orientation of the face toward its direction, and the schema of interaction between the eyes and the face is obviously introduced

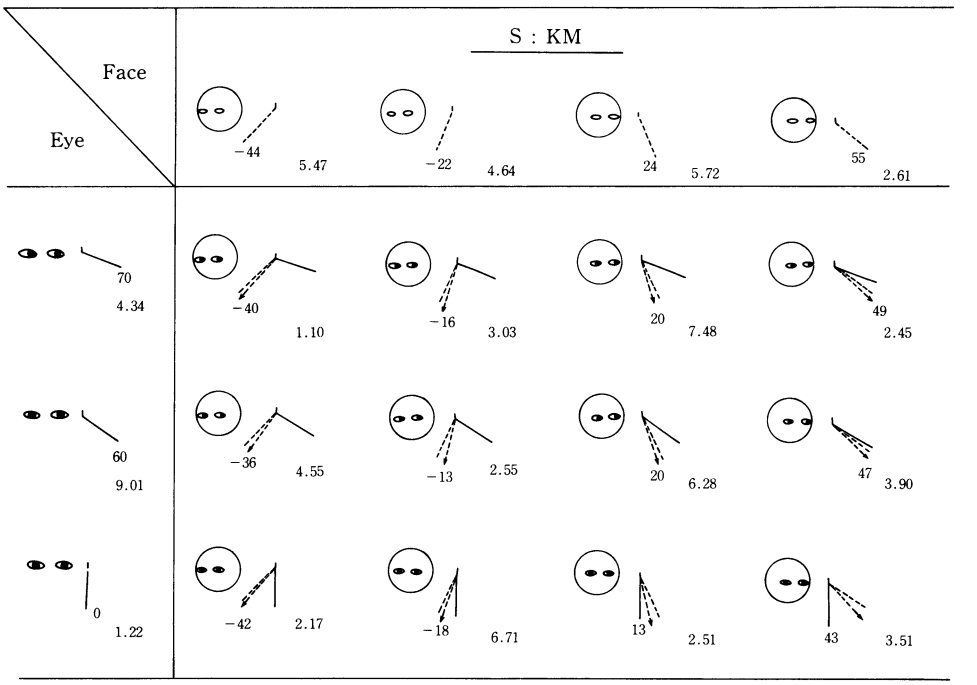



Fig. 7. Results of KM in Exp. III. ↓, face orientation in the eye-face pattern, Mean and *SD* are attached in terms of degrees in angle; ⋮, face orientation in the face pattern; |, gaze direction of the eyes alone.

there. In the results of KT in Experiment II, the apparent gaze direction counterbalanced the two forces of the eyes and the face pulling against each other in the eye-face pattern, or the pulling force toward the face orientation was reduced enough for an amount of interaction. The results in KT should not be attributed to the one-way-like interaction from face to eyes where the face-frame effect did not work so strongly as in KM and ME. Such an interaction of a reciprocal type between the eyes and the face could not be observed especially in the results of Experiment I, however.

Thus inferred two types of interaction, i.e., the one-way-like type and the mutual type, conclusively indicate that the face orientation plays an important role as a frame for the estimation of the gaze direction.

## Experiment IV

To confirm the frame effect of the face orientation, further investigation was performed with an extreme reduction of the frame. Such figures as presented in Figs. 10, 11, and 12 were provided for the patterns, i.e., the eyes and a short vertical line beside them. It may be supposed that the face orientation effect takes place in these simplified figures, too, since the face-frame is so effective as in the preceding experi-

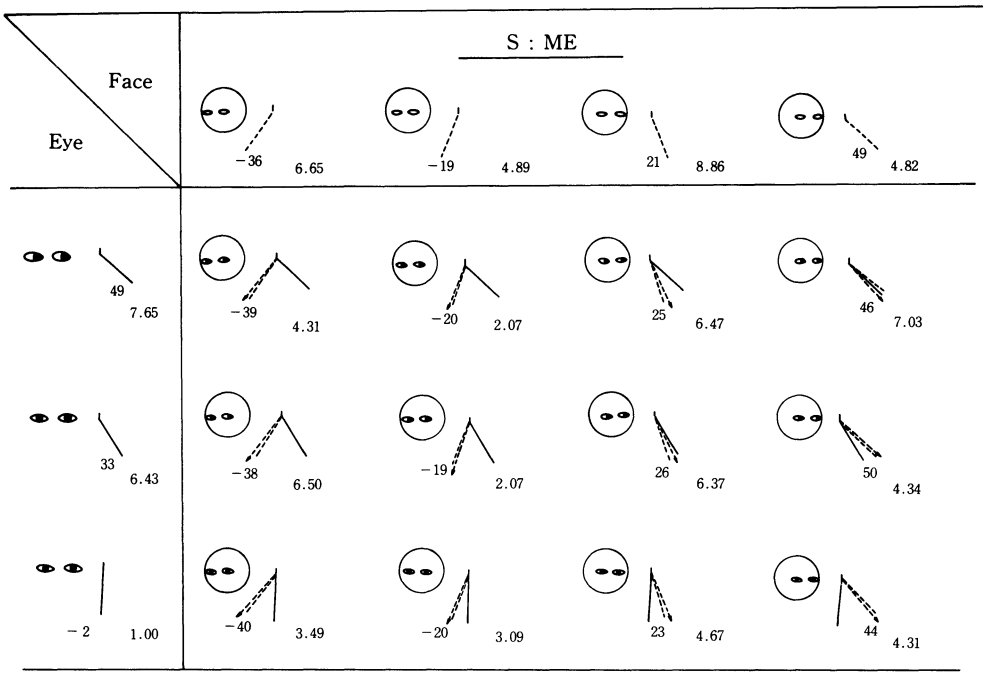



Fig. 8. Results of ME in Exp. III.

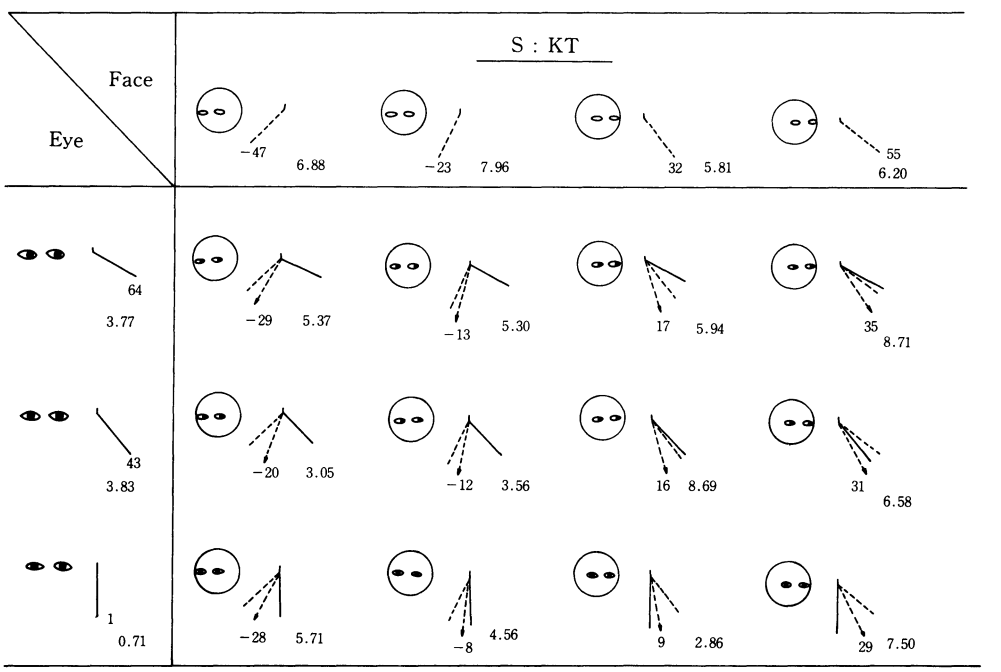



Fig. 9. Results of KT in Exp. III.

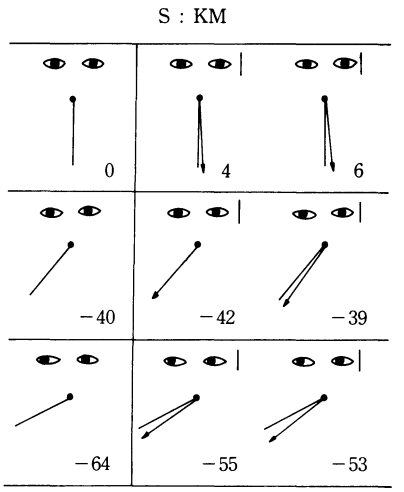



Fig. 10. Results of KM on Exp. IV. | , gaze direction of the eyes, with mean in terms of degrees in angle ; ↓ , gaze direction of the eyes in which a short vertical line was attached as minimized face contour.

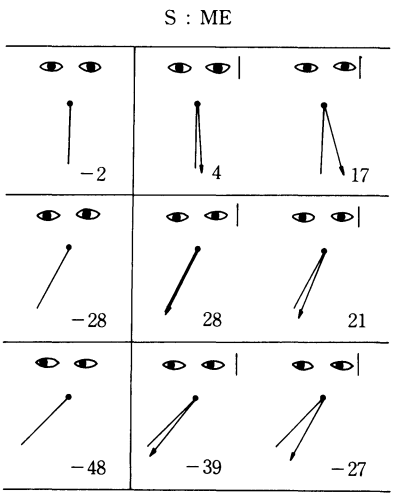



Fig. 11. Results of ME on Exp. IV.

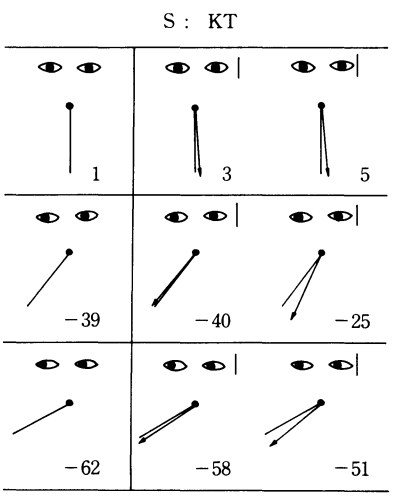



Fig. 12. Results of KT on Exp. IV.

ments.

In this experiment, conducted under the same method as the preceding, the direction of gaze was measured for three patterns : the eyes without a line, the eyes with a line separated 1 cm to their right, and the eyes with a line separated 0.5 cm to their right. The vertical length of the line was 2 cm.

*Results and Discussion :*

From the individual data of the three *S*s shown in Figs. 10, 11, and 12, the conclusion may introduce that the vertical line behaved itself like the face-contour and it pulled the direction of the gaze toward its side, though its effect was not so dramatic

as Experiments I and II. These circumstances showed up throughout the three *S*s including KM in whom the face-frame has not worked so effectively as the other two *S*s in Experiments II and III, and became clearer at the session of 0.5 cm than that of 1 cm.

It should be concluded that the frame effect of the face is powerful as supposed previous to the experiment, since the face-frame is effective even if its frame is reduced to such a line as was presented in the experiment.

## Conclusion

As the results of the above four different types of examination about the eye-face pattern, it may be introduced that the apparent gaze has its direction determined in such a manner that the apparent face orientation in some degree towed toward it the eyes' proper line of gaze. The eyes made a stand against the towing force of the face, and in consequence the perceived direction of the gaze in the eye-face pattern was intermediate between the eyes' proper direction of gaze and the face orientation, when these two lines were not aligned.

The following two types of towing effect (face-frame effect) were observed within the three *S*s: One was dramatic and the other was not so. The latter, which was offered by an *S*, was the mutual interaction style between the eyes and the face, where the face orientation pulled the eyes' proper gaze toward it with its porce being reduced enough for an amount of interaction, and consequently the face-frame effect reduced so much.

On the contrary to the above, the direction of gaze had little influence upon the face orientation in the other two *S*s. The one-way-like type of interaction from face to eyes was discernible ; the marked effect of the face orientation took place enough for an amount of the one-way-like interaction. Thus, the face orientation played an important role as a frame in the perception of the gaze direction at the eye-face pattern.

Further evidence supporting these properties of the face-frame was offered by an extreme reduction of faceness. As was expected, the gaze was attracted, though not so dramatic, toward a short vertical line at the eyes' side that functioned as the minimized face contour.

Such a striking effect of the face-frame was observed across the conditions where the discrepancy in direction between the eyes and the face was large and the full face did not affect so much.

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