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LOOKING AT UPSIDE-DOWN FACES[1]

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Memory for faces was compared with memory for other classes of familiar and complex objects which, like faces, are also customarily seen only in one orientation (mono-oriented). Performance was tested when the inspection and test series were presented in the same orientation, either both upright or both inverted, or when the two series were presented in opposite orientations. The results show that while all mono-oriented objects tend to be more difficult to remember when upside-down, faces are disproportionately affected. These findings suggest that the difficulty in looking at upside-down faces involves two factors: (*a*) a general factor of familiarity with mono-oriented objects; and (*b*) a special factor related only to faces.

It is a well-known fact that pictures of human faces, when viewed upside-down, are extremely difficult to recognize (Arnheim, 1954, p. 86; Attneave, 1967, p. 26; Köhler, 1940, p. 60). Köhler not only noted this, but also speculated that the difficulty was attributable to the loss of "facial expression" in the inverted picture. More recently, investigators have examined this phenomenon in several ways. Brooks and Goldstein (1963) showed that recognition of inverted faces is worse than that of upright faces when children are asked to identify snapshots of their classmates. That memory for inverted faces is poorer than memory for upright faces among adults has been shown in a paired-associate task (Goldstein, 1965) and a recognition task (Hochberg & Galper, 1967).

These studies have not indicated the extent to which the difficulty in viewing an upside-down face is related specifically to the face. An alternative hypothesis would be that any set of objects customarily seen in one orientation, i.e., mono-oriented, might be more difficult to recognize when inverted. Some evidence for this hypothesis was reported by Henle (1942), who showed that alphabetic letters were correctly perceived more frequently than their mirror reversals by *S*s familiar with the letters, and by Ghent (1960), who found that young children are markedly dependent on familiar orientation for recognizing realistic figures. In addition, Dallett, Wilcox, and D'Andrea (1968) reported that memory for upright magazine pictures was better than that for the same pictures when presented upside-down. The investigators did not indicate, however, the extent of homogeneity among the pictures or the degree to which the pictures were of objects that are customarily mono-oriented.

The present experiments were designed to test whether a general impairment on mono-oriented objects when inverted could account for the difficulty with viewing upside-down faces. More specifically, performance on upright and inverted tasks for faces was compared with that for other classes of everyday objects having a priori properties similar to faces in being mono-oriented, familiar, complex, and not easily verbalized, i.e., objects that are not distinguished from each other by the use of simple labels.

To test performance, a forced-choice recognition memory task was used. In this task, *S*s were shown individual pictures (an inspection series) and then presented with pairs of pictures (a test series). In the test series they indicated the one of the pair they thought they had seen in the inspection series. Three experiments were conducted. In the first and third, the

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orientation of the materials in both the inspection and test series was the same (both upright or both inverted). In the second, the orientations were opposite (inspected upright and tested upside-down or inspected upside-down and tested upright).

Experiment I

Method

Subjects.—There were 26 paid volunteers, 13 men and 13 women, ranging from 18 to 31 yr. of age (mean age = 21.7 yr.). These were undergraduate and graduate students attending summer schools in the Boston area and represented a wide variety of geographical origins and academic interests.

Materials.—There were 64 different pictures, all black and white, within each of four types of materials: faces, houses, airplanes, and men in motion. All pictures were pasted on a 3 × 5 in. card for presentation.

The faces were studio pictures of adult males, chosen to be similar with respect to general age, expression, and lack of outstanding distinguishing features, such as glasses, beards, or unique marks. All poses were full face, and the pictures were trimmed just under the chin to eliminate as much clothing as possible. The houses were generally of the same architecture, but were not as uniform as the faces in orientation of view or size of picture. In addition, since all were actual photographs, the pictures included trees and other natural features, although they were trimmed to minimize the presence of distinguishing features, such as fences, front stoops, and roof markings.

Neither the airplanes nor the men in motion were real photographs, but were caricatures. The planes were sideview silhouettes of all types and models (military, commercial, and private) of planes found in the world today. The men-in-motion pictures consisted of the same cartoon stick figure engaged in various everyday movements and postures, with no other objects present in any of the pictures.

Procedure.—Each *S* looked at an inspection series of 40 pictures, presented singly and turned by *E* at a rate of 3 sec. per picture. Then a test series, consisting of 24 pairs of pictures, was presented. Each pair contained 1 old picture (an exact duplicate of a picture in the inspection series) and a new picture (one not previously shown), and *S* had merely to indicate which picture in each pair was the old one. The *S* proceeded at his own rate in the test series. Since only 24 pairs were in the test series, there were 16 pictures in the inspection series which did not recur in the test series.

Each inspection and test series constituted a block and was a mixed list, containing two different types of materials, 20 of each in the inspection series and 12 pairs of each in the test series. The order of presentation of the 40 inspection series pictures was randomized, with the two exceptions that neither of the two materials was shown for more than four consecutive cards and that there were always at least 2 of the nonrecurring pictures, one of each type of material, at either end of the series. The order of the 24 test series pairs was dictated by the order of pictures in the inspection series, so that there was a constant lag between each inspection picture and its occurrence in the test series.

All *S*s went through four such blocks of inspection and test series, viewing two blocks rightside-up (both series upright) and two upside-down (both series inverted). Thus each *S* performed in all experimental conditions, viewing the four materials in two presentations. The order of presentation among the blocks was balanced in the following manner: (*a*) Each *S* was shown all four materials (two blocks) first; half of the *S*s saw these two blocks upside-down first, the other half rightside-up first; (*b*) the mixing of the materials was such that roughly one-third of the *S*s had blocks consisting of faces–houses or airplanes–men-in-motion, one-third had blocks of houses–airplanes or faces–men-in-motion, and the remaining third had blocks of airplanes–faces or houses–men-in-motion; (*c*) the blocks were alternated so that each picture was shown rightside-up as often as it was upside-down; and (*d*) the sexes were balanced with regard to all of these conditions.

TABLE 1

Mean Errors, Exp. I

Material	Presentation			
	Test and inspection series upright		Test and inspection series inverted	
	M	*SD*	*M*	*SD*
Faces	.89	1.09	4.35	1.41
Houses	2.23	1.60	3.42	1.36
Airplanes	3.65	1.69	3.85	2.03
Men in motion	2.35	1.27	3.27	1.58

Results

The mean errors, with their standard deviations, appear in Table 1. An analysis of variance of the error scores showed that there were significant differences as a function of presentation, $F\ (1, 25) = 90.90$, $p < .0005$, materials, $F\ (3, 75) = 6.63$, $p < .001$, and their interaction, $F\ (3, 75) = 9.18$, $p < .0005$.

Although all materials were more difficult in the inverted presentation, the extent to which each type of material contributed to this effect varied. Using *t* tests for matched pairs, two-tailed, the effect of inversion was

greatest for faces, t (25) = 8.48, $p < .001$, significant but not as great for the houses, t (25) = 3.01, $p < .01$, and the men in motion, t (25) = 2.15, $p < .05$, and not significant for the airplanes, t (25) < 1.

The materials also differed in their overall difficulty. Although this finding is not of primary interest here, the major reason for it was that the airplanes tended to be the most difficult material in either presentation.

Of greater interest is the fact that the Presentations × Materials interaction was significant. Further analysis showed that this was due mainly to the faces, which were easier than all the other materials when viewed upright, t (25) = 7.31, $p < .001$, but more difficult than the rest when viewed upside-down, t (25) = 2.53, $p < .02$. Examination of the individual scores produced added evidence of the existence of a difference between faces and the other materials. In general, those who did better in the inverted orientation also tended to be the ones who did better in the upright orientation. However, for faces, the reverse was true. Taking the average inverted score for houses, airplanes, and men in motion, and arbitrarily assigning all *S*s to a better group ($n = 14$, average error = 2.88) and a worse group ($n = 12$, average error = 4.25), the better group is also better on the upright task (average error = 2.36), while the worse group is still the worse one (average error = 3.19). Using a t test for independent samples, two-tailed, the difference between the two groups in their upright scores is significant at the $p < .05$ level, t (24) = 2.46.

On the other hand, arbitrarily assigning all *S*s by their score on the inverted-face task to a better group ($n = 14$, average error = 3.29) and a worse group ($n = 12$, average error = 5.58), we find that the better group is now the *worse* one on the upright-face task (average error = 1.29), while the worse group is the *better* one (average error = .42). This difference on the upright-face task is significant at the $p < .05$ level, t (24) = 2.14.

Sex differences.—Men and women did not differ in their total upright or inverted scores. There were differences between materials, however, in that the men's average upright and inverted score for airplanes was better than that of the women, t (24) = 2.26, $p < .05$, while the women's average upright and inverted score for houses was better, but not significantly, than that of the men, t (24) = 1.91, $p < .10$. In both cases the t test was for independent samples and two-tailed. There were no sex differences for either the faces or the men in motion.

TABLE 2

MEAN ERRORS, EXP. II

Material	Presentation			
	Up-Down		Down-Up	
	M	*SD*	*M*	*SD*
Faces	3.81	1.71	5.14	1.39
Houses	2.86	1.83	3.43	1.47
Airplanes	3.19	1.94	4.14	1.58
Men in motion	4.05	1.79	4.24	1.72

Order of presentation.—There were no differences when the groups were characterized by viewing order, upright first or inverted first, or by the mixture of the materials in the different blocks.

EXPERIMENT II

Experiment II required *S*s to make a mental inversion of the materials, presenting the inspection and test series in opposing orientations.

Method

Subjects.—There were 21 paid volunteers, 13 men and 8 women, ranging from 18 to 26 yr. of age (mean age = 21.1 yr.). The general nature of the sample was the same as that of Exp. I.

Materials and procedure.—The materials were the same as those used in Exp. I, and the overall procedure was exactly the same with one exception: For each *S* the two presentations were up-down (inspection series presented upright and test series inverted) or down-up (inspection series presented inverted and test series upright). As in Exp. I, each *S* performed in all experimental conditions, viewing the four materials in both presentations.

Results

Table 2 contains the mean errors with their standard deviations. An analysis of variance of the errors shows that there were

significant differences as a function of presentation, F (1, 20) = 11.67, $p < .01$, and materials, F (3, 60) = 4.37, $p < .01$, but not of their interaction, F (3, 60) = 1.09.

Although all materials were worse in the down-up presentation than the up-down presentation, faces were the most affected. Using t tests for matched pairs, two-tailed, the difference in presentation was significant for the faces, t (20) = 3.12, $p < .01$, but not for the houses, t (20) = 1.44, airplanes, t (20) = 1.59, or men in motion, t (20) < 1. The materials again differed in overall difficulty, this time mainly because the houses were easiest in both presentations.

Sex differences.—As in Exp. I, men and women did not differ in their total scores. Men tended to do better on airplanes in both presentations, but there were no differences for the other materials.

Order of presentation.—There were no differences due to order of presentation.

Comparison of results between Experiments I and II.—In general, for each material the up-down performance (Exp. II) tended to be worse than the upright performance (Exp. I) by about the same amount that the down-up (Exp. II) was worse than the inverted (Exp. I). This consistent decline reflects the added difficulty imposed by the necessity for inverting the pictures mentally.

With the faces, however, the up-down performance was disproportionately worse than that of the upright. This is apparent if for each material, one compares the up-down and down-up difference from Exp. II with the upright-inverted difference from Exp. I. Using t tests for independent samples, two-tailed, the difference between these differences is significant for faces, t (45) = 3.55, $p < .001$, but not for houses, t (45) = 1.09, airplanes, t (45) = −.99, or men in motion, t (45) = 1.26. Thus, while all the materials tended to become more difficult in Exp. II, the upright faces were disproportionately affected.

The major finding from the first two experiments is that faces are different from the other materials in two ways. First, although all the materials were more difficult when viewed upside-down, faces were especially difficult (Exp. I). Second, although all the materials were more difficult when S was required to make a mental inversion, the upright face was again disproportionately affected (Exp. II).

At least two interpretations of these results may be made. The first is that there is something special about faces that makes them particularly difficult even when compared with other mono-oriented objects. The second is that the difference between faces and the other materials is due solely to differences in degree of difficulty among the materials when presented upright. According to this interpretation, the easier a material when upright, the more it will be affected by inversion, and thus the disproportionate difficulty in remembering upside-down faces merely reflects the fact that the faces were the easiest material when viewed rightside-up.

To try to differentiate between these two interpretations of the results, a third experiment was designed in which memory for faces was compared with memory for another class of objects which, while meeting all the previous criteria in being mono-oriented, complex, familiar, and not easily verbalized, would also be as easy to remember as faces in the upright presentation. In addition, since the faces used in the first two experiments were studio pictures, the third experiment also investigated the possibility that the difficulty in remembering faces could be attributed solely to the special effects of light and shadow inherent in such pictures. Therefore an artist's line drawings of adult male faces, made to specification so that they were similar to the studio pictures but with all light and shadow cues eliminated, were used.

Experiment III

Method

Subjects.—There were 23 paid volunteers, all male undergraduates attending the regular school session.

Materials.—There were 36 different pictures, all black and white, of two types of materials: artist's sketches of faces and drawings of faceless figures clothed in different period costumes. The sketches were cropped very severely, so that no hair, ears, or chin lines were present. The costumed figures

were also cropped so that only the faceless head and torso of each figure were shown.

Procedure.—The procedure was the same as that of Exp. I, except that the inspection and test series were both shorter. The inspection series contained only 18 pictures, while the test series contained 18 pairs of pictures. Each block of inspection and test series was composed of equal numbers of faces and costumes, and each *S* viewed two blocks, one rightside-up and the other upside-down.

Results

For faces, the upright errors were $M = 1.35$, $SD = 1.13$, and the inverted errors were $M = 2.69$, $SD = 1.40$. For the costumes, the upright errors were $M = .48$, $SD = .71$, and the inverted errors were $M = .78$, $SD = .78$. Using t tests for matched pairs, two-tailed, the difference between upright and inverted errors was significant for the faces, $t\ (22) = 4.00$, $p < .001$, and strong but not quite significant for the costumes, $t\ (22) = 1.91$, $p < .10$. More important, performance for the costumes was better than that for the faces in the upright presentation, $t\ (22) = 3.14$, $p < .01$, as well as in the inverted presentation, $t\ (22) = 5.31$, $p < .001$. Thus the faces, although not the easier material in the upright presentation, were still more affected by inversion when compared with the costumes.

Discussion

The results of the third experiment indicate that upside-down faces are difficult to remember even when the differences between materials are such that the faces are not the easiest to remember in the upright presentation. In addition, the difficulty is not limited to studio photographs, but can also be shown to exist with line drawings.

The data from all three experiments support the interpretation that the inverted face is especially difficult to remember because of two factors: a general factor of familiarity with mono-oriented objects and a special factor involving only the faces. The general factor is seen as affecting all of the materials used, making them more difficult to recognize when upside-down; the special factor relates to the disproportionate difficulty created by the inverted face.

It is interesting to speculate what such a special factor might involve, even though this question is unanswerable from the present experiments. One clue may be provided by verbal reports from *S*s when they are asked how they tried to remember the various materials. They seemed to use two alternative strategies, either searching for some distinguishing feature or attempting to get a general impression of the whole picture. The first tended to be used for most of the materials; the second was used mostly for faces, with *S* trying to remember some personal impression made by the face. None of the *S*s, however, reported being able to use the second strategy when looking at the inverted face. Whatever the relevant variables, further investigation into the difficulty with inverted faces may by implication tell us something about how people recognize normal (i.e., upright) faces and how we distinguish one face from another.

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