VISUAL ASYMMETRY IN FACIAL RECOGNITION

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ABSTRACT

VISUAL ASYMMETRY IN FACIAL RECOGNITION

By

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Past experiments have shown that the right side of a person's face seems to resemble his whole face more than the **left** side does. ("Right" means adjacent to the person's right arm, appearing in the observer's left visual field.) More recent research on perceptual asymmetries in connection with hemispheric localization suggested that the "resemblance" bias is due to more direct information transfer from the right side of the face to the perceiver's right hemisphere, where the facial recognition function seems to be localized.

135 subjects were tested in two separate experiments. Test material consisted of 20 photographed faces; composites were made of two left half-faces combined and two right half-faces combined. Half of the subjects viewed an original full-face photo and chose which of the two composites were more similar to the whole face; the remaining subjects viewed a mirror image of the whole face and chose from the same composites. This reversed the sides of the face relative to the observer. The only difference between the two conditions was in the orientation of the whole face: either original or reversed.

The hypothesis was that subjects would choose the right half-face composite significantly less often when viewing the reversed whole face than when viewing the original, because the position of the right side of the face was changed relative to the subject. Previous investigators assumed the effect was due to characteristics of the face itself; if that were true, the reversal of the whole face should have no effect on the proportion of right-composite choices.

The results established a visual-field explanation for the effect. With pictures presented to individual subjects, a 59% right-composite choice bias changed to 43% with the whole face reversed. Slide projection to groups showed an even stronger difference: from 60% to 39%. Both experiments were done with no fixation point; subjects were allowed free view of the pictures.

The results are congruent with other perceptual asymmetries found in hearing and vision, and are explainable by right-hemisphere specialization for facial recognition: visual pathways are arranged so that left-visual field input goes directly to the right hemisphere while right-visual field input goes directly to the left hemisphere and must be transferred to the right via the corpus callosum when facial recognition is required.

The only result not congruent with a hemispheric specialization explanation is the lack of difference for left-handers. Their bias for the left visual field was expected to be less because of their known tendency toward less complete hemispheric specialization (or lateralization).

An alternate explanation for the results in a left-to-right scanning habit developed through reading; this was not thought likely because of recent experiments showing no difference between Hebrew readers and English readers on various perceptual tasks (Hebrew is read right to left).

Logical extensions of this research are to: 1) test the extent of generalization of this effect by using abstract and natural patterns other than faces; 2) examine the relation between facial recognition ability for whole faces and the amount of asymmetry (bias for the left visual field) shown by individual subjects; 3) examine the effect of delayed recall (memory); 4) test readers of Hebrew to determine whether the effect is due to reading habits.

Approved ______________________

Date ______________________

VISUAL ASYMMETRY IN FACIAL RECOGNITION

By

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A THESIS

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To Carol

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Thanks, Dr. Bakan

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INTRODUCTION

In 1933 Werner Wolff decided to test an ancient popular notion of physiognomy: that the right side of a person's face resembles his whole face more than the left side does. Wolff used photographs and a similarity choice procedure, and claims to have shown that people in general perceive a stronger resemblance between the right side and the whole face ("right" refers to the person photographed, so that the right side of the face is adjacent to his right arm). No numbers were reported; his conclusion was simply that the right side of the face was "plainly preferred."

Several other claims were made at that time concerning "public" and "private" character, species vs. individual expression, and expression of neurotic conflict, all related to one side of the face or the other.

McCurdy (1949) repeated Wolff's experimental procedure, reporting it more explicitly: from a full-face photograph a duplicate and a mirror image is made. Each picture is cut down through the midline of the face, then reassembled to make two composites of two right halves and two left halves. The result is a pair of apparently complete faces but showing perfect bilateral symmetry. These are displayed to subjects along with the original full-face photograph, and subjects choose which composite more closely resembles the original.

McCurdy found that for 29 out of 42 picture-sets, his group of 62 subjects found the right composite more like the whole face. This supported Werner Wolff's results.

The same experiment was done for the third time in 1952 (Lindzey, 1952) with 18 photographs. Gardner Lindzey found that for 14 of the 18, the right composite was chosen by the majority of the 52 judges, 10 of the 18 at a significant level. There was no relationship found with handedness or side preferences. Lindzey concluded: "...the greater similarity of the right side of the face to the whole face is a consistent, replicable relationship. There does not seem to be any simple explanation as to why this relationship exists. Neither anatomy or physiology pose an immediate answer."

The objective of the present study was to test a possible physiological explanation for this phenomenon, in a preliminary way, by adding a single manipulation to the standard procedure. Authors of every previous study assumed that the bias for the right side of the face (in the observer's left field of vision) was due to the content of the face itself. The speculations about "public" and "private" character expression depended on the effect being in the photographed person's features.

An alternate possibility is that observers tend to see the right side of a face as more familiar simply because it lies in their left visual field; that is, the source of the effect could lie not in the features but in the observer himself. In this case, reversing the whole face to its mirror image would place the left side of the face in the "preferred" position (see Figure 1).

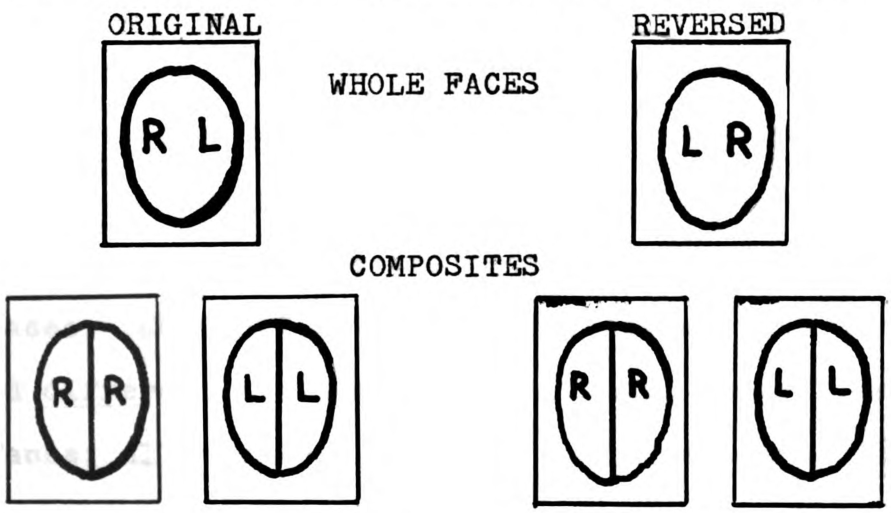

Fig. 1. Illustration of picture arrangement for the two conditions

Collecting judgments on resemblance of composites to both the original and the reversed face therefore provides a simple test of the hypothesis: that the bias is due to a visual field effect rather than to actual differences in the photographed faces. Following is a summary of the physiological evidence suggesting that material in the left visual field may be perceived differently than material in the right visual field.

Evidence for Hemispheric Localization of Facial Recognition

Much research in the past decade has shown an association between facial recognition deficit and right hemisphere damage. Hecaen (1962) showed that true agnosia for faces occurs more often with right than with left hemisphere injury; this is a rare, severe disability, and precise experimental methods are necessary to bring out the more common partial agnosia for faces, in which persons typically do not even notice their deficit and have no trouble recognizing faces of friends and relatives.

De Renzi and Spinnler (1966) and Benton and Gordon (1964) used a recognition method in which one photographed face was viewed briefly and then picked out from an array of faces. De Renzi later (1968) repeated this work and added different views of the same face, as well as sections of faces; all research showed a definite connection between right hemisphere damage and poor performance relative to controls on a recognition task. Left-hemisphere damage produced no such deficit.

Exact localization of the facial-recognition site in the right hemisphere has not been achieved and may not be possible. The damage to De Renzi's subjects was to various parts of the temporal and parietal lobes; he found no correlation between the size of lesion, kind of illness, or length of disability with performance on the facial recognition test.

Brenda Milner (1968) tested a total of 163 patients with partial or complete temporal lobectomy for their ability to recognize unknown faces. The procedure was similar to De Renzi's; subjects were matched for size of lesion, age, intelligence, seizure history, and extent of tissue removed. The overall findings were that right-hemisphere damage impaired facial recognition while left-hemisphere damage didn't.

Other investigators have worked with variables connected with this basic finding (Yin, 1970, Benton, 1968) without compromising the basic fact of right-hemisphere localization for a facial recognition ability.

Asymmetries of Perception

If it is granted that facial recognition is somehow associated with the right hemisphere more than the left, then it seems possible that a visual field asymmetry may exist for this ability. Perhaps visual material transferred directly to the right hemisphere is more salient or more easily remembered than material transferred to the left hemisphere. This possibility is suggested by much recent research demonstrating asymmetrical perception in vision and audition.

Many "split-brain" studies, in which the cerebral commissures are severed for relief from epileptic seizure, have left no doubt that a general visual recognition function is located in the right hemisphere (Sperry, 1968, Gazzaniga, 1967). In persons with an intact corpus callosum (the main tract connecting the two hemispheres), the approximately three million interconnecting nerve fibers with a 5-6 msec. transmission time serve to equalize and minimize to an infinitesimal level any asymmetries of perception. Yet such asymmetries have been demonstrated, largely through the work of Doreen Kimura and M. P. Bryden.

Audition

The basic experimental procedure for measuring asymmetries of audition involves simultaneous presentation of matched pairs of words or digits to both ears (Kimura, 1961, 1963, 1967). Normally a right-ear superiority appears; that is, a subject can report the right-ear input more accurately than the left-ear input. The differences are small but consistent. Kimura's speculation is that the contralateral ear-brain nerve pathways are slightly more efficient, being more direct and possibly suppressing the ipsilateral (same-side) input.

By 1967 enough research had been done to stimulate M. P. Bryden's article (Bryden, 1967) which summarized four possible models for the established right-ear asymmetry for words and digits: the models used explanations of order effect, differential short-term memory storage, simple strength or clarity of the contralateral input, and differential thresholds for the material. The final explanation may involve one, several, or none of these models, but that the effect is related to hemispheric specialization for verbal function seems clear from the following research.

Curry (1965) assessed the effects of handedness on dichotic listening performance and found a much smaller difference (and some reversals of direction of difference) between the two ears for left-handers. All left-handers were pooled; their dominant hemisphere for speech was unknown. Most left-handers are thought to be less "lateralized" than right-handers; that is, functional specialization is less complete, so that verbal function is more evenly distributed between hemispheres. Therefore smaller differences between scores for the two ears would be expected.

Kimura (1967) improved on Curry's idea by testing 13 persons whose speech lateralization was reversed, as tested by the sodium amytal technique which allows selective anesthesia for one hemisphere only. As expected, these persons showed a left-ear superiority for digit recall, the left ear in this case being contralateral to the hemisphere dominant for speech.

Bakker (1970) also showed a strong relationship between handedness and asymmetry for verbal recall; Knox, in addition (1970), showed a developmental trend: females around five years of age begin to exhibit right-ear superiority for verbal recall. Five-year old boys show less of a superiority or none at all, because it develops later for them (tying in well with the generally earlier development of language skills in females).

These last two studies have additional meaning; on another task involving non-verbal stimuli--either Morse code-like patterns of long and short sounds or "environmental" sounds--the subjects performed better with the left ear. The relationship was as strong as with verbal sounds and showed the same variations for left-handers. Kimura's earlier conclusions (Kimura, 1964) showing a left-ear superiority for recognition of melodies, could now be expanded to include other non-verbal material, and led to the hypothesis that the non-dominant hemisphere is responsible for non-verbal auditory analysis in general.

Vision

In the area of vision a similar research trend has been going on. Here there is more confusion, less clear results, but at least under certain conditions the right visual field is superior for recognition of letters (see Kimura, 1961, 1966, 1969). Others, however, claim that the effect is due to reading habits (Forgays, 1953, Heron, 1957, Mishkin & Forgays, 1952) or simply errors in procedure (White, 1969). Even though most work has supported the right visual field superiority for words and digits, there seems to be enough conflicting evidence to postpone accepting a hemisphere dominance explanation. Also, there is no easily demonstrated left visual field superiority for any non-verbal forms, although geometrical shapes and abstract forms have been tried.

In dichotic listening experiments, there is no way to specify the route and end-point of a sound since each ear has ipsilateral and contralateral connections. Sound from either ear is carried to both hemispheres. This is not true with visual-field experiments, however, because the visual pathways allow this control: the left halves of both retinas project exclusively to the left hemisphere, while both right halves project to the right hemisphere. This is apparently a strict division down the exact center of the fovea, and there is no overlap (Polyak, 1957). Therefore any material to the left of a point of focus goes first to the right hemisphere (see Figure 2). If we look at the center of a face, an image of the right side of the face (adjacent to the person's right arm) will therefore be transmitted first to our right hemisphere.

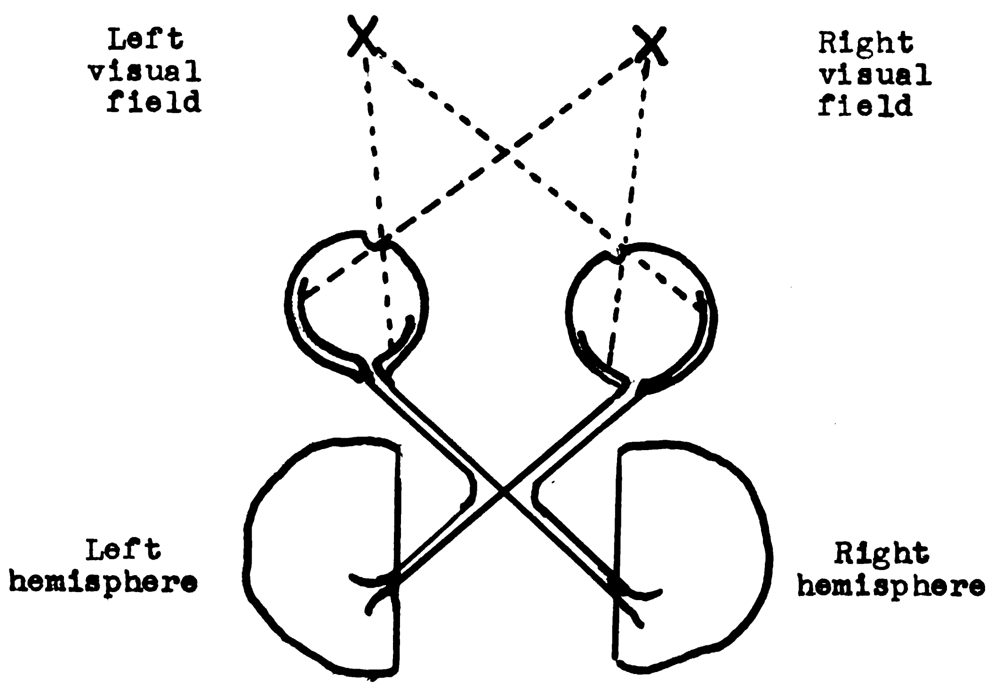

Fig. 2. Relations between visual fields, visual pathways, and hemispheres

The attempts to demonstrate right-field superiority for verbal material recall have usually used tachistoscopic presentation to control which material goes to which hemisphere. Subjects must carefully fixate on a point in the center of a field; stimuli are flashed on either side or both sides of the fixation point for such a brief time that the subject cannot move his eyes in reflex movement toward the stimulus.

The tachistoscopic presentation method produces especially startling results when persons with severed cerebral commissures are tested. Two in particular should be noted here because they provide such direct support for the present study.

Kinsbourne and Trevarthen (unpublished, described by Sperry & Levy, 1970) found that when a stimulus such as a square is presented in the exact midline of the visual field to commissurotomy patients, each hemisphere perceives a complete square rather than the half-square which is actually projected to it. In other words, there is an hallucinated completion of the stimulus by each half-brain.

The second finding related this completion effect to perception of faces. Levy, Trevarthen & Sperry (1970) constructed what were called chimeric faces. One side of the face would, for example, have a mustache, glasses, and short hair, while the other side had a beard, but no mustache, no glasses, and long hair. The midline of the face was the dividing point between the two sets of characteristics.

These chimeric faces were tachistoscopically presented to commissurotomy patients with a fixation point between the eyes. The subjects were then asked to indicate what they had just seen by choosing between the two complete versions of the chimeric face: one made up of the right-half features (glasses, mustache, short hair) and the other made up of left-half features. These were now normal-looking faces.

The authors report that subjects consistently chose the face made up of the features from the right half of the chimeric face (which appeared in the left visual field). This would be expected from the established localization in the right hemisphere for facial recognition. Further, when asked if they noticed anything unusual about the chimeric face in the tachistoscope, they could detect nothing strange at all about it, even though the features were completely different. Material in the right visual field was ignored.

Such research reveals the completion effect at work in complex perception. Apparently subjects doubled and reversed the half-face in the left visual field to make a whole face, and this process was not at all conscious. We are seldom aware of asymmetry in the faces of those familiar to us; this may be because of a cognitive shortcut of paying more attention to one side of the face and then doubling it (the completion effect). It should not seem unreasonable to make such assumptions about intact brain function based on experimental evidence from split-brain subjects, who only reveal the effects of hemispheric specialization in the most basic form. Their perception, unlike "intact" persons, is not equalized by continuous information exchange between hemispheres.

The perception of a split-brain subject should be seen as more structurally basic, with callosal fibers serving to equalize the natural differences and biases. This inter-hemispheric integration, though very rapid and effective, does not appear to be complete. Therefore, searching for perceptual asymmetries, as the present study does, amounts to an attempt to detect the residual effects of laterally unequal brain organization.

Method of presentation

Tachistoscopic presentation was not thought necessary in the present study for a number of reasons. One important one is the artificiality of the tachistoscope situation; such a rapid flash severely limits the amount of information which can be retained from a complex visual pattern. Also, fixation would be rigidly limited to the center of the face, and acuity falls off rapidly away from the fovea. If a subject is not allowed to scan a face, then choosing which half-face composite more closely resembles the whole face is likely to become a chance matter. Scanning is known to be essential for building up a visual memory.

As shown before, dichotic listening tests reveal consistent hemisphere effects which seem subject to the variables of age and handedness. For visual-field experiments, based on the same expectations, results are not as clear. Yet in the case of vision, input can be limited to one hemisphere or the other, while with audition there is no way to limit the input to one hemisphere. One would expect more clear-cut results from visual experiments instead of from audition, since the experimental conditions are "cleaner." So this suggests that it is not absolutely necessary to prevent visual input from the right visual field to the right hemisphere, and vice versa; auditory research shows the hemisphere effect without such restrictions.

There are other important differences between visual and dichotic presentation which lessens their comparability. The dichotic effect depends on "confusion"--that is, two overlapping sounds presented simultaneously, requiring the subject to eliminate one or the other so that he can give full attention to a single input. This overlapping does not necessarily exist with tachistoscope presentation, because we are capable of noticing several items in a visual field simultaneously and integrating them into a total picture.

Also, when letters are presented simultaneously in both right and left visual fields, there is usually a left field superiority, instead of the expected right. This procedure is the closest approximation to the dichotic listening simultaneous presentation, yet the results are directly opposite. To show superiority of the right visual field for visual stimuli, the material must be presented in only one field at a time (see White, 1969, for further visual-field complications).

Another reason for avoiding tachistoscope presentation is the assumption that subjects will actually fixate on the midline of the face for most of their viewing. If this is true, the bulk of the visual information from each side of the face will go the the proper contralateral hemispheres, just as a tachistoscope presentation would do.

Finally, some vision research done without control of fixation has produced a left field bias. Takala (1951) investigated many perceptual asymmetries. One consistent finding was that persons pay more attention to the left side of a pattern, and are more accurate in reproducing the left side of it. Lila Ghent Braine (1968) demonstrated more accurate perception for small differences in a pattern on the left side; this study was done with Israeli subjects, incidentally, which suggests that reading habits (Hebrew is read from right to left) are separate from hemispheric functional dominance.

S. H. Bartley (1959, 1968) has found an effect in subjects viewing photographed scenes and reversals of these scenes: under certain conditions objects in the left visual field appear larger and closer than the same objects in the right visual field.

M. Gaffron studied classical paintings (Gaffron, 1950, 1956) and found again that viewers notice items more in the left visual field. Artists, he claims, seem to be aware of this bias and in turn adjust their paintings to the viewer's asymmetrical perception.

None of these last studies except Braine's took account of evidence for hemispheric specialization gained from fixation-controlled visual research; the findings are very diverse and lend only mild support to the expectation in this study. But they suggest that strict fixation control is not necessary to reveal perceptual asymmetry.

The final and convincing reason for not using tachistoscopic presentation is that Wolff, McCurdy, and Lindzey did not use it, and the bias for the right side of the face still appeared.

Statement of Hypothesis

The purpose of this study, then, was to determine whether the bias for the right side of the face is due to a visual field effect or to anatomical characteristics of the face. Reversing the whole face to which the composite half-faces are compared was expected to change the overall proportion of right-composite choices. Specifically, subjects should choose the right-half composite less often when viewing the reversed face than when viewing the original face. This would show a consistent attentional bias for whatever material lay in the left visual field.

The interaction between handedness and asymmetry is strong evidence for the hemispheric-specialization explanation in the dichotic listening and visual field research, so it was expected that handedness would affect these results too. Assuming less complete lateralization for left-handers in general, the responses of persons classified as left-handers should show less of a bias for one composite, and they should be less affected by reversal of the whole face.

METHOD

Subjects

All subjects were volunteers from undergraduate psychology courses, roughly equal numbers of males and females. They were assigned at random to one or the other experimental group. For the first 12 sets of pictures 82 subjects were used: 41 for the original and 41 for the reversed condition. 22 for each condition were used for pictures 13 through 20.

Subjects for the slide experiment were undergraduates enrolled in a perception course in four different laboratory sections. Two groups viewed the slides under the original condition (25 total) and two under the reversed condition (28 total).

Apparatus

Faces of 20 persons were photographed (13 men, 7 women) with care taken to center the face in relation to the camera so that the plane of the face was perpendicular to the line of sight. Lighting on the face was equalized by centering the head directly beneath a single overhead light source. Normal facial asymmetry was the characteristic being studied, so beyond these precautions no efforts were made to eliminate lateral differences in the appearance of the face, such as expression or hair style.

Four 4" x 5" prints were made of each face, two in the original orientation and two reversed. For each set, one original and one reversed print were cut vertically through the midline of the face. This procedure often required compromise; but most of the time points midway between the eyes, the middle of the nose, and the middle of the lips were in a straight line.

The opposite halves of the two pictures were mounted together in a mounting press on mat board, aligning the matching parts of the face. The line where the two halves met was not invisible, but was kept as unobtrusive as possible. After mounting, the sides were trimmed to give exactly the same clearance on each side between the face and the edge of the picture. The finished composites were approximately 4" x 5", with little or no neck showing. Thus each composite contained information from only half the face (see Appendix A).

The remaining two prints for each set were mounted whole on mat board trimmed to 4" x 5" and labelled "Original" or "Reversed" on the back.

Some information was also collected using slides. For this experiment each set of pictures was photographed onto slide film in the standard orientation (whole face on top, two composites underneath). Position of the composites was equalized between right and left. Because of error in photography, only the first 18 sets were used.

Procedure

Standard instructions were: "I'm going to show you 20 sets of pictures and I'd like your opinion about some similarities (first set presented to S). In each case, both lower pictures will have some resemblance to the upper picture, but one usually looks much more like it--as if it captures the essence of his personality. Your first impression is all I need, so it's not necessary to analyze similarities point by point. Just indicate which of the lower pictures you think bears a greater overall resemblance to the upper picture."

The pictures were placed on a table directly in front of the seated subject and removed as soon as he made his choice. The same order of presentation was always followed, although the position of the composites was randomly varied.

Each subject was assigned at random to either the "original" or "reversed" condition. "Original" condition meant that the upper face (the whole face) appeared as the camera photographed it--as in real life. "Reversed" condition meant that the reversed whole-face print was used, so that the face was a mirror image of itself. The only difference between the two conditions was whether the original or the reversed whole face was shown for comparison with the composites.

Procedure for slides

The slides were shown in a long narrow room to minimize lateral differences in viewing orientation. Subjects received the same instructions and in addition were asked to record their own responses on answer sheets, indicating whether the left or the right lower picture more closely resembled the upper picture. Slides were exposed for about 10 seconds apiece.

To change from the original to the reversed condition, the slides were simply reversed (Figure 3):

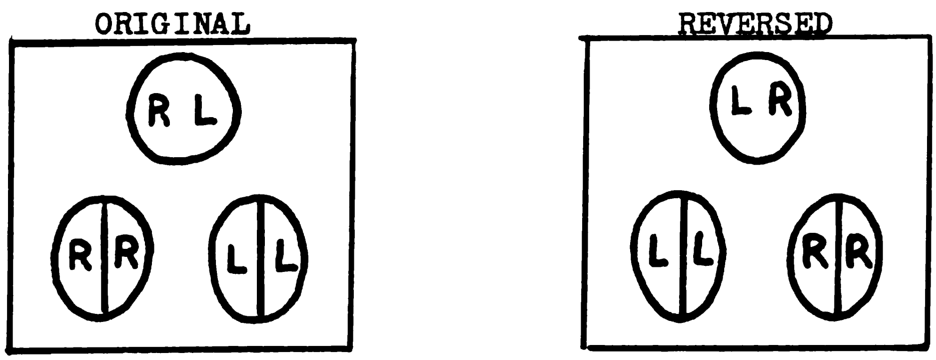

Fig. 3. Effect of slide reversal

This procedure reversed only the whole face and the positions of the two composites; the appearance of the composites themselves was unchanged by reversal, since they are bilaterally symmetrical. Since left or right position was randomized, the change in positions on the slide was inconsequential.

Handedness

Degree of left or right-handedness was assessed by a 14-item usage questionnaire (Crovitz, 1962) for 55 subjects. All others were simply asked which hand they wrote with. The questionnaire also contained questions about handedness in the subject's immediate family.

RESULTS

Figure 4 and Figure 5 present the results graphically; Table 1 and Table 2 in tabular form. The main effect expected was for the percentage of right-composite choices to be higher for the original than for the reversed condition. This was true for 19 out of 20 pictures in the individual presentation experiment. Individual comparisons showed significant differences (5% or above) for seven pictures in the predicted direction, and none for the reverse direction. For the groups shown slides, 16 out of 18 pictures produced differences in the predicted direction, 12 at 5% or above; none were significant in the opposite direction.

Since the pictures were theoretically equal in their ability to reveal the effect of position in the visual field, results for all pictures and all subjects were combined. For the individual presentation data, the average difference in right-composite choices was 16%; a test for the difference between proportions showed a *z*-value of 6.15 (one-tailed). 2.32 or higher is necessary for significance at the 1% level.

For the slide presentation data, the average difference in right-composite choices was 21%; the overall *z*-value was 4.7.

For both experiments, the Wilcoxon matched-pairs signed-rank test--a non-parametric test which takes account of the direction and degree of difference--showed a significant effect beyond the .001 level.

Table 1

PROPORTIONS OF RIGHT-HALF COMPOSITE CHOICES
(Individual presentation)

Picture	Original N	Original %	Reversed N	Reversed %	Difference (O-R)	Z-value
1.	41	.66	41	.46	.20	1.83*
2.	"	.58	"	.44	.14	--
3.	"	.61	"	.37	.24	2.20**
4.	"	.88	"	.60	.28	2.56***
5.	"	.46	"	.39	.07	--
6.	"	.71	"	.63	.08	--
7.	"	.37	"	.24	.13	--
8.	"	.73	"	.58	.15	--
9.	"	.49	"	.30	.19	1.77*
10.	"	.39	"	.36	.03	--
11.	"	.63	"	.41	.21	1.91*
12.	"	.58	"	.34	.24	2.20**
13.	22	.45	22	.36	.09	--
14.	"	.68	"	.55	.13	--
15.	"	.59	"	.36	.23	1.53
16.	"	.54	"	.59	-.05	--
17.	"	.68	"	.41	.27	1.80*
18.	"	.64	"	.59	.05	--
19.	"	.54	"	.27	.27	1.80*
20.	"	.54	"	.41	.13	--
	Average	.59	Average	.43	Ave. .155	Overall $\underline{z}$: 6.15***

* = significant at 5% level
** = significant at 2% level
*** = significant at 1% level or beyond

Table 2

PROPORTIONS OF RIGHT-HALF COMPOSITE CHOICES
(Slide presentation)

	Original		Reversed			
Picture	N	%	N	%	Difference (O-R)	Z-value
1.	25	.72	28	.68	.04	--
2.	"	.72	"	.43	.29	2.13**
3.	"	.40	"	.57	-.17	--
4.	"	.92	"	.53	.39	3.17***
5.	"	.40	"	.39	.01	--
6.	"	.76	"	.64	.12	--
7.	"	.32	"	.11	.21	1.90*
8.	"	.80	"	.46	.34	2.55***
9.	"	.52	"	.18	.34	2.55***
10.	"	.52	"	.57	-.05	--
11.	"	.56	"	.18	.38	2.90***
12.	"	.52	"	.21	.31	2.36***
13.	"	.52	"	.28	.24	1.79*
14.	"	.56	"	.21	.35	2.63***
15.	"	.84	"	.39	.45	3.38***
16.	"	.68	"	.61	.07	--
17.	"	.52	"	.25	.27	2.03**
18.	"	.56	"	.32	.24	1.76*
	Average	.60	Average	.39	Ave. .21	Overall z: 4.7***

* = significant at 5% level
** = significant at 2% level
*** = significant at 1% level or beyond

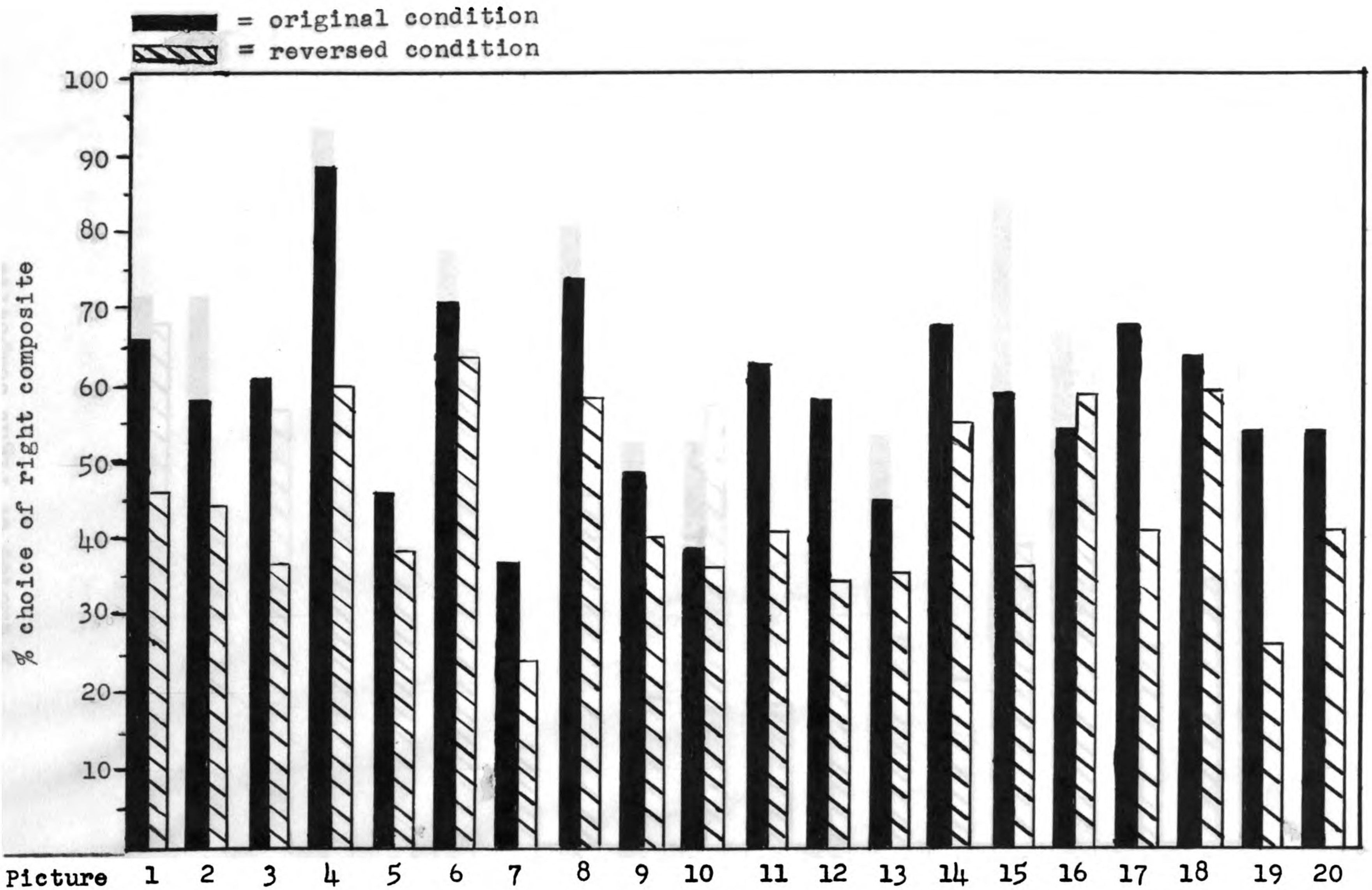

Fig. 4. Effect of whole-face reversal on right-composite choices
(individual presentation)

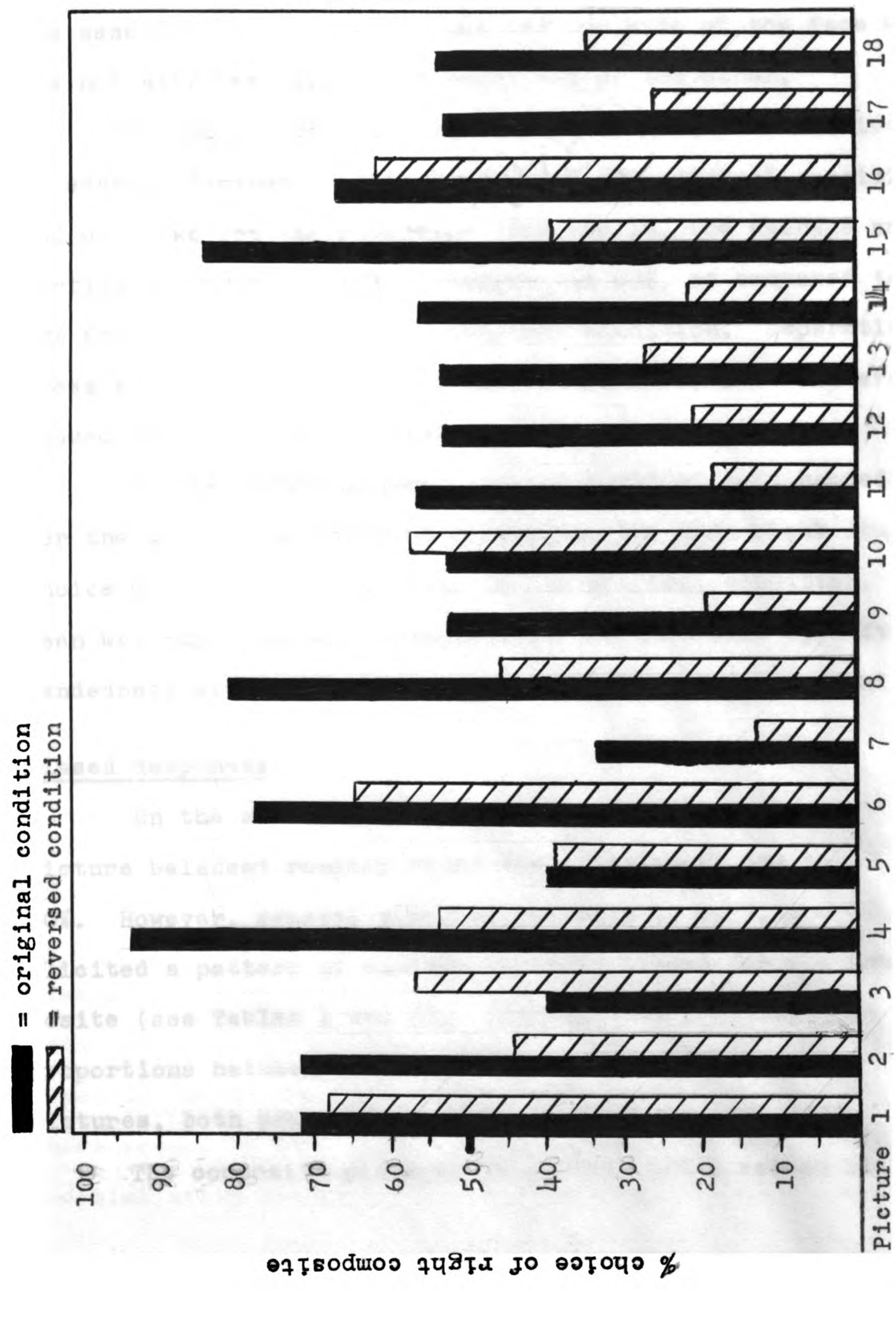

Fig. 5. Effect of whole-face reversal on right-composite choices (slide presentation)

The averages of all proportions regardless of experimental condition were 51% for the individual presentation, and 49.5% for the slide presentation. This shows that there was essentially no overall bias for one side of the face which was not attributable to one condition or the other.

Of the 82 subjects from the individual presentation, 15 were predominantly left-handed for the original condition, and only two for the reversed. For the 15, the average proportion of right-composite choices was 60%, as compared to 59% for all subjects in the original condition. Separating these subjects into familial and non-familial left-handers showed no difference between them.

Of the right-handers, ten had familial left-handedness. For the six in the reversed condition, the mean right-composite choice was 40%. For the four in the original condition, the mean was 68%. Average responses seemed unaltered by left-handedness either in the subject or in the subject's family.

Biased Responses

On the average, a pair of proportions for a given picture balanced roughly equal distances above and below 50%. However, several pictures, notably 4, 6, 7, and 10, elicited a pattern of choices strongly biased for one composite (see Tables 1 and 2). Although the difference in proportions between conditions was similar to the other pictures, both proportions still favored one composite.

The composite pictures in general often seemed bizarre and inhuman, usually because of distortions in the hairline. If the whole face had a strongly defined part in the hair, the part would be doubled in one composite and eliminated entirely in the other. It was thought that subjects were being influenced in their similarity judgments by a dimension of "naturalness."

Accordingly, twelve subjects were tested with the hairline covered on both composites, in the original condition only. For the four most strongly biased pictures, results are shown in Table 3:

Table 3

EFFECT OF COVERED HAIRLINE
ON RIGHT-COMPOSITE CHOICES (ORIGINAL CONDITION)

Picture	Uncovered	Covered
4	.88	1.00
6	.71	.67
7	.37	.44
10	.39	.11

In two cases, covering the hairline only caused a stronger bias; the remaining two showed a much slighter reversal of bias.

On the possibility that the explanation for these biases might lie in an overall dimension of naturalness rather than only in the hairline, eight new subjects were asked to choose the most natural composite from each pair. There seemed to be little correlation between these ratings and similarity biases. For the four most strongly biased, two could be explained by a "naturalness" dimension and two could not:

Table 4

RELATION OF CHOICE BIAS TO "NATURALNESS" RATINGS

Picture	% right-composite choices	% right-composite chosen as more natural
4	.88	1.00
6	.71	.87
7	.37	.62
10	.39	.75

Reliability

To test the reliability of the choice proportions, Pearson product-moment correlations were calculated between the three sets of data:

(Rev. cond.)	Indiv. pres. x slides:	$r = .50$
(Orig. cond.)	Indiv. pres. x slides:	$r = .69$
(Orig. cond.)	Indiv. pres. x hair covered:	$r = .62$
(Orig. cond.)	Slides x hair covered:	$r = .47$

DISCUSSION

General findings

The main prediction was strongly supported by the data from both the individual presentation and the slide presentation groups. The results obtained by Wolff, McCurdy, and Lindzey therefore should be seen in a new light: the right side of the face does seem more familiar, on the average;

the right side resembles the whole face more, but only because it is in the left field of vision, and not because of characteristics in the face itself. This asymmetry is a function of the perceiver rather than of the face, and so all the speculations about "good" and "bad" sides, or "public" vs. "private," now become even more groundless.

The data show that a set of twenty pictures elicits about a 10% bias on the average favoring whatever part of the face is in the left field of vision. It is important that the average % choice of one composite combined for both conditions is very near 50. This means that on the average no bias exists for anything connected with facial features, but that the effect is entirely due to those features being on the right side of a person's face.

The effect is fully as strong using projected slides as with individual presentation, so in the future, data can be collected much more economically from groups. Apparently no control of fixation is necessary for the effect to occur. Tachistoscopic presentation was tried briefly with seven subjects to test for possibly stronger biases; the results showed a slight trend in the predicted direction, but not strong. So it may be that unrestricted scanning is necessary to provide a suitable basis for comparison.

Explanation of the few pictures which elicited unusually biased choices of the right or left composite is difficult. Half of them could be explained by the dimension of "naturalness;" but half of them could not, at least with the small

number of ratings used in this study. Covering the hair seemed to alter the responses somewhat, but just as often in one direction as the other, so that the effect remained as strong.

The answer to such response biases may lie in uniquely noticeable features on one side of the face which are easily remembered (mole, scar, or wrinkle, for example) although no such features are apparent in pictures 4, 6, 7, and 10, which are the most biased.

Effects of handedness

Left-handedness was expected to influence the choice responses in this study. The apparent lack of relationship may be due to insufficient numbers of left-handers, but if not, then there are two alternatives: either hemispheric specialization has nothing to do with the effect, or it does, and facial recognition is not subject to differences in hemisphere lateralization caused by left-handedness.

Reasoning post hoc, one could say that visual perception and facial recognition in particular are more primitive abilities than letter-word recognition. Therefore this skill may be more firmly localized in the right hemisphere and only the more recently developed verbal ability is affected by differences in handedness.

Levy (1969) speculated that manipulation of discrete symbols--the essence of verbal ability--is a more advanced and more efficient way of handling information. Therefore this ability would replace or even neurologically displace (decrement through disuse) more cumbersome visual memory. The higher incidence of eidetic imagery in children and non-literate cultures is in line with this idea.

Also, evidence is emerging that left-handedness is associated with deficits in visual-perceptual ability (Silverman, 1966, James, 1967) as measured on the WAIS performance scale and other tests. The reasoning here is that left-handers may have speech representation more evenly divided between the hemispheres, and so visual-perceptual ability would be displaced or even superseded. This disability could cause an overall deficit because visual perception cannot be developed in the left hemisphere.

By this very speculative argument, left-handers would not be expected to show a reversal, since there is no evidence that visual perception is as "movable" as language skill is, in terms of brain localization. We would expect a decrement in performance, possibly with memory for faces, but in the present study there was no way to detect a decrement in performance.

For this reason alone it is important to extend this study to involve memory. Using a facial recognition procedure similar to Milner's, subjects could be shown a set of whole faces briefly and then asked to choose from among a larger number of left-half and right-half composites which faces they had just seen. When compared with results from a similar experiment using whole faces only, this procedure would show the degree of relationship between handedness, general facial recognition ability, and perceptual asymmetry.

Hemispheric specialization vs. Reading habits

It seems certain that at least for faces there is an attentional bias directed toward the left field of vision. Except for the lack of difference for left-handers, the effect is well explained by hemispheric localization. But it may not be necessary to bring in physiological factors at all; the effect could be due to a general left-to-right scanning habit developed through reading. It could be said that we read faces like we read print. This explanation is unlikely, however, as the following evidence indicates.

During the 1950's research began which attempted to explain the results of visual-field letter-recognition studies. Mishkin & Forgays (1952), Orbach (1952) and others pursued the notion that right-visual field superiority for letter recognition could be explained by "selective training" of the hemi-retinas, through learning to read. The best test of this hypothesis was to test readers of a language written from right to left.

The finding was that Hebrew readers recognized Hebrew words better in the left visual field, if they had learned Hebrew first. This was reported by Mishkin & Forgays but seemed tentative and was not replicated. Further doubt was cast on this result, however, when it was found that words presented vertically instead of horizontally consistently revealed right-visual field superiority for English and

Hebrew readers (Bryden, 1963, Barton, 1965, Goodglass & Benton, 1963, Overton & Weiner, 1965).

Vertical presentation of words probably controls for the information content difference between the beginning and the ending of a word; if word beginnings are actually more meaningful than endings, as these researchers claimed, then the right visual field would have an advantage. So at this point there seem to be no real differences between English and Hebrew readers in visual field asymmetry.

More interesting yet is the discovered relationship between handedness and visual-field effect. Bryden (1963) and Goodglass & Benton (1967) both report correlations between left-handedness and strength of the right visual field superiority. They explained this by hemispheric specialization; left-handers, being probably less completely lateralized, show less of an asymmetry effect. This fits well with dichotic listening studies showing less asymmetry for left-handers. When combined with the general findings of right-visual field superiority regardless of reading habits, it seems unlikely that the effect for faces would be explainable by any scanning tendencies developed through reading. This question is easily tested, however, on a sample of native Hebrew readers. If they show a bias for the left side of the face, then reading habits would explain these results. If the bias is for the right side, as with native readers of English, then a hemisphere explanation seems more likely.

Visual stimuli related to faces

One important extension of this research would be to test abstract patterns and other complex visual stimuli. Some authors (Benton & Van Allen, 1968, De Renzi et al., 1968, Yin, 1970) have suggested that facial recognition may be a somewhat separate trait. However, Robert Yin gives the intriguing finding that right-hemisphere damaged patients did worse than all other groups on a normal facial recognition test, but also performed better than all other groups when the faces were inverted. De Renzi & Spinnler (1966) showed that impairment for facial recognition is not correlated with any deficiency for recognizing chair styles and architecture. These are both complex visual stimuli which require subtle discriminations.

Bornstein (1969) points out thatthe human face is the earliest visual stimulus that we learn to attend to. The faces of persons hovering above us may give a primal importance to facial recognition unmatched by any other class of objects.

At any rate, the bias toward the left visual field for faces is strong enough so that it can be easily tested with other stimuli than faces. Complex patterns such as lace, ornate embroidery, snowflakes, as well as computer-generated patterns, can be tested for the asymmetry effect by combining halves of two similar patterns, then testing recognition and memory for left and right sides. Assuming tentatively that the effect is due to hemispheric localization, investigating non-facial patterns is an indirect way of determining the nature of hemispherid localization more precisely.

Individual differences

Another area for further research is individual differences. There was large variation in the proportions of right-composite choices for each subject, which stimulates two questions: 1) why do some have stronger asymmetry than others? 2) How stable is an individual's bias? Handedness failed to explain the first question; the answer may lie in something like field dependence.

The degree of asymmetry for a given person does seem stable. Immediate retesting of six subjects, changing from "original" to "reversed" condition, lowered their score of right-composite choices in every case. The scanty data suggested at least that those who show a strong asymmetry in one condition will show it just as strongly for the other. The best way to test this stability or reliability of response is with two separate sets of pictures; the correlation between magnitude of asymmetry under the two conditions would be a measure of response reliability.

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APPENDICES

APPENDIX A

SAMPLE OF PHOTOGRAPHS USED

(reduced in size)

Whole-face
Original

Whole-face
Reversed

Right composite

Left composite

APPENDIX B

PROPORTIONS OF RIGHT-COMPOSITE CHOICES FOR INDIVIDUAL SUBJECTS

Original condition			Reversed condition		
Individual presentation					
.77	.78	.55*	.22	.42	.58
.67	.67	.50*	.33*	.50	.33
.78	.67	.70	.56	.58	.42
.44	.44	.70*	.33	.25	.40
.56*	.75*	.60	.33	.60	.30
.67	.91	.35	.67	.16	.50
.56*	.50	.70	.44	.33	.60
.78*	.70	.55	.67	.58	.45
.55	.60*	.65	.56	.33	.20
.22*	.70	.62	.56	.35	.60
.78	.65	.35	.44	.60	.45
.67*	.55*		.42	.45	
.78*	.65		.33	.35	
.78*	.50*		.83*	.25	
.67*	.55		.50	.55	
Slide presentation					
.56	.83		.39	.44	
.78	.61		.33	.33	
.50	.61		.50	.33	
.50	.61		.50	.28	
.78	.67		.50	.39	
.39	.56		.39	.39	
.61	.56		.39	.33	
.39*	.56		.33	.33	
.61	.78		.22	.67	
.61	.61		.61	.44	
.83	.67		.28	.33	
.33			.28	.44	
.67			.22	.28	
.56			.67	.33	

* = left-handed