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LATERALITY DIFFERENCES IN THE RECOGNITION OF LINE ORIENTATION

By

HITOSHI H O N D A (本田仁視)

(Department of Psychology, Tohoku University, Sendai)

Three experiments were performed to investigate the accuracy of the recognition of line orientation tachistoscopically exposed successively in the right and left visual fields in normal right-handed *S*s.

In experiment I, a significant left-field superiority for the recognition of line orientation was confirmed.

In experiment II, in order to examine the effects of the distance of the test stimuli from a fixation point, the test stimuli were presented on the central fixation point and in the positions of angular distance of 1, 2 and 4 degrees to the right and left of the fixation point. The orientation of lines was recognized more accurately in all positions in the left visual field than in the corresponding positions in the right visual field, and the recognition curve was extremely asymmetric.

In experiment III, the effects of the viewing conditions were examined. Irrespective of the viewing conditions, the accuracy in the left visual field was superior to that in the right visual field, and the recognition accuracy under the monocular viewing conditions was on a level with that under the binocular viewing conditions. As to the effects of the eyedness, the left-field superiority was shown, whether the *S* sighted the stimuli with his dominant eye or with his nondominant eye. And finally, the accuracy difference between the 2 nasal hemiretinas was much greater than that between the 2 temporal hemiretinas.

The results were interpreted as lending support to the hypothesis that the right "minor" hemispheres play an important role in certain nonverval visuo-spatial functions.

INTRODUCTION

In man, the temporal hemiretina in each eye projects directly to the ipsilateral visual cortex, whereas the optic nerves from each nasal hemiretina cross at the chiasma to project to the contralateral visual cortex. This means a stimulus in the left visual field (LVF), i.e., left of fixation, is received by the right hemisphere, whether that stimulus is viewed monocularly or binocularly. The converse is true of the stimuli in the right visual field (RVF). With a tachistoscope, stimuli may be presented exclusively to one visual field, while the *S* is fixating a central point. Many authors showed that verbal stimuli such as letters or words presented to the RVF are more accurately identified than when they are presented to the LVF (Mishkin & Folgays 1952, Orbach 1952, Heron 1957, Harcum & Finkel 1963). They suggested that the directional scan in reading English produced a bias favoring the RVF. These findings seemed to exclude the role of cerebral functional asymmetry, in favor of learned visual habits. However, Barton *et al.* (1965) presented vertically printed Hebrew and

English three-letter words to Israeli *S*s. American *S*s were also tested for three-letter English words under similar conditions. A significant RVF superiority was found for both groups and for both languages, despite the fact that Hebrew, unlike English, is read from right to left. Barton *et al.* interpreted their findings as favorable for the hypothesis that alphabetic material arriving in the major hemisphere is more readily identified than similar material arriving in the hemisphere contralateral to the language areas.

On the other hand, it is also known that certain nonverbal materials are perceived more accurately in the LVF than in the RVF. Kimura (1966) presented verbal and nonverbal stimuli to normal *S*s by means of a tachistoscope. Letters were more accurately identified in the RVF, as previously established, but the enumeration of certain nonalphabetical stimuli was more accurate when they appeared in the LVF. She concluded that the left posterior part of the brain plays an important role in the identification of verbal-conceptual forms, while the corresponding area on the right has other functions in the registration of nonverbal stimuli. In subsequent studies, Kimura *et al.* found LVF superiority for dot localization (Kimura, 1969) and for depth perception (Durnford & Kimura, 1971).

With respect to the perception of directionality, Fontenot & Benton (1972) investigated the accuracy of recognition of the direction of lines and nonsense words tachistoscopically exposed to the RVF and the LVF in normal right-handed *S*s and found a significant left-field superiority for the recognition of direction and a significant right-field superiority for recognition of words. They interpreted their results as confirming the hypothesis, generated from the studies of tactile recognition of direction in patients with unilateral cerebral disease, that the right hemisphere plays a distinctively important role in the perception of directionality. However, Adams (1971) showed negative results. No difference was found in the accuracy of the perception of direction as a function of visual half-field. Umilta *et al.* (1974) reported a more analytical study by utilizing a reaction time (RT) paradigm. In their experiments, *S*s were trained for discriminating the orientation of lines exposed for a moment on the right or left side of a fixation point, and asked to press a key in response to the previously determined positive stimuli. The results showed a right-field superiority for RT in an "easy" task, an opposite left-field superiority for RT in a "difficult" task, and no clear-cut inter-field differences in a task of intermediate difficulty. The opposite hemispheric superiorities found with the different discriminations were attributed to the use of verbal mediators in the discrimination preferred by the left hemisphere, and to the use of a nonverbal strategy in the discrimination preferred by the right hemisphere.

The present investigation represents further studies on the laterality differences in the visual perception of line orientation. The accuracy of recognition of the direction of lines tachistoscopically exposed in the left and right visual field in normal right-handed *S*s was determined under various conditions. Experiment I was attempted to confirm the LVF superiority in the recognition of line orientation. Experiment II was tried to investigate the effects of the distance of test stimuli from the fixation point, and in experiment III were examined the effects of the viewing conditions, of the eyedness and of the hemiretinal (optic tract) variables.

Experiment I

The aim of this experiment was to obtain more experimental data of field-superiority in the recognition of line orientation tachistoscopically presented to the LVF and the RVF in normal right-handed *S*s.

Method

Subjects: Nine male and female university students, ranging in age from 20 to 26 years, served as *S*s on a voluntary basis. All *S*s were right-handed with normal or corrected vision. Handedness was determined by the *S*'s self-assessment about the hand used for writing, drawing, throwing and so on. Sighting dominance was examined by the sighting-past-the-finger method. Of the 9 *S*s, 5 *S*s showed dominance of the left eye and 4 *S*s dominance of the right eye.

Stimuli: Stimuli consisted of thin lines subtending approximately 1 degree visual angle and were centered on a point 2 degrees to the left or to the right of the fixation point. Following 4 sets of test stimuli were used in this experiment.

1) Set-H (Horizontal): this set consisted of 7 lines with an angular separation of 5 degrees. They were one horizontal line and 6 slant lines which resulted from 5, 10 and 15 degrees clockwise and counterclockwise rotations of the line in the horizontal position. (Fig. 1-a)

2) Set-V (Vertical): this set consisted of 7 lines which were inclined at 75, 80, 85, 90, 95, 100 or 105 degrees from the horizontal. (Fig. 1-b)

3) Set-RO (Right oblique): this set consisted of 7 lines which were inclined at 30, 35, 40, 45, 50, 55 or 60 degrees clockwise from the vertical. (Fig. 1-c)

4) Set-LO (Left oblique): this set consisted of 7 lines which were inclined at 30, 35, 40, 45, 50, 55 or 60 degrees counterclockwise from the vertical position. (Fig. 1-d)

Each stimulus was drawn on a white card in black ink, and presented with a three channel tachistoscope (TKK TR-TYPE) to the RVF and the LVF successively.

Procedure: The *S* was asked to fixate a black dot (1.5 mm in diameter) placed at the center of the visual field (14 degrees high and 14 degrees wide). The exposure field was approximately 82 cm from the *S*'s eyes. The fixation point was presented for 2500 msec. Immediately after the disappearance of the fixation point, test stimuli were exposed for a moment to the LVF or RVF. The exposure time of each stimulus was 50 msec. This exposure duration was employed on the ground that the duration of this order is clearly too short to allow eye movements, and that *S*s are fully able to recognize the stimulus patterns and so the accuracy of the recognition of the line orientation does not seem to be influenced by visual acuity itself. The *S*s

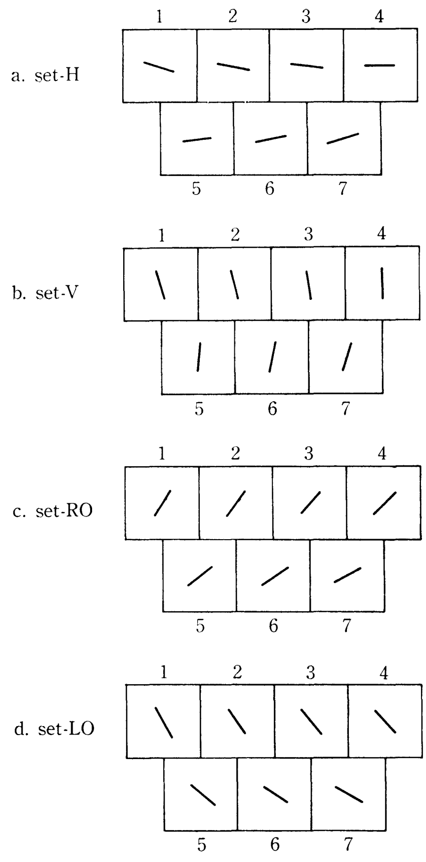

Fig. 1. Stimulus sets used in experiment I.

were instructed to fixate the central fixation point until the test stimuli had been exposed, and not to predict the visual field to which the stimulus was going to presented. Each stimulus was presented twice to each visual field, therefore, 112 stimuli were presented to each *S* in all. Each *S* was given 4 types of stimulus set in irregular order. After each stimulus presentation, the *S* was required to choose, from a visual display of the 7 different orientations, the line that was presented to him. *S* responded by saying the number attached to each line on a visual display which was placed in front of him. Responses were recorded, and mean percentages of correct responses were later calculated separately for right and left visual fields, and separately for each stimulus set. Through the experiment *S*s sighted the stimuli under binocular viewing conditions. *S* was never informed whether his responses were correct or not.

RESULTS

The mean percentages of correct responses from 9 *S*s are shown in Table 1, classified by the visual half-field in which the stimulus appeared and the sets of stimuli. Fig. 2 presents the results graphically. It is evident that, regardless of the sets of stimuli, accuracy of recognition of the orientation of lines is greater in the left than in the right. A two-tailed signed rank test indicated that the inter-field differences of set-H, set-R and overall mean value were statistically significant ($p<.02$, $p<.05$, and $p<.05$ respectively). In Fig. 3 the mean percentages of total correct responses of all stimulus sets are shown, classified by *S*s. Seven of the 9 *S*s showed a left field superiority and 2 showed a right field superiority. As described above, the two-tailed signed rank test for matched pairs, applied to these data, showed a significant

Table 1. Percentages of number of correct responses for each visual field in experiment I.

Stimulus set		set-H	set-V	set-RO	set-LO	total
Visual field	LVF	77%	62	57	43	59
	RVF	62	58	39	38	49

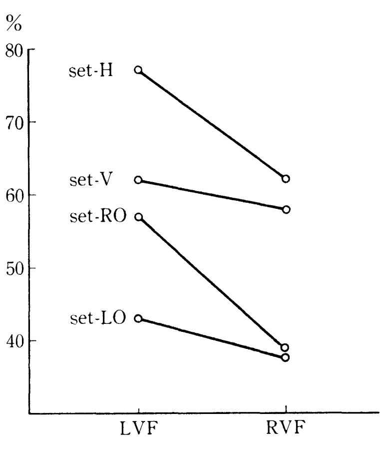

Fig. 2 Percentages of number of correct responses for each visual field of each stimulus set.

left field superiority. One *S* participated in this experiment repeatedly 5 times on separate days. The left-field superiority in recognition of line orientation was maintained throughout the series of experiments. (Fig. 4)

Experiment II

In experiment I, the left-field superiority in the recognition of line orientation was ascertained. The next experiment was designed to examine the effects of the distance of test stimuli from the fixation point.

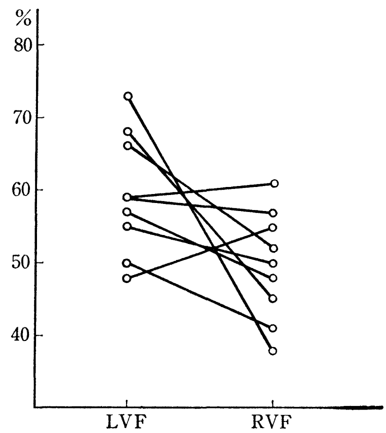

Fig. 3. Percentages of number of total correct responses of all stimulus sets for each visual field in individual *S*s.

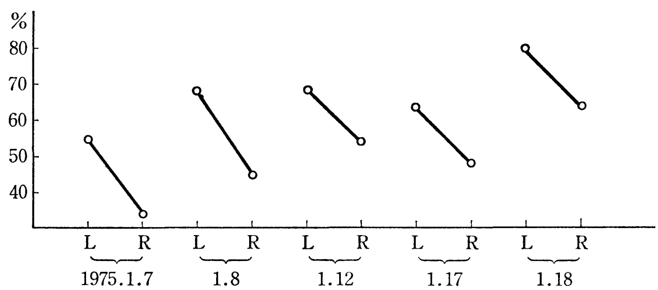

Fig. 4 Results obtained repeatedly 5 times on separate days from one *S*.

Method

Subjects: Ten male and female university students, ranging in age from 21 to 26 years, served as *S*s in experiment II on a voluntary basis. All *S*s were right-handed with normal or corrected vision. Handedness was determined by the *S*'s self-assessment about the hand used for writing, drawing, throwing and so on. Sighting dominance was examined by the sighting-past-the-finger method. Of the 10 *S*s, 5 *S*s demonstrated the dominance of the left eye, and 5 *S*s the dominance of the right eye.

Stimuli: The stimuli used in experiment II consisted of 10 thin lines with an angular separation of 18 degrees. The length of the line subtended approximately 1 degree visual angle. Each stimulus was drawn on a white card in black ink, and presented in 7 different positions of the visual field, with a three-channel tachistoscope used in experiment I. These positions were so situated that the mid-points of the lines lay on the central fixation point and at angular distance of 1, 2 and 4 degrees to the right and to the left of the fixation point. Through the experiment, *S*s sighted the stimuli under binocular conditions.

Procedure: The *S* was asked to fixate a fixation point (1.5 mm in diameter) placed at the center of the visual field (14 degrees high and 14 degrees wide). The fixation point was presented for 2500 msec. Immediately after the disappearance of the fixation point, each test stimulus was exposed for 50 msec twice in each position, therefore, in all, 140 stimuli were presented to each *S* in random order. After each stimulus presentation, the *S* was required to choose the line that was presented to him from a visual display (Fig. 5). On the visual display, 20 lines with an angular separation of 9 degrees were drawn. Of the 20 lines, only 10 (odd numbered lines in Fig. 5) were presented as test stimuli, and the rest 10 lines (even numbered lines in Fig. 5) were added to the visual display in order to adjust the difficulty of a task. Needless to say, the *S* was not informed that only the half of the 20 lines would be presented as test stimuli. The *S* responded by saying the number attached to each line on a visual display, which was placed in front of him. *S* was never informed whether his responses were correct or not. Responses were recorded, and mean percentages of correct responses were later calculated separately for each position where the stimuli were presented.

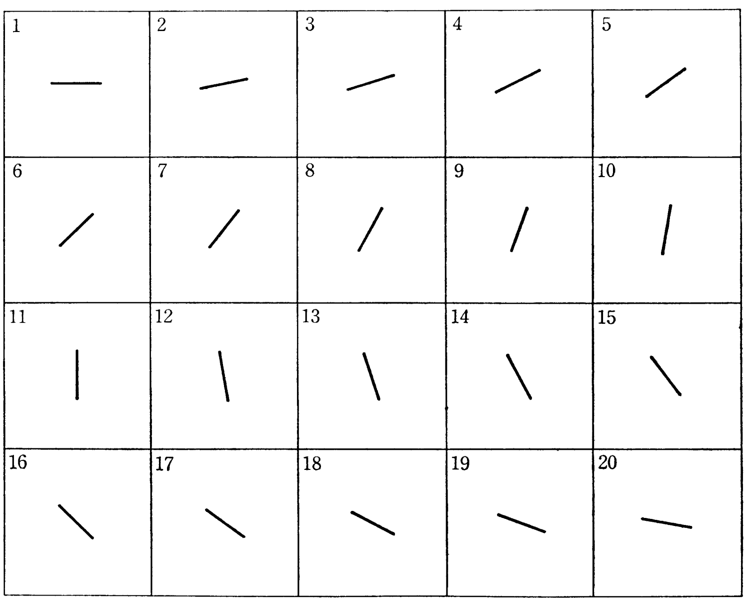

Fig. 5 A visual display used in experiments II and III

Results

The mean percentages of correct responses from 10 *S*s are shown in Table 2, classified by the positions where the stimuli were presented. Fig. 6 presents the results graphically. The orientation of lines was recognized more accurately in all positions in the LVF than in corresponding positions in the RVF. A one-tailed signed rank test applied to the data showed significant inter-field difference between the scores in the positions of an angular distance of 1 degree from the fixation point ($p<.025$). The inter-field difference between the scores in the positions of 4 degrees from the fixation point was also significant ($p<.05$), and no significant difference was shown in the positions of 2 degrees from the fixation point ($p>.05$).

Accuracy of 54% was achieved for stimuli presented in the center position. The scores in 3 positions in the RVF were on much the same level, and inferior to the score on the central position. The highest score was obtained in the position of an angular distance of 1 degree to the left of the fixation point. In the LVF, accuracy was decreased as the position of stimuli became far away from the fixation point. Statistical treatments showed significant difference between the scores on positions of 1 and 4 degrees in the LVF ($p<.025$).

Contrary to our expectations, the accuracy in the recognition of line orientation

Table 2. Mean scores (M), standard deviations (SD) and Percentages (%) of number of correct responses at different angular distances from the fixation point.

	Degrees from the fixation point						
	0°	1°		2°		4°	
Visual field		LVF	RVF	LVF	RVF	LVF	RVF
M	10.8	12.7	9.3	11.6	10.0	11.0	9.6
SD	1.08	2.10	2.24	2.84	2.53	1.42	2.16
%	54	64	47	58	50	55	48

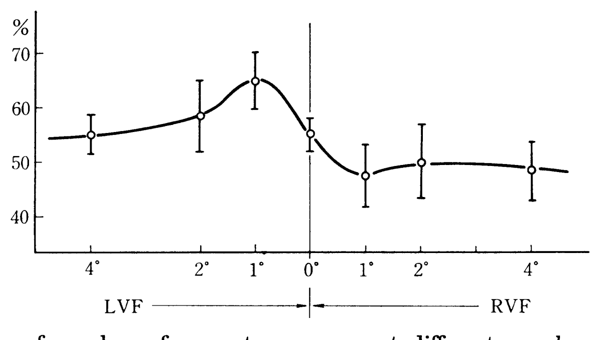

Fig. 6 Percentage of number of correct responses at different angular distances from the fixation point. Vertical bars give standard deviation of each mean score.

in the central position was considerably low, and the score was approximately at the middle point between 2 scores in the positions of 1 degree to the right and left from the fixation point. The score in the central position and that in the position of 1 degree to the left was significantly different ($p<.025$). In addition, the extreme asymmetry of the curve shown in Fig. 6 was not predicted from the previous studies on left-right differences of recognition of verbal stimuli (Mishkin & Folgays 1952, Heron 1957).

EXPERIMENT III

In experiments I and II, we obtained left-field superiority exclusively under binocular viewing conditions. Next experiment was designed to examine the effects of the viewing conditions. In man, the temporal hemiretina in each eye projects through the uncrossed optic tract to the ipsilateral visual cortex, whereas the nasal hemiretina in each eye projects through the crossed optic tract to the contralateral visual cortex. Therefore, under monocular viewing conditions, we are able to examine the effeciency of the 4 possible connections of hemiretina and optic tract separately.

METHOD

Subjects: Ten right-handed male and female students, ranging in age from 22 to 26 years, served as *S*s voluntarily. Each *S* had normal and equal acuity in each eye. Sighting dominance was examined by the sighting-past- the-finger method. Of the 10 *S*s, 5 *S*s demonstrated dominance of the left eye, and 5 *S*s dominance of the right eye.

Stimuli: The stimuli used in experiment III consisted of 20 thin lines with an angular separation of 9 degrees. The length of the lines subtended approximately 1 degree visual angle. Each stimulus was drawn on a white card in black ink, and presented to the left or right of the central fixation point successively with a three-channel tachistoscope used in experiments I and II. The mid-point of each line was laid at angular distance of 1.5 degrees to the right or to the left of the fixation point.

Procedure: The *S* was asked to fixate the fixation point (1.5 mm in diameter) which appeared at the center of the visual field (14 degrees high and 14 degrees wide). The fixation point was presented for 2500 msec. Immediately after the disappearance of the fixation point, each test stimulus was exposed for 50 msec.

The experiment was made under 3 viewing conditions, i.e., monocular viewing with right eye, monocular one with left eye and binocular one with both eyes. The monocular viewing situations were made by attaching a shielding plate to the viewing hood of the tachistoscope so that the *S* saw the visual field only with right eye or with left eye. Under each viewing condition, 20 stimuli were presented to each visual half-field in random order, and hence, in all, 120 stimuli were given to each *S*. The stimulus presentations in each viewing condition were divided into 2 sessions, each of which included the presentations of 10 stimuli to each visual half-field, therefore, each *S* received 6 sessions. The *S*s were given these 6 sessions in random order.

After each stimulus presentation, the *S* was required to choose the line that was presented to him from a visual display. The visual display used in experiment III and that in experiment II were the same (Fig. 5). However, in experiment III, all of 20 lines on the visual display were presented as test stimuli. The *S* responded by saying the number attached to each line on the visual display placed in front of him. Never was *S* informed whether his responses were correct or not. The mean percentages of correct responses were calculated separately for each viewing condition.

Results

The results are shown in Table 3 and Fig. 7. Under every viewing condition, the orientation of line was more accurately recognized in the LVF than the RVF. Statistical treatments applied to these data showed significant inter-field difference under every viewing condition (monocular viewing with right eye – $p<.01$, monocular with left eye – $p<.025$ and binocular – $p<.005$, one-tailed signed rank test). An analysis of variance on the data is shown in Table 4. The factor of the viewing conditions (A) was not significant, whereas the inter-field difference (B) was significant ($p<.01$). A×B interaction was not significant. This means that, irrespective of viewing conditions, the line orientation is recognized more accurately in the LVF than the RVF.

Table 3. Mean scores (M), standard deviations (SD) and percentages (%) of number of correct responses under each viewing condition.

Viewing condition	Monocular				Binocular	
	Left eye		Right eye			
Visual field	LVF	RVF	LVF	RVF	LVF	RVF
M	12.1	10.0	11.1	8.6	11.9	9.6
SD	2.5	3.1	3.0	2.6	2.5	2.8
%	60.5	50	55.5	43	59.5	48

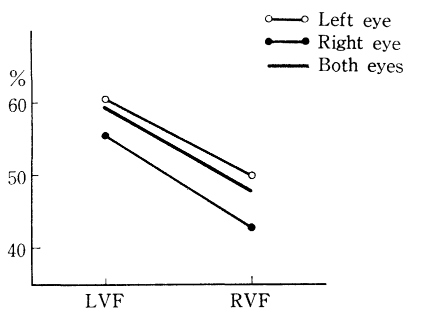

Fig. 7. Percentages of number of correct responses for each visual field under each viewing condition.

Table 4. Analysis of variance on the data of experiment III.

Source	df	MS	F
Viewing conditions (A)	2	7.8	1.84
Visual fields (B)	1	79.35	29.17(p<.01)
subjects (C)	9	33.26	—
A×B	2	0.20	0.063
A×C	18	4.28	—
B×C	9	2.72	—
Error	18	3.18	—

In order to examine the effects of eye dominance on the half-field superiority, the data from dominant eye and those from nondominant eye were separately calculated. Of the 10 *S*s, 5 *S*s showed dominance of right eye and 5 *S*s dominance of left eye. The results are shown in Fig. 8. The left-field superiority was shown in both dominant eye and nondominant eye (dominant eye —p<.01, nondominant eye —p< .01, one-tailed signed rank test). The accuracy in dominant eye seems to be greater than in nondominant eye, but the difference between the two groups was not statistically significant.

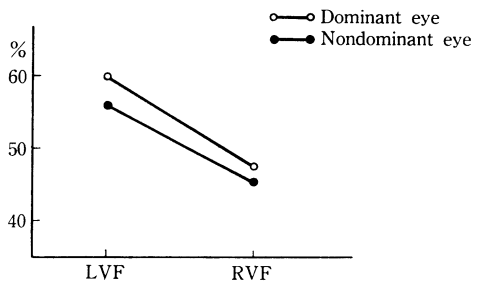

Fig. 8. Percentages of number of correct responses for each visual field in dominant and nondominant eyes.

As shown in Table 3, the highest accuracy in recognition of line orientation is shown in the LVF of the left eye, whereas the lowest accuracy in the RVF of the right eye. This means that a greater inter-field difference is produced by the nasal hemiretinas of the right and left eyes which project through crossed optic tracts to the contralateral visual cortex (Fig. 9). On the other hand, no significant difference was shown between the two temporal hemiretinas, i.e., the RVF of the left eye and the LVF of the right eye, which project through uncrossed optic tracts to the ipsilateral visual cortex.

Discussion

The left-field superiority in the recognition of the orientation of the line was confirmed in experiment I. The results of the present study are consistent with those

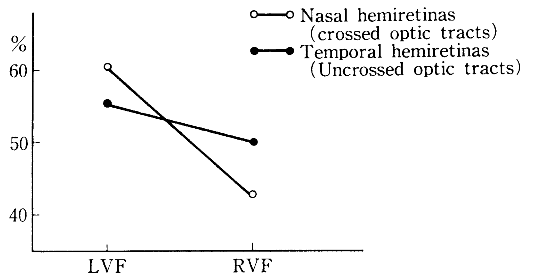

Fig. 9. Comparison of laterality differences in nasal and temporal hemiretinas. Details in text.

of Fontenot & Benton (1972) and Kimura & Durnford (1974), whereas Adams (1971) and White (1971) failed to show the left-field superiority.

This kind of experiment seems to be influenced by many factors. One of the factors is the exposure duration of the test stimuli. In our study, the test stimuli were exposed consistently for 50 msec. This exposure duration was employed on the ground that the duration of this order is clearly too short to allow eye movements, and that the *S*s are fully able to see the stimulus patterns and hence the accuracy in recognition of line orientation does not seem to be influenced by visual acuity itself. Fontenot & Benton presented the stimuli at near the recognition threshold (7–13 msec). In addition, the angular separation of the lines was small in our study (5 degrees) as compared with that employed in Fontenot & Benton's study (18 degrees). In spite of the disparities in the exposure duration and the angular separation of the stimulus lines, left-field superiority was obtained in both studies. This means that the laterality differences in recognition of tachistoscopically presented pattern stimuli seem to be a composite function of many factors including the exposure duration and the type of stimulus material. Therefore, we are required to investigate the interaction of the relevant factors. In experiment II, we attempted to examine the effects of the distance of test stimuli from the fixation point.

As regards verbal stimuli, Mishkin & Folgays (1952) investigated the accuracy of tachistoscopic recognition of words exposed at various distances from fixation. They found that accuracy was highest in the center position and gradually dropped on either side of the center. The data indicated that the laterality differences are restricted to certain parts of the visual field. For their experimental conditions the region fell within the visual angle subtended by points at 1 degree 11 minutes and 4 degrees 46 minutes from fixation. The results obtained in our study of line orientation were somewhat different from those of Mishkin & Folgays. First, the accuracy in the center position was, contrary to expectation, relatively low. Is there any possibility of the test stimuli having been visually blocked, in the center position, by the fixation point which was presented until the appearance of the test stimuli? However, *S*s' introspective reports showed that the visual test stimuli in the center position were scarcely disturbed by the fixation point, and that *S* saw the stimulus patterns more clearly in the center position. Therefore the relatively low accuracy in the center position can not be explained only by the interference of the fixation point. Secondly, the degree of accuracy at 3 positions in the RVF was approximately on the same level, whereas in the LVF the accuracy was decreased as the position of stimuli became far away from the central position. The recognition curve for line orientation exposed in several positions in the LVF and RVF (Fig. 6) was different from that shown by Mishkin & Folgays for four-letter words, except that the inter-field difference, though in the opposite direction, was shown in both studies. We have no sufficient answer to these disagreements so far. However, it may safely be said that in our experimental situation the recognition of line orientation was not so influenced by the distribution of visual acuity on the retina. On the other hand, it seems that the accuracy of tachistoscopic recognition of words considerably depends on the visual acuity itself.

In experiment III, the effects of the viewing conditions were examined. The result is that, irrespective of the viewing conditions, the accuracy in the LVF is superior to that in the RVF. This finding suggests that the hemiretina on which the stimuli are projected or the optic tract through which the informations are transmitted is not the only determinant of the left-field superiority in recognition of the line orientation. It should be noted that the recognition accuracy under the monocular viewing conditions was on a level with that under the binocular viewing condition. No significant difference in the recognition accuracy was found among the 3 viewing conditions. The results suggest that, in the present experimental situations, the binocular viewing was not of advantage to the recognition of line orientation. As regards verbal stimuli, some authors investigated the inter-field difference in each eye separately, and found greater inter-field difference in the left eye than the right (Barton *et al.* 1965, Overton & Wiener 1965, Markowitz & Weitzman 1969, Neill *et al.* 1971), whereas contrary results were reported, too (Crovitz & Lipscomb 1963). In Harcum & Dyler's (1962) experiment with nonverbal complex patterned stimuli, most *S*s showed left-field superiority irrespective of the eye used. Although the results obtained in the present study are consistent with those of Harcum & Dyler, we cannot draw a conclusion because of the different experimental situations.

The left-field superiority was shown, whether the *S* sighted the stimuli with his dominant eye or with his nondominant eye. According to the *S*'s introspective report, when the two eyes of each *S* have about equal acuity, the test stimuli which were sighted with the dominant eye appeared more stably than those sighted with the nondominant eye. Nevertheless, the inter-field difference was shown in either case, and there is no significant difference between the total scores of correct responses for dominant eye and for nondominant eye.

As previously stated, the factor of the visual pathway was not the only determinant of the inter-field difference in recognition of line orientation. However, Fig. 9

suggests that the accuracy difference between the 2 nasal hemiretinas (i.e., the LVF of the left eye and the RVF of the right eye) is greater than that between the temporal hemiretinas (i.e., the LVF of the right eye and the RVF of the left eye). Of the 10 *S*s, 7 *S*s showed a greater inter-field difference in the nasal hemiretinas than in the temporal hemiretinas. By the way, significantly better recall for digits projected to the nasal hemiretinas has been found when digits pairs were presented one by one to each eye separately (Bower & Haley 1964, Sampson 1969) and during binocular fixation (Sampson & Spong 1961). Nasal superiority has been found in reporting a spaced string of digits (Crovitz & Lipscomb 1963), in color rivalry (Crovitz & Lipscomb 1963) and in the reproduction of complex patterned stimuli (Harcum & Dyler 1962). On the other hand, temporal superiority has been found under monocular noncompetitive situation (Marcowitz & Weitzman 1969, Neill *et al.* 1971). These studies suggest that there are functional difference between the crossed (nasal) and uncrossed (temporal) optic tracts. The suggestion, however, cannot explain the results obtained in our study, since, as shown in Fig. 9, the nasal hemiretina of the left eye showed the highest accuracy, whereas that of right eye the lowest accuracy. One possible hypothesis for the explanation of our results is that, the nasal hemiretinas (i.e., crossed optic tracts) are more closely related to the specified function of the right and left hemispheres than are the temporal hemiretinas (i.e., uncrossed optic tracts).

It is well known that the parietro-occipital area of the left hemisphere is important for language, and the right-field superiority in recognition of letters and digits could thus be due to the fact that the imput from the RVF is more directly transmitted to the left occipital lobe than is the imput from the LVF. On the other hand, it is also known that the right hemisphere is more related to certain nonverbal visuo-spatial functions than is the left hemisphere. This has been supported by the studies which showed left-field superiority in the enumeration of certain nonalphabetical stimuli (Kimura 1966), in dot localization (Kimura 1969), in depth perception (Durnford & Kimura 1971) and in the recognition of line orientation (Fontenot & Benton 1972). The present study confirmed the left-field superiority in recognition of line orientation, and this finding is consistent with the well known idea about the specific functions in the right "minor" hemispheres.

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