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Pat Huston
Pacific University

Eric Knutson
Pacific University

Jack Potter
Pacific University

Steve Tweit
Pacific University

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Abstract

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DETERMINATION OF MONOCULAR AND BINOCULAR FIELD PREFERENCES AND THEIR RELATIONSHIPS TO EYE DOMINANCY

Presented by

Pat Huston
Eric Knutson
Jack Potter
Steve Tweit

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INTRODUCTION:

In preparation for our study, we reviewed the experiments of Mishkin and Forgays, Woodburn Heron, and Harcum, whom we felt were most representative of the work which had already been done in the field in question.

In Mishkin and Forgays' original experiment, the subjects were placed 24" from the stimulus target and were allowed to view the display binocularly. Each word was 2" long and subtended an angle of 36'. The words were eight-letter words; the exposure time was .15 sec. The center of each laterally-placed word was 2" to the left or the right of fixation, an angular distance of 4 degrees and 45 minutes. They found that words to the right of fixation were recognized $2\frac{1}{2}$ times more readily than words to the left. The words were presented in a random order.

Mishkin and Forgays' performed a later experiment in which four letter words of the same letter size as the words in the original experiment were used. They found that for four letter words the phenomenon of right field preference was elicited only within an area which ranged from 1 degree 11 minutes to 4 degrees 46 minutes lateral to fixation. They also added the option of random central stimulus, combined with the lateral presentations and found that 98% accuracy was elicited for words placed in the central position. However, the scoring system was based on an all-or-none principle: no points were given unless the word was completely correct.

Woodburn Heron, who conducted his experiments with a distance of 7' from the observer to the stimulus plane, found that right field preference was most marked at distances of 2 degrees 45 minutes and 4 degrees 15 minutes for letter groups and 5 degrees and 6 minutes for single letters. Heron's letter groups subtended an angle of 1 degree

27 minutes each, were composed of four letters arranged in the form of a square. His exposure time was .1 sec. When the subject was told which side of the field the letters would appear in, performance improved for the left field but not for the right. However, between about $1\frac{1}{2}$ and 4 degrees, performance was still better for the right visual field.

Heron also reported that there was no significant field preference when nonsense or familiar forms were used instead of letters in the stimulus display.

In another experiment, Heron discovered that when letters were shown simultaneously in the right and left fields, more are recognized in the left field rather than in the right.

Dyer and Harcum, in a study of school children and pre-school children, found that the school children who had learned to read, showed a marked right field preference while the pre-schoolers, who had not learned to read, showed no significant difference in performance between right and left visual fields. In their experiment, the exposures were given both monocularly and binocularly using one exposure time of .15 sec. The targets used were a series of filled and unfilled circles. The monocular results closely approximated the binocular results.

As a preface to this experiment, Huston conducted a preliminary study on field preference. The target material was composed of three to five letter words exposed first in the right field then in the left at a lateral distance similar to that used in this study. The material was presented at the nearpoint using an exposure time of 1/10 sec. Ten exposures in the right field were followed by ten exposures in the left. The result was definite preference for the right hemi-field, possible due to the order of the exposures. The fact that the subjects know where the stimuli would appear may well have had a significant influence on the results.

PROBLEM:

In this paper we investigated the difference between field preference for the left eye versus the right eye. We accepted the hypothesis that the right field should be preferred over the left field for readers of English. However, we expected right field preference to be more marked for the dominant than the non-dominant eye. We also expected perception in the central field to predominate over perception in either the right or left hemifield.

PROCEDURE:

Our testing equipment was composed of: a 35mm. slide projector with tachistoscope attachment, a back-projection screen and a chin-head rest to insure a constant testing distance. We mounted the projector and screen on a board which elevated the fixation point to a position at eye level, and maintained the screen and projector in a fixed position. We used a target distance of 14 inches, which we felt was close to the average reading distance for the population studied.

We used a draftsman's stencil to print a series of four-numbered digits on 5 x 8 white cards. The digits were either placed in the center of the card or a measured distance to the right or left of center. We then photographed the cards with a 35mm. camera, to enable use of the 35mm. projector.

A total of ninety slides was used, with thirty slides distributed in each of three trays. Each tray contained ten central slides, ten right field slides, and ten left field slides, randomized using a table of random numbers. Each of the three slide tryas was presented to the left eye, right eye, and both eyes an equal number of times, just as the right eye, left eye, and both eyes were tested the same

RESULTS:

The scoring system was as follows: five points were given for a completely correct response, four points for a response in which the four digits were correct but the order was changed, three poinst for three correct digits in any order, two points for two digits, one point for one digit, and zero points if all digits were missed. We added the scores for each presentation to obtain our totals and means for performance for each field for each eye.

We eliminated one subject when performing our statistical evaluation of the results. That is we actually had 21 subjects rather than twenty. The subject elaborated on the material presented, recording five to six digits in some cases, making our scoring system inapplicable.

Referring to Table I, we can see by inspection that the means show no significant lateral field preference for the right eye, left eye, or both eyes. Of the fifteen subjects whose right eye was dominant, seven showed better performance in the right field with the right eye, eleven showed better performance in the right field with the left eye, and seven showed better performance in the right field for both eyes. Of the four subjects whose left eye was dominant, three showed better performance in the right field for the right and left eyes, and all four performed better in the right field when using both eyes. The means for the left-eye dominant group also showed a more marked right field preference when using the left eye or both eyes than when using the right eye or than the right-eye dominant group under any of the testing conditions. One subject showed variable dominance.

Table II, which refers to the right eye, shows that ten subjects

had scores which were higher for the left eye and ten which were higher for the right. The standard deviation was greater for the right field than for the left field. This shows that there was no significant difference.

Referring to Table III, we find that 13 subjects performed better in the right field than in the left field. Six subjects showed equal performance for both fields. The standard deviation was practically the same for the right and left fields.

Table IV, reveals that performance was virtually equal for the right and left fields. Eleven subjects performed better in the left, and one subject showed equal scores for both fields. The standard deviation was a little higher for the right field presentations than for the left.

Table V reveals that every subject performed better in the central field than either lateral field.

Table VI explains Table V more lucidly. Ten subjects performed better with the dominant eye than the non-dominant eye. Thirteen subjects showed a higher score for the right and seven for the left.

Table VII reveals that, of the ten subjects who performed better with the dominant eye, eight preferred the right field and two the left. Of the nine subjects who performed best with the non-dominant eye, five preferred the right field and four the left. Below Table VII we have calculated the probability for right field preference by the dominant eye being due to chance. The calculation shows that the preference of the right field by the dominant eye is significant at the 5% level.

The variables we added to the work which had been done by the authors reviewed were the question of eye dominance and the use of digits as target material. Our exposure time was also shorter than that used in previous studies.

We were surprised that we did not find a significant difference in performance between the right and left hemifields. The previous experiments also reveal a contradiction: Dyer and Harcum found a definite right field preference using forms as target material, while Heron found no difference in hemifield preference for familiar and unfamiliar forms. We can only assume that performance on digits cannot be equated to performance on letters and words. Mishkin and Forgays and Heron obtained their results using letters and words as stimulus material. Digits may be likened to forms in that neither may be considered a function of language. This may result in different response processes than those elicited by language-related material.

It is also possible that our short exposure time affected the results. Increasing the difficulty of the task may have decreased the differences in performance between right and left fields. Mishkin and Forgays showed that increasing the difficulty of the task by increasing the distance between the central fixation point and the lateral presentation also reduced the differences between performance in the two hemifields. We feel that introducing a central presentation may well have affected the performance on the lateral presentation, in one of several ways: (a) better control of fixation and (b) possible difference between 2 and 3 choice sets.

The fact that the left-eye dominant subjects showed a much more definite preference for the right field is an indication that further study using more subjects whose left eye is dominant might be profitable. It is quite possible that, in view of the small number os subjects tested, our results were merely due to chance. At any rate, more data needs to be taken to determine the actual significance of our findings.

What may be the most significant discovery of our study is the fact

that, of the ten subjects whose dominant eye showed a higher overall score than the non-dominant eye, eight of these showed a preference for the right hemifield. This is significant at the 5% level. To determine the actual ramifications of these results, a more complete study should be done using more subjects and a more representative sampling of the population. This might also be related to the fact that of the nine subjects whose performance was better with the non-dominant eye, five preferred the right field and four the left. We had one subject who failed to show a marked dominance using our criteria.

Further studies should attempt to include more subjects whose left eye was dominant and should control the nearpoint refraction.

In summary, we feel that the findings partially reinforce our original hypothesis that the dominant eye should show a more marked right field preference than the non-dominant eye. The qualification that we didn't predict is the apparent fact that under the conditions of this experiment the non-dominant eye shows superior performance just as often as the dominant eye. We also feel that in view of the contradictions in results obtained by Heron, Dyer and Harcum, and us using non-alphabetical material, this area merits more carefully-controlled study. Perhaps a study contrasting performance on digits with performance on forms should be conducted.

SUBJECT	DOMINANT EYE	RIGHT EYE			LEFT EYE			BOTH EYES		
		Right	Left	Center	Right	Left	Center	Right	Left	Center
A	RIGHT	+39	29	50	+34	32	50	+36	33	48
B	RIGHT	-21	25	48	30	30	50	-26	32	46
C	RIGHT	-17	24	50	+19	14	49	-24	27	50
D	RIGHT	-5	15	48	-1	11	45	-8	10	47
E	RIGHT	-16	29	50	-20	34	50	-19	31	48
F	RIGHT	+10	0	38	-12	14	48	+21	18	50
G	RIGHT	+36	21	47	+28	8	50	+36	23	50
I	RIGHT	-24	31	47	+47	27	40	-20	41	41
K	RIGHT	-21	24	49	+32	21	46	+27	25	50
M	RIGHT	-9	10	13	+16	15	16	+18	16	33
O	RIGHT	+35	25	46	+29	14	48	-27	29	46
P	RIGHT	+36	30	50	+29	27	50	+35	34	50
Q	RIGHT	+35	28	50	+36	35	50	-32	33	50
S	RIGHT	+7	6	22	+8	3	27	14	14	26
T	RIGHT	-18	20	43	+19	18	48	+33	25	46
	TOTAL	329	317	651	340	316	683	376	391	681
	MEAN	21.9	21.1	43.4	22.7	21.1	45.5	25.1	26.1	45.4
H	LEFT	+42	36	50	+42	38	5-	+43	38	50
J	LEFT	+27	16	50	+42	23	50	+32	27	49
L	LEFT	-14	27	32	-19	27	26	+35	27	48
N	LEFT	+31	28	44	+32	27	48	+30	27	50
	TOTAL	114	107	176	140	115	174	140	119	197
	MEAN	28.5	26.7	44.0	35.0	28.8	43.5	35.0	29.8	49.2
R	VARIABLE	-26	34	50	+28	23	48	-27	28	50
TOTAL		469	458	877	508	454	905	543	538	928
MEAN		23.4	22.9	43.8	25.4	22.7	45.2	27.1	26.9	46.4

Overall performance and mean scores grouped by eye dominance.

TABLE I

RIGHT EYE: Standard deviation and correlation coefficient for right eye - right and left eye.

TABLE II

SUBJECT	R*	L	r	l	r^2	l^2	rl
A	39+	29	+15.6	+6.1	243.4	37.2	95.2
B	21-	25	-2.4	+2.1	5.8	4.4	-3.0
C	17-	24	-6.4	+1.1	40.9	1.2	-7.0
D	5-	15	-18.4	-7.9	339.0	62.5	145.4
E	16-	29	-7.4	+6.1	59.8	37.2	-75.1
F	10+	0	-13.4	-22.9	179.5	524.4	306.9
G	36+	21	+12.6	-1.9	158.5	3.6	-23.9
H	42+	36	+18.6	+13.1	346.5	171.9	243.7
I	24-	31	+.6	+8.1	.4	65.5	4.9
J	27+	16	+3.6	-6.9	9.8	47.6	-24.8
K	21-	24	-2.4	+1.1	5.8	1.2	-2.6
L	14-	27	-9.4	+9.1	88.3	16.9	-38.5
M	9-	10	-14.4	-12.9	207.5	166.5	185.8
N	31+	28	+7.6	+5.1	57.8	26.0	38.8
O	35+	25	+11.6	+2.1	134.6	4.4	14.4
P	36+	30	+12.6	+7.1	158.5	50.5	89.5
Q	35+	28	+11.6	+5.1	134.6	26.0	59.2
R	26-	34	+2.6	+11.1	6.6	123.2	28.9
S	7+	6	-16.4	-16.9	269.4	285.2	277.2
T	18-	20	-5.4	-2.9	29.2	8.9	15.7
	469	458			2471.0	1663.8	1680.5

$\bar{R}$ + 23.4 $\bar{L}$ + 22.8

TABLE III
O.S.

	R*	L	r	l	r^2	l^2	rl
A	34+	3	+8.6	+9.3	74.0	86.5	+79.98
B	30°	30	+4.6	+7.3	21.2	53.3	+33.58
C	19+	14	-6.4	-8.7	41.0	75.7	+55.68
D	1-	11	-24.4	-11.7	595.4	136.9	+285.48
E	20-	34	-5.4	+11.3	29.2	127.7	-61.02
F	12-	14	-13.4	-8.7	179.6	75.7	+116.58
G	28+	8	+2.6	-14.7	6.8	216.1	-38.22
H	42+	38	+16.6	+15.3	275.6	234.1	+253.98
I	27-	40	+1.6	+17.3	2.6	299.3	+27.68
J	47+	23	+21.6	+.3	466.6	.1	+6.48
K	32+	21	+6.6	-1.7	43.6	2.9	-11.22
L	19-	27	-6.4	+4.3	41.0	18.5	-27.52
M	16-	15	-9.4	-7.7	88.4	59.3	+72.38
N	32-	27	+6.6	+4.3	43.6	18.5	+28.38
O	29-	14	+3.6	-8.7	13.0	75.7	-31.32
P	29+	27	+3.6	+4.3	13.0	18.5	+15.48
Q	36+	35	+10.6	+12.3	112.4	151.3	+130.38
R	28+	23	+2.6	+.3	6.8	.1	+.78
S	8+	3	-17.4	-19.7	302.8	388.1	+342.78
T	19+	18	-6.4	-4.7	41.0	22.1	+30.08
	508 $\bar{R}$=25.4	454 $\bar{L}$=22.7	0	0	2397.6	2060.4	1301.20

TABLE IV

O.O.

	R*	L	r	l	r^2	l^2	rl
A	36+	33	+8.9	+6.1	79.2	37.2	54.29
B	26-	32	-1.1	+5.1	1.2	26.0	-5.61
C	24-	27	-3.1	+.1	9.6	0	-.31
D	8-	10	-19.1	-16.9	364.8	285.6	+322.79
E	19-	31	-8.1	+4.1	65.6	16.8	-33.21
F	21+	18	-6.1	-8.9	37.2	79.2	54.29
G	36+	23	±8.9	-3.9	79.2	15.2	-34.71
H	43+	38	+15.9	+11.1	252.8	123.2	176.49
I	20-	41	-7.1	+14.1	50.4	198.8	-100.11
J	32+	27	+4.9	+.1	24.0	0	.49
K	27+	25	-.1	1.9	0	3.6	.19
L	35+	27	+7.9	+.1	62.4	0	.79
M	18+	16	-9.1	-10.9	82.8	118.8	99.19
N	30+	27	+2.9	+.1	8.4	0	.29
O	27-	29	-.1	+2.1	0	4.4	-.21
P	35+	34	+7.9	+7.1	62.4	50.4	56.09
Q	32-	33	+4.9	+6.1	24.0	37.2	29.89
R	27-	28	.1	+1.1	0	1.2	.11
S	14[e]	14	-13.;	-12.9	171.6	166.4	168.99
T	33+	25	+5.9	-1.9	34.8	3.6	-11.21
	543 R=27.1	538 L=26.9	0	0	1410.4	1167.6	778.52

Table II Calculations

$$S_h = \sqrt{\frac{\Sigma h^2}{N}} = \sqrt{\frac{2471.0}{20}} = 11.11$$

$$S_l = \sqrt{\frac{\Sigma l^2}{N}} = \sqrt{\frac{1663.8}{20}} = 9.12$$

$$r = \frac{\Sigma hl}{N S_h S_l} = \frac{1330.5}{20 \cdot 11.11 \cdot 9.12} = +.66$$

Table III Calculations

$$S_h = \sqrt{\frac{\Sigma h^2}{N}} = \sqrt{\frac{2397.6}{20}} = 10.58$$

$$S_l = \sqrt{\frac{\Sigma l^2}{N}} = \sqrt{\frac{2060.9}{20}} = 10.15$$

$$r = \frac{\Sigma hl}{N S_h S_l} = \frac{1301.2}{20 \times 10.58 \times 10.15} = \frac{1301.2}{2147.74} = +.61$$

Table IV Calculations

$$S_r = \sqrt{\frac{\Sigma r^2}{N}} = \sqrt{\frac{1410.4}{20}} = 8.40$$

$$S_l = \sqrt{\frac{\Sigma l^2}{N}} = \sqrt{\frac{1167.6}{20}} = 7.64$$

$$r = \frac{\Sigma rl}{N S_r S_l} = \frac{778.52}{20 \times 8.40 \times 7.64} = +.60$$

BEST SCORE

SUBJECT	DOM. EYE	NON DOM EYE	CENTER	OVER ALL FIELD PREFERENCE
A	2	3	1	Right
B	3	2	1	Left
C	2	3	1	Left
D	2	3	1	Left
E	3	2	1	Left
F	3	2	1	Right
G	2	3	1	Right
H	2	3	1	Right
I	3	2	1	Left
J	2	3	1	Right
K	3	2	1	Right
L	3	2	1	Left
M	3	2	1	Right
N	2	3	1	Right
O	2	3	1	Right
P	2	3	1	Right
Q	3	2	1	Right
R	No Dom Eye Rt. Eye Best		1	Left
S	2	3	1	Right
T	3	2	1	Right

#1=Best
#2=Second
#3=Third

TABLE V

DOMINANT EYE BEST	10
NON-DOMINANT EYE BEST	9
RIGHT FIELD BEST	13
LEFT FIELD BEST	7

TABLE VI

RIGHT FIELD preferred c/w DOMINANT EYE BEST	8
LEFT FIELD preferred c/w DOMINANT EYE BEST	2
RIGHT FIELD preferred c/w NON-DOMINANT EYE BEST	5
LEFT FIELD preferred c/w NON-DOMINANT EYE BEST	4

TABLE VII

Symbols for Tables II, III, IV

\+ = R > L = 11

\- = R < L = 9

o = R=L = 1

$\therefore$ = R = L

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