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## EXPANSION OF THE VISUAL FORM FIELD BY PERIMETER TRAINING

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# Contrails

## FOREWORD

This report is the second of a series describing the results of an investigation conducted at Miami University, Oxford, Ohio, under Contract No. AF 18(600)-25, between Miami University and the Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. The task, Size of Form Field as a Factor in Check Reading Aircraft Dials, is carried under Project 7186, Visual Presentation of Information, Dr. James M. Vanderplas, Project Scientist. The task was initiated by Mr. J. M. Christensen, Psychology Branch, Aero Medical Laboratory. Supervision of testing procedures and analysis was performed by Dr. C. W. Crannell, Miami University.

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This is the second in a series of experiments designed to examine the possibility of increasing the size of the visual form field by specialized training. The present investigation was concerned with the effect of various amounts of perimetric training on the visual form field. Five groups were used: a control group which received no training, and four groups which received, respectively, 10, 20, 30 and 40 half-hour sessions of training. As in a previous experiment, there was considerable improvement in ability to identify familiar stimuli presented farther and farther from the foveal area, but no evidence of transfer to other stimuli.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

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Colonel, USAF  
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Directorate of Research

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## I. INTRODUCTION

This is the second of a series of experiments designed to test whether or not it is possible by appropriate training to expand the acuity for form toward the periphery of the visual field. In spite of evidence in the literature that such expansion is possible, and does transfer to other tasks (1, 3, 5, 6, 7, 9), the present writers have been unable to substantiate such findings (2).

A previous experiment did indicate, however, that the ability to recognize familiar digits farther and farther toward the periphery of the visual field was learned quicker by perimetric training than by tachistoscopic training (2). The present experiment was designed to test the effects of various amounts of perimetric training, and to try again to obtain positive transfer to some visual task other than the specific one on which the subjects were trained.

As suggested in a previous report (2), the Air Force is interested in any proved technique that will enable aircrew members to respond quicker and more accurately to peripheral cues. This is particularly true as speed increases, making it even more important that aircrew members respond accurately and with minimum delay.

Obviously, before design specifications can be predicated on this or any phenomenon, the Air Force must be assured that the procedures produce enduring and beneficial results to individuals engaged in Air Force type tasks. This is the purpose of these investigations. At the same time, it is hoped that these investigations will lead to a better understanding of the fundamental nature of "form field expansion."

## II. PROCEDURE

### A. Preliminary Tests

All subjects were male students from Miami University. They were given the same preliminary test battery. The visual requirements, as determined by testing with the Bausch and Lomb Ortho-Rater, were the same as for the first experiment (2); i.e., minimum near acuity: 9, 9 and 9 for right, left and both eyes respectively. A student was rejected if any near vision score was less than 10, and at the same time there was a far vision score of less than 9. Students with a minor anomaly of phoria or distance acuity were distributed as evenly as possible among the single control and four experimental groups.

Each subject was required to supply biographical information in an attempt to relate his past experience to his results in this experiment.

The first preliminary test was a Dial Checking Test (Figure 1). It comprised twenty-five slides of simulated aircraft dials. Each slide contained twenty-five simulated aircraft dials, on which one pointer (but never more than one) deviated from normal. This provided a visual field of approximately 15°

from the center of the field perpendicularly to the side, or approximately 21° from the center to a corner. In this test 75 presentations were made, using each of the slides three times.

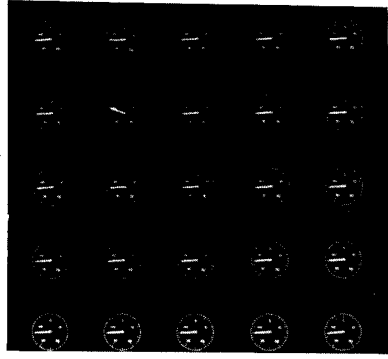


Figure 1. Type of Slide Used In Dial Checking Test

of the field was approximately 23½". Viewing distance from the screen again was 28".

Immediately after administration of the dial checking test, a second test, "Tracking," was administered. Twenty slides were prepared for this (see Figure 2). On the first ten slides there were four numbers (1 to 4), vertically at the left and four capital letters (A to D), vertically at the right. Each of the numbers was connected to one of the letters by an irregular line which crossed, and in some cases recrossed, one or more of the other lines. One of the numbers was circled. Exposure time was .10 seconds. The subject was to record which number he thought was encircled and also to which letter the encircled number was connected.

The second ten slides had five elements instead of four. There were also two demonstration slides. The height of the digits and the letters on the first ten slides, when projected, was 2½", on the second ten, 2". The direct distance between the center of digit 1 and letter A was 19", while the diagonal distance

The third preliminary test was the Robinson and Hall "Test of Reading Ability for History" (8). Form Canada was administered to half the subjects, while Form Russia was administered to the other half.

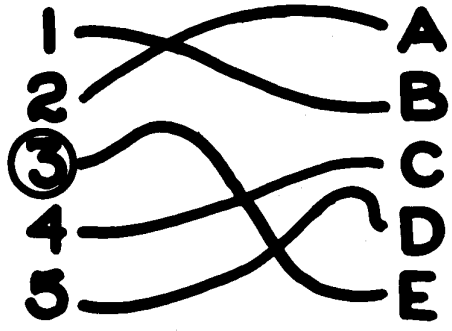


Figure 2. A slide used in the Tracking Test.

The fourth preliminary test was a test of peripheral acuity, using a Ferree-Rand Perimeter, Type 71-57-13 (see Figure 3). The perimeter was modified in two respects:

(1) An exposure device, developed at the Aero Medical Laboratory, presented numbers, ½" high, on a continuous 35mm film belt, which contained the numbers from 0 to 9. A manually operated shutter was provided. A motor drive for oscillating the numbers at one excursion per second was attached for use during the training sessions.

(2) Because the exposure device cast considerable shadow on the numbers when



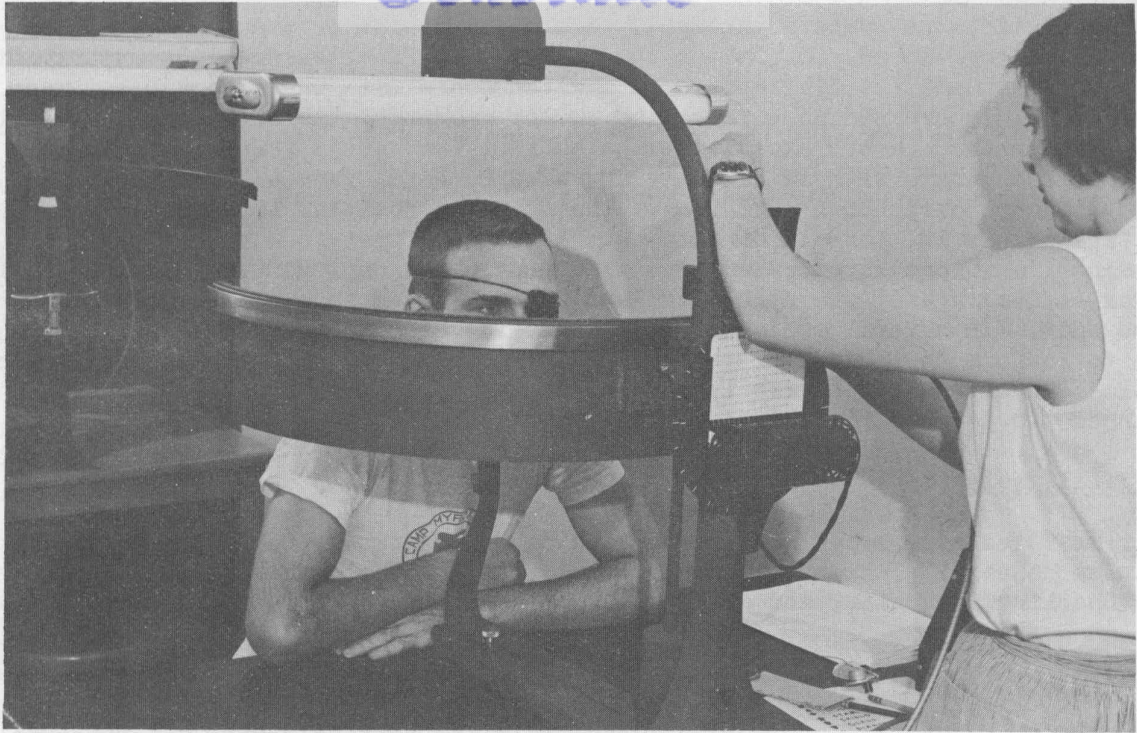


Figure 3. Modified Ferree-Rand Perimeter

the ordinary perimeter lighting system was used, a two-lamp neon light, daylight type, was installed. A test with a Norwood exposure meter indicated that the illumination was quite even at all exposure points, being approximately 64 ft-c, with a variation of not more than 2%.

Each digit was exposed for one second. Each eye was tested separately for the temporal, nasal, superior and inferior coordinates. Each eye was tested alternately to prevent tiring. Exposures started at  $24^{\circ}$ , at which point three different numbers were exposed, unless the subject missed one. If a number was missed, the exposure device was moved in two degrees, and three new digits were presented. This continued until the subject got three correct, when the exposure device was moved out until a digit was missed. The score was the maximum number of degrees at which three numbers were read correctly. If three numbers were not read correctly at twelve degrees, the score was taken to be ten degrees, since it was impossible to move the exposure device nearer than twelve degrees to the center. Complete instructions may be found in Appendix II.

#### B. Training Procedure.

Fifty subjects were divided into 5 groups of 10 each. Group A received 10 training sessions; Group B, 20 sessions; Group C, 30 sessions; Group D, 40 sessions; and Group S, a control group, the preliminary and final tests only, separated by an interval of 30 days. Each subject, except those in Group S, reported for 5 sessions weekly, with slight variations due to illness or vacation periods. The training was performed with the perimeter, utilizing a motor drive

# Contrails

for oscillating the numbers through a lateral excursion of about  $5/8''$ , at the rate of  $1\frac{1}{4}''$  per second. One major change was made from the previous experiment. In that experiment training ceased on a given coordinate when the subject made an error. This created some variation in the amount of training from subject to subject. In the present experiment the subject was always tested for each eye and each coordinate with 12 randomly arranged numbers, four each at three successively more peripheral positions. The starting position for the first training session was  $12^\circ$  for all directions. After the first four numbers at this distance, four more were presented at  $14^\circ$  and  $16^\circ$ , except for the temporal fields, (nasal retinal areas) where  $12^\circ$ ,  $14^\circ$  and  $20^\circ$  were used in order to miss the blind spot. In several subjects, variations in this temporal field training were made to conform to individual variations in location and extent of the blind spot. If all 12 numbers were correctly read by the subject, the three positions were advanced two degrees for the following training session.

## C. Final Tests

Final tests were administered on the days immediately following the final training session. These final tests consisted of retests on the Ortho-Rater, Dial Checking, Tracking, and alternate form of the Reading Test. These tests required two sessions. On the next session a final perimeter test was given. Stationary numbers were used for testing. The starting position for each coordinate was determined by the accuracy of performance on the final training session. Unlike the previous experiment (2) testing did not stop at the point where a subject first missed a number, but was continued until the subject again missed one or more numbers. At the next session a Landolt Ring test was administered. Again, an effort was made to keep the testing more nearly identical for all subjects by starting at the same position and continuing the test out to much the same peripheral setting, regardless of the errors made. On the final testing session, a Form Test (see Figure 4) was given, under much the same con-

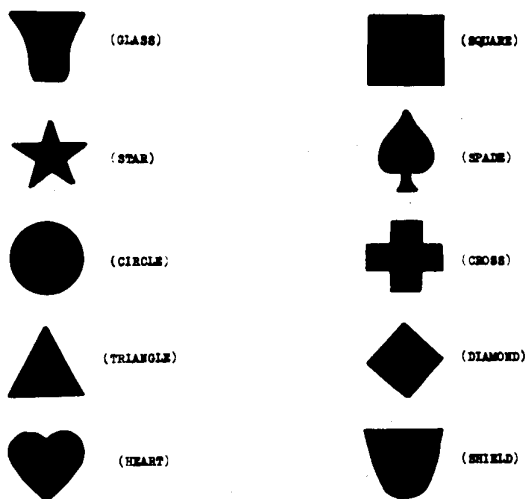


Figure 4. The items of the final Form Test. Names assigned to each form are shown in parentheses.

ditions as the Landolt Ring Test, but, because the using more peripheral settings. Appendix IV shows the complete instructions for these final tests.

### III. RESULTS AND DISCUSSION

The effectiveness of the perimeter training is presented graphically in Figure 5. This figure shows the learning curves for all four experimental groups. The maximum and minimum form fields which serve as bases for the learning curves are shown in Appendix IV. For obvious reasons the learning curves

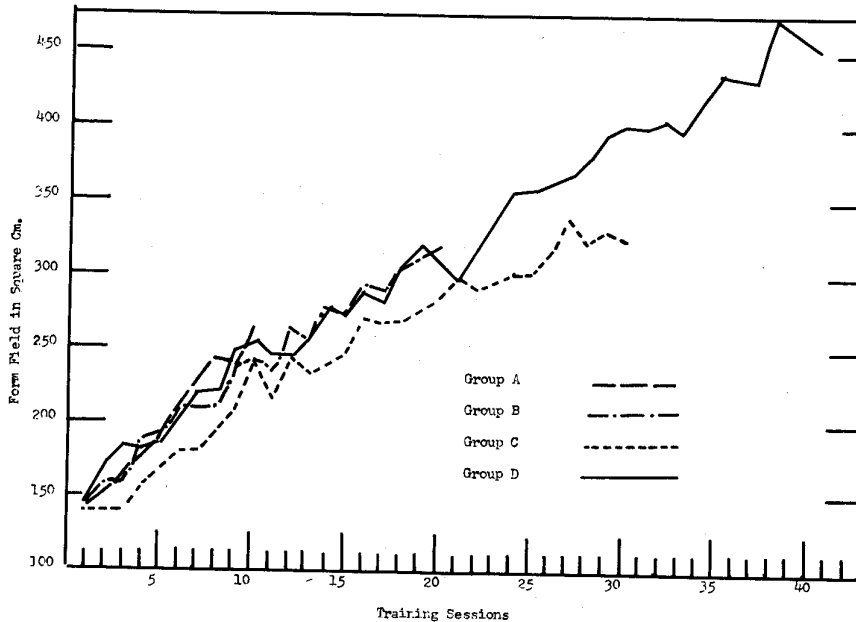


Figure 5. Mean Average Form Field During Perimeter Training.

for the present experiment do not coincide with those of the previous experiment. In the first place, the height of the numbers was increased  $3/8"$  to  $1/2"$ . (The width of the numbers, on the other hand, was decreased from  $1/4"$  to  $3/16"$ , so that the approximate areas of such numbers as 6, 8 and 9 were the same in both experiments). Second, the illumination with daylight type neon lights was brighter and more free from shadows; and third, the general construction of the newer exposure device was much better, and did not involve the removal and replacement of a large covering device within the visual field as each exposure was made.

Figure 5 shows that all four groups began training with almost identical mean form fields. However, Group C proved to be clearly inferior to the other three groups in rapidity of progress. The reasons for this are obscure.

Tables 1 through 5 show the pretest and posttest scores for the five groups. As in the previous experiment, the only consistent differences are for the perimeter tests and the Landolt Ring Test. A study of the mean gains from pretest to posttest reveals that for the perimeter average form field all the differences between each of the training groups and the control group, S, are highly significant ( $t$ 's for each group, compared with S, are 4.42, 6.39, 3.43 and 5.30

respectively). The mean gains in Landolt Ring score are highly significant for the differences between Group S and Groups A and B ( $t$  is 4.53 and 3.68 respectively). The mean gains in Landolt Ring scores in Groups C and D are not significantly greater than that of Group S; however, if the data of both groups are combined, the  $t$  for the difference between this mean based on 20 cases and that for Group S is 3.62, significant at better than the one percent level.

The data were treated by application of analysis of covariance. The remaining tables of this report present the more pertinent analyses from among the many that were computed. Tables 6 through 10 confirm the absence of any transfer from the perimeter training task to such tests as dial checking, tracking, and reading rate or accuracy. The analyses of covariance for the remaining data, Tables 11 through 16, were performed separately for minimum and maximum form fields, and show not only that there is no significant difference among groups on pretests, but also that the posttest differences for perimeter form field and Landolt Ring scores are highly significant. In view of the clear evidence of positive transfer from perimeter training on numbers to the similar, but not identical task of perceiving Landolt Rings, it is interesting that no significant transfer was found to the perception of the series of visual forms. Inspection of the tables shows that for each of the experimental groups there is a slight numerical difference in their favor over the mean for the control group. Neither the analyses of covariance nor  $t$  tests between the control group and any combination of the experimental groups shows any significance for the difference, variance within groups being relatively high.

In addition, it should be noted that the two experimental groups with shorter training seem to exhibit more transfer effect to the Landolt Ring task than do the two groups with longer training. However, differences between these experimental groups are not significant. This implies that whatever transfer to the Landolt Ring task occurs, appears after a small amount of perimeter training on the numbers, and does not increase with further training.

One incidental feature of these studies is perhaps worth noting. In studying the results for reading rate and accuracy, it was frequently noted that cases appeared in which an appreciable gain in reading rate was accompanied by a loss in comprehension. Computations of percent gain in rate and accuracy were made. Correlations then were computed between rate and accuracy for the 45 subjects in the present and a previous experiment whose initial test was "Canada," and for the 43 subjects whose initial test was "Russia." These correlations were  $-.36$  (significant at the 5% level) and  $-.10$  (not significant). In view of the fact that the mean test scores for these two groups of subjects from different experiments were not equivalent, standard scores were also computed for all rate scores and accuracy scores. The correlations of net standard score gains in rate with those in accuracy were  $-.17$  and  $-.08$  for the two groups mentioned.

These data indicate that, as far as these subjects were concerned, a gain in reading rate was not accompanied by a corresponding gain in reading accuracy. While the rate-accuracy relationships are not significantly negative, the finding

# Controls

TABLE 1

GROUP S (CONTROL) PRETEST AND POSTTEST SCORES

Subj. No.	Dial Checking			Tracking			Perimeter Test Average Field		
	I*	II**	G***	I	II	G	I	II	G
1	7	19	12	8	9	1	118	169	51
2	30	27	-3	14	10	-4	241	346	105
3	13	11	-2	9	7	-2	136	195	59
4	10	22	12	9	10	1	108	173	65
5	13	7	-6	8	12	4	239	167	-72
6	17	7	-10	8	5	-3	107	140	33
7	13	12	-1	1	6	5	146	178	32
8	13	17	4	5	4	-1	121	177	56
9	10	21	11	6	8	2	123	135	12
10	21	14	-7	6	6	0	101	116	15
M	14.7	15.7	1.0	7.4	7.7	0.3	144.0	179.6	35.6

Reading Test

Subj. No.	Form	Rate			Accuracy			Landolt Score	Form Score
		I	II	G	I	II	G		
1	R-C	349	303	-46	79	85	6	36	56
2	C-R	197	255	58	75	76	1	42	102
3	C-R	212	225	13	38	59	21	37	55
4	R-C	261	237	-24	56	74	18	22	57
5	C-R	176	198	22	60	58	-2	15	54
6	C-R	190	225	35	85	82	-3	16	57
7	R-C	281	282	1	84	77	-7	20	62
8	R-C	176	151	-25	64	59	-5	24	42
9	R-C	183	170	-13	91	75	-16	22	48
10	C-R	125	194	69	87	65	-22	21	50
M		215.0	224.0	9.0	71.9	71.0	-0.9	25.5	58.3

\* I = pretest score  
 \*\* II = post-test score  
 \*\*\* G = gain from pretest to post-test

TABLE 2

GROUP A (10 SESSIONS) PRETEST AND POSTTEST SCORES

Subj. No.	Dial Checking			Tracking			Perimeter Test Average Field		
	I*	II**	G***	I	II	G	I	II	G
1	24	31	7	4	9	5	142	256	114
2	12	22	10	11	15	4	142	291	149
3	12	20	8	12	16	4	151	237	86
4	12	15	3	4	7	3	95	231	136
5	7	11	4	6	7	1	99	175	76
6	20	20	0	9	10	1	133	309	176
7	21	20	-1	5	9	4	146	250	104
8	8	11	3	3	4	1	136	197	61
9	13	11	-2	6	3	-3	126	257	131
10	14	23	9	3	3	0	87	235	148
M	14.3	18.4	4.1	6.3	8.3	2.0	125.7	243.8	118.1

Reading Test

Subj. No.	Form	Rate			Accuracy			Landolt Score	Form Score
		I	II	G	I	II	G		
1	R-C	217	218	1	73	75	2	42	103
2	C-R	184	185	1	60	73	13	62	52
3	C-R	381	366	-15	74	78	4	48	40
4	R-C	192	226	34	52	75	23	62	76
5	C-R	324	324	0	85	68	-17	25	29
6	C-R	239	356	117	85	49	-36	67	53
7	R-C	188	261	73	74	65	-9	61	74
8	C-R	169	210	41	78	72	-6	43	81
9	C-R	316	480	164	65	56	-9	39	92
10	R-C	158	170	12	74	68	-6	41	61
M		236.8	279.6	42.8	72.0	67.9	-4.1	49.0	66.1

\* I = pretest score  
 \*\* II = post-test score  
 \*\*\* G = gain from pretest to post-test

# Controls

TABLE 3

GROUP B (20 SESSIONS) PRETEST AND POSTTEST SCORES

Subj. No.	Dial Checking			Tracking			Perimeter Test Average Field		
	I*	II**	G***	I	II	G	I	II	G
1	18	25	7	8	6	-2	152	342	190
2	18	18	1	5	8	3	117	382	265
3	10	11	1	8	6	-2	137	317	180
4	22	25	3	9	11	2	125	282	157
5	19	19	0	5	10	5	117	364	247
6	26	31	5	12	13	1	97	179	82
7	6	9	3	6	4	-2	115	311	196
8	16	17	1	8	6	-2	178	414	236
9	15	31	16	3	8	5	113	253	140
10	24	23	-1	6	9	3	121	260	139
M	17.4	21.0	3.6	7.0	8.1	1.1	127.2	310.4	183.2

Reading Test

Subj. No.	Form	Rate			Accuracy			Landolt Score	Form Score
		I	II	G	I	II	G		
1	R-C	204	241	37	50	73	23	58	68
2	R-C	204	212	8	67	71	4	40	93
3	C-R	129	136	7	73	65	-8	30	60
4	R-C	248	215	-33	76	63	-13	28	63
5	C-R	200	226	26	75	82	7	64	82
6	C-R	287	421	134	81	65	-16	44	58
7	C-R	350	406	56	83	86	3	62	54
8	C-R	205	225	20	58	71	13	73	74
9	C-R	185	216	31	85	69	-16	37	45
10	R-C	348	347	-1	82	92	10	34	86
M		236.0	264.5	28.5	73.0	73.7	0.7	47.0	68.3

\* I = pretest score  
 \*\* II = post-test score  
 \*\*\* G = gain from pretest to post-test

TABLE 4

GROUP C (30 SESSIONS) PRETEST AND POSTTEST SCORES

Subj. No.	Dial Checking			Tracking			Perimeter Test Average Field		
	P*	II**	G***	I	II	G	I	II	G
1	11	18	7	6	8	2	171	404	233
2	14	14	0	8	9	1	152	359	207
3	14	13	-1	8	8	0	91	225	134
4	15	10	-5	6	7	1	79	313	234
5	17	27	10	9	9	0	105	272	167
6	15	19	4	7	6	-1	111	274	163
7	17	21	4	10	11	1	255	274	19
8	12	20	8	8	13	5	248	268	20
9	15	25	10	11	12	1	152	557	405
10	13	22	9	6	5	-1	143	246	103
M	14.3	18.9	4.6	7.9	8.8	0.9	150.7	319.2	168.5

Reading Test

Subj. No.	Form	Rate			Accuracy			Landolt Score	Form Score
		I	II	G	I	II	G		
1	R-C	232	260	28	75	92	17	28	74
2	C-R	187	147	-40	40	67	27	30	57
3	C-R	271	280	9	84	78	-6	23	48
4	R-C	266	261	-5	74	65	-9	18	58
5	C-R	229	290	61	84	76	-8	14	66
6	R-C	148	201	53	93	60	-33	29	48
7	C-R	182	221	39	85	77	-8	40	81
8	R-C	283	237	-46	72	77	5	24	62
9	R-C	187	209	22	73	67	-6	49	93
10	C-R	240	322	82	65	76	11	30	59
M		222.5	242.8	20.3	74.5	73.5	-1.0	28.5	64.6

\* I - pretest score  
 \*\* II = post-test score  
 \*\*\* G = gain from pretest to post-test



# Contrails

TABLE 5

GROUP D (40 SESSIONS) PRETEST AND POSTTEST SCORES

Subj. No.	Dial Checking			Tracking			Average Field Perimeter Test		
	I*	II**	G***	I	II	G	I	II	G
1	25	16	-9	9	7	-2	131	401	270
2	10	17	7	10	12	2	148	549	401
3	23	26	3	12	11	-1	250	334	84
4	26	33	7	15	13	-2	152	327	175
5	20	33	13	9	9	0	117	333	216
6	11	15	4	7	7	0	101	298	197
7	17	25	8	5	12	7	173	340	167
8	24	28	4	6	11	5	264	766	502
9	14	18	4	6	8	2	94	334	240
10	18	24	6	7	6	-1	128	515	387
M	18.8	23.5	4.7	8.6	9.6	1.0	155.8	419.7	263.9

Reading Test

Subj. No.	Form	Rate			Accuracy			Landolt Score	Form Score
		I	II	G	I	II	G		
1	C-R	294	280	-14	67	75	8	24	50
2	C-R	157	181	24	50	68	18	30	90
3	C-R	238	207	-31	85	83	-2	30	63
4	R-C	213	138	-75	72	81	9	42	70
5	R-C	179	162	-17	73	72	-1	31	53
6	R-C	180	211	31	52	50	-2	23	51
7	R-C	151	180	29	78	45	-33	25	59
8	R-C	345	239	-106	63	77	14	54	84
9	R-C	203	205	2	63	36	-27	25	39
10	C-R	170	316	146	80	61	-19	37	53
M		213.0	211.9	-1.1	68.3	64.8	-3.5	32.1	61.2

\* I - pretest score

\*\* II - post-test score

\*\*\* G - gain from pretest to post-test

TABLE 6

ANALYSIS OF COVARIANCE OF DIAL CHECKING  
PRETESTS (x) AND POSTTESTS (y) (ITEMS CORRECT)

Source	df	Sx <sup>2</sup>	Sxy	Sy <sup>2</sup>	<u>Errors of Estimate</u>		
					Sum of Squares	df	Mean Square
Total	49	1518.50	1094.50	2288.50	1499.61	48	---
Between Groups	4	172.20	211.30	342.60	---	---	---
Within Groups	45	1346.30	883.20	1945.90	1366.50	44	31.06
Adjusted Means:					133.11	4	33.27

Mean Squares

Between Groups	43.05	85.65	
Within Groups	29.92	43.24	
F	1.44	1.98	Adjusted F: 1.07
$r_{xy}$ (within):	.55	$r_{xy}$ : .87	

Group Means

<u>Group</u>	<u>x</u>	<u>y</u>
S (Control)	14.7	15.7
A (10 Sessions)	14.3	18.4
B (20 Sessions)	17.4	21.0
C (30 Sessions)	14.3	18.9
D (40 Sessions)	18.8	23.5

ANALYSIS OF COVARIANCE OF DIAL CHECKING  
PRETESTS (x) AND POSTTESTS (y) (ITEMS CORRECT PLUS NEAR MISSES)

Source	df	S <sub>x</sub> <sup>2</sup>	S <sub>xy</sub>	S <sub>y</sub> <sup>2</sup>	<u>Errors of Estimate</u>		
					Sum of Squares	df	Mean Square
Total	49	1208.98	352.18	1489.38	1386.79	48	---
Between Groups	4	96.08	72.78	180.88	---	---	---
Within Groups	45	1112.90	279.40	1298.50	1228.36	44	27.92
Adjusted Means:					158.43	4	39.61

Mean Squares

Between Groups	24.02	47.72	
Within Groups	24.73	28.86	
F	---	1.65	Adjusted F: 1.42
$r_{xy}$ (within):	.23	$r_{xy}$ : .54	

Group Means

<u>Group</u>	<u>x</u>	<u>y</u>
S (Control)	34.6	34.8
A (10 Sessions)	33.1	38.4
B (20 Sessions)	36.4	38.8
C (30 Sessions)	34.2	36.6
D (40 Sessions)	36.8	40.5

ANALYSIS OF COVARIANCE OF TRACKING  
PRETESTS (x) AND POSTTESTS (y)

Source	df	Sx <sup>2</sup>	Sxy	Sy <sup>2</sup>	<u>Errors of Estimate</u>		
					Sum of Squares	df	Mean Square
Total	49	398.32	258.00	448.50	281.39	48	---
Between Groups	4	30.52	18.50	21.40	---	---	---
Within Groups	45	367.80	239.50	427.10	271.14	44	6.16
Adjusted Means:					10.25	4	2.56
<u>Mean Squares</u>							
Between Groups		7.63		5.35			
Within Groups		8.17		9.49			
F		---		---	Adjusted F:	---	
		$r_{xy}$ (within): .60		$r_{xy}$ : .72			

<u>Group</u>	<u>Group Means</u>	
	<u>x</u>	<u>y</u>
S (Control)	7.4	7.7
A (10 Sessions)	6.3	8.3
B (20 Sessions)	7.0	8.1
C (30 Sessions)	7.9	8.8
D (40 Sessions)	8.6	9.6

ANALYSIS OF COVARIANCE OF READING RATE  
PRETESTS (x) AND POSTTESTS (y)

Source	df	Sx <sup>2</sup>	Sxy	Sy <sup>2</sup>	<u>Errors of Estimate</u>		
					Sum of Squares	df	Mean Square
Total	49	1948.48	1671.92	2676.18	1241.55	48	---
Between Groups	4	51.68	126.32	320.48	---	---	---
Within Groups	45	1896.80	1545.60	2355.70	1096.27	44	24.93
Adjusted Means:					145.28	4	36.32

Mean Squares

Between Groups	12.92	80.12	
Within Groups	42.15	52.35	
F	---	1.53	Adjusted F: 1.46
$r_{xy}$ (within):	.73	$r_{xy}$ :	.98

Group Means

<u>Group</u>	<u>x</u>	<u>y</u>
S (Control)	21.6*	22.5
A (10 Sessions)	23.7	28.1
B (20 Sessions)	23.7	26.7
C (30 Sessions)	22.3	24.3
D (40 Sessions)	21.3	21.3

\* For purposes of statistical treatment scores were coded by division by 10.

ANALYSIS OF COVARIANCE OF READING ACCURACY  
PRETESTS (x) AND POSTTESTS (y)

Source	df	Sx <sup>2</sup>	Sxy	Sy <sup>2</sup>	<u>Errors of Estimate</u>		
					Sum of Squares	df	Mean Square
Total	49	8084.82	1630.54	6191.38	5862.53	48	---
Between Groups	4	209.32	316.44	582.28	---	---	---
Within Groups	45	7875.50	1314.10	5609.10	5389.83	44	122.50
Adjusted Means:					472.70	4	118.18

Mean Squares

Between Groups	52.33	145.57	
Within Groups	175.01	124.65	
F	---	---	Adjusted F: ---
	r <sub>xy</sub> (within): .20	r <sub>xy</sub> : .91	

Group Means

<u>Group</u>	<u>x</u>	<u>y</u>
S (Control)	71.9	71.0
A (10 Sessions)	72.0	67.9
B (20 Sessions)	73.0	73.7
C (30 Sessions)	74.5	73.5
D (40 Sessions)	68.3	64.8

ANALYSIS OF COVARIANCE OF PERIMETER FIELD  
PRETESTS (x) AND POSTTESTS (y) (MINIMUM FORM FIELD)

Source	df	Sx <sup>2</sup>	Sxy	Sy <sup>2</sup>	<u>Errors of Estimate</u>		
					Sum of Squares	df	Mean Square
Total	49	664.42	581.44	5492.08	4983.26	48	---
Between Groups	4	33.32	117.54	2663.88	---	--	---
Within Groups	45	631.10	463.90	2828.20	2487.20	44	56.53
Adjusted Means:					2496.06	4	624.02

Mean Squares

Between Groups	8.33	665.97	
Within Groups	14.02	62.85	
F	---	10.60	Adjusted F: 11.04
$r_{xy}$ (within):	.35	$r_{xy}$ :	.40

Group Means

Group	<u>x</u>	<u>y</u>
S (Control)	11.9*	15.4
A (10 Sessions)	11.0	19.5
B (20 Sessions)	10.1	24.1
C (30 Sessions)	11.9	28.0
D (40 Sessions)	12.4	36.6

\* For purposes of statistical treatment, all scores were coded by division by 10.

TABLE 12

ANALYSIS OF COVARIANCE OF PERIMETER FIELD  
PRETESTS (x) AND POSTTESTS (y) (MAXIMUM FORM FIELD)

Source	df	Sx <sup>2</sup>	Sxy	Sy <sup>2</sup>	Errors of Estimate		
					Sum of Squares	df	Mean Square
Total	49	1706.58	1948.40	9632.00	7407.51	48	---
Between Groups	4	138.28	398.40	3973.40	---	---	---
Within Groups	45	1568.30	1550.00	5658.60	4126.69	44	93.79
Adjusted Means:					3280.82	4	820.21

Mean Squares

Between Groups	34.57	993.35	
Within Groups	34.85	125.75	
F	---	7.90	Adjusted F: 8.75
$r_{xy}$ (within):	.52	$r_{xy}$ :	.54

Group Means

Group	<u>x</u>	<u>y</u>
S (Control)	17.0*	20.8
A (10 Sessions)	14.1	29.3
B (20 Sessions)	15.9	36.5
C (30 Sessions)	18.1	38.0
D (40 Sessions)	18.8	47.4

\* For purposes of statistical treatment, all scores were coded by division by 10.



ANALYSIS OF COVARIANCE COMPARING PERIMETER MINIMUM  
PRETEST FORM FIELD (x) WITH LANDOLT RING SCORE (y)

Source	df	Sx <sup>2</sup>	Sxy	Sy <sup>2</sup>	<u>Errors of Estimate</u>		
					Sum of Squares	df	Mean Square
Total	49	664.42	146.34	11,210.18	11,177.95	48	---
Between Groups	4	33.32	-325.26	4,708.28	---	--	---
Within Groups	45	631.10	471.60	6,501.90	6,149.49	44	139.76
Adjusted Means:					5,028.46	4	1257.12

Mean Squares

Between Groups	8.33	1,177.07
Within Groups	14.02	144.49
F	---	8.15      Adjusted F: 8.99
$r_{xy}$ (within):	.23	$r_{xy}$ : -.82

Group Means

<u>Group</u>	<u>x</u>	<u>y</u>
S (Control)	11.9*	25.5
A (10 Sessions)	11.0	49.0
B (20 Sessions)	10.1	47.0
C (30 Sessions)	11.9	28.5
D (40 Sessions)	12.4	32.1

\* For purposes of statistical treatment, all perimeter pretest scores were coded by division by 10.

*Controls*  
TABLE 14

ANALYSIS OF COVARIANCE COMPARING PERIMETER MAXIMUM  
PRETEST FORM FIELD (x) WITH LANDOLT RING SCORE (y)

Source	df	Sx <sup>2</sup>	Sxy	Sy <sup>2</sup>	<u>Errors of Estimate</u>		
					Sum of Squares	df	Mean Square
Total	49	1,706.58	597.62	11,210.18	11,000.90	48	---
Between Groups	4	138.28	-646.08	4,708.28	---	---	---
Within Groups	45	1,568.30	1,243.70	6,501.90	5,515.62	44	125.36
Adjusted Means:					5,485.28	4	1,371.32

Mean Squares

Between Groups	34.57	1,177.07	
Within Groups	34.85	144.49	
F	---	8.15	Adjusted F: 10.94
	r <sub>xy</sub> (within): .39	r <sub>xy</sub> : -.80	

Group Means

<u>Group</u>	<u>x</u>	<u>y</u>
S (Control)	17.0*	25.5
A (10 Sessions)	14.1	49.0
B (20 Sessions)	15.9	47.0
C (30 Sessions)	18.1	28.5
D (40 Sessions)	18.8	32.1

\* For purposes of statistical treatment, all perimeter pretest scores were coded by division by 10.

ANALYSIS OF COVARIANCE COMPARING PERIMETER  
MINIMUM PRETEST FORM FIELD (x) WITH FORM SCORE (y)

Source	df	Sx <sup>2</sup>	Sxy	Sy <sup>2</sup>	<u>Errors of Estimate</u>		
					Sum of Squares	df	Mean Square
Total	49	664.42	776.90	14,144.50	13,236.08	48	---
Between Groups	4	33.32	-116.90	631.40	---	--	---
Within Groups	45	631.10	893.80	13,513.10	12,247.25	44	278.35
Adjusted Means:					988.83	4	247.21

Mean Squares

Between Groups	8.33	157.85	
Within Groups	14.02	300.29	
F	---	---	Adjusted F: ---
	r <sub>xy</sub> (within): .31	r <sub>xy</sub> : .81	

Group Means

<u>Group</u>	<u>x</u>	<u>y</u>
S (Control)	11.9*	58.3
A (10 Sessions)	11.0	66.1
B (20 Sessions)	10.1	68.3
C (30 Sessions)	11.9	64.6
D (40 Sessions)	12.4	61.2

\*\* For purposes of statistical treatment, all perimeter pretest scores were coded by division by 10.

ANALYSIS OF COVARIANCE COMPARING PERIMETER  
MAXIMUM PRETEST FORM FIELD (x) WITH FORM SCORE (y)

Source	df	Sx <sup>2</sup>	Sxy	Sy <sup>2</sup>	<u>Errors of Estimate</u>		
					Sum of Squares	df	Mean Square
Total	49	1,706.58	1,981.70	14,144.50	11,843.33	48	---
Between Groups	4	138.28	-155.30	631.40	---	---	---
Within Groups	45	1,568.30	2,137.00	13,513.10	10,601.18	44	240.94
Adjusted Means:					1,242.15	4	310.54

Mean Squares

Between Groups	34.57	157.85
Within Groups	34.85	300.29
F	---	---
		Adjusted F: 1.29
$r_{xy}$ (within):	.46	$r_{xy}$ : .53

Group Means

<u>Group</u>	<u>x</u>	<u>y</u>
S (Control)	17.0*	58.3
A (10 Sessions)	14.1	66.1
B (20 Sessions)	15.9	68.3
C (30 Sessions)	18.1	64.6
D (40 Sessions)	18.8	61.2

\* For purposes of statistical treatment, all perimeter pretest scores were coded by division by 10.

does suggest caution in the use of acceleration procedures for the correction of a reading deficiency. If the background of a slow reading habit resides in difficulty in comprehension, an artificial acceleration of reading speed is an attack upon the symptom, and may result in poor comprehension. However, if the deficiency in speed of reading has been brought about by inferior oculo-motor habits or physiological difficulties, acceleration of the reading rate may not harm comprehension. The writers are of the opinion that training in reading acceleration is largely an individual, or clinical matter, and that generalized attempts to increase reading speed in masses of individuals are, at the very least, uneconomical.

#### IV. SUMMARY AND RECOMMENDATIONS

Earlier experiments had suggested the possibility that training in the viewing of peripheral objects would lead to certain generalized improvements in such tasks as reading skill and utilization of extra-macular retinal areas for the perceiving of form. The present study involved four different amounts of perimeter training (10, 20, 30 and 40 one-half hour sessions). Positive transfer to such tasks as dial check reading, dissimilar stimuli (i.e., non-digits), or reading could not be found. As in a previous experiment, the most reasonable explanation of the results seems to be that the improvement demonstrated in the training task is the result of the subjects' learning to respond to reduced cues. It is, therefore, necessary again to recommend that the Air Force not embark on any large-scale "form field expansion" training program without substantial evidence that such training will result in lasting benefits to the trainees.

*Contrails*  
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INSTRUCTIONS FOR DIAL CHECK READING TEST

1. (Paragraph 1 -- How to operate the specific type of projector, is omitted from this appendix.)
2. One or two subjects are run at a time, seated 28" from the screen and slightly to the side -- with two subjects, one on either side.
3. Say: IT IS THE PURPOSE OF THIS EXPERIMENT TO SEE HOW WELL YOU ARE ABLE TO CHECK READ SIMULATED AIRCRAFT INSTRUMENT DIALS, WHEN THESE DIALS ARE EXPOSED FOR A VERY BRIEF PERIOD OF TIME. (Turn on projector, expose Null slide.) NOTICE THAT THERE ARE FIVE ROWS AND FIVE COLUMNS WITH FIVE DIALS EACH. NOTICE THAT EACH OF THE TWENTY FIVE POINTERS IS NOW INDICATING THE SAME READING OF THIRTY SEVEN AT APPROXIMATELY NINE O'CLOCK. DURING THE EXPERIMENT ONE OF THE DIALS WILL ALWAYS BE POINTING TO FORTY, OR APPROXIMATELY THE TEN O'CLOCK POSITION, LIKE THIS. (Expose Slide 9.) IT WILL BE YOUR JOB TO INDICATE ON YOUR ANSWER SHEET WHICH ONE OF THE TWENTY FIVE POINTERS IS DEVIATING. ON THE SLIDE YOU ARE NOW OBSERVING THE DIAL WITH THE DEVIATING POINTER IS IN THE SECOND ROW, THIRD COLUMN. (Turn off projector and pass out the sample answer slip, a row of items cut from an answer sheet.) TO MARK THE ITEM YOU HAVE JUST SEEN, YOU WOULD MAKE AN X ON THE LITTLE CIRCLE IN THE SECOND ROW, THIRD COLUMN. DO THIS NOW ON THE LITTLE SLIP I HAVE GIVEN YOU. (Make sure subject makes proper X.)
4. (Close the shutter and set it at 10.) REMEMBER, ON EVERY SLIDE ANY ONE, BUT NEVER MORE THAN ONE, OF THE POINTERS WILL BE DEVIATING. WE WILL NOW HAVE TWO PRACTICE TRIALS. WHEN I SAY READY, DIRECT YOUR ATTENTION TO THE CENTER OF THE SCREEN. WHEN I SAY NOW, I SHALL EXPOSE THE SLIDE. SINCE THE PROBLEM ORDERS ARE SELECTED AT RANDOM, YOU WILL BE BEST PREPARED IF YOU DIRECT YOUR ATTENTION TO THE CENTER OF THE SCREEN EVERY TIME I SAY READY.
5. Practice trial 1 -- slide 15. Be sure the shutter is set at 10. Turn on projector. READY....NOW. On the word now, press the lever. Allow about 5 sec. to write the answer.) THE CORRECT ANSWER WAS ROW TWO, COLUMN FOUR. YOU SHOULD HAVE MARKED THIS AS THE SECOND ITEM ON YOUR ANSWER SHEET. DID YOU GET THIS ITEM RIGHT? (Say the following only if the subject missed the item: VERY WELL, I SHALL EXPOSE THE SAME ONE AGAIN. REMEMBER IT IS IN ROW TWO, COLUMN FOUR. WATCH CAREFULLY. READY....NOW. Expose No. 15 again.)
6. Practice trial 2 -- Slide 25. NOW WE SHALL HAVE A SECOND PRACTICE TRIAL. READY....NOW. (Expose slide 25.) THE CORRECT ANSWER WAS ROW TWO, COLUMN TWO. (Even if the subject was wrong, do not expose again.)
7. NOW WE SHALL BEGIN THE TEST ITSELF. (Pass out answer booklet and have subject fill in name and date.) NOTICE THAT THE ITEMS ARE NUMBERED ACROSS THE ANSWER SHEET. YOU MUST MARK ONE OF THE ITEMS ON EVERY TRIAL. IF YOU ARE NOT SURE, GUESS, EVEN IF YOUR GUESS IS PURELY CHANCE. ANY QUESTIONS? THIS IS ITEM ONE....READY....NOW. THIS IS ITEM TWO....READY....NOW.

(Allow about 5 seconds for writing each answer. Run the 25 slides in order 1-25, then 25-1, and again 1-25. Check that the subject is actually working across the sheet and not down the columns.)

INSTRUCTIONS FOR PERIMETER TEST

1. The subject is seated before the perimeter. No. 9 is exposed at R 24°. This is at 15° at edge of exposure device; on left, edge is at L 33°. Hand turning device is used to keep numbers centered. Light is on; if either bulb flickers, turn off and on again. If it does not stop, replace.
2. Say: THIS IS A TEST OF YOUR ACUITY AT THE PERIPHERY OF YOUR EYE. DURING THE TEST ONLY ONE EYE WILL BE USED AT A TIME. THE OTHER EYE WILL BE KEPT COVERED WITH THIS SHIELD. WE SHALL TEST EYES ALTERNATELY SO AS NOT TO TIRE YOUR EYE. I SHALL SET A NUMBER FROM ZERO TO NINE IN THIS OPENING. NUMBER NINE IS NOW SHOWING. THEN WHILE YOU LOOK STRAIGHT AHEAD, I SHALL EXPOSE A NUMBER FOR ABOUT A SECOND LIKE THIS. (Demonstrate with screen -- count "1000-one-1000-two," raising screen on one and lowering it on two.)
3. THE WAY TO LOOK STRAIGHT AHEAD DURING THE EXPOSURE IS TO PUT YOUR CHIN ON THIS CHINREST AND ADJUST IT SO THAT YOU CAN SEE YOUR OWN EYE CENTERED DIRECTLY IN THE MIRROR. (At this point, help subject with shield over left eye, and adjust correctly to right eye.) ARE YOU SET NOW? THIS IS THE WAY IT WILL GO. STARE STEADILY AT YOUR EYE IN THE MIRROR. READY.... (Expose No. 9.)
4. I SHALL NOW EXPOSE UP TO THREE DIFFERENT NUMBERS AT THIS POINT. IF YOU MISS ONE OF THEM, I SHALL MOVE IN A LITTLE AND TRY AGAIN. I SHALL MOVE IN UNTIL YOU GET THREE RIGHT. THEN I SHALL MOVE IN EVEN MORE AND START OUT AGAIN UNTIL YOU MISS ONE. ANY QUESTIONS? (Expose numbers according to system on back of perimeter. If subject moves his eye, do not count trial, and say: I THINK YOUR EYE MOVED A LITTLE THAT TIME. TRY TO STARE STRAIGHT AHEAD. Expose a new number.)
5. Continue in by two degree steps until subject gets three right. Then come in fourdegrees and start out. If subject misses at this setting, come in by two degree steps until subject gets three right; then go out again by two degree steps. It is not possible to go below 12°. If subject fails at 12° write 10° in the appropriate space. Note also that temporal measures often run into the blind spot where the subject sees nothing at all. The blind spot is usually someplace around 14°-18°. Some subjects have no form field beyond this spot when first tested. Record the last position on the way out at which subject gets three right.
6. NOW WE SHALL TEST YOUR LEFT EYE. CHANGE THE SHIELD OVER TO THE RIGHT EYE AND MOVE YOUR HEAD TO THE OTHER SIDE OF THE CHINREST. (Test left in same manner, starting at 24° and moving in by two degree steps.)
7. NOW WE SHALL TEST THE OTHER SIDE OF YOUR RIGHT EYE. CHANGE THE PATCH AND MOVE YOUR HEAD OVER. (Move scale over to left perimeter and test.)
8. NOW THE LEFT EYE.
9. NOW WE SHALL TEST THE UPPER PART OF EACH EYE. THE RIGHT EYE FIRST. (Swing the perimeter to the vertical, lamp at subject's left. Change to vertical numbers.)



# Contrails

10. Now the

10. NOW THE LEFT EYE.

11. NOW WE SHALL TEST THE LOWER PART OF EACH EYE. THE RIGHT EYE FIRST. (Make the necessary perimeter shift by placing slider at bottom.)

12. AND NOW THE LEFT EYE. (When done, allow subject to look at his scores. If he asks what the average is, tell him we are now finding that out for this special device with numbers, which is being used for the first time.)

## INSTRUCTIONS FOR PERIMETER TRAINING

1. The number oscillator is connected and set to run at one complete cycle per second. Slider is set at four degrees below subject's score on previous day, unless score was 12°.

2. Say: TODAY WE SHALL BEGIN TRAINING YOUR ACCURACY OF PERIPHERAL VISION. NOW, HOWEVER, THE NUMBERS WILL BE MOVING, LIKE THIS. (Start motor.) WE SHALL TRY FOUR DIFFERENT NUMBERS AT THREE POSITIONS. WE SHALL BEGIN WITH YOUR RIGHT EYE. COVER YOUR LEFT EYE AND GET YOUR RIGHT EYE CENTERED IN THE MIRROR.

3. Measure each eye in turn, starting 4° below score of previous day.\*

\* Special instructions for right and left temporal.

a. if score of previous day was 12 or 14 degrees, start at 12 degrees, try 14 degrees, then skip to twenty and also try twenty-two, even if subject fails at twenty.

b. if score of previous day was 20, 22 or 24 degrees, start at 20 degrees.

## APPENDIX III

### INSTRUCTIONS FOR FINAL TESTS

1. On the day following the final training session on the perimeter, the subjects will be retested on the dials, the tracking test, orthorater, and the alternate form of the reading test.

ALL INSTRUCTION MUST BE READ EXACTLY AS IN THE FIRST TESTS.

2. On the next day (or at the earliest, in the afternoon if the other tests were given in the morning) a retest is given on the perimeter using the same numbers as in the first test.

a. The oscillating device is detached, and replaced with the handle for centering the numbers.

b. Say: THIS IS A TEST OF YOUR ABILITY TO SEE THE NUMBERS WHEN THEY ARE NOT MOVING. I SHALL START AT A GIVEN SETTING, AND THEN MOVE OUT

*Control*

GRADUALLY FROM THERE UNTIL YOU BEGIN TO MAKE MISTAKES. WE SHALL TEST YOUR RIGHT EYE FIRST. PLACE THE PATCH OVER YOUR LEFT EYE.

- c. Start at the setting prescribed on the special Perimeter Record for Final Tests.  
Part A. Administer 3 numbers and go on to next setting. Work out by 2 degree steps. Record the number of degrees at which the subject first misses one or more of 3.
- Then go on out two degrees and see if subject misses any. If not, continue out - but if he misses one or more, record the number of degrees at which this occurs.
- d. The starting number of degrees will be 2 degrees below the lowest setting of the last training period.
- e. IMPORTANT EXCEPTIONS
- (1) If subject misses one or more on the very first setting, work in two degrees if the setting is more than 12, and continue to work in until the subject gets all three correct. In such cases, the entries in columns B and C will be the two setting just beyond this one.
  - (2) If starting point is 12, and subject misses one or more out of 3, try 14. If subject gets all correct, try 16 (but see (3) below). If he missed at 14, columns B and D read 12 and 14; in the second case 12 and 16.
  - (3) For Left Temporal and Right Temporal, if starting point is 12 or 14, both 18 and 20 must be tried. 16 is never used in any case for these positions. This is also true if subject has to work back as in (1).
- f. Note important difference from the first test: In that case we recorded the highest setting at which all 3 were correct; now we record the first two settings at which one or more out of 3 is missed.

### 3. Landolt Ring Test.

- a. This test must be separated from perimeter test by at least half a day. The special holder with Landolt rings is in place. Check that the rings are centered. Exposure is made by moving knob in direction of arrow on the "a" of "a thousand-one," and releasing knob on "two" of "a thousand-two."
- b. Say: THIS IS A TEST OF YOUR ABILITY TO SEE ANOTHER KIND OF OBJECT. THE OBJECTS ARE LITTLE RINGS WITH GAPS IN THEM, AND WILL BE SHOWN LIKE THIS. THERE ARE EIGHT SUCH RINGS. LOOK AT THIS CARD (Show model.) THE POSITIONS ARE TOP, BOTTOM, LEFT, RIGHT, TOP LEFT, TOP RIGHT, BOTTOM LEFT, BOTTOM RIGHT. USE THESE TERMS IN CALLING OUT YOUR ANSWERS. WE SHALL START WITH YOUR RIGHT EYE. ANY QUESTIONS?
- c. Administer 5 circles each at 12, 20 and 28 according to the Perimeter Record, Final Tests, Part B. If subjects get 2 or more right at the third step, also give 5 at 4th step. If two or more right at the 4th

*Control*  
step, also use 5th step. Follow the random number chart for exposures, omitting 9 and 0 where they occur.

4. Form Test.

- a. This test must be separated by at least half a day (preferably a whole day) from the previous test. The special holder with the 10 forms is in place, forms centered. Exposure is the same as for Part B, above.
- b. Say: THIS IS ANOTHER TEST OF YOUR ABILITY TO SEE OTHER KINDS OF OBJECTS. THE OBJECTS ARE LIKE THOSE ON THIS CARD. (Show card and read names of objects. Leave card at base of perimeter to be referred to by S.) THE OBJECTS WILL BE SHOWN IN THE SAME WAY THE LITTLE RINGS WERE THE LAST TIME. I AM LEAVING THE CARD WHERE YOU CAN SEE IT SO THAT YOU MAY REFER TO IT BETWEEN TRIALS FOR THE CORRECT NAMES OF THE OBJECTS.
- c. Follow the indicated procedure, with 5 objects per setting. This is much the same as for the previous test, except degree settings are different. Where random order card reads "O", show Form X.
- d. After the horizontal tests, say: THE OBJECTS WILL NOW BE ON THEIR SIDES. THIS MAY MAKE A FEW OF THEM LOOK DIFFERENT.

TABLE OF ESTIMATED FORM FIELDS, IN SQUARE CENTIMETERS,  
SHOWING RANGE FROM LOWEST (L) TO HIGHEST (H) AND MEAN (M) FORM FIELDS

Maximum Form Field is the estimated total area covered with both eyes regardless of overlap; Minimum Form Field is the estimated area of form field with complete binocular overlap; the final column, "AV.", is the mean of the two.

GROUP A

Training Session	Maximum			Minimum			AVE.
	L	H	M	L	H	M	
1	120	207	166.6	91	149	115.1	140.9
2	120	227	179.8	91	171	127.4	153.6
3	119	294	199.4	87	190	136.8	168.1
4	130	333	213.8	90	212	145.3	179.6
5	143	302	225.2	91	232	151.3	188.3
6	140	355	247.8	104	279	178.6	213.2
7	141	365	274.6	106	272	182.9	228.8
8	164	413	288.6	95	273	200.6	244.6
9	186	441	295.6	95	271	185.8	240.7
10	166	519	316.4	121	363	212.9	264.7

GROUP B

Training Session	Maximum			Minimum			AVE.
	L	H	M	L	H	M	
1	126	216	176.4	95	143	114.3	145.4
2	112	294	185.0	79	198	126.7	155.9
3	140	265	192.4	95	159	123.5	158.0
4	161	290	220.4	95	205	153.7	187.1
5	166	286	231.2	125	188	153.4	192.3
6	189	295	243.0	119	214	173.1	208.1
7	156	328	243.0	131	239	172.9	208.0
8	202	323	247.6	147	211	175.6	211.6
9	186	366	269.9	130	248	194.9	232.4
10	186	444	277.3	145	347	208.1	242.7
11	180	337	272.8	123	269	198.0	235.4
12	161	435	316.6	128	298	212.6	264.6
13	223	396	300.0	136	287	217.8	258.9
14	167	458	316.3	141	399	238.8	277.6
15	183	446	310.1	121	369	224.1	267.1
16	227	436	358.9	137	328	225.9	292.4
17	232	450	341.2	147	324	238.8	290.0
18	178	575	351.1	141	379	253.3	302.2
19	185	468	369.2	132	330	254.4	311.8
20	180	584	374.1	123	391	262.3	318.2

# Contrails

GROUP C

Training Session	Maximum			Minimum			AV.
	L	H	M	L	H	M	
1	103	253	166.7	87	139	109.5	138.1
2	120	198	166.4	86	146	116.1	141.3
3	117	257	169.1	87	160	112.7	140.9
4	94	239	189.9	86	158	122.3	156.1
5	111	290	203.0	79	190	133.6	168.3
6	156	279	212.3	102	204	145.0	178.7
7	143	309	215.4	83	197	141.0	178.2
8	158	305	226.1	103	243	155.3	190.7
9	136	356	238.7	110	270	171.7	205.2
10	166	432	279.7	111	321	200.7	240.2
11	160	365	261.4	95	261	168.6	215.0
12	173	416	280.0	122	306	204.3	242.2
13	186	438	274.6	137	287	190.9	232.8
14	185	380	285.6	119	275	198.2	241.9
15	186	432	298.0	124	302	201.1	249.6
16	207	463	326.9	112	347	217.3	272.1
17	192	536	316.5	141	372	221.0	268.8
18	216	482	317.7	144	353	222.9	270.3
19	215	583	329.1	143	347	224.9	277.0
20	206	546	332.9	139	353	237.1	285.0
21	182	671	352.3	123	410	244.2	298.3
22	190	582	337.5	158	470	247.4	292.5
23	190	618	348.1	129	460	243.4	295.8
24	242	503	350.9	150	376	251.0	301.0
25	215	624	357.0	147	416	247.8	302.4
26	257	677	373.9	147	410	260.4	317.2
27	228	702	397.4	157	583	283.1	340.3
28	194	707	377.8	151	468	266.9	322.4
29	219	748	397.8	167	497	278.4	338.1
30	225	786	389.5	150	477	260.5	325.0

# Controls

GROUP D

Training Session	Maximum			Minimum			AV.
	L	H	M	L	H	M	
1	123	233	172.2	94	156	119.5	145.9
2	131	266	196.1	99	246	143.2	169.7
3	156	342	211.8	110	285	155.8	183.8
4	139	300	215.9	104	227	146.7	181.3
5	162	360	220.6	108	202	149.9	185.3
6	162	320	237.2	112	235	166.5	201.9
7	198	360	262.4	129	242	173.5	218.0
8	186	396	262.2	108	249	180.4	221.3
9	214	397	289.9	129	309	206.4	248.2
10	187	464	296.2	136	363	214.3	255.3
11	197	435	290.9	131	300	200.6	245.8
12	203	417	287.2	136	288	200.9	244.1
13	238	450	315.2	151	311	219.4	267.3
14	215	488	316.8	144	386	233.1	275.0
15	204	446	320.3	158	342	223.8	272.1
16	234	449	333.9	139	356	238.7	286.3
17	242	567	338.3	150	311	226.6	282.5
18	240	494	362.6	147	390	252.6	307.6
19	285	555	376.4	164	347	264.4	320.4
20	243	480	355.6	147	382	264.2	309.9
21	219	446	334.5	180	366	258.9	296.7
22	267	550	379.7	168	365	260.9	320.3
23	300	527	382.7	189	397	288.8	335.8
24	282	626	409.0	221	431	303.0	356.0
25	287	661	414.6	198	426	301.9	358.3
26	262	716	414.5	207	435	310.5	362.5
27	262	630	435.8	225	431	297.2	366.5
28	330	748	454.1	215	417	307.5	380.8
29	302	697	454.4	217	505	334.7	394.6
30	308	665	466.7	211	503	335.4	401.1
31	337	698	455.5	219	539	345.3	400.4
32	302	729	466.1	199	562	343.5	404.8
33	335	729	455.9	240	491	340.4	398.2
34	340	771	474.3	248	602	356.2	415.3
35	365	887	499.9	259	618	368.2	434.1
36	382	872	502.1	252	618	369.0	435.6
37	343	744	479.5	247	612	385.3	432.4
38	323	1025	538.5	252	804	410.9	474.7
39	357	983	543.7	237	684	392.6	468.2
40	389	842	527.3	248	648	394.2	460.8