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THE EFFECT OF DISTRACTION LIGHTS UPON PERFORMANCE ON THE
MASHBURN SERIAL COORDINATION TEST

by

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A report on research conducted at the State University of Iowa,
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NATIONAL RESEARCH COUNCIL

2101 Constitution Avenue, Washington, D. C.
Division of Anthropology and Psychology

Committee on Selection and Training of Aircraft Pilots

April 28, 1944

Dr. Dean R. Brimhall
Director of Research
Civil Aeronautics Administration
Washington, D. C.

Dear Dr. Brimhall:

Attached is a report entitled The Effect of Distraction Lights Upon Performance on the Mashburn Serial Coordination Test by Roy Dale Nance, Claude E. Buxton, and Kenneth W. Spence. This report is submitted by the Committee on Selection and Training of Aircraft Pilots with the recommendation that it be included in the series of technical reports issued by the Division of Research, Civil Aeronautics Administration.

This report presents an analysis of performance on the Mashburn apparatus with and without distraction lights, supplemented by: (1) a study of the effect of lengthening the time limits on the reliability of the test, and (2) an evaluation of the effects of fatigue upon test performance. These studies, involving a small number of cases, are exploratory in character. Apart from the findings, the report is of interest as an example of cooperation between the Committee on Selection and Training of Aircraft Pilots and the Army Air Forces in the investigation of basic problems in the selection of pilots.

Cordially yours,



Morris S. Viteles, Chairman
Committee on Selection and
Training of Aircraft Pilots
National Research Council

RGR:ts

EDITORIAL FOREWORD

In 1943, the Committee on Selection and Training of Aircraft Pilots with the cooperation of the Army Air Forces and the U. S. Navy, undertook further investigation of the reliability and relative validity of certain of the psychomotor tests which were being currently employed in the selection of applicants for flight training. These studies were undertaken with the view of determining (1) the effects of extending the time limits (or increasing the number of trials) on the reliability and validity of these instruments; (2) the effects of certain other modifications in the procedures of administration on the reliability and validity; and (3) the interrelationships of these psychomotor tests and certain psychomotor and paper-and-pencil tests which are not being employed in selection batteries at the present time. The over-all goal is, of course, the construction of a selection test battery of greater validity than those already in use. Prior to the initiation of the program sponsored by the Committee on Selection and Training of Aircraft Pilots, the State University of Iowa was already cooperating with the Army Air Forces in an experimental analysis of psychomotor tests. The present report represents, to some extent, an incidental study growing out of this earlier program undertaken as a result of a conference held at the State University of Iowa in April 1943. The study was designed through the cooperation of Lt. Col. A. W. Helton, and the authors of the report, and the staff of the Committee on Selection and Training of Aircraft Pilots.

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SUMMARY

The Mashburn Serial Reaction Time Apparatus is being employed as a selection test for the prediction of ultimate success or failure in flight training. It consists of a panel on which are mounted three double rows of lights, and a platform in front of the panel on which are installed a rudder bar, control stick, and seat, simulating the principal controls found in an airplane cockpit.

At any given moment only one of the lights is on in any given row. The pattern of lights appearing in one row of each pair of rows is "selected" by the apparatus. The lights on the other row of each pair of rows can be "moved" by movements of the controls, one row being controlled by "rudder movements," another row by "aileron movements" and the third by "elevator movements." The task of the subject taking the test is to "move" the control lights so that they are matched with the lights "selected" by the apparatus. As soon as a match is made, the apparatus selects a new pattern. The score on the test is determined by the number of matchings made by a subject in a given interval of time.

In addition to the "stimulus" lights and "control" lights, there is an additional vertical row of lights on each side of the panel of the apparatus. These lights can be turned off or on at the experimenter's discretion, and are intended to be used primarily as distractors. However, they have not been consistently employed in the test situation. The purpose of this experiment was to determine the effect of these lights on the performance of subjects taking the test.

Two groups of subjects were used in this research. The first group composed of 50 service men, was given a "short test," scores being determined on the basis of eight minutes of continuous work. The distraction lights were lighted during alternate minutes of this test period. Separate scores, in terms of number of matchings, were determined for the "distraction lights on" and "distraction lights off" part of the test.

The second group of subjects, composed of 50 service men, were given a two-minute pre-test on the Mashburn apparatus with the distraction lights lighted. Pairs of subjects having equivalent pre-test scores were determined, one member of each pair being put into each of two sub-groups. One sub-group was then submitted to the test with distraction lights off, and the other group with distraction lights lighted. These groups took the "long test," consisting of three eight-minute periods on the apparatus, separated by two-minute rest periods.

At the completion of the test all subjects were asked a number of questions regarding their opinions in reference to various aspects of their performances.

The results of the experiment indicated that:

1. The fact that the distraction lights are lighted or not lighted makes little or no difference in average scores of men taking the test under the two conditions, and the relationships between scores made under the two conditions are high.

2. Both the long and the short tests are highly "reliable," i.e., if the men were tested again, the scores on the re-tests would probably be consistent with the scores on the original test. The long test was found to be more reliable than the short test.

3. There is a high relationship between scores on the first half of both tests and the scores on the complete tests.

4. While the men answered differently to questions regarding their opinion of the effect of the distraction lights on their performance, regarding their feelings of fatigue, and their methods of moving the controls, no significant differences were found in average scores of groups of men who gave affirmative and negative answers to the various questions.

THE EFFECT OF DISTRACTION LIGHTS UPON PERFORMANCE ON THE MASHBURN SERIAL COORDINATION TEST¹

INTRODUCTION

With the reawakening of interest in aviation psychology shortly preceding this war, the development of tests and instruments for the selection of potentially successful candidates for flight training was greatly accelerated. Considerable emphasis was placed on the development of psychomotor tests on the grounds that flying an airplane demands complex and accurately coordinated movements of the hands and feet.

The Mashburn Serial Reaction Time apparatus (see Figure 1) has been one of the most widely used Psychomotor tests in which the actual control operations of a plane are simulated. In the Harvard revision of the original model a number of "distraction lights" were added to the control panel.² These "distractors," however, have not been consistently used in the test situation. In fact, no provision is made for their use in the present testing procedures. This study represents a preliminary investigation of the effect of these distractors on the test results.

APPARATUS

The Mashburn Serial Reaction Time apparatus consists of an upright panel (see Figure 1) on which are mounted three double rows of jeweled signal lights, thirteen signal lights appearing in each row. One row in each of the double rows consists of green "jewels," the other of red "jewels." A rudder bar, control stick, and seat, simulating the principal controls found in an airplane cockpit, are installed directly in front of this panel of lights.

In the test situation the stimulus objects are three red lights, one in each of the rows of red pilot lights. At any given moment only one red light is lighted in each of the rows, the particular pattern (location of the three lights) being automatically "selected" by stepping relays built into the apparatus (see Appendix A). Similarly, at any given moment only one green (control) light is lighted in each of the rows of green pilot lights. The location of the green jewels which are lighted is, however, dependent upon the position of the controls (rudder bar and stick). Right-left movements of the stick cause the green light in the upper row to "move" from right to left. Forward movement of the stick causes the green light in the perpendicular row to move down, and backward movement of the stick moves it up. Movement of the rudder bar with right or left pressure causes the green light in the bottom row to move right or left respectively.

¹A thesis submitted by R. D. Nance in partial fulfillment of the degree of master of arts in the Department of Psychology, State University of Iowa, Iowa City, Iowa.

²McFarland, R. A. and Channell, R. C. A Serial Reaction Time Apparatus for Appraising Pilot Aptitude. Boston: Harvard University, 1943. (Copy in Committee files.)

The task of the subject is to adjust the green (control) lights by appropriate movement of the controls so that they are in direct alignment with the red lights, (i.e., the subject must arrange the green lights in the same pattern as the pattern of red lights which is automatically selected by the stepping relays of the apparatus). When he succeeds in matching positions of green lights with red ones, and in maintaining the matching for approximately 0.5 second, the apparatus automatically presents a new (red) stimulus pattern. The whole cycle is then repeated.³

In addition to the rows of stimulus and "control" lights a single row of five lights, alternately red and green, is located on each side of the "lights" panel. These lights are independent of the stimulus patterns and of the control movements, and are intended to be used primarily as distractors. They can be turned on or off at the experimenter's discretion (see distraction lights, Figure 1).

A control unit placed on the experimenter's table is wired into the regular circuit of the apparatus. This unit contains the master switch for the apparatus and an emergency button which activates the stepping relays controlling the presentation of patterns of lights. A commercial "magnetic message-register" records the number of matchings and makes it possible, therefore, for each man's score to be read directly for any length of the test period. (For a more complete description and wiring diagram of the control unit, see Appendix A, Figure A-I.)

STATEMENT OF THE PROBLEM

The Washburn apparatus has sometimes been operated with the distraction lights burning constantly and sometimes without. Although the test is being employed quite successfully in the selection of pilot personnel, the question might be raised as to whether presence of the distraction lights increases or decreases the validity of the test.⁴ If the distraction

³The number of settings before the test begins to repeat the pattern is thirteen. There are three such repeated patterns in each revolution of the stepping relay. In this experiment, a rest period was inserted following a given period of practice on the test. When the subject resumed his task, he began at whatever setting had not been completed at the moment the preceding practice trials were halted.

⁴In a preliminary study made in the spring of 1943, 20 civilian men and 40 women were used as S's. Randomly selected halves of male and female groups were given the test with and without distraction lights, respectively. The results were contradictory, i.e., the women in the without-distraction-lights group made slightly higher scores than did women in the with-distraction-lights group. Conversely, the male group with-distraction-lights made slightly higher scores than did the male group without-distraction-lights. In both cases the differences were not statistically significant. It was decided, therefore, to repeat the experiment using a larger group of male subjects only. See Buxton, C. E. The effect of distraction lights upon performance on the Washburn Serial Coordination Test. Iowa City: State University of Iowa, 1943. (Unpublished.)

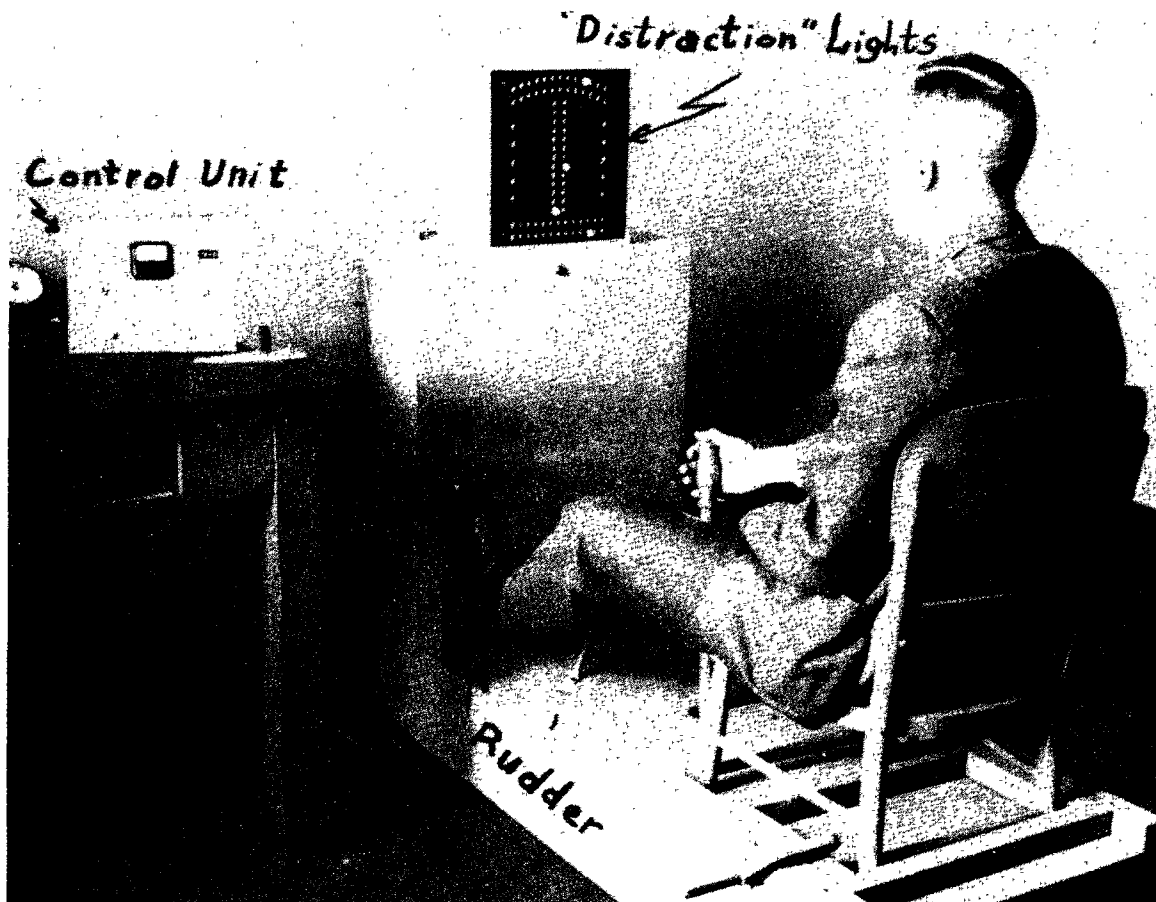


Figure 1

The Mashburn Serial Coordination Test

tion lights produce no significant change in the rank order of subjects taking the test, there is no reason for the armed services to be concerned with this aspect of the test. If such a change does seem to occur, the armed services can then secure empirical validation data to determine how the test might best be administered.

The chief purpose of this experiment was to determine the effect of the distraction lights on (1) the rank order of the test subjects and (2) the level of their performance on the test.

The design of the experiment also provides the following information:

1. An estimation of the reliability of the Mashburn Test under these particular conditions.
2. The correlations between various portions of the test and the total test scores, i.e., the determination of the minimum test length possible under these conditions which provides the same rankings as those obtained by using the total test.
3. An evaluation of the effects of fatigue upon performance on the test.

SUBJECTS

The 100 service men serving as subjects in this experiment were divided almost equally between two different age groups, the average of one group being 19 years and the other, 26 years. The two age groups showed approximately the same performance during the short test. It was decided, therefore, to retain them both. The younger group showed a slightly higher average score on the longer test period but even here the difference was not significant. Motivation of subjects seemed to be uniformly high.

EXPERIMENTAL PROCEDURE

General. The 100 subjects were divided into two groups of 50 each. One of these groups took the "short test" in which each subject performed for 8 minutes on the Mashburn. The other took the "long test" and performed a total of 24 minutes. Test scores (number of matchings) were recorded for each subject at the end of each one-minute period of work. At the beginning of the tests the experimenter carefully demonstrated how the apparatus worked and what the subject was supposed to do. Oral directions were given explaining the test and the desired performance (see Appendix B for exact instructions to the subject).

The Short Test (8 minutes work). The short test may be described as follows: After demonstration of one setting of lights by the experimenter, the subject sat in the chair, manipulated the controls, and then removed his hand from the stick. At the appropriate signal he then began the test.

Twenty-five of the subjects in one group started the test with the vertical side lights (distraction lights) illuminated. This is to be referred to as Order A, short test. The remaining 25 men in the group began the test with the vertical side lights not illuminated. This is to be referred to as Order B, short test.

At the end of each one-minute period of work, these lights were switched off (or on). The "A" group, therefore, had the distraction lights burning during their odd-numbered minutes of work, while the "B" group had the lights burning during their even-numbered minutes of work. The subjects were tested in an ABBAEBBA order.

The Long Test (24 minutes work). The long test began (following a demonstration by the experimenter, etc.) with a 2-minute pre-test period during which the distraction lights were illuminated for all subjects. On the basis of the pre-test scores the 50 subjects were split into two matched groups. The groups were matched by selecting pairs of subjects who made similar scores. Each pairing was made to within one matching (1 score point) of lights on the test. One member of each pair of subjects was given the test with the side (distraction) lights illuminated, the other member with the side lights turned off.

The "lights" condition is to be referred to as Condition A, long test; and the "no-lights" condition is to be referred to as Condition B, long test. A rest period of 2 minutes was given after the 8th and 16th minutes. During this rest period the subject was instructed to remove his hands and feet from the controls.

Test Conditions. All of the testing was carried out in the evening between 7 and 10 o'clock in a quiet room. The window shade was drawn, and a ceiling light (60 watts) was left burning. In this moderately dim illumination the experimenter was able to observe the subject's performance and yet the panel lights stood out clearly enough for the subject to distinguish them.

Subjective Data. In order to get an indication of the subjects' opinions concerning their own performance for comparison with their actual performance records, a list of questions was drawn up for both the short and the long test groups.

The questions for the long test were mimeographed and presented to each subject after the test was completed (see Appendix C). He answered these without any help from the experimenter. Questions for the 2-minute test were presented orally.

RESULTS

Effect of Distraction Lights Upon Rank Order of Subjects

In order to approximate the true correlation between performance under the two conditions (lights and no-lights) it would be necessary to run the same group of men twice, once with lights and once without, and to eliminate

the effects of previous experience. Due to the learning which is involved this procedure was impossible in actual fact, for on the second test the subjects probably would have been ranked in a different fashion, both because some of them might have profited more from practice than others and because the two conditions might demand different "abilities." In the light of these considerations, another procedure was employed to provide an approach to the true correlation.

For the short test, two scores were obtained for each man -- total score with lights, and total score without lights. These 50 pairs of scores were correlated. The procedure used here is roughly analogous to correlating odd and even trials on a test, but the "lights" factor enters in so that the two halves cannot be assumed to be exactly comparable in Order A and Order B.

It was assumed that two half-scores secured in this manner would be more comparable to each other than would scores on two tests (one with lights, one without) taken at different times with no carry-over of practice effects, since, with the exception of the major variable, lights--no-lights, such experimental conditions as the physiological state of the individual and other sources of systematic variation in level of performance stay nearly the same for both halves of the test. The correlation figure obtained between the two half-scores probably may be considered the upper limit which the true figure could possibly reach.

For the long test, scores of the 25 men on Condition A (lights) were correlated with the scores of the 25 men on Condition B (no-lights). These two groups had been matched as nearly as possible so that men in one group would be like the men in the other as regards initial level of performance on the test. It was considered legitimate, therefore, to correlate these two sets of scores just as though they represented one group of subjects, instead of two, and to assume that the obtained coefficient would set a lower limit for the true figure. It was assumed that this coefficient would be lower than the true figure since the two groups were not identical.

The "lights--no-lights" correlation coefficient for the short test was .84, and for the long test, .62. If we can assume that these two values set the limits for the true value then we may conclude that the true correlation between the two test conditions is relatively high. The introduction of the distraction, lights probably does not materially disturb the ranking of the subjects.⁵

⁵Editor's Note. It should be noted that these limits are set without regard to the difference in length of the tests. The correlation coefficient of .84 for the short test represents the correlation between two 4-minute tests, while the correlation coefficient of .62 for the long test represents the correlation between two 24-minute scores.

Levels of Performance

Changes in performance with different amounts of practice were determined for both the short and the long test. These changes are presented graphically in Figures 2 and 3. In both tests, the curve for the "lights" condition started out higher than the curve for the "no-lights" condition. The latter, however, was higher toward the end of the practice period.⁶

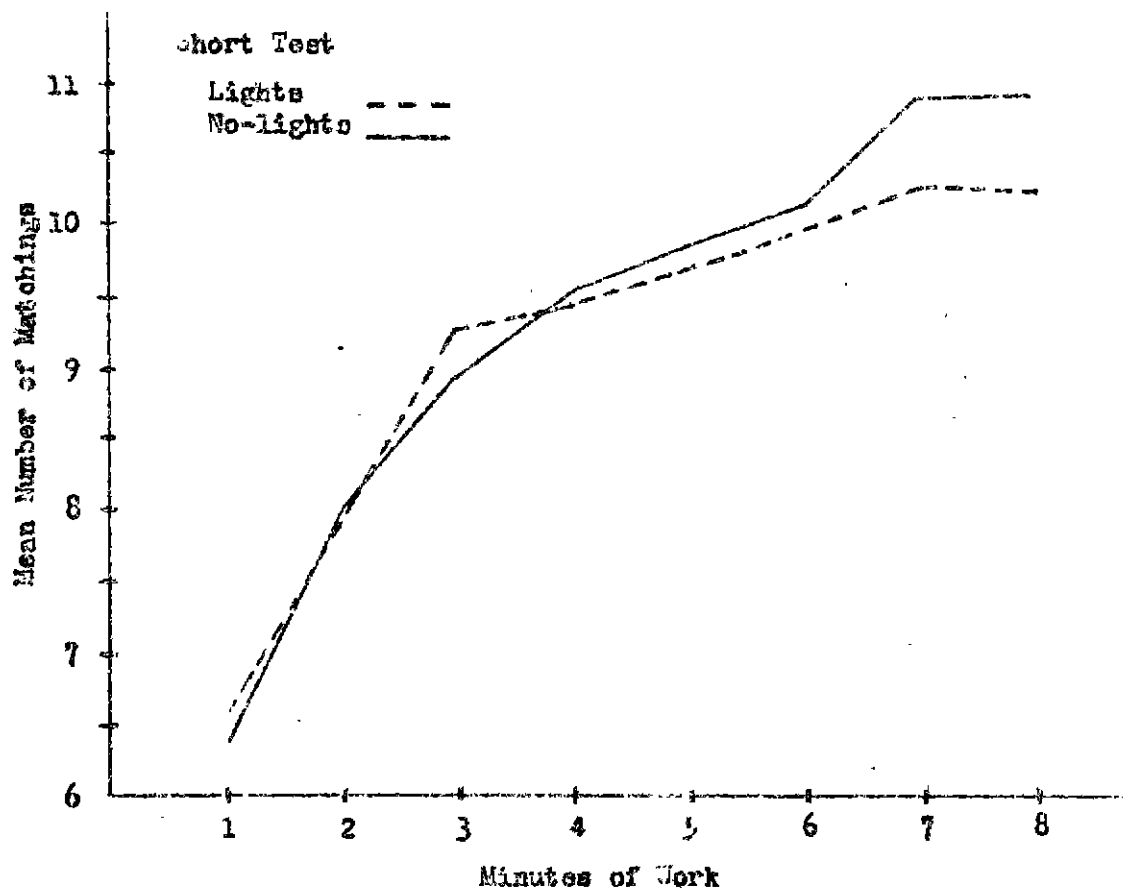


Figure 2
Changes in Performance with Practice
(Short Test)

⁶Data on which these curves are based are presented in Appendix D, Tables D-1 and D-2.

Presented in Table I are the means, standard deviations, and t's for the difference in performance under the lights and no-lights conditions for both the short and the long test. For the short test, the mean score made with the lights was compared with the mean score made without the lights. For the long test, mean total score made on Condition A (lights) was compared with the mean total score made on Condition B (no-lights).

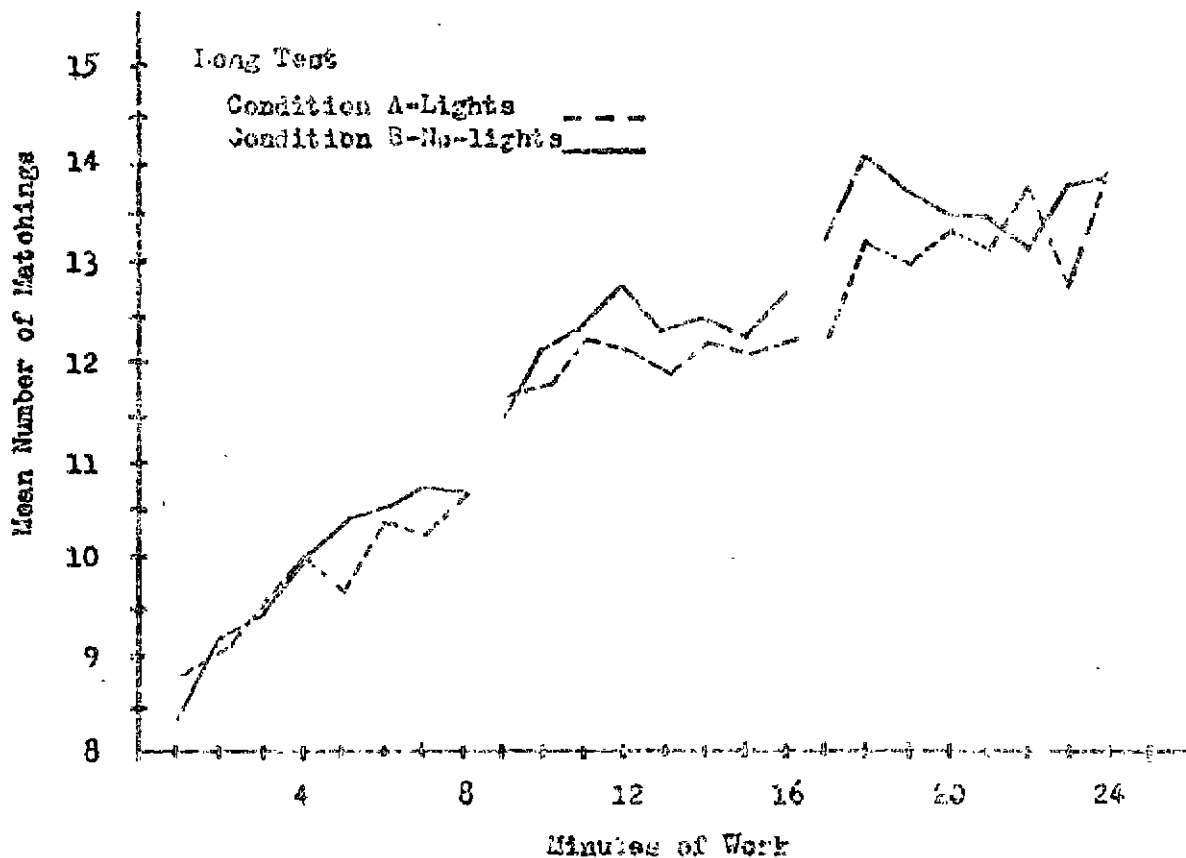


Figure 3
Changes in Performance with Practice¹
(Long Test)

¹Breaks in the lines indicate the two-minute rest period which was given after every eight-minute period of practice.

TABLE I

MEAN SCORES ON LONG AND SHORT TESTS WITH AND WITHOUT DISTRACTION LIGHTS

<u>Tests and Conditions</u>	<u>Mean Number of</u> <u>Mistakes</u>	<u>Standard</u> <u>Deviation</u>	<u>t</u>
Short test, Lights	36.5	6.9	1.07
Short test, No-lights	37.1	7.2	
Long test, Lights	280.0	40.7	.81
Long test, No-lights	286.0	43.4	

Although there is a fairly consistent difference in favor of the "no-lights" condition on both the short and the long test, neither of these differences approached statistical significance. Therefore, the superiority of the performance in the "no-lights" condition could be attributed to chance. The presence or absence of the so called distraction lights seems to be a matter of little consequence as far as the mean level of performance on the Mashburn is concerned.

Reliability of the Tests

Reliability coefficients were computed for performance of the four groups of subjects. In the case of the two conditions of the long test, odd-even coefficients were obtained. A more complex procedure was necessary in the case of the short test. The Condition A subjects had had "lights" on the odd minutes of work and "no-lights" on the even minutes. The Condition B subjects had had exactly the reverse. An odd-even coefficient in either of these cases would have matched "lights" scores with "no-lights" scores and would have been influenced by the variable whose effect was the main problem of investigation. The best that could be done in this case was to obtain two "lights" scores and two "no-lights" scores for each individual. These scores were then correlated in the following fashion:

<u>Lights</u>		<u>No-lights</u>	
<u>Minutes</u>	<u>Minutes</u>	<u>Minutes</u>	<u>Minutes</u>
A1 and 5	A3 and 7	A2 and 6	A4 and 8
B2 and 6	B4 and 8	B1 and 5	B3 and 7

The letter "A" accompanied by an odd number refers to a minute of work when the distraction lights were turned on. Accompanied by an even number, it signifies that the distraction lights were turned off. The opposite is true for "B". The effect is that, in both the above cases, the first and third "lights" scores are being correlated against the second and fourth "lights" scores and that the first and third "no-lights" scores are being correlated against the second and fourth "no-lights" scores. These corre-

lations are presented in Table II.⁸

TABLE II

RELIABILITIES OF LONG AND SHORT TESTS WITH AND WITHOUT DISTRACTION LIGHTS

	<u>Lights</u>	<u>No-lights</u>
Short Test	.83	.82
Long Test	.97	.96

The lights--no-lights variable apparently produced practically no difference in reliability of performance. Only the usual factor of length of work sample seemed influential. It will be noted that here, as in other studies, the estimated reliability of Mashburn performance is high.

Correlations Between Segments of the Tests

An attempt was made to discover to what extent scores on various portions of the test were correlated with the total test scores. On the basis of such data it may be possible to shorten the tests, in the interests of economy of time and effort, without substantially changing validity coefficients previously secured on the basis of the total scores.

It was discovered that by the end of the first minute of work on the two orders of the short test, the scores were beginning to be distributed in somewhat the same manner as that existing at the end of eight minutes. The coefficients obtained for the short test are presented in Table III.

TABLE III

CORRELATION BETWEEN SCORES AT END OF FIRST AND FOURTH
MINUTE, AND TOTAL SCORES
(Short Test)

	A (Lights on odd-numbered minutes)	B (Lights on even-numbered minutes)
First minute with Total	.82	.72
First four minutes with Total	.95	.97

⁸Editor's note. It is not indicated whether those reliabilities have been corrected by means of the Spearman-Brown formula. If they have not, the figures for the short test represent the correlation between two 2-minute scores; those for the long test represent the correlation between two 12-minute scores. It should be noted that the reliability figures for the short test are approximately equal to the correlation coefficient of .84 between conditions of distraction and non-distraction, whereas the reliabilities for the long test are much higher than the correlations between scores of paired subjects.

It appears that for purposes of ranking a group of subjects according to their performance on this apparatus, a test half as long as the one used here would be sufficient.

The same data obtained for the long test showed slightly lower correlations. In this case, segments of the long test were compared which, in the early stages of practice, overlapped less with the total score than was the case for the short test. The results of this analysis of the long test are presented in Table IV.

TABLE IV
CORRELATIONS BETWEEN SEGMENTS OF THE TESTS AND TOTAL SCORE
(Long Test)

	A (Lights)	B (No-lights)
Pre-test score with Total	.71	.82
First 4 min. with Total	.86	.94
First 8 min. with Total	.94	.96
First 12 min. with Total	.97	.99
First 16 min. with Total	.99	.99
First 20 min. with Total	.99	.99

It will be noted that by the end of the first four minutes there is a correlation of .94 with the total score for the Condition B (non-distraction) group; and that by the end of eight minutes, scores under both "A" and "B" conditions showed a sufficiently high relationship with total scores for most purposes. The scores after 12 minutes ranked the men in almost exactly the same order as they were ranked by total scores. Five of the coefficients were .99, and one .97.

The correlations between scores on each segment of the long test (total score for each of the 3-minute work periods which were separated by a two-minute rest) also are uniformly high, all coefficients being within the range of .85 to .95, as is evident from Table V. A high degree of relationship, therefore, is indicated between scores on one segment of the test, and scores on any other segment.

TABLE V

INTERCORRELATION BETWEEN SCORES ON 8-MINUTE SEGMENTS OF LONG TEST

8-minute Segments	A (Distraction)	B (Non-distraction)
1 vs. 2	.901	.894
1 vs. 3	.854	.907
2 vs. 3	.947	.914

Questionnaire Data

As was indicated earlier (see experimental procedure), the subjects were asked to answer a series of questions regarding their performance under the different conditions. The following three questions were asked orally to the men taking the short test:

1. "Did you find it any easier to match when the side lights were off than when they were on?"
2. "Did the turning off and on of the side lights itself bother you?"
3. "Did you get tired enough toward the end to have it affect your performance?"

In spite of the leading nature of these questions, less than half the men answered questions 1 and 3 affirmatively, 17 and 12 men respectively giving "yes" answers. Thirty of the fifty subjects answered question 2 affirmatively, stating that the turning off and on of the distraction lights bothered them.

As is evident from Table VI, there was very little relationship between the answers to these questions and actual performance on the test. The mean total scores of groups of subjects answering each question "yes" or "no" differed only slightly.⁹ In no case did the difference approach statistical significance.

The subjects taking the long test were given a mimeographed sheet containing six questions (see Appendix C). The answers to questions 1, 2, and 4 are tabulated in Table VII.

Only the 25 men taking the test under Condition A answered question 1: "Do you think the lights on the sides had any effect on your performance?"

⁹The group of men who stated that they found the test easier when the distraction lights were off actually showed a higher mean score than did the group of men who answered question 1 negatively. The difference, however, was small and not significant.

TABLE VI

MEAN SCORES ON SHORT TEST OF GROUPS OF MEN GIVING AFFIRMATIVE AND
NEGATIVE ANSWERS TO QUESTIONNAIRE ITEMS

<u>Question 1</u>	<u>N</u>	<u>Mean No. Matchings</u>	<u>S.D.</u>
Yes	17	75.0	11.4
No	33	72.9	14.4
<u>Question 2</u>			
Yes	30	73.5	11.2
No	20	73.9	16.3
<u>Question 3</u>			
Yes	12	72.8	15.9
No	36	73.9	12.6

If so, what?" Men who answered "yes" mentioned the glare and the resultant added fatigue. Some confusion was reported when the top and bottom "working" or test lights were at the extremes within their rows and thus close to the distraction columns, but no mention was made of the lights as a serious influence. The difference in performance, although not statistically significant, was in favor of the group who said that the side lights had no effect upon their performance.

All 50 men answered question two: "Did you notice yourself getting tired? If so, how did this affect your performance?" Thirty-nine of the men reported subjective evidence of fatigue, but eight of these said it had little or no effect on their performance. Mention was made of unsteadiness, of decreasing accuracy and ability to coordinate, and slowing up of reaction. The difference, though not statistically significant, was in favor of the men who reported fatigue. The standard deviation of the distribution of mean scores for the "yes" group was markedly smaller than that for the "no" distribution, although again the difference lacks statistical significance. It might be tentatively hypothesized that the men who reported fatigue were more highly motivated, worked harder, and thus yielded more homogeneous performances.

Question four concerned the method of matching the lights: "Did you make the matchings one right after the other for the three different rows of lights, and hold each one, or did you attempt to make all three matchings at the same time?" Tabulation indicated that 26 men matched successively, or "one after the other," 6 simultaneously or "at the same time," and 18 men used both methods.

As is evident from Table VII, the differences in mean scores between the groups matching "successively" and "simultaneously," and "successively" and "all others" were the largest ones found. The group who matched suc-

cessively or "one after the other" had lower mean scores. These differences although relatively large were not significant, yielding t values of .83 and 1.16 respectively.¹⁰

TABLE VII

MEAN SCORES ON LONG TEST OF GROUPS GIVING AFFIRMATIVE AND
NEGATIVE ANSWERS TO QUESTIONNAIRE ITEMS 1, 2, and 4

<u>Question 1</u>	<u>N</u>	<u>Mean No. Matchings</u>	<u>S.D.</u>
Yes	7	270.7	42.4
No	18	283.6	39.4
<u>Question 2</u>			
Yes	39	284.1	37.4
No	11	279.0	55.7
<u>Question 4</u>			
<u>Controls moved:</u>			
successively	26	276.3	44.8
simultaneously at least part of the time	24	290.3	37.8
always simultaneously	6	293.3	38.1

Question three was phrased: "Did the rest period affect your performance? If so, how?" Three subjects claimed a harmful effect from the rest period, implying that it "threw them off their stride." One other subject spoke of an immediate harmful effect but a general beneficial one. All others were fairly definite about the beneficial effects of the rest period. They spoke in terms of "relaxation," "escape from tension," "resting of the eyes."

¹⁰Editor's note. If differences of this magnitude were found in a large sample, alterations in the directions given to subjects before the test might well be indicated. The directions to the subject contain the statement, "You will do best if you match the top and middle lights with the stick first." (See Appendix B.) In view of the fact that the mean scores of men who ignored this suggestion and matched simultaneously were considerably higher than the mean scores of the men who acted in accordance with this suggestion, it is conceivable that an extraneous variable, "following instructions," related negatively to performance, might have been inserted into the test situation by the nature of the directions to the subject.

There was no division of opinion regarding question five, "Did the little jewels (lights) along the sides have any effect on your performance even though they were not turned on?" The 25 men in the "B" or non-distraction-lights group were unanimous in denying any effect.

Question six, also answered by only the 25 men in the "B" group, was phrased: "Did the change from having the lights on the sides turned on during the practice period to having them turned off during the actual test bother you? That is, did it have any effect on your performance? If so, what?" One man stated that his performance seemed better after the practice period, but that presence or absence of the lights probably had little to do with it. The remainder of the men simply answered "no" to the question.

SUMMARY AND CONCLUSIONS

This report has presented an experimental investigation involving the effect of distraction lights on performance on The Washburn Serial Coordination Test. The specific problem was to test the effect of the two vertical rows of red and green distraction lights appearing on each side of the stimulus panel of that instrument on the subject's performance in the test.

Two groups of subjects were employed. The first group, composed of 50 service men, were given a short test. Scores on the test were determined from the number of "matchings" of stimulus and control lights during an eight-minute period of continuous work. The distraction lights were illuminated during alternate minutes of this test period.¹¹ Separate scores, in terms of number of matchings, were determined for the "distraction lights on" and "distraction lights off" parts of the test.

The second group of subjects, composed of 50 service men, were administered a 2-minute pre-test on the Washburn apparatus with the distraction lights lighted. On the basis of these pre-test scores, two matched sub-groups of 25 men each were obtained. One of these sub-groups was given the long test with distraction lights burning, the other sub-group was given the long test without distraction lights. The long test consisted of three eight-minute periods on the Washburn, separated by two-minute rest periods. All scores, again, were in terms of number of matchings of stimulus and control lights.

At the completion of the test period questionnaires were submitted to all subjects. The subjects taking the short test were required to express their opinions on the effect of the distraction lights on their performances, and on the effect of fatigue on their performances. In addition the subjects taking the long test were questioned regarding their opinion of the effect of the rest periods on their performance, and regarding their method of handling the controls on the Washburn apparatus.

¹¹Half of the men in this group began the test with lights off, i.e., the lights were off during the odd minutes in the period. For another half of the men the lights were off during the even minutes of the period.

On the basis of the results obtained in this experiment, the following tentative conclusions may be drawn:

1. The fact that vertical rows of distraction lights are lighted or not lighted makes little or no difference in the mean level of performance under the two conditions and the correlation between scores made under the two conditions is high. The true correlation between performance under the two conditions probably lies within the limits .62 and .84. The coefficient .84 represents the relationship between scores with lights and without lights for the same group of individuals. The coefficient .62 represents the relationship between scores of paired members of two sub-groups, one sub-group taking the test with distraction lights burning, the other with distraction lights not burning.
2. Both short and long tests showed a high split-half reliability, the latter, as expected, being the more reliable. The reliability coefficients for the short test under the distraction lights and non-distraction lights conditions were respectively .83 and .82. The comparable reliability coefficients for the long test were .97 and .96.
3. On the short test, scores at the end of the first four minutes correlated .95 and .97 with the total scores, for the distraction and non-distraction conditions respectively. On the long test, scores at the end of eight minutes under the two conditions correlated .94 and .96 with their respective total scores. When scores for progressively longer periods were correlated with total score, progressive increases in the correlation coefficients were noted.
4. No statistically significant differences in mean scores were evident between groups of men answering given questionnaire items affirmatively and negatively. It is of interest, however, that:
 - a. At least one-third of the subjects stated that the side lights had been a distraction.
 - b. Over half the subjects taking the short test stated that the change in the distraction lights (the fact that they were lighted and unlighted during alternate minutes of work) was distracting.
 - c. At least half the subjects in both groups reported that they began to feel tired during the course of the test.
 - d. Twenty-six of the subjects taking the long test reported that they made control adjustments first with one control and then with the other, i.e., that they moved the controls "one after another" or successively. The remaining 24 reported that they moved stick and rudder simultaneously at least a part of the time. The mean score of this latter group was markedly higher than the mean score of the group who moved the controls "successively," but the difference was not statistically significant.

APPENDIX A

Hashburn Counter Circuit
and
Hashburn Control Unit

Mashburn Counter Circuit

This device consists of a Western Electric 12A message register and suitable voltage supply.

A rectifier circuit supplies 25 volts for the register coil. This coil is in series with the normally made contact of a relay. The coil of this relay is in parallel with the stepping relay coil of the Mashburn apparatus. When a "match" on the Mashburn has been successfully completed, 110 volts a.c. are applied to the coil of the stepping relay, and consequently to the coil of the counter circuit relay. The relay operates, breaking the normally made contact in series with the message register coil putting the register into operation. As soon as the Mashburn stepping relay also operates, the voltage supply to itself and to the counter circuit relay is removed; thus, the message register locks up again in readiness for the next match.

It was found necessary to use a break rather than a make circuit for the message register coil because of the lag in operation in making.

MASHBURN COUNTER CRT

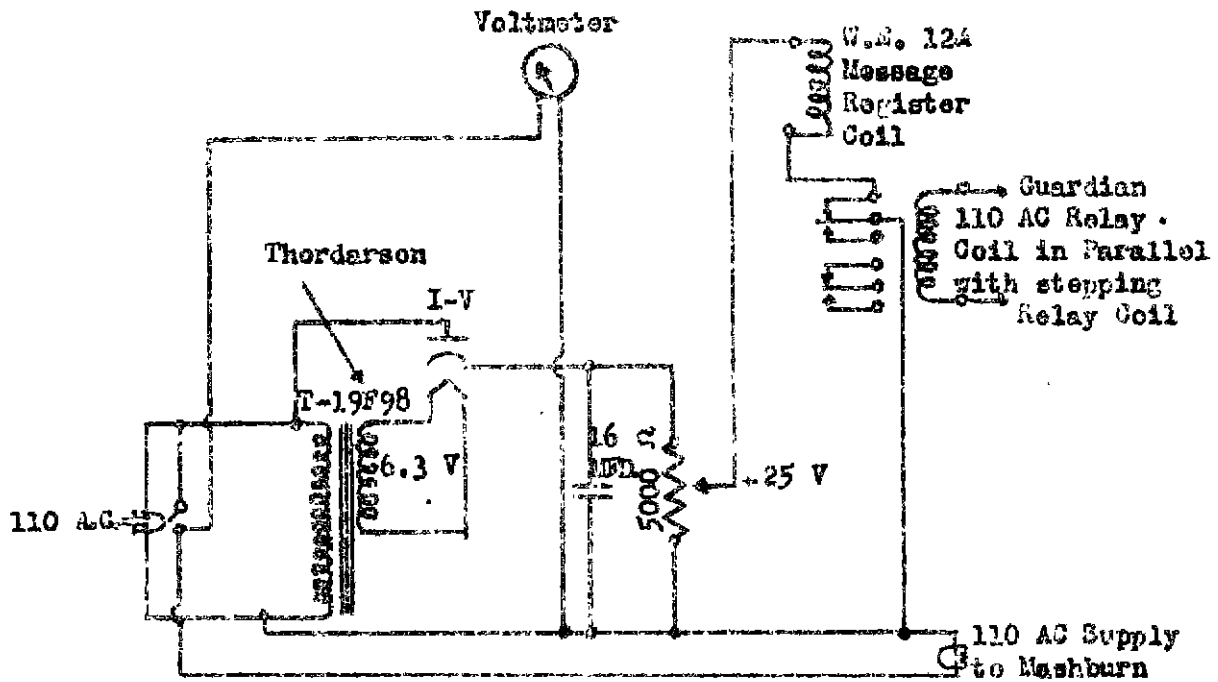


Figure A-1
Control Unit, Mashburn Test

APPENDIX B

Directions to the Subject
(Mashburn Test)

APPENDIX B

Distraction; Mashburn; Nance, 1943
(Instructions for 8-min. test)

Apparatus turned on

1. During demonstration by examiner. "This is a coordination test. When you sit in the chair (examiner takes a seat in apparatus), push your right foot forward on the rudder bar as far as possible (demonstrate) to see if the chair needs adjusting for you. Keep your feet well up on the rudder bar so that your heels do not touch the floor."

2. "Your task is to match each of these three red lights (point) with a green one. The red lights are stationary, but you can move the green lights by operating the stick and the rudder bar. If the green light goes off altogether, it means that you are between electrical contact points. Keep moving until you find out where you are. When you have matched all three of the lights, you must hold it for a half-second; and then a new setting of red lights will appear (demonstrate slowly with setting No. 1)."

After completing setting No. 1, say:

3. "The new setting is then to be matched as quickly as possible in the same way. You will hear a buzzing sound from my control box at intervals, but pay no attention to it. The vertical lights on the sides (point) will be alternately turned off and on, but you are to keep right on working."

4. While candidate is seated, and after adjustment of seat: "Use only your preferred hand on the stick throughout the test. Do not match the lights now but move the controls as I direct you. Move the green light in the top row by moving the stick to right and left. Try it. Move the middle green light by moving the stick toward and away from you. Try it. Move the green light in the bottom row by moving the rudder bar. Try it. Now let go of the stick. You will do best if you match the top and middle lights with the stick first."

5. "Now we are ready for the test. It will be a little less than ten minutes long. Match as many patterns of lights as you can. Your score will be the number of patterns you match. You are not to talk during the test. (Read counter.) Ready (start clock). Begin."

6. At end of eight minutes, stop apparatus.

Note 1: Voltmeter must read at least 115 volts.

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Distraction; Mashburn; Nance, 1943
(Instructions for 24-min. test)

Apparatus turned on

1. During demonstration by examiner. "This is a coordination test. When you sit in the chair (examiner takes seat in apparatus), push your right foot forward on the rudder bar as far as possible (demonstrate) to see if the chair needs adjusting for you. Keep your feet well up on the rudder bar so that your heels do not touch the floor."
2. "Your task is to match each of these three red lights (point) with a green one. The red lights are stationary, but you can move the green lights by operating the stick and the rudder bar. If the green light goes off altogether, it means that you are between electrical contact points. Keep moving until you find out where you are. When you have matched all three of the lights, you must hold it for a half-second; and then a new setting of red lights will appear (demonstrate slowly with setting No. 1)."
- After completing setting No. 1, say:
3. "The new setting is then to be matched as quickly as possible in the same way. You will hear a buzzing sound from my control box at intervals, but pay no attention to it."
4. While candidate is seated, and after adjustment of seat: "Use only your preferred hand on the stick throughout the test. Do not match the lights now, but move the controls as I direct you. Move the green light in the top row by moving the stick to the right and left. Try it. Move the middle green light by moving the stick toward and away from you. Try it. Move the green light in the bottom row by moving the rudder bar. Try it. Now let go of the stick. You will do best if you match the top and middle lights with the stick first and then the bottom light."
5. "Now we are ready for the test. There will be first a practice period of two minutes followed by three trials, each a little less than ten minutes long, with a brief rest period between trials. During this rest period, you are to simply lean back in your chair and relax. After each rest, you are to wait until I tell you to go before starting to operate the controls again. Match as many patterns of lights as you can. Your score will be the number of patterns you match. You are not to talk during the test." (Read counter.) "Ready (start clock). Begin."
6. Stop apparatus according to plan outlined in instructions.

Note 1: Voltmeter must read at least 115 volts.

APPENDIX C

Mimeographed Questions Used With the Long Test

Name _____

Group _____

Distraction; Lashburn; Nance, 1943
Questions -- Long Test

Subjects for whom lights on sides were turned on during the actual test,
answer questions 1-4.

Subjects for whom lights on sides were not turned on during the actual test,
answer questions 2-6.

Questions:

1. Do you think the lights on the sides had any effect on your performance? Yes _____ No _____. If so, what?

2. Did you notice yourself getting tired? Yes _____ No _____. If so, how did this affect your performance?

3. Did the rest period affect your performance? Yes _____ No _____. If so, how?

4. Did you make the matchings one right after the other for the three different rows of lights and hold each one, or did you attempt to make all three matchings at the same time? One after another _____ Same time _____.

5. Did the little jewels (lights) along the sides have any effect on your performance even though they were not turned off? Yes _____ No _____. If so, what?

6. Did the change from having the lights on the sides turned on during the practice period to having them turned off during the actual test bother you? That is, did it have any effect on your performance? Yes _____ No _____. If so, what?

APPENDIX D

Mean Scores for Successive Minutes of Work
on the Short and Long Tests

TABLE D-1

MEAN SCORES FOR SUCCESSIVE MINUTES OF WORK
(Short Test)

<u>Minute of Work</u>	<u>Lights</u>	<u>No-lights</u>
1	6.6	6.3
2	7.9	8.0
3	9.2	8.9
4	9.4	9.5
5	9.6	9.8
6	9.9	10.1
7	10.2	10.8
8	10.2	10.8

TABLE D-2

MEAN SCORES FOR SUCCESSIVE MINUTES OF WORK
(Long Test)

<u>Minute of Work</u>	<u>Lights</u>	<u>No-lights</u>
1	8.8	8.4
2	9.1	9.2
3	9.5	9.4
4	10.0	10.0
5	9.7	10.4
6	10.4	10.5
7	10.2	10.7
8	10.6	10.6
9	11.6	11.4
10	11.8	12.1
11	12.2	12.4
12	12.2	12.8
13	11.9	12.3
14	12.2	12.4
15	12.1	12.3
16	12.2	12.7
17	12.2	13.1
18	13.2	14.1
19	13.0	13.7
20	13.3	13.5
21	13.1	13.4
22	13.8	13.1
23	12.8	13.8
24	14.0	13.9