INTELLECTUAL CHANGES DURING PROLONGED PERCEPTUAL ISOLATION (DARKNESS AND SILENCE)

A Thesis

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by

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ABSTRACT OF THESIS

Recent studies of the effects of isolation upon human subjects have largely ignored intellectual performance. These studies have also concentrated on short periods of isolation. This study is an attempt to evaluate the effects of sensory deprivation on a variety of intellectual abilities on subjects confined for a relatively long period of time.

Sixteen subjects were placed in a dark and sound-proofed chamber for a period of a week or longer. A battery of tests, measuring eleven different abilities, was administered before, during and after isolation. A matched group of 16 control subjects were given the same tests at the same time intervals.

No significant difference was found between control and experimental subjects for tests measuring verbal fluency, verbal reasoning, number facility, numerical reasoning, abstract reasoning, space relations and rote learning. Three tests showing impairment by the experimentals were recent memory (recall and recognition), dexterity and perceptual ability.

Where comparison is possible, the results of this study support the findings of other experiments under conditions of darkness and silence, but differ from those conducted under conditions of low diffuse light level and low noise level.

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CHAPTER I

THE PROBLEM AND INTRODUCTION

I. STATEMENT OF THE PROBLEM

During the last decade, considerable scientific interest has been shown in the effects of isolation and monotony upon human performance. This has been prompted largely by recent technological advances; for example, in space craft and nuclear submarines where individuals will be required to function in restricted quarters for long periods of time and under relatively monotonous conditions.

The first experimental studies of the effects of isolation were carried out at McGill University in the early 1950's. Since that time at least a dozen investigations have been undertaken in various American laboratories. All of these, however, have employed relatively short periods of isolation ranging from a half hour to three or four days. Only three subjects have been studied for as long as six days. Furthermore, the concern in almost all of these studies has been with changes in perceptual and motor processes. Appraisal of intellectual functioning has been largely ignored.

The purpose of the present experiment is two-fold: (a) the use of isolation periods of a week or longer and (b) an intensive appraisal of intellectual functioning at various intervals during isolation under monotonous conditions of constant darkness and silence.

II. INTRODUCTION

The development of a pushbutton technology has focused the attention of scientists on the practical problems confronting personnel working in relative solitude under monotonous conditions. There are a number of situations in which these two conditions of isolation and monotony can be found. Watching a radar screen for long periods of time is one example. Other examples are sentry or "look out" duties, piloting aircraft on long flights, serving in submarines and manning isolated outposts in the far north. Lapses of attention or errors in such activities, especially if they involve a constant watch on instruments, may have serious consequences. A better understanding is required, therefore, of the effects of isolation and monotony on intellectual and perceptual performance.

In addition to its practical significance, research on isolation can be of considerable theoretical importance. There is much evidence from neurophysiological studies which indicates that the normal functioning of the waking brain is dependent upon a constant exposure to sensory stimulation, which produces a continuing "arousal reaction" or general alertness in the organism (Jasper, 1941; Walter, 1953). Furthermore, the evidence suggests that when this sensory stimulation does not change periodically it quickly loses its power to cause the arousal reaction in the waking brain (Sharpless and Jasper, 1956). What all of this physiological data suggests is that the maintenance of normal, intelligent, adaptive behavior in the organism is dependent upon a continually varied sensory input coming into the brain. If this is so, a

reduction of the sensory input and particularly its variability, should produce some drastic behavioral changes. There are two ways in which this hypothesis could be tested. The first is to section various sensory nerve tracts which feed impulses into the brain and then observe any resultant impairment of functioning. The second approach, an environmental one, is to deprive the subject, non-surgically, of as many sensory stimuli as possible. This could be accomplished by placing him in constant darkness and silence and restricting his movements in order to reduce variations in kinesthetic sensitivity. For human subjects, the second recourse, which is employed in this study, is obviously the only one available.

It is clear, therefore, that a study of isolation will not only have considerable practical significance but it will also further our knowledge about the functioning of the brain.

The thesis proper begins with a historical resumé of the rather limited research on intellectual functioning under conditions of sensory deprivation. The second chapter includes a description of the apparatus, subjects, tests and procedure, together with a statement of the results. The thesis concludes with a third chapter on the interpretation of the results and a general discussion.

III. HISTORICAL BACKGROUND

Prior to 1950 most of our knowledge on the effects of isolation has been limited to autobiographical observations and literature of an anecdotal nature. There have been reports or cursory observations of

people in solitary confinement in prison, of individuals cast adrift in life boats or rafts, of solitary adventurers or explorers, of people living alone in the Arctic, of religious recluses and ascetics. Through many of these reports there run accounts of perceptual distortions, hallucinations, emotional disturbances and general impairment of intellectual functioning. An excellent survey of these non-experimental reports is given in a review article by Solomon, Leiderman, Mendelson and Wexler, 1957.

The first systematic experimental studies of the effects of isolation were carried out by Hebb and his students at McGill in the early 1950's. Since this early work, which was largely of an exploratory nature, the research has tended to follow two main lines. The first concerns the effects of constant low illumination and low noise level and the second, the effects of constant darkness and silence. The survey of the literature will be dealt with under these two headings. Furthermore, it will be restricted to studies concerned with intellectual and emotional changes.

Studies on Low Illumination and Low Noise Level.

In the McGill study (Scott, Bexton, Heron and Doane, 1959; Bexton, Heron, and Scott, 1954) subjects were paid to lie 24 hours a day on a bed in a lighted, semi-soundproofed cubicle measuring 8 ft. x 4 ft. x 6 ft. Translucent goggles admitted diffuse light but no patterned vision. Cotton gloves with cardboard cuffs extending from elbow to finger tip limited

tactile perception while the subject was in the cubicle. Auditory perception was limited by a foam-rubber pillow, the walls of the cubicle and the masking noise generated by the air conditioner and other equipment. A two-way speaker system allowed communication between experimenter and subject, and an observation window enabled the experimenter to watch the subject. The subjects, 22 English-speaking male college students, were asked to stay in isolation as long as they could. They were fed and went to the toilet upon request. The cardboard cuffs were removed at these times. These breaks averaged two to three hours a day.

The intellectual battery of tests used included multiplication, arithmetic "catch" problems, number series completion, word making, anagrams. These tests were administered before and after isolation and during isolation after 12 hours, 24 hours, and 48 hours. Associative learning and digit span from the Wechsler memory battery, together with an analogies test were given before isolation and immediately prior to emergence. A third battery of tests of a perceptual nature was given prior to isolation and immediately after emergence. Included in this battery was a test of dexterity, mirror drawing.

Two measures were obtained for the intellectual tests in the first battery, time scores and error scores. Where time scores were concerned, word making showed a decrement for the experimental group for all three test periods during isolation ($p < .02$) and number series a decrement at the 12-hour period ($p < .05$). With error scores, anagrams showed a decrement at the 24-hour period ($p < .05$); word-making at the

12-hour period ($p < .05$) and at the 48-hour period ($p < .02$). These results, while they do show some impairment, are not particularly outstanding insofar as statistical significance in three cases (anagrams, number series, and word-making at the 12-hour period) was at the 5% level which barely meets the requirements for significance and is hardly indicative of any gross difference between groups. The only intellectual ability which showed well established decline was word-making with significant impairment on time scores ($p < .02$ for all three test periods) and on error scores as well ($p < .05$ for the 12-hour test and $p < .02$ for the 48-hour test). There was no significant difference between groups for prior-to-isolation or post-isolation testing. In the second battery of tests there was no difference between groups for digit span and analogies, although in associative learning experimentals did somewhat more poorly than did controls ($p > .10$). There was also no significant difference between groups for the test of mirror drawing.

While the results from the McGill study are not outstanding statistically, one should bear in mind that the general trend was towards impairment, with arithmetic, number series, multiplication and associative learning showing a tendency toward impairment on error scores. Time scores also showed a tendency in this direction for anagrams, arithmetic and multiplication.

Another experiment utilizing conditions of low level light and constant sound was conducted at New York University (Goldberger and Holt, 1958). The subject was paid to lie in a small partially sound-

proofed room measuring 14 ft. x 7 ft. x 10 ft. for a period of eight hours. A 300 W ceiling fixture provided constant light while eye cups made from ping-pong balls prevented patterning in the visual field. A constant masking white noise was fed into the subject's ears via earphones. Gloves and cardboard cuffs limited tactile stimulation. A two-way intercom system and a one-way mirror in the wall of the isolation chamber permitted the experimenter to both communicate with and observe the subject. The subjects, 11 male freshmen (from an original sample of 14) remained in isolation for eight hours broken only by lunch and trips to the bathroom. During these times the cardboard cuffs were removed.

The following tests were presented before and at the termination of the isolation period: subtest 5 (Arithmetic Reasoning) of the Otis Group Intelligence Scale; the Story Recall subtest of the Babcock Test battery; subtest 3 (Logical Deductions) of the Watson-Glaser Critical Thinking Appraisal, and the Digit Span subtests of the Wechsler-Bellevue Intelligence Scale. All tests were presented aurally over the intercom system, except for logical deductions which was a written test. Except for logical deductions, on which a significant number of the subjects performed more poorly ($p < .01$), there was no evidence of impaired ability. On the other three, the majority of the subjects showed improved scores on the post-isolation tests, although this did not reach statistical significance. However, before commenting on the trend towards improvement, it should be pointed out that no control subjects were used and there is no evidence that the alternate forms used for post-isolation testing were exactly

equivalent to those used prior to isolation. Even if the tests were equivalent one could expect improved scores during the second testing session on the basis of practice and familiarity with the testing situation. Indeed, some of the subjects remarked that they felt more at ease with the experimenter during the second session than they had felt during the first. In view of the failure to run controls, it is impossible to evaluate this study or to compare it with results obtained by other researchers.

Studies on Darkness and Silence.

Three studies carried out at Princeton University are concerned with the effects of darkness and silence upon intellectual abilities. They shall be designated as first study, second study and third study, in order of publication. The physical conditions for the three studies are almost identical, with only minor alterations. Subjects were paid to confine themselves to a small cell (4 ft. x 9 ft. x 8 ft.) within a floating chamber (15 ft. x 9 ft.). The cell was light-proof and sound-proof. During the first two experiments ear-plugs were also used, but were later discarded to avoid a "sea-shell" effect. Subjects were admitted to the outer floating chamber for testing, attending to toilet needs and when eating. Cardboard gauntlets limited tactile perception.

First study (Vernon and Hoffman, 1956). This was a preliminary experiment in which four male college seniors were confined for a period of 48 hours. Tests used were 12-item adjective lists presented aurally before isolation, at the 24-hour period, 48-hour period, and after isolation. The results indicated improvement for the experimentals as

compared to the control group of four subjects for both the 24-hour testing period and the 48-hour one. Because of the inadequate sample a subsequent validation study was undertaken.

Second study (Vernon and McGill, 1957). Nine male graduate students were confined under the same conditions for a period of 72 hours. 15-item adjective lists were presented aurally before isolation, after 24 hours, at 12-hour intervals thenceforth during isolation, and after isolation. The results of this experiment failed to support the preliminary study in that the experimentals showed no significant improvement over the controls. Neither was there any evidence of impairment. While there was no significant difference between groups, there was a tendency toward improvement on the part of the experimentals.

To summarize the findings of these two studies one can say that while there is insufficient evidence for improvement in rote learning under these conditions, there is a clear indication that isolation under conditions of darkness and silence does not produce any impairment in rote learning ability.

Third study.(Vernon, McGill, Gulick, and Candland, 1959). This experiment was concerned with the effects of darkness and silence on skills of a perceptual-motor nature. The conditions were the same as those in the first two studies, except that earplugs were not used. Nine male graduate students were paid to undergo isolation for periods of 24 hours, 48 hours, and 72 hours. There were three subjects for each of the three confinement periods. Of the five tests used two were a measure of dexterity, pursuit rotor and mirror drawing. Although the authors claim

a statistically significant decrement on the rotary pursuit test for the 48-hour experimental group as compared to the controls, it should be pointed out that the N in each group is too small to warrant the statistical procedure used, i.e. the Wilcoxin test which requires a minimum N of six pairs.

It is obvious that the studies outlined above are not directly comparable because of varying conditions, different periods of isolation and different types of tests. Interpretation in some instances is complicated by lack of controls and inadequate samples. The present study differs even more markedly from its predecessors in method of test presentation and in degree of isolation. Most of the tests in the current study were presented visually while most of them had been presented aurally in prior studies. In this experiment, built-in facilities precluded any socialization which had formerly accompanied toilet requirements and mealtimes. Hence the only social stimulation available has been limited to a 45-minute verbal exchange once a day at testing time. Even this exchange was kept to an absolute minimum.

In summary, this study differs from its forerunners in four principle ways: (1) variety of tests (2) length of isolation period (3) method of presenting tests and (4) degree of social isolation.

CHAPTER II

EXPERIMENTAL METHOD

I. THE PROBLEM

The preceeding chapter has outlined the nature of the research done on isolation or sensory deprivation. It has been pointed out that many of these studies have suffered from the short length of the isolation period. It has also been shown that very little work has been done on the effects of sensory deprivation on intellectual abilities. Where this area has been touched, the nature of the tests has been so limited that no broad evaluation has been possible. It is the purpose of this study to determine the effects of prolonged sensory deprivation, under conditions of darkness and silence, on intellectual abilities.

II. APPARATUS

Isolation Chamber.

A X-sectional view of the isolation chamber is shown in Fig. 1. It consists of a translucent plexiglas dome 7 ft. in height, 9 ft. in diameter and 7½ ft. at the base. It is surrounded on five sides by a system of fluorescent and incandescent lights by means of which the interior of the dome can be flooded with diffuse light of any intensity or wavelength. This lighting system was not utilized in the present

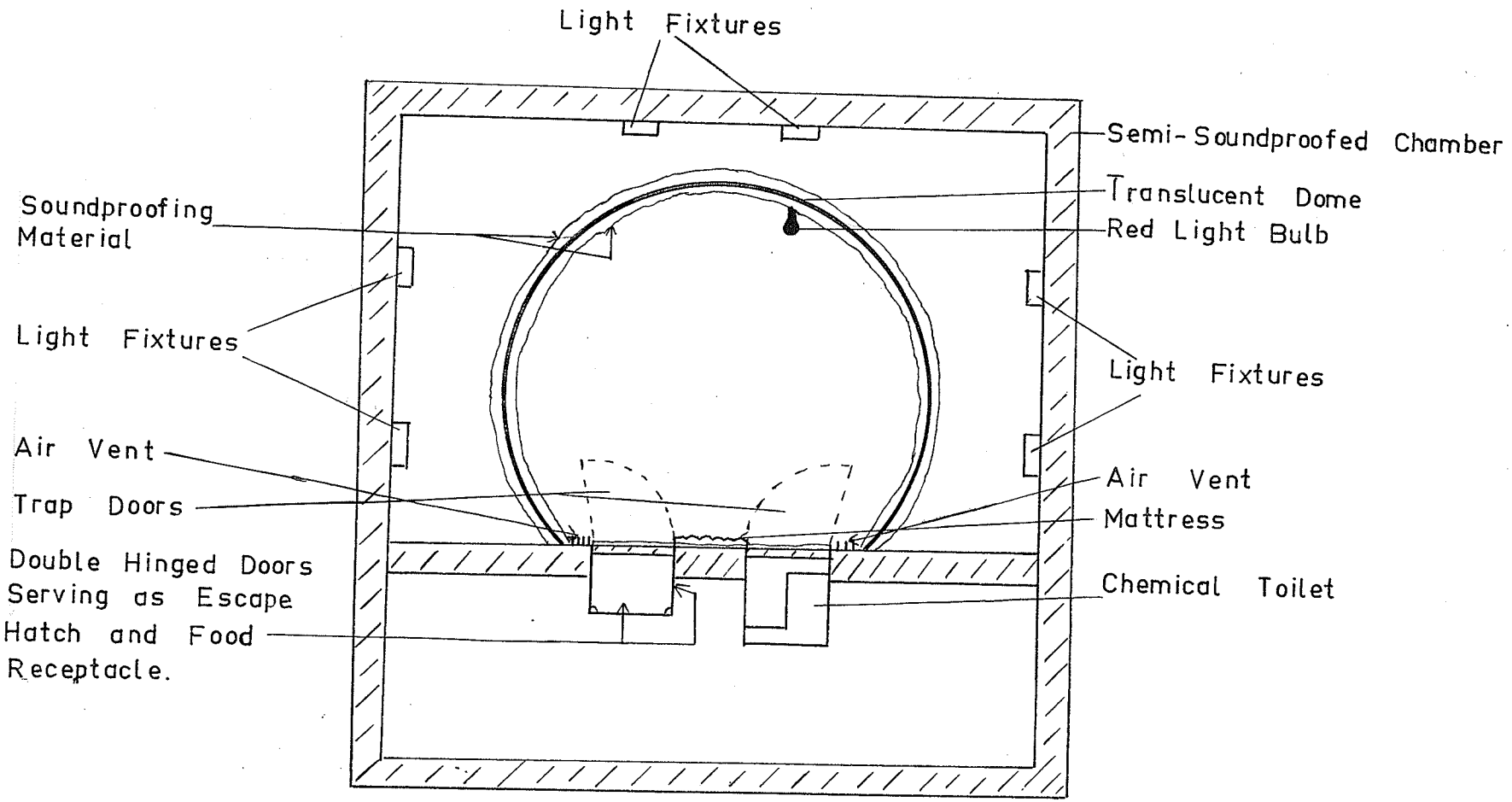


Fig. 1

Cross sectional view of isolation chamber

experiment on darkness and silence. In order to sound-proof the chamber, the inside and outside surface of the plexiglas dome, as well as the floor, was lined with an 8 in. layer of sound-absorbing material. The inner floor of the dome was dovered with a thick grey carpet. Toilet facilities, and a food chamber which doubled as an entrance hatch, were built-in underneath the floor so that each could be reached by raising a trap door level with the inside floor of the dome. An air-conditioning unit provided a constant source of fresh air at any desired temperature. A two-way intercom system enabled the experimenters to keep a continuous check on the breathing and movements of the subject and also allowed the experimenter to communicate with the subject during the testing period. A coded buzzer arrangement kept the actual verbal exchange between subject and experimenter to a minimum. By this signaling system, the experimenter could indicate the presence of food in the food box, ask the subject to start time estimates, and convey similar simple kinds of information. The only piece of furniture in the chamber was an inflated air mattress on which the subject lies. The subject did not leave the dome at any time during his period of isolation. The dome and the lighting system were housed inside a semi-soundproofed chamber of plywood measuring 14' x 14' x 14'. This plywood chamber was situated at one end of a larger room in which the experimenters worked. The inside of the plexiglas dome is soundproofed to the extent of 70 db. attenuation.

Tests.

A battery of tests, measuring eleven different abilities, was prepared. Nine of these abilities were of an intellectual nature and two

of a perceptual-motor variety. Eight equivalent forms of each test were constructed. These tests, together with their time limits are listed below.

1. Number Facility (4 min.) was appraised by a test consisting of relatively simple problems in arithmetic involving addition, subtraction, division and multiplication.

2. Numerical Reasoning (4 min.) was measured by a test involving the solution of various numerical sequences. A sequence of numbers was presented. The subject was required to find the rule or principle by which the sequence was determined and to fill in the following two numbers.

3. Verbal Fluency (3 min.) was appraised by asking the subject to write down all the words he could think of beginning with a certain letter, with the exception of proper nouns.

4. Verbal Reasoning (3 min.) was appraised by problems such as the following: _____ is to borrow as rich is to _____. The subject was required to select from two lists of words the ones which would logically go in the blank spaces.

5. Abstract Reasoning (4 min.) was tested by items of the type found in the abstract reasoning test of the Differential Aptitude Battery. Each problem consists of four designs or figures which make a series and the subject is required to discover the rule or principle determining the sequence and then must select from the answer figures the one which would be next or fifth in the sequence.

6. Space Relations (8 min.) was measured by two tests. The first test, appraising two-dimensional space visualization, consists of examining a certain design or pattern and then selecting the exact parts which will fit together to make it. The second test, appraising three-dimensional space, consists of patterns which can be folded into figures. For each pattern, five figures are shown and the subject has to decide which of these figures can be made from the pattern shown.

7. Rote Learning was tested by presenting aurally a list of nine three-letter words (e.g. red, ask, tub) which the subject was required to learn to a criterion of two successive errorless trials. The inter-word interval was 1 sec. and the inter-trial interval was 5 sec.

8. Recall. The subject is presented with a list of 20 nonsense syllables which he studies for 3 min., reading the list over as many times as possible in the time limit. He then writes down as many of the syllables as he can remember.

9. Recognition. After the attempt at reproduction, the subject is shown a list containing the previously mentioned 20 nonsense syllables mixed in with 30 others. From the whole list he then attempts to select the 20 syllables which he first learned.

10. Perceptual Ability (1 min.) was appraised by presenting the subject with two pages of randomized numbers ranging from 0 to 9 and asking him to cancel all the one's or two's or three's etc.

11. Dexterity was measured by three 1-minute tests. They consist of placing one dot in each triangle (1/8 in. high), making two check marks in each square (3/8 in. x 3/8 in.) and tracing a line through a maze without touching any of the sides.

The above-mentioned tests were made short deliberately so that the total testing period or the total encroachment on isolation would be as short as possible. The total testing period lasted approximately 45 mins.

SUBJECTS

The subjects were paid volunteers who largely fell in the following categories: (a) graduate students in psychology (b) graduate students in the biological sciences and (c) air-crew personnel at the R.C.A.F. Station, Winnipeg. The subjects were screened psychiatrically and also for normality of EEG's. Of the initial sample of 22 subjects, six requested release from isolation within the first three days leaving 16 effective subjects, fourteen of whom were in isolation for 7 days, one for $8\frac{1}{2}$ days and one for 10 days. Of the final sample of 16 subjects four were females. The mean age of the experimental group was 24.1 years (range 19-34). The control group of 16 subjects (selected out of an initial sample of 22 S's) had the same proportion of graduate students, air-crew and the two sexes as the experimentals. They were also matched for age and intelligence scores on the Henmon-Nelson test. Many of the control group had initially volunteered as experimental subjects. The mean age of the control group was 23.4 years (range 19-30).

PROCEDURE

The subjects were paid to lie 24 hrs. a day on an air mattress in a dark and sound-proofed chamber. They constantly wore a set of specially constructed earmuffs (devised by National Research Council, Canada) which

served to reduce any sounds they might make inside the dome. They were instructed to lie as still as possible on the mattress and not to engage in any singing or humming or any other vocal or physical activity. Each subject was monitored throughout the isolation period by a communication system which revealed satisfactory adherence to the instructions against making any sounds. This auditing system was sufficiently sensitive to pick up the breathing, snoring and any other slight sounds that the subject might make. No gauntlet-type gloves or other types of manual restrictions were imposed upon the S. A two-way speaker system allowed communication between the subject and experimenter when necessary. The coded buzzer system has already been described (See Apparatus: Isolation Chamber). An experimenter was on duty at all times. The subjects were asked to stay in the chamber for a week and during this time were prevented as far as possible from determining what time it was. The slightest indication by the subject that he wished to terminate the experiment was sufficient for his immediate release. Hence any subjects who found the conditions of isolation excessively difficult are not included among the experimental group. The subjects were fed a flavourless, enriched liquid food called "Fabulous Lady" which was augmented with coffee, tea, fruit juice and occasional sandwiches on request. The subjects were fed on demand.

All test administrations were performed within the dome. Before isolation the subjects received standardized instructions regarding the nature of the tests, and were presented with samples by way of illustration. During the initial testing session these instructions were repeated via the

intercom before the administration of each test. By this means, errors due to misunderstanding or ignorance of the procedure were kept to a minimum. The procedure was as follows: A 15-watt red light bulb located in the ceiling of the dome was turned on. The subject was given a 5 min. light adaptation period. The subject removed the test battery and clipboard which were placed inside the food receptacle by the experimenter via a door in the bottom of the receptacle; the subject sat down on the "step-down" toilet seat located below the red light bulb; the experimenter gave the subject instructions for taking the tests over the two-way speaker system; the completed test battery was replaced in the food receptacle; the subject was asked to report on any experiences he may have had since the last test session; the red light was extinguished. The test battery was administered inside the chamber at the beginning of the isolation period, at intervals of approximately 24 hrs. (actual intervals might range from 18 to 30 hrs.) and one day after emerging from isolation. The total testing time rarely exceeded 45 mins. No tests were administered during the seventh day (except in 10-day S) in order that EEG records could be taken. The subject was not told about the time intervals but only that he might be tested periodically. All of the tests were presented visually except the rote learning test which was given over the inter-com system. The order of presentation of the 11 daily tests was randomized from day to day. The equivalent forms of the tests were also randomized for the different subjects.

The control subjects were given the same tests at the same time intervals as the experimentals. All of the tests were administered inside the chamber under red light. Many of the control group had initially volunteered as experimental subjects. During the testing period of a week, they led a normal, active life, with no restrictions imposed except during the 45-minute daily testing period, when they were confined to the isolation chamber.

CHAPTER III

EXPERIMENTAL FINDINGS AND DISCUSSION OF RESULTS

I. RESULTS

Figs. 2-12 show the scores obtained by the experimental and control groups on the eleven abilities appraised before, during and one day after release from isolation. It can be seen that on verbal reasoning (Fig. 2) and rote learning (Fig. 3) the experimentals almost invariably did better than the controls during the whole period of isolation. However, neither the difference in overall performance on the verbal reasoning test ($p > .50$) nor that on the rote learning ($p > .30$) is statistically significant nor are any of the daily differences significant. On abstract reasoning (Fig. 4) there is no significant difference between the two groups ($p > .90$). Furthermore, the better performance of the experimentals during the first two days and their poorer performance during the last three days is also not significant ($p > .40$; $p > .40$, respectively). The results on the space relations test (Fig. 5) are similar to those on abstract reasoning. There is again no significant difference in overall performance for the two groups ($p > .40$), neither is the better performance of the experimentals during the first four days and their inferior performance during the last two days significant ($p > .10$; $p > .30$ respectively). On the verbal fluency test (Fig. 6) the experimentals did poorer than the controls on all six daily tests. However, on neither the overall

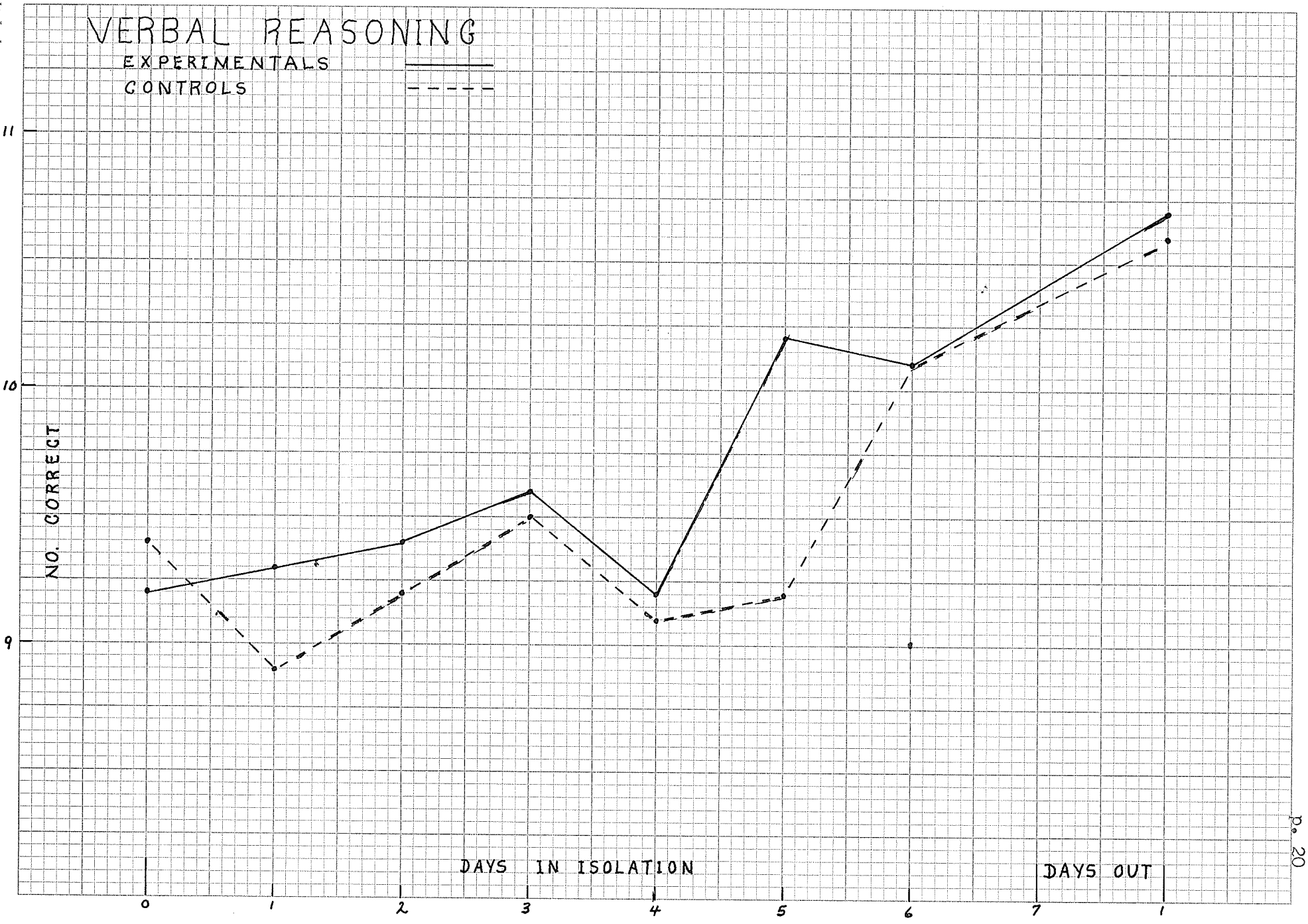
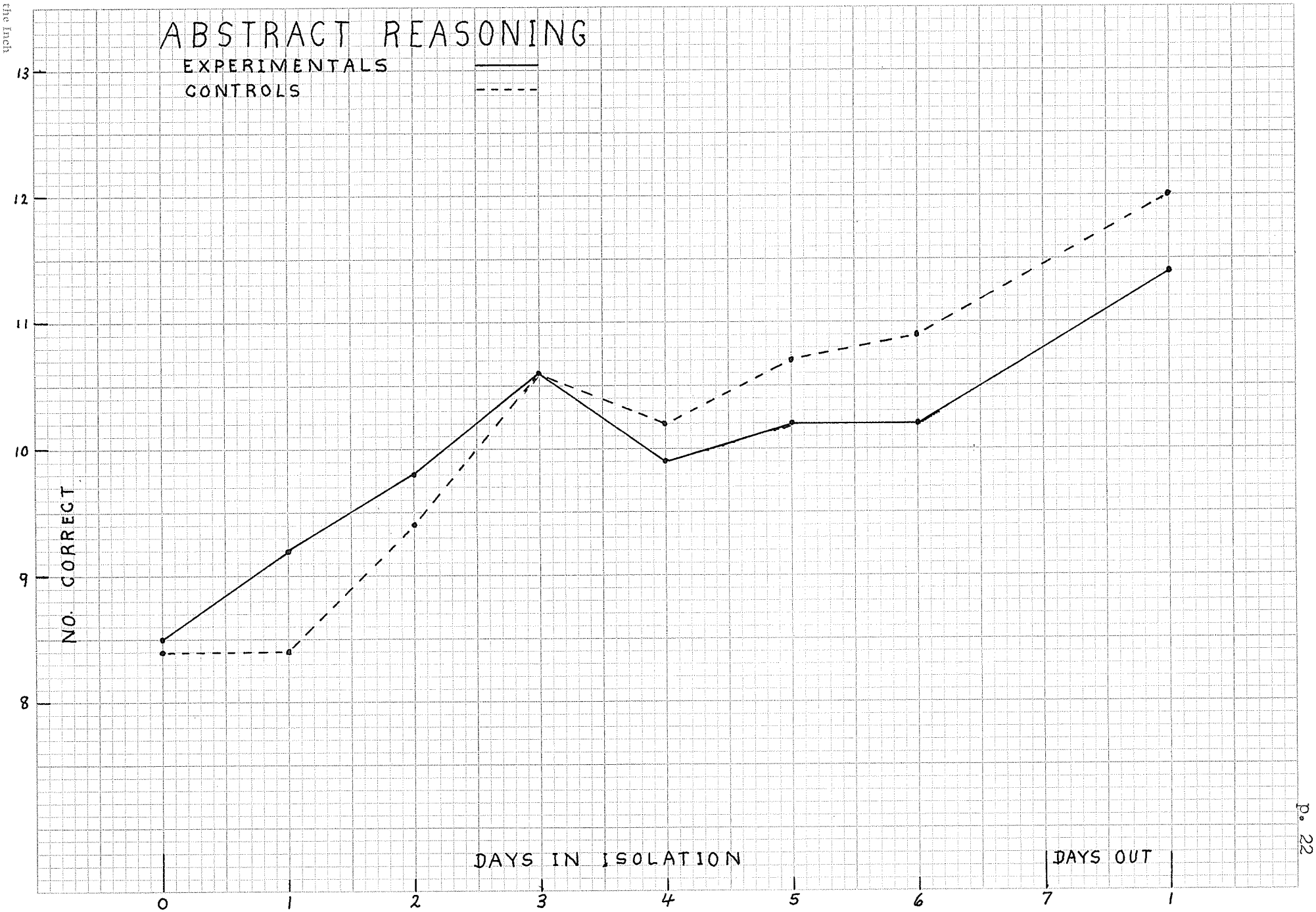

VERBAL REASONING
EXPERIMENTALS
CONTROLS
11
10
9
NO. CORRECT
DAYS IN ISOLATION
DAYS OUT
0
1
2
3
4
5
6
7
1

Fig. 2


ROTE LEARNING
EXPERIMENTALS
CONTROLS
TRIALS TO CRITERION
6
5
4
3
DAYS IN ISOLATION
DAYS OUT
0
1
2
3
4
5
6
7
1

Fig. 3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EXPERIMENTALS
CONTROLS
NO. CORRECT
13
12
11
10
9
8
DAYS IN ISOLATION
DAYS OUT
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1
2
3
4
5
6
7
1

Fig. 4

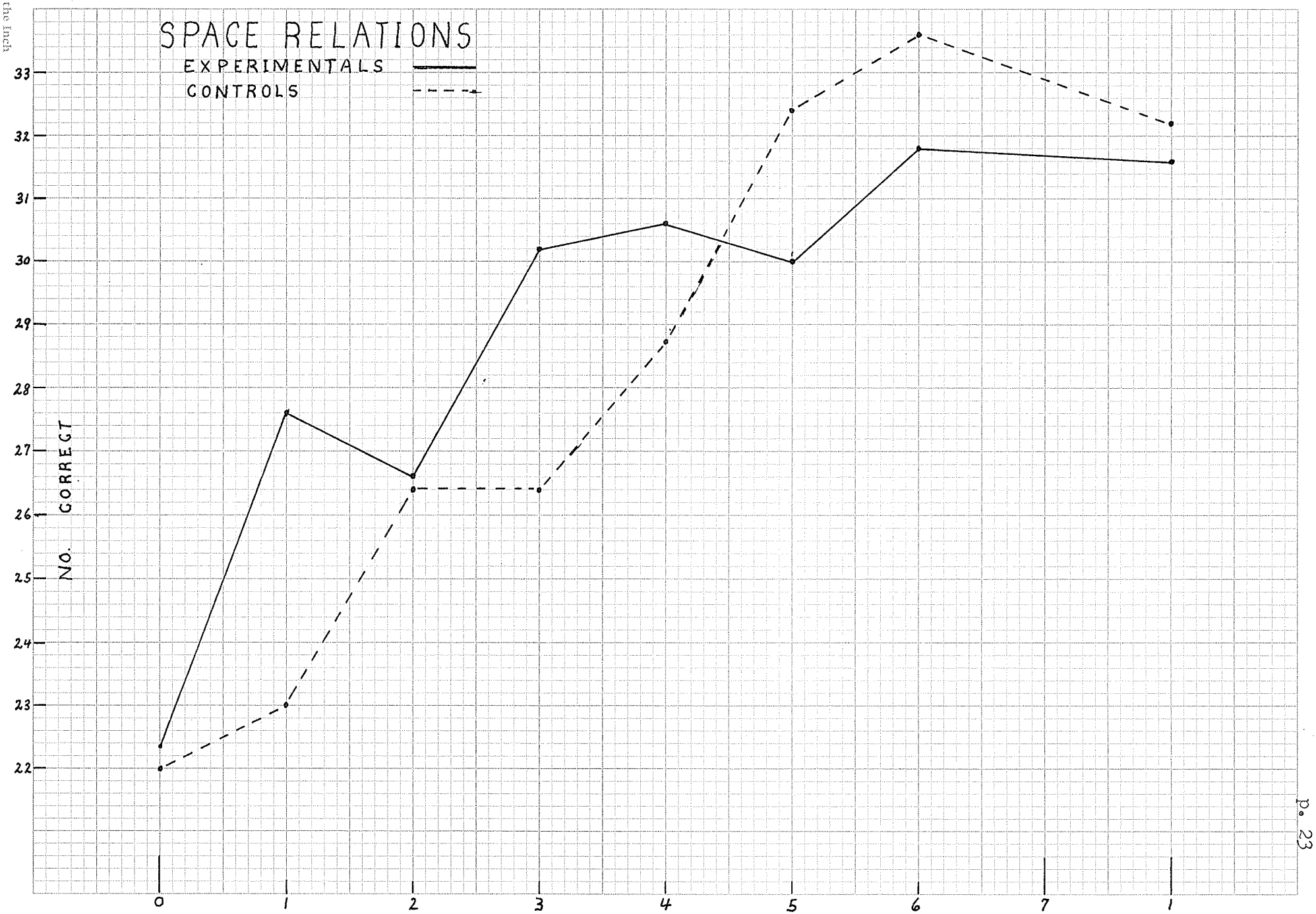

SPACE RELATIONS
EXPERIMENTALS
CONTROLS
NO. CORRECT
33
32
31
30
29
28
27
26
25
24
23
22
0
1
2
3
4
5
6
7
1

Fig. 5

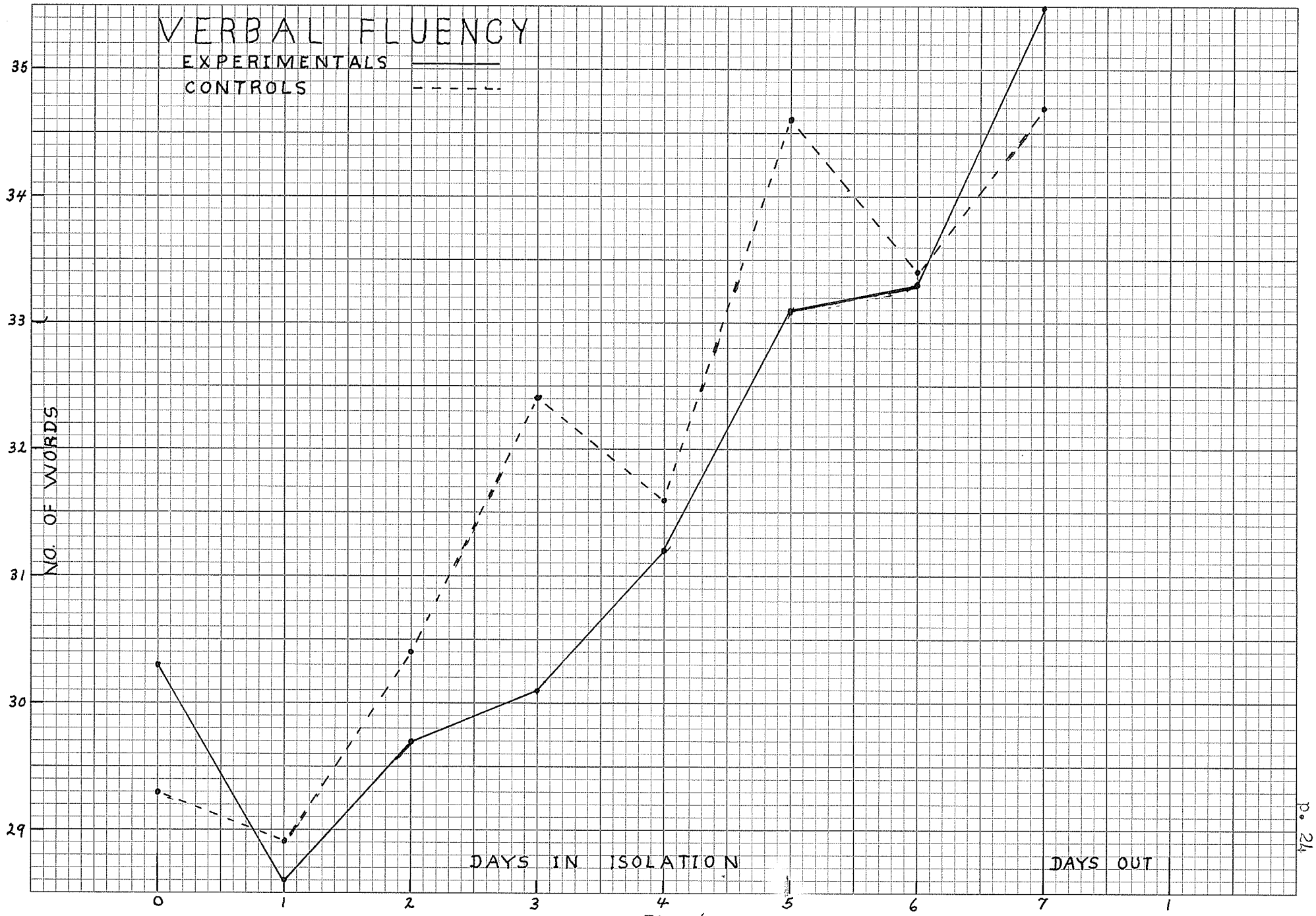

VERBAL FLUENCY
EXPERIMENTALS
CONTROLS
35
34
33
32
31
30
29
NO. OF WORDS
DAYS IN ISOLATION
DAYS OUT
0
1
2
3
4
5
6
7
1

Fig. 6

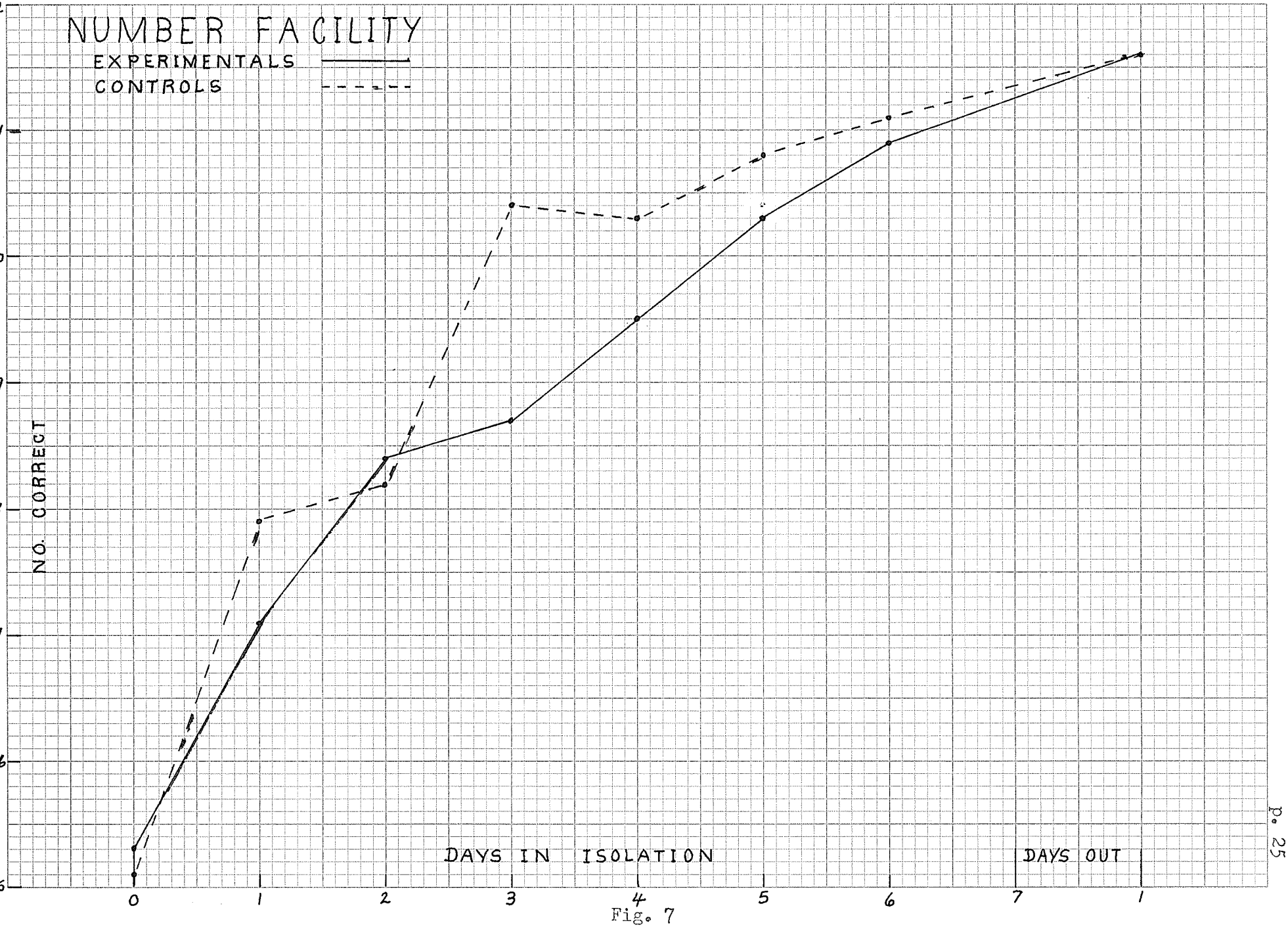

NUMBER FACILITY
EXPERIMENTALS
CONTROLS
NO. CORRECT
42
41
40
39
38
37
36
35
0
1
2
3
4
5
6
7
1
DAYS IN ISOLATION
DAYS OUT

Fig. 7

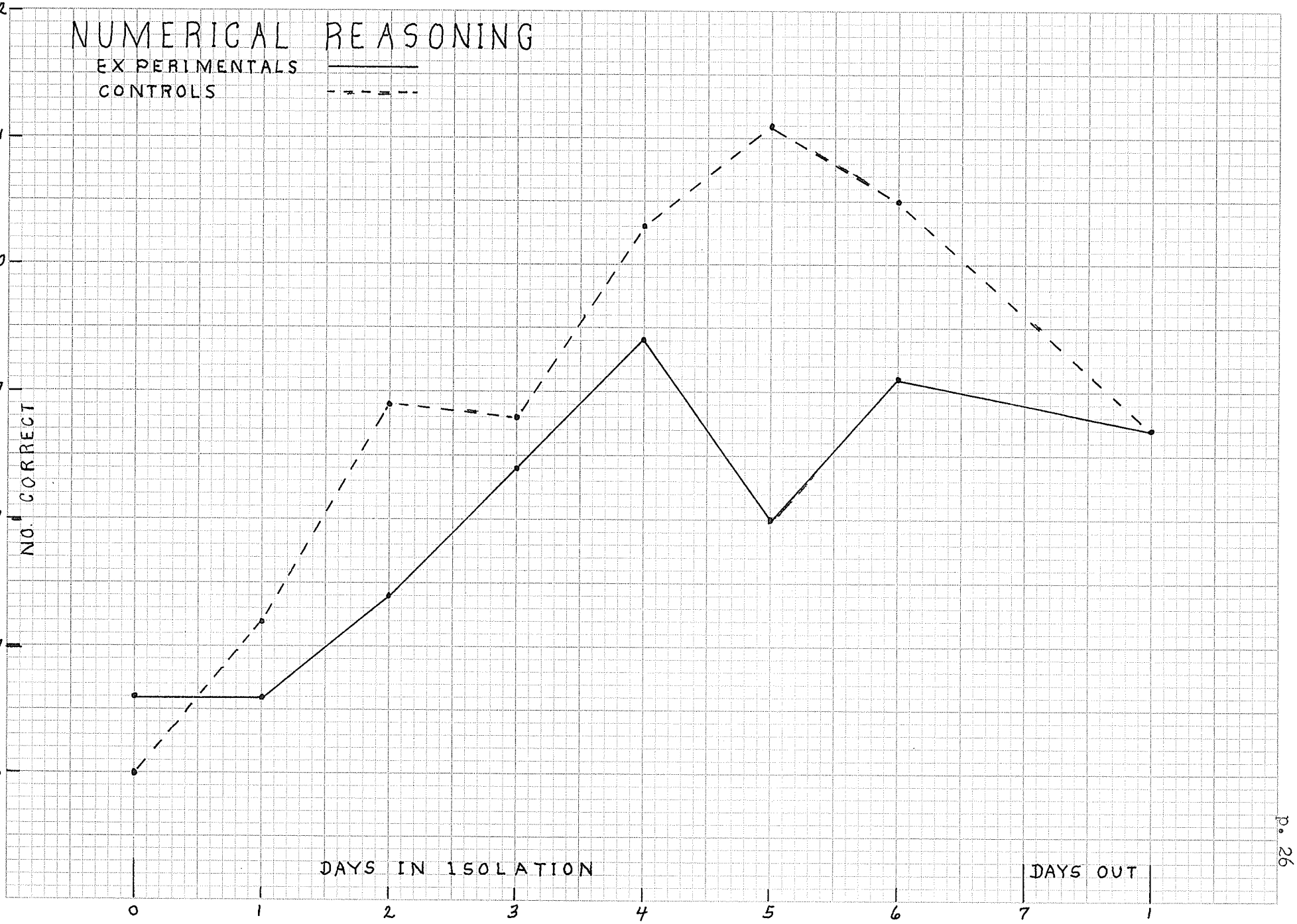

NUMERICAL REASONING
EXPERIMENTALS
CONTROLS
NO. CORRECT
22
21
20
19
18
17
16
DAYS IN ISOLATION
DAYS OUT
0
1
2
3
4
5
6
7
1

Fig. 8

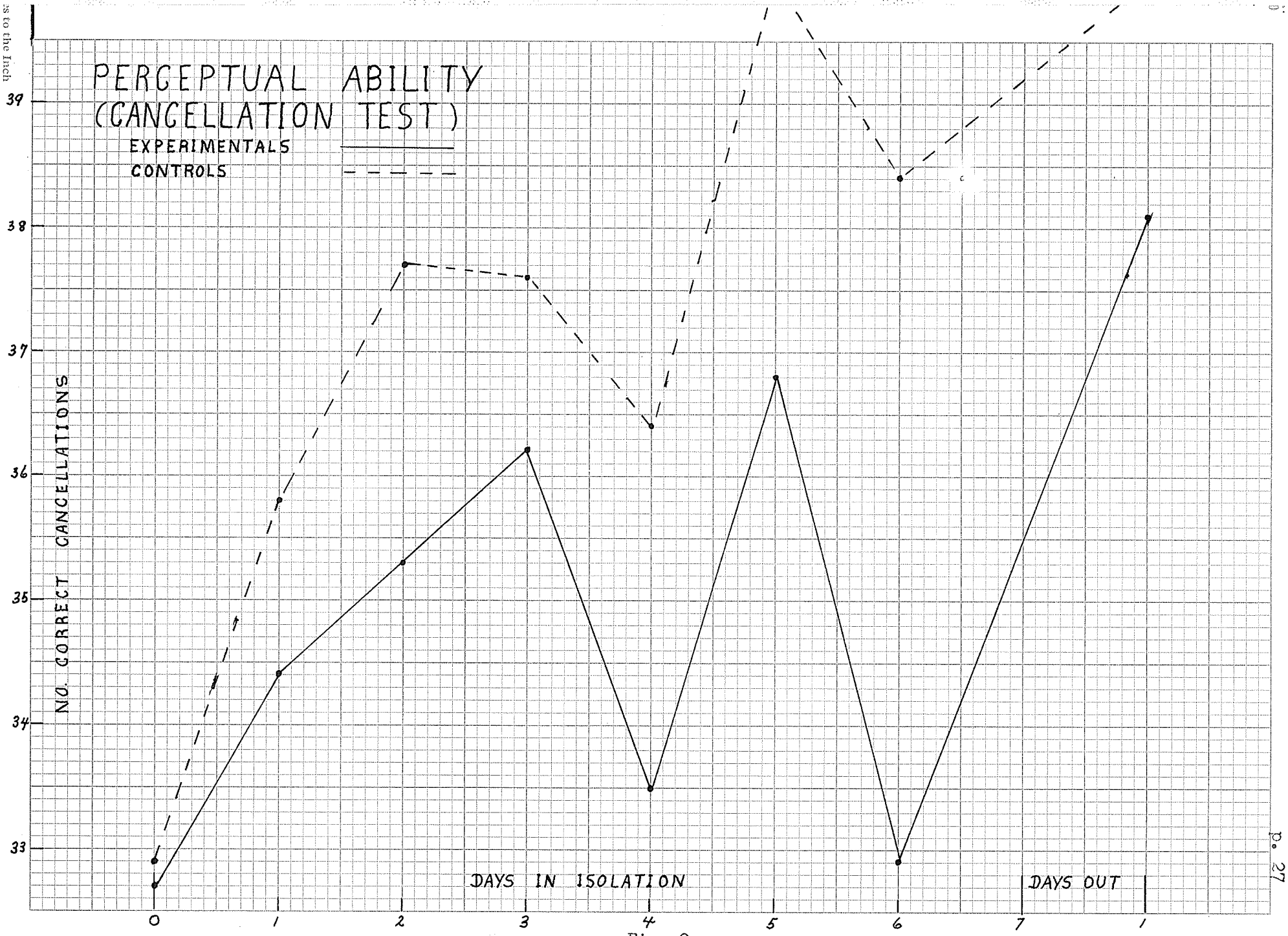

PERCEPTUAL ABILITY
(CANCELLATION TEST)
EXPERIMENTALS
CONTROLS
NO. CORRECT CANCELLATIONS
39
38
37
36
35
34
33
DAYS IN ISOLATION
DAYS OUT
0
1
2
3
4
5
6
7
1

Fig. 9

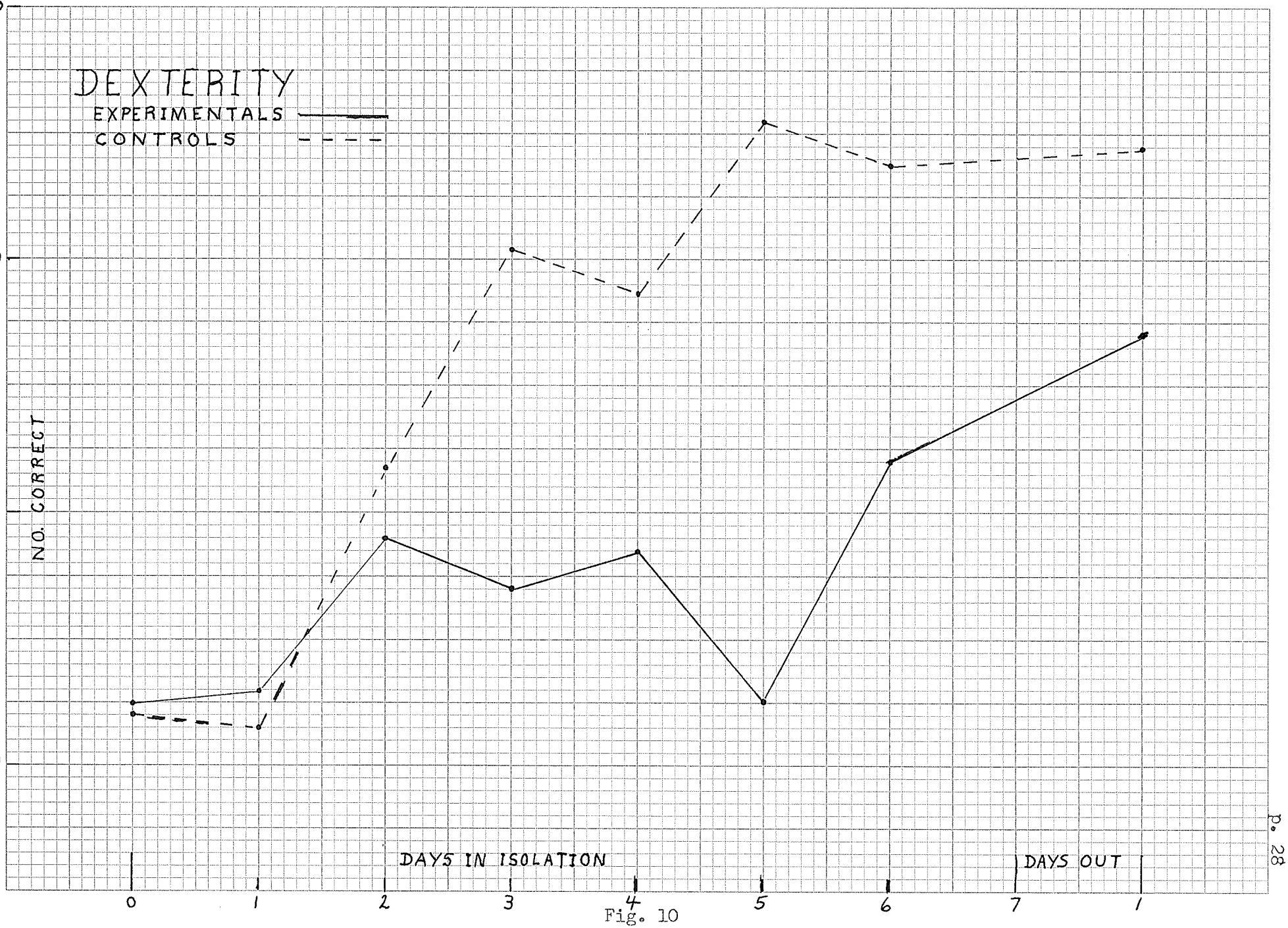
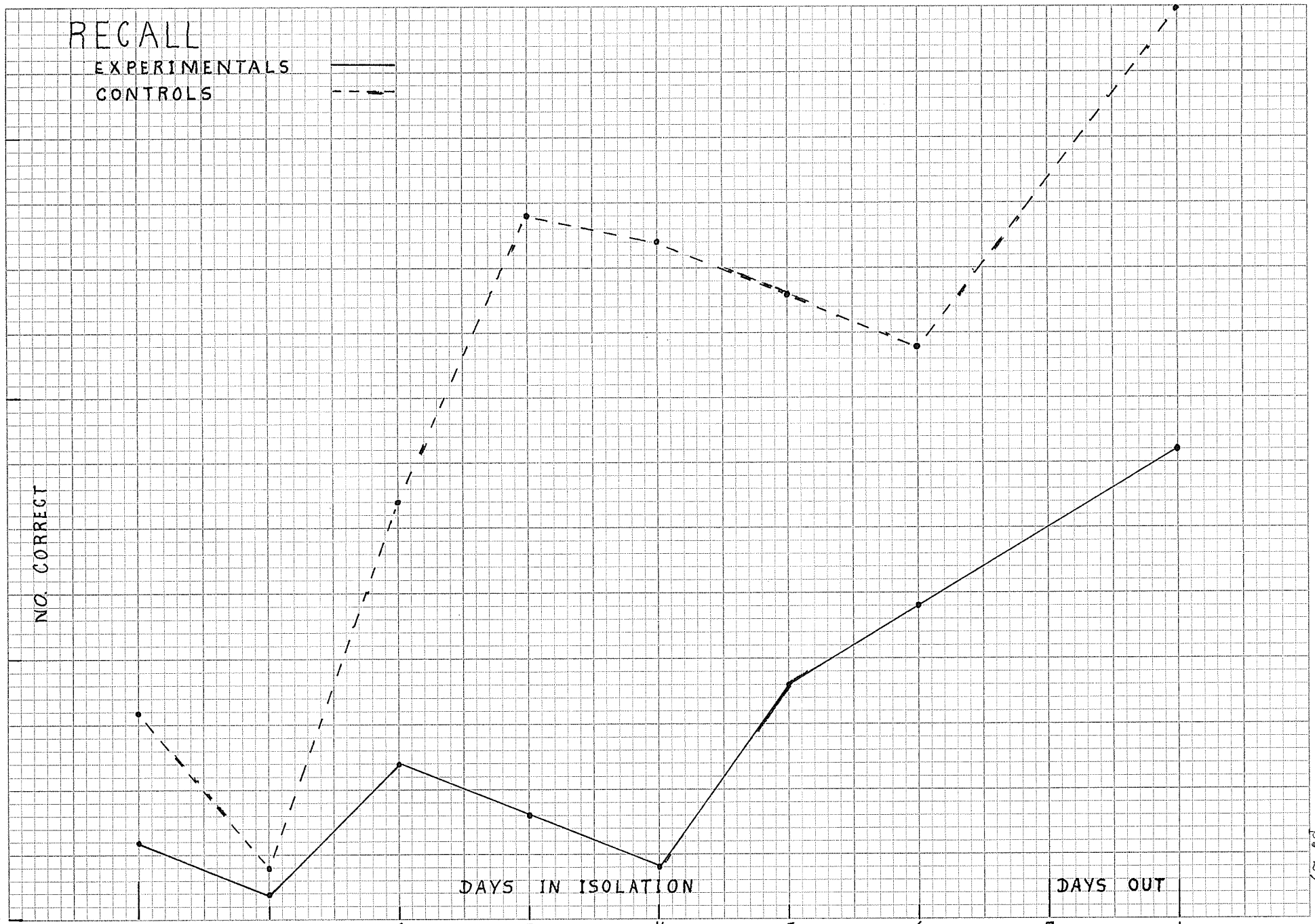

DEXTERITY
EXPERIMENTALS
CONTROLS
160
150
140
130
NO. CORRECT
DAYS IN ISOLATION
DAYS OUT
0
1
2
3
4
5
6
7
1

Fig. 10


RECALL
EXPERIMENTALS
CONTROLS
NO. CORRECT
9
8
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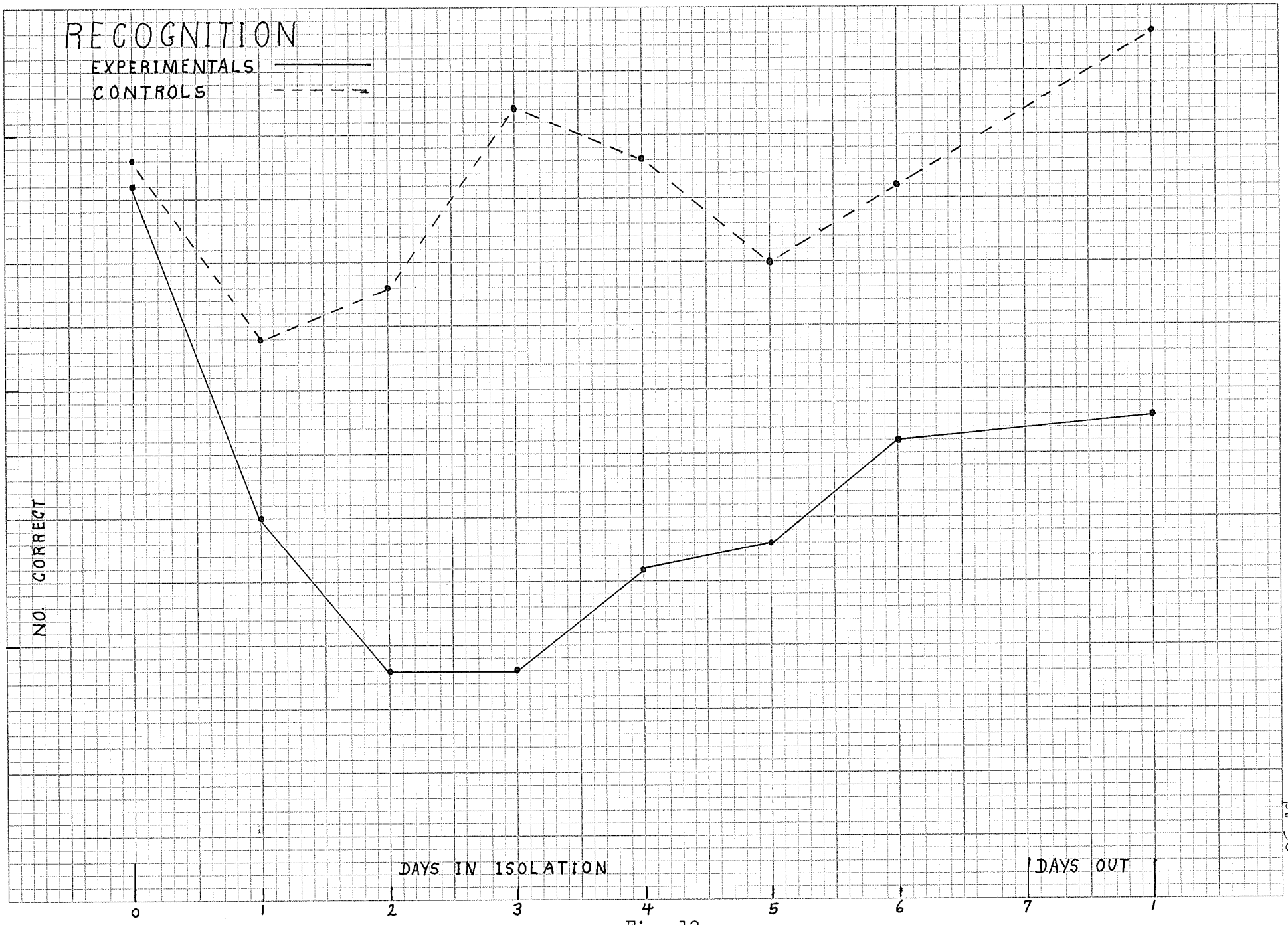
DAYS IN ISOLATION
DAYS OUT

Fig. 11


RECOGNITION
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DAYS IN ISOLATION
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6
7
1

Fig. 12

performance ($p > .50$) nor on any of the daily tests were the differences statistically significant. Similarly, the over-all inferior performance of the experimental group on number facility (Fig. 7) is not significant ($p > .40$), nor are any of the daily differences significant. On none of the six abilities were there any significant differences present on the post-isolation test.

On numerical reasoning (Fig. 8) the experimental group did poorer than the controls on all six days. However, the overall difference was not statistically significant ($p > .10$) although on the last days the difference almost approached the five per cent level of confidence ($p > .05 < .10$).

On the remaining four abilities viz. perceptual, dexterity, recall and recognition (Figs. 9, 10, 11, 12) the performance of the experimentals (combined results days 1-6) was significantly worse than that of the controls ($p > .01 < .05$; $p > .01 < .05$; $p < .01$; $p = .01$, respectively). On the daily tests, recall and recognition memory showed a significant impairment from the third day on ($p > .01 < .05$; $p > .01 < .05$, respectively), perceptual ability from the fourth day ($p = .05$) and dexterity from the fifth day on ($p = .01$). Furthermore, in the case of both recall and recognition the experimentals still exhibited a significant impairment one day after isolation ($p = .05$).

A summary of these results is given in Table I.

Subjective Reports.

The relative absence of impairment of most of the intellectual abilities is supported to a degree by the introspective reports of the subjects. Of the 16 experimental subjects only four consistently reported

TABLE I

SUMMARY OF RESULTS

Test	Trend				p-value
Verbal Reasoning	Experimentals show overall improvement				$p > .50$
Rote Learning	"	"	"	"	$p > .30$
Abstract Reasoning	"	"	improvement--first 2 days		$p > .40$
	"	"	impairment--last 3 days		$p > .40$
Space Relations	"	"	improvement--first 4 days		$p > .10$
	"	"	impairment--last 2 days		$p > .30$
Verbal Fluency	"	"	overall impairment		$p > .50$
Number Facility	"	"	"	"	$p > .40$
Numerical Reasoning	"	"	"	"	$p > .10$*
Perceptual	"	"	"	"	$p > .01 < .05$
Dexterity	"	"	"	"	$p > .01 < .05$
Recall	"	"	"	"	$p < .01$
Recognition	"	"	"	"	$p = .01$**

* p-values up to and including this test are not significant

** p-values for last four tests are significant

(from the second day) an inability to think normally, or to concentrate or having difficulty organizing their thoughts. Of the remaining 12 subjects, seven reported no intellectual impairment at all while five reported impairment only from the fifth day on. This impairment largely took the form of a reduction of motivation to think. Loss of motivation may have coincided with a prevalent physical condition often reported as lethargy or "tired feeling." Physical exertion of any kind seemed to be difficult for some of the subjects, to the extent that opening the food trap and lifting out the food became a major task. The feeling of lethargy and lack of motivation is typified by one subject who said "It took too much effort to think so I just vegetated." Other subjects reported that their intellectual powers were sharpened during the entire period of isolation. Some subjects found it much easier to visualize or to create visual imagry. Improved visual imagry seemed to be largely confined to those individuals who had been good visualizers before entering the dome.

Several other experiences are worth mentioning. When doing the recall and recognition tests some subjects reported considerable frustration and said that their minds went blank when they tried to recall or recognize words which they had seen several minutes before. Another type of experience was reported pertaining to the dexterity test. A number of subjects reported that the small triangles into which they had to place a dot occasionally faded out. One subject, during the nineth and tenth day, reported that not only did the triangles fade out but that they reappeared in another place. An examination of his test results, showing dots a half inch or so away from the triangle, seemed to support his experience. These reports would

seem to suggest that the impairment of dexterity which was found to occur may have a perceptual rather than a motor origin--at least towards the end of the isolation period.

Emotional reactions to isolation varied from mild depression to a state of euphoria. Sometimes these emotional states continued for some days or even weeks after termination of the isolation period. One subject reported that he remained elated for two weeks after, one reported a state of depression for a similar period, another was reported to be extremely irritable for about a week, still another reported unusual forgetfulness on the second day, to the extent that she was unable to perform her normal work efficiently.

Perhaps the most striking thing about these subjective reports is their variability. Where one subject reported impaired thinking, another reported improved thinking; where one felt elation, another felt depression; where one had difficulty resuming his normal work, another returned to work with increased zest.

II. DISCUSSION OF RESULTS

The results of this study indicate that prolonged perceptual isolation produces a differential effect on the various abilities appraised. With the exception of recall and recognition there is no reason to believe that purely intellectual abilities, as measured by the test battery used, are in any way impaired. Furthermore, there are <u>suggestions</u> that some of these abilities, e.g., rote learning, verbal and abstract reasoning

and space relations may even be improved during the first several days of isolation. On the other hand, abilities of a perceptual-motor nature, as measured by the cancellation and dexterity tests, are impaired considerably. A direct comparison of these findings with those of others in the literature is difficult in view of the preoccupation by most investigators with isolation conditions of low illumination and low noise level rather than darkness and silence. However, several reports emanating from Princeton University where work is underway under conditions very similar to those in this laboratory confirm some of our findings. It was found, for example, that rote learning (adjective lists of 12 to 15 words) was not impaired during three days of darkness and silence. Furthermore, in the first study (Vernon and Hoffman, 1956) a significant improvement in rote learning ability was found during the first two days while in the second study there was a suggestion of an improvement (Vernon and McGill, 1957). No impairment of the ability to concentrate or of clarity of thinking was reported (Vernon and Hoffman, 1956). Again, in line with our findings, there was a suggestion of impairment in dexterity after a period of two days of isolation (Vernon, McGill, Gulick and Candland, 1959).

This absence or almost total absence of intellectual impairment under prolonged periods of darkness and silence is at variance with the results obtained under conditions of low diffuse light and low noise level. For example, Goldberger and Holt, 1958, reported an inability on the part of the subjects to "think normally with ease and efficiency, a paucity of thoughts and inability to concentrate on any topic for very long"--all within a period of eight hours. Furthermore, there was an <u>apparent</u> impairment on

on a complex reasoning task given immediately after the eight hour isolation period; apparent because of the failure to run control subjects.

The results of the McGill studies where subjects were again tested under diffuse light and low noise level for periods up to three or four days are also at variance with those obtained from the Manitoba and Princeton laboratories (Bexton, Heron and Scott, 1954; Scott, Bexton, Heron and Doane, 1959). These investigators reported that "after a few hours in isolation the subjects found that such efforts as solving problems and thinking about things tended to be abortive. They reported that the disorganization in their thinking became more pronounced as the experimental period advanced, and described their thought processes in the later stages with such words as sterile, garbled, disjointed, confused, ineffectual, shallow." The results on the test batteries, which appraised verbal, numerical and learning abilities, and which were administered during and after isolation, also showed an impairment in some of the abilities, particularly word-making. Furthermore, where the differences were not significant they were almost invariably in the direction of poorer performance for the experimentals. There certainly was no suggestion of the experimentals doing better at any time on any test.

The problem now arises as to the reason or reasons for these apparently conflicting results. There are several possible explanations. The first is that darkness and silence produces less general disorganization of brain function than does continuous low illumination and low noise level. Support for this view has been obtained in this laboratory where it was shown that the EEG's, although of an abnormal nature at the end of a week long

isolation period, are almost invariably back to normal within three hours after emerging from isolation. On the other hand, three McGill subjects isolated for six days under conditions of low illumination and noise level still showed abnormal EEG's, three and one half hours after termination of isolation (Heron, Doane and Scott, 1956). This suggestion of a greater interference with normal brain function by constant low illumination and sound could, presumably, be reflected in greater intellectual impairment. Another possible explanation lies in the types of tests administered in the Manitoba and McGill laboratories. In this laboratory all of the tests, with the exception of rote learning, were presented visually while the McGill battery of tests was almost entirely of an aural nature presented over the inter-com. With aural tests the factor of recent memory is of some importance and if this ability was impaired, as it was in this laboratory, it could account for the poor performance of the McGill subjects on almost all of their cognitive tests. A third possible explanation lies in the shortness of our intellectual battery which was usually completed in about 45 minutes as against up to two hours for the McGill battery. With the shorter tests, the possibility of motivational decline might be less and consequently the performance might be better than under a longer test session. In all likelihood, all three factors or explanations may be involved.

In conclusion it is of interest to point out some resemblances between the intellectual-perceptual changes reported in this paper and those reported in the literature on ageing. It is a well established fact that recent memory, perceptual ability and dexterity are abilities most

susceptible to ageing while the more complex reasoning processes are more resistant to ageing. This differential effect is essentially what characterizes the performance of our isolated subjects. This similarity is shown even more clearly in a recent study emanating from this laboratory (Bilash and Zubek, 1960) where 634 subjects ranging in age from 16 to 89 years were given a test battery appraising eight factorially "pure" mental abilities. Many of these tests were identical to those employed in the isolation experiment. It was found that verbal fluency, numerical ability and space relations held up extremely well with age while recent memory, dexterity and perceptual ability showed an early and progressive loss. This similarity between the two sets of data seems to <u>suggest</u> that prolonged sensory isolation (darkness and silence) may produce intellectual-perceptual changes similar in many respects to those found in old age.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Sixteen subjects were placed in a dark and sound-proofed chamber for a period of a week or longer. A battery of tests, measuring eleven different abilities, was administered before, during and one day after isolation. A carefully matched group of 16 control subjects were given the same tests at the same time intervals. The results indicate that there is no significant difference in performance on tests measuring verbal fluency, verbal reasoning, number facility, numerical reasoning, abstract reasoning, space relations and rote learning. Of the intellectual abilities, only recent memory (recall and recognition) was significantly impaired. This impairment was still present one day after emerging from isolation. Two other abilities viz. dexterity and perceptual ability were also significantly impaired.

The results of this study support the findings of other experiments in isolation under conditions of darkness and silence, in that none of these prior experiments had shown intellectual impairment, although there had been a hint of impairment in dexterity in one study. However, they differ from the results obtained under conditions of low level diffuse light and low noise level where impairment in intellectual functions has been demonstrated.

The differential impairment shown in this study also resembles results obtained from ageing studies, with the same abilities, i.e. recent memory, dexterity and perceptual ability showing susceptibility to both prolonged isolation and the ageing process.

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A P P E N D I X

VERBAL REASONING

DIRECTIONS

Most of the sentences in this test have the first word and the last word left out. You are to pick out words which will fill the blanks so that the sentence will be true and sensible.

For the first blank, pick out a numbered word--1, 2, 3 or 4. For the blank at the end of the sentence, pick one of the lettered words--A, B, C, or D. Mark the appropriate number in the first blank and the appropriate letter in the second blank.

EXAMPLE X _____ is to water as eat is to _____

1. continue 2. drink 3. foot 4. girl

A. drive B. enemy C. food D. industry

Drink is to water as eat is to food. Drink is numbered 2, and food is lettered C. Put the number 2 in the first blank, and the letter C in the second blank.

Now look at the next sample.

EXAMPLE Y _____ is to one as second is to _____

1. middle 2. queen 3. rain 4. first

A. two B. fire C. object D. hill

First is to one as second is to two. First is numbered 4, and two is lettered A. Put the number 4 in the first blank, and the letter A in the second blank.

A few sentences will have only one blank to fill in.

EXAMPLE Z Supper is to night as breakfast is to _____

1. include 2. morning 3. supper 4. corner 5. door

Supper is to night as breakfast is to morning. Morning is numbered 2, so you would put number 2 in the blank.

VERBAL REASONING TEST (1)

(1) _____ is to track as automobile is to _____

1. train 2. quite 3. worth 4. yellow
A. road B. star C. truck D. million

(2) _____ is to window as panel is to _____

1. lock 2. view 3. shade 4. pane
A. door B. cloth C. metal D. lock

(3) She is to hers as I is to _____

1. my 2. me 3. our 4. mine 5. we

(4) _____ is to composer as Whitman is to _____

1. Dali 2. Van Gogh 3. Riley 4. Brahms
A. musician B. poet C. entertainer D. president

(5) _____ is to telephone as Edison is to _____

1. Morse 2. Bell 3. Whitney 4. Marconi
A. radio B. telegraph C. airplane D. phonograph

(6) Lend is to borrow as rich is to _____

1. wealthy 2. poor 3. money 4. poverty 5. beg

(7) _____ is to wire as radio is to _____

1. telephone 2. steel 3. copper 4. rope
A. wireless B. television C. microphone D. program

(8) _____ is to tame as lion is to _____

1. timid 2. bold 3. train 4. cow
A. lioness B. hunt C. wild D. tiger

(9) Circle is to segment as house is to _____

1. wall 2. bathtub 3. stone 4. sink 5. stairs

(10) _____ is to temperate as hot is to _____

1. moderate 2. tropic 3. climate 4. prohibition
A. mild B. cold C. bothered D. temperature

(11) _____ is to chain as bead is to _____

1. watch 2. iron 3. pull 4. link
A. pearl B. board C. necklace D. aim

?) Penury is to affluence as philanthropy is to _____

1. disorganization 2. egoism 3. miserliness 4. philosophy 5. poverty

) _____ is to steer as pork is to _____

1. beef 2. bull 3. cow 4. barn
A. steak B. lard C. chop D. pig

) _____ is to river as coast is to _____

1. flood 2. boat 3. bank 4. tide
A. beach B. spa C. sea D. sled

) The opposite of defeat is _____

1. glory 2. honor 3. victory 4. success 5. hope

) _____ is to door as pane is to _____

1. home 2. lock 3. wood 4. panel
A. glass B. window C. echo D. view

_____ is to land as knot is to _____

1. desert 2. mile 3. acre 4. form
A. rope B. meter C. sea D. mountain

The opposite of stingy is _____

1. wealthy 2. extravagant 3. generous 4. economical 5. poor

Quell is to revolt as cure is to _____

1. riot 2. health 3. disease 4. medicine 5. doctor

Pain is the opposite of _____

1. poison 2. torment 3. agony 4. comfort 5. punish

ROTE LEARNING

Instruction Sheet

Say to the subject:

"I am going to read you a list of nine three letter words. When I have finished I want you to repeat the list to me in the correct order. Wait until I have read the entire list. Each time that you make an error or are unable to remember a word, I will read the list again. When you are able to repeat the list in order twice in succession we will stop. This will mean that you have learned the list correctly."

To the experimenter:

The words should be repeated at 1 sec. intervals. Allow no more than 30 secs. for the subject to repeat the list. If he has not succeeded in repeating the list 30 secs. after you have finished reading it, consider it a failure and repeat it again.

ROTE LEARNING

Test 1.

red ask tub few gum oil any cap zoo

ABSTRACT REASONING

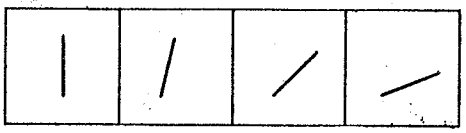
DIRECTIONS

In this test you will see rows of designs or figures like those on this page. Each row is a problem. You are to mark your answers as shown in the samples below.

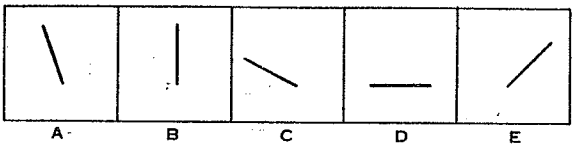
Each row consists of four figures called Problem Figures and five called Answer Figures. The four Problem Figures make a series. You are to find out which one of the Answer Figures would be the next, or the fifth one in the series.

EXAMPLE X

PROBLEM FIGURES



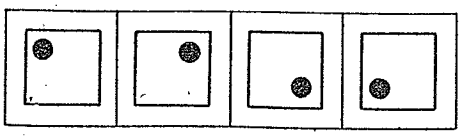
ANSWER FIGURES



Note that the lines in the Problem Figures are falling down. In the first square the line stands straight up, and as you go from square to square the line falls more and more to the right. In the fifth square the line would be lying flat. So the answer is D,

EXAMPLE Y

PROBLEM FIGURES



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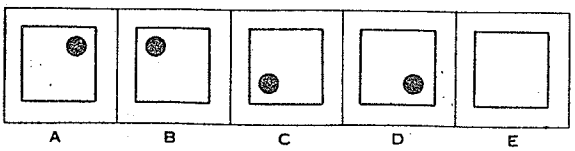
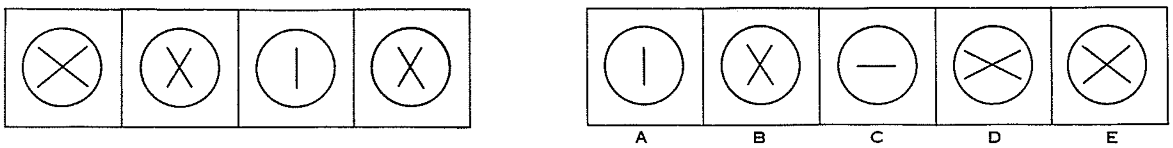


Study the position of the black dot. Note that it keeps moving around the square clockwise: upper left corner, upper right corner, lower right corner, lower left corner. In what position will it be seen next? It will come back to the upper left corner. Therefore, B is the answer,

Remember—You are to select the one figure from among the Answer Figures which belongs next in the series.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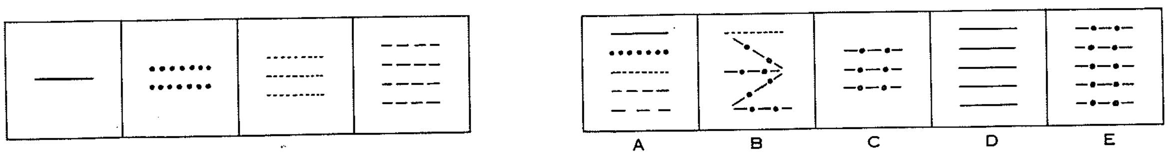
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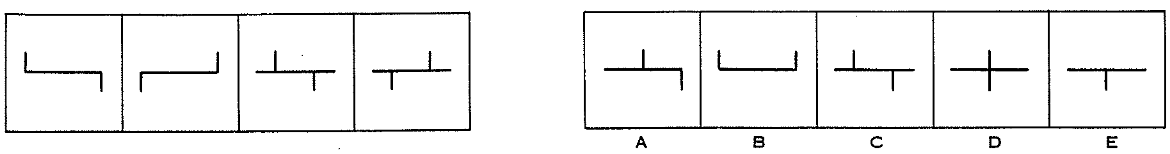
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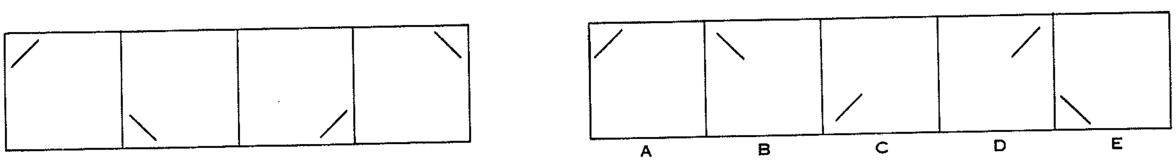
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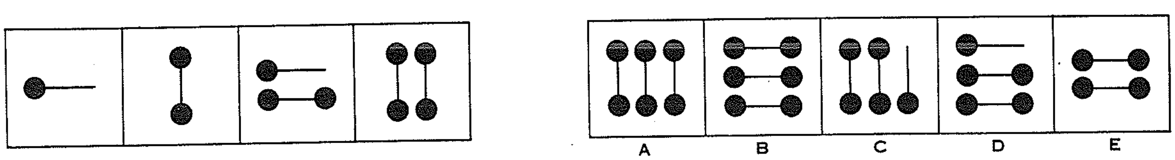
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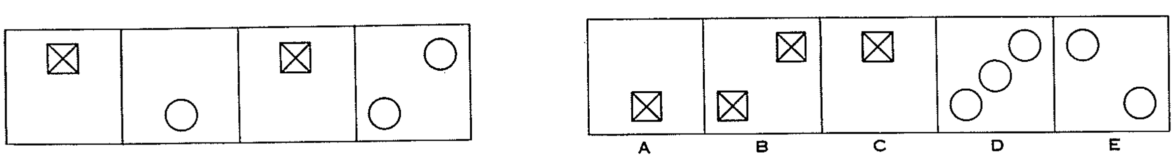
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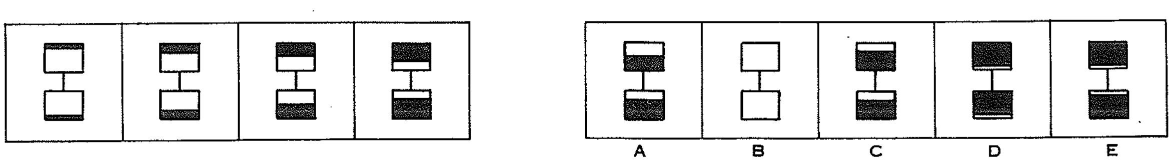
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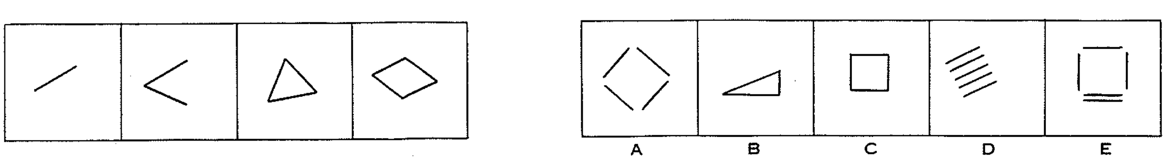
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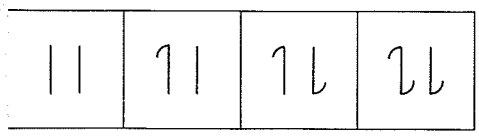

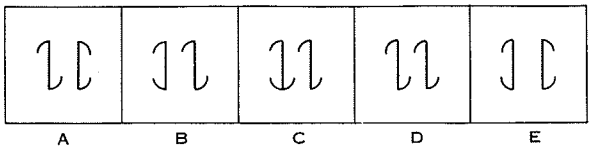
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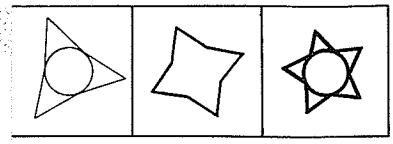

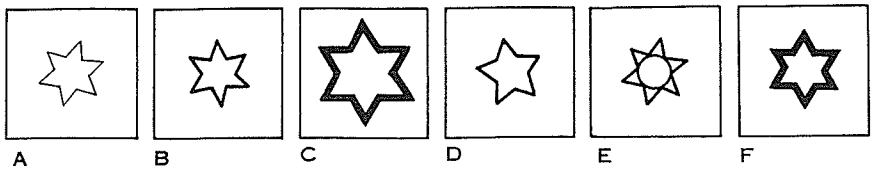
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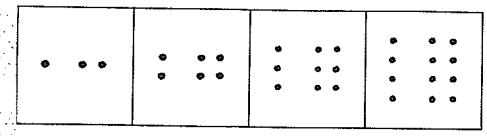

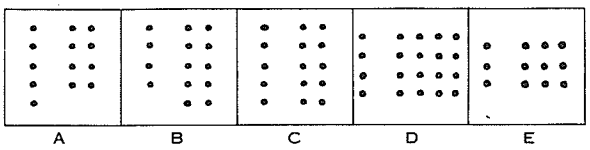
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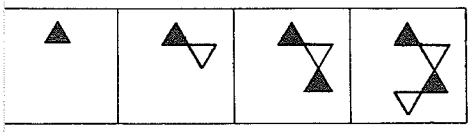

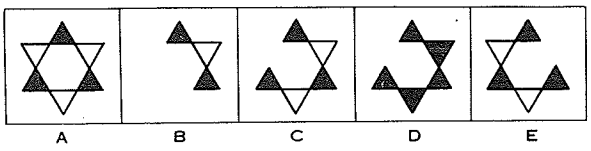
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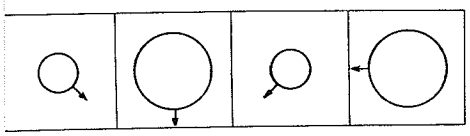

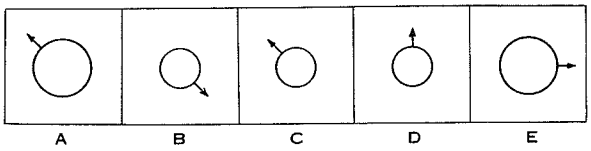
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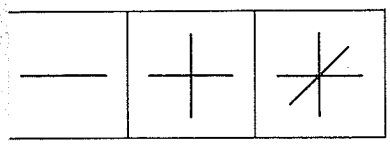

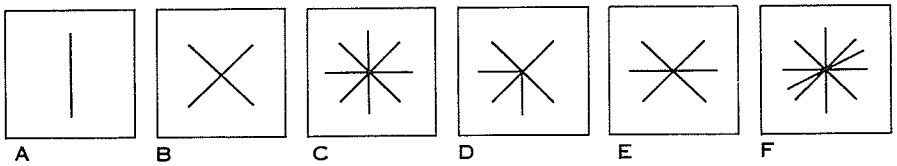
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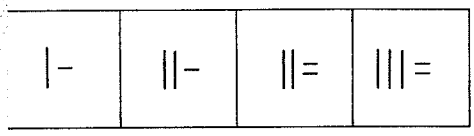

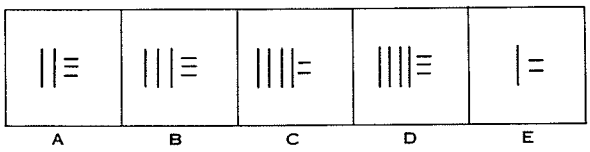
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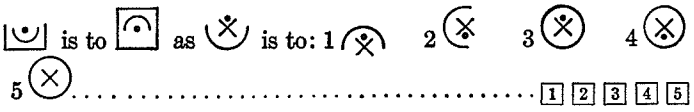
is to
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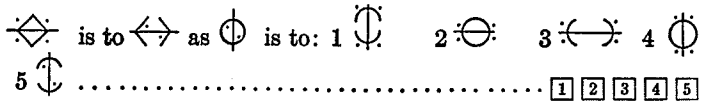
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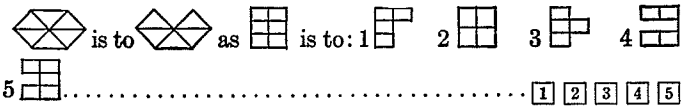
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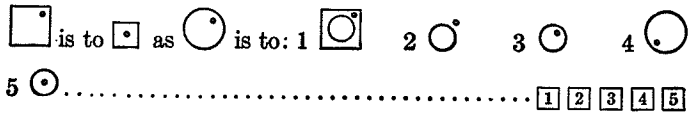
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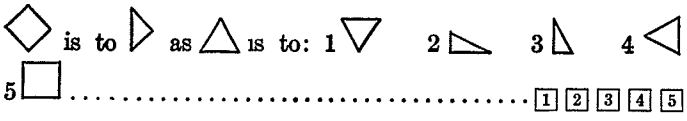
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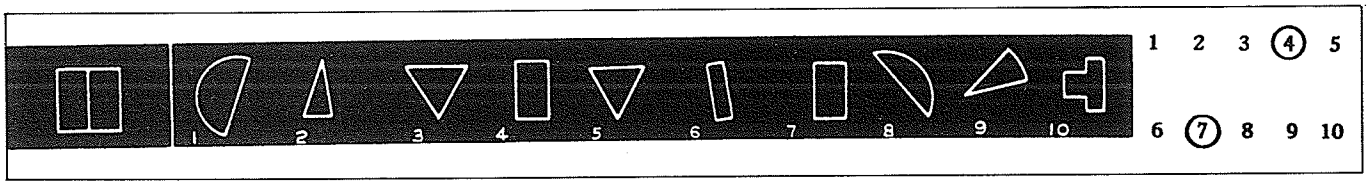
1 2 3 4 5

SPACE RELATIONS TEST

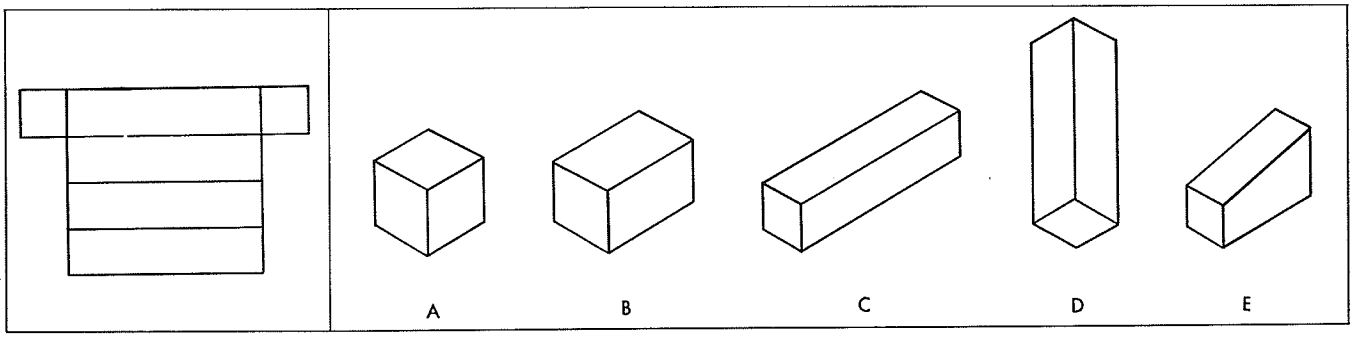
Name:
Group:
Date:

These tests consist of 18 patterns which can be made up into figures, 8 of type A, and 10 of type B.

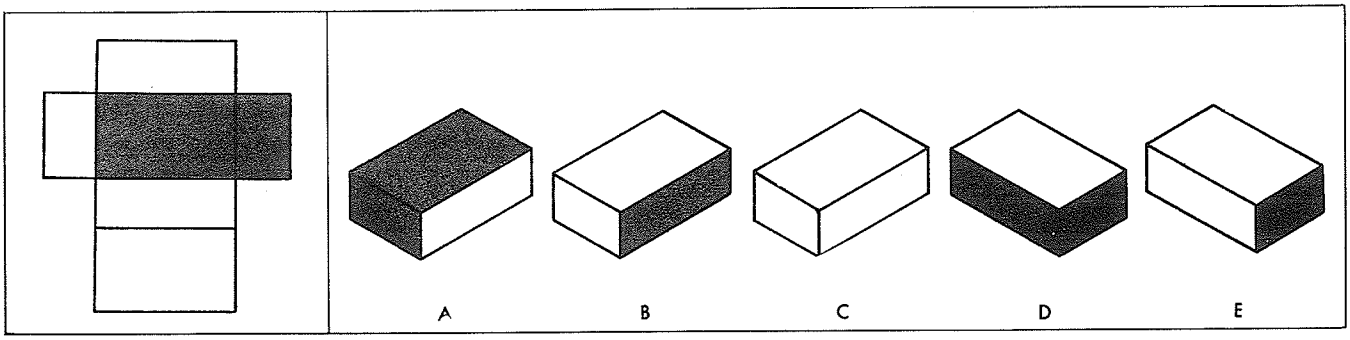
Type A: Select the parts that will make up the figure on the left and circle the corresponding numbers on the right. See sample:



Type B: On the left you see a pattern which, when folded, will make one or more of the figures on the right. Circle the letter or letters corresponding to your choice. See sample:

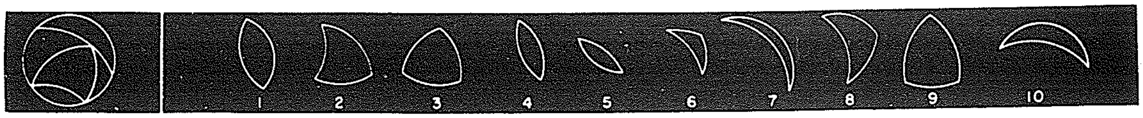


Sometimes the shape of all the figures will be correct for the pattern given, but only some, or perhaps one, of the figures will have the correct markings or shading. See sample:



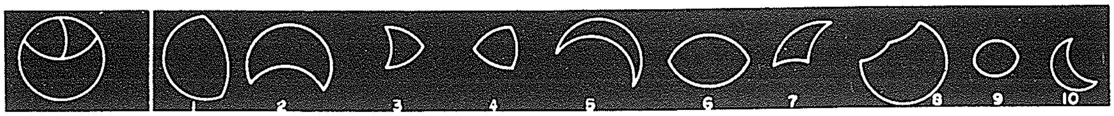
N. B. The pattern shown is always the outside of the figure.

Space Relations Test 1



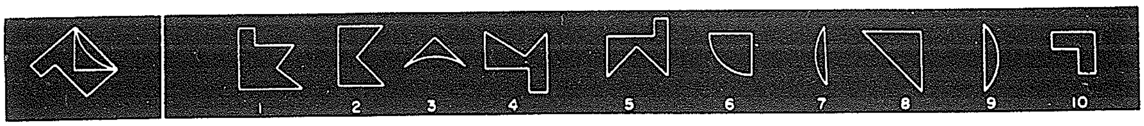
1 2 3 4 5

6 7 8 9 10



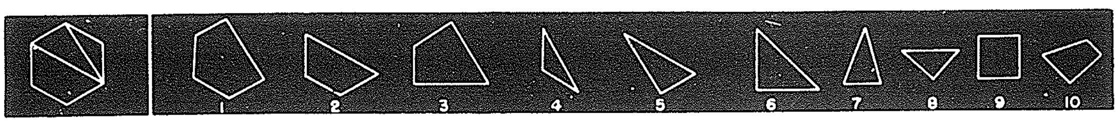
1 2 3 4 5

6 7 8 9 10



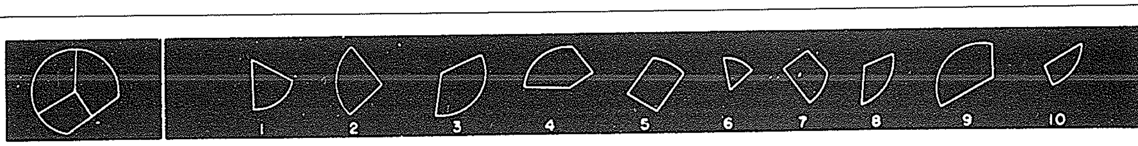
1 2 3 4 5

6 7 8 9 10



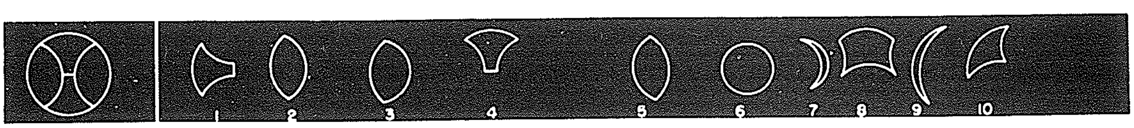
1 2 3 4 5

6 7 8 9 10



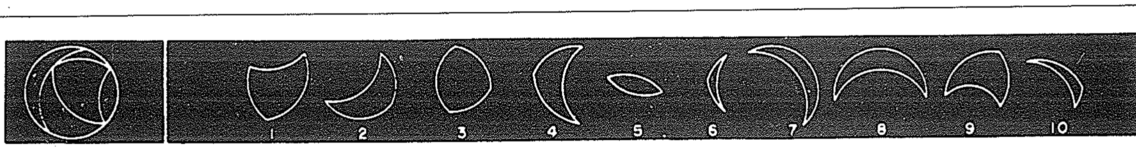
1 2 3 4 5

6 7 8 9 10



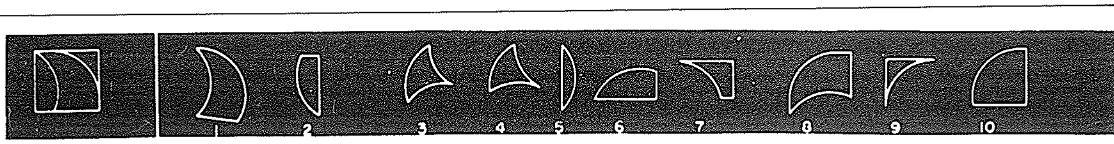
1 2 3 4 5

6 7 8 9 10



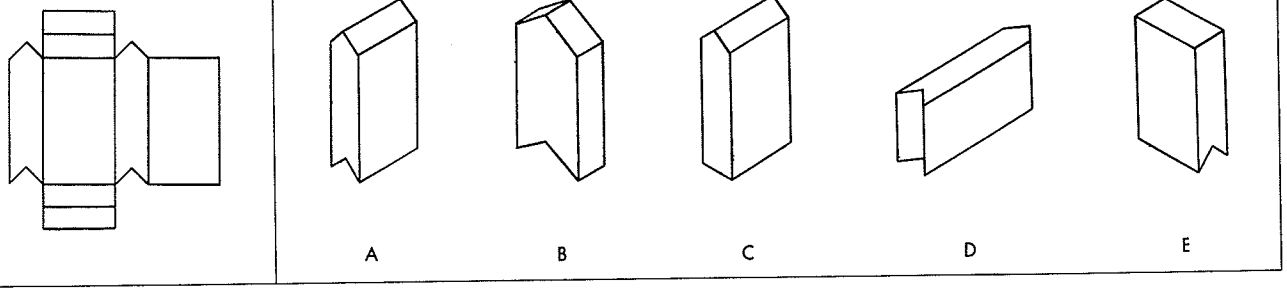
1 2 3 4 5

6 7 8 9 10



1 2 3 4 5

6 7 8 9 10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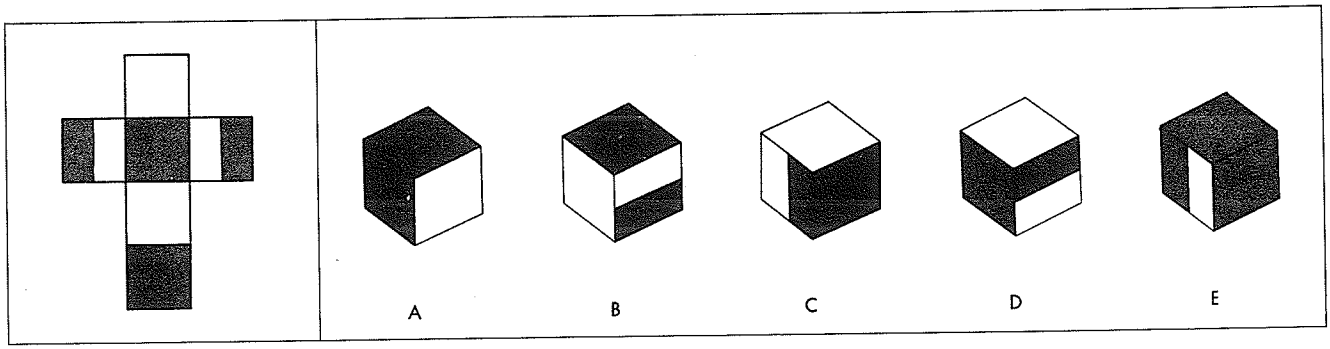
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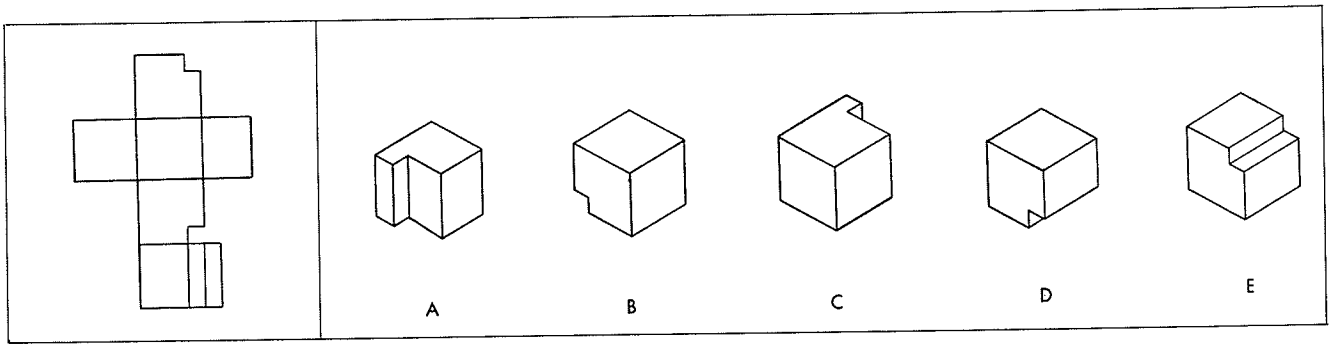
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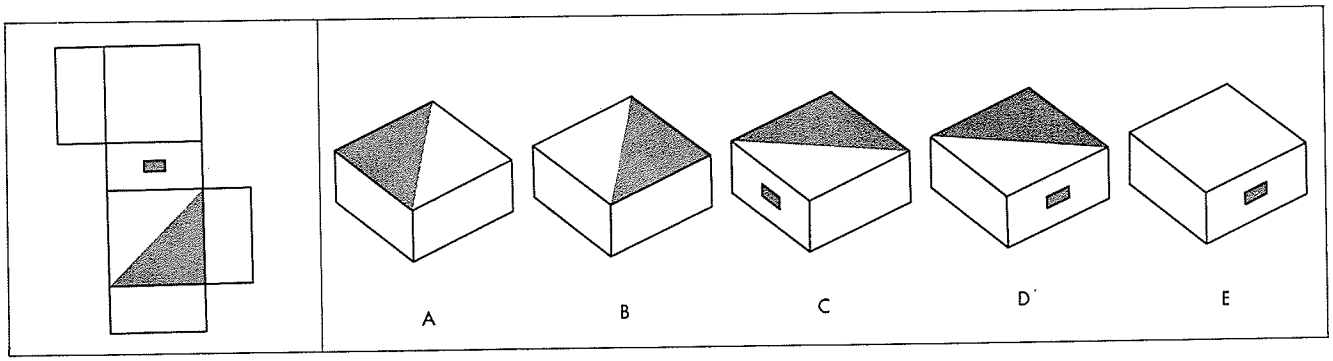
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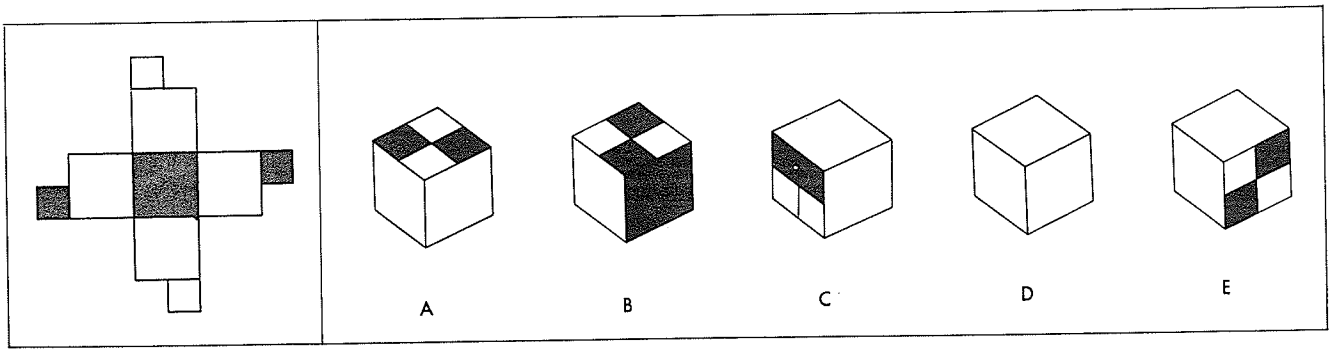
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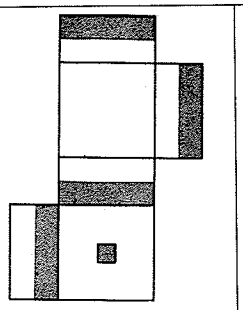
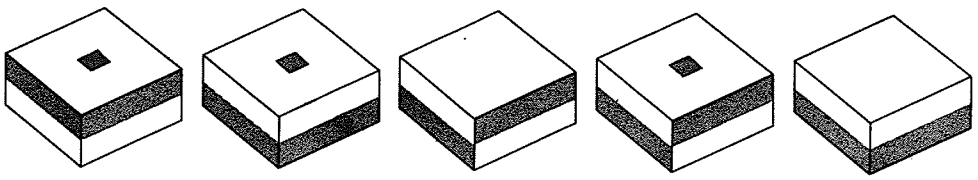
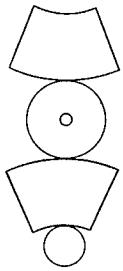
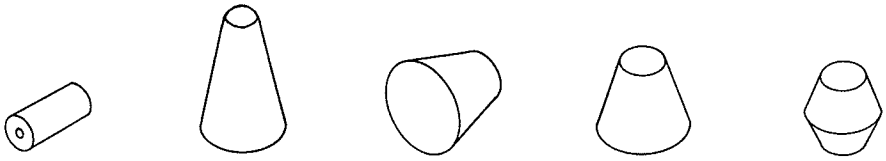


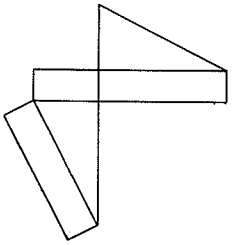


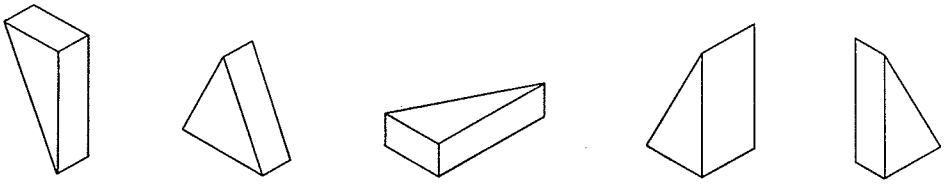
A B C D E



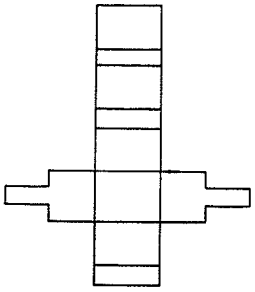


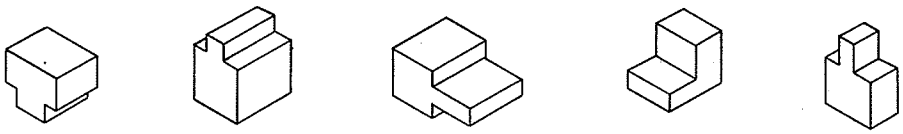
A B C D E



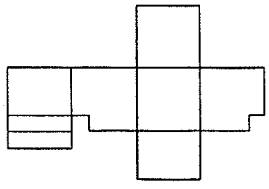


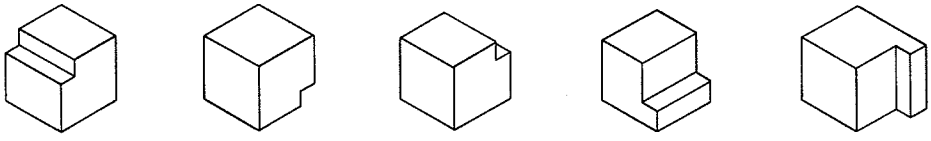
A B C D E





A B C D E





A B C D E

Verbal Fluency

Instruction Sheet

This test consists of a blank sheet of paper with a letter at the top. You are to write down all the words you can think of beginning with that letter. For example, if the letter were "t", you would then write down all the words you could think of beginning with the letter "t."

Do not write down proper names.

Verbal Fluency Test 1.

D

NUMBERS TEST ( ) (NUMBER FACILITY)

This is a test of your aptitude to work with the number system--or other symbol systems, such as files, codes, standard procedures, etc. Below are three samples of the questions you will answer in the test proper. These samples have been answered for you. Study these three questions, and see why they were answered as they were.

4 + 7 + 3 =	12	13	<u>14</u>	15
24 ÷ 6 + 3 =	<u>7</u>	8	6	10
5 x 9 + 4 =	45	<u>49</u>	51	54

Now answer the questions below. <u>Underline</u> the correct answer. In each problem, start with the first number, then the second, then the third. Do the problems in your head as much as possible. If you want to figure, use the space at the right.

6 + 2 - 1 =	6	7	8	9
11 + 7 ÷ 3 =	2	3	4	6
3 + 4 x 2 =	14	15	16	18

Be sure you understand what you are to do. When the signal is given, you will answer more questions like these. <u>Work quickly but be accurate</u>. The allotted time is short, and you will not be expected to finish.

Name:

Group:

Date:

Now wait for the signal to begin the test proper.

2 + 5 + 4 =	9	10	11	12
9 - 3 + 1 =	4	5	6	7
2 x 3 - 3 =	3	4	5	6
6 + 8 + 9 =	20	23	25	27
8 - 5 x 4 =	8	10	12	14
9 ÷ 3 + 7 =	7	8	9	10
5 + 8 + 6 =	16	17	19	21
7 - 4 + 9 =	12	13	14	15
6 x 5 + 4 =	30	34	36	39
2 + 7 + 4 =	20	21	22	23
5 - 6 + 2 =	9	11	12	15
7 ÷ 3 + 4 =	9	11	13	16
3 - 19 - 3 =	1	2	3	4
8 x 6 + 7 =	49	51	53	55
3 + 12 - 6 =	19	20	21	23
4 x 9 + 5 =	38	41	43	45
6 + 8 + 11 =	41	43	45	46
4 + 19 - 1 =	29	30	31	32
6 x 7 + 8 =	50	52	54	56
3 - 9 + 4 =	24	26	28	32
5 + 14 + 7 =	34	36	37	38
9 + 21 ÷ 3 =	6	8	9	10
7 - 16 x 2 =	22	23	26	31
1 + 7 + 16 =	28	32	34	36
1 - 8 - 11 =	10	11	12	14
6 x 2 + 9 =	39	41	42	44

7 x 7 + 3 =	52	53	54	56
21 + 30 + 9 =	54	60	66	70
9 x 12 - 1 =	95	98	107	112
48 ÷ 8 x 7 =	42	48	49	56
42 - 13 - 5 =	16	18	22	24
53 + 19 + 3 =	65	75	83	86
16 + 27 - 3 =	30	34	36	40
28 + 34 - 11 =	46	51	53	61
6 x 11 + 13 =	69	73	79	83
114 - 79 ÷ 5 =	5	7	12	15
62 + 39 ÷ 14 =	115	119	125	127
54 + 42 ÷ 12 =	4	6	7	8
66 + 25 - 12 =	59	69	76	79
98 ÷ 7 x 3 =	42	45	48	54
72 + 58 - 21 =	99	109	116	119
13 x 16 + 31 =	228	236	239	245
24 x 8 ÷ 12 =	8	14	16	24
07 ÷ 3 - 23 =	46	48	56	58
44 ÷ 8 + 67 =	85	88	91	95
69 + 125 ÷ 14 =	18	21	24	26
33 x 16 - 829	487	489	498	499
97 + 86 x 8 =	1384	1386	1456	1464
38 ÷ 26 + 471 =	484	486	494	504
42 x 12 ÷ 14 =	20	24	36	38
72 - 546 ÷ 7 =	16	18	24	32
73 ÷ 13 x 46 =	746	874	966	1104
38 x 67 - 1769 =	657	697	777	867

Mathematical Ability (NUMERICAL REASONING)

Instruction Sheet

This test consists of 20 sequences of numbers. Each sequence has two blank spaces following it and you are to fill in the correct numbers in the blank spaces. The sequence or order of the numbers is determined by some rule or principle. You must discover the rule or principle before you will be able to fill in the two blanks.

Example 1:

2 4 6 8 10 ___ ___

Rule or principle:

Each number is increased by 2. Therefore the correct numbers in the blanks will be 12 (10 + 2); and 14 (12 + 2).

Example 2.

8 3 4 3 2 3 1 ___ ___

Rule or principle:

Every second number is divided by 2. Otherwise the 3 is repeated. Therefore the correct numbers in the blanks will be 3 and $\frac{1}{2}$.

These are only two examples. There will be many different kinds of rules and principles governing the sequences of the test proper. Think carefully.

MATHEMATICAL ABILITY TEST (1) (NUMERICAL REASONING)

Find the rule in each problem and fill in the blank spaces with the correct numbers.

1. 5 10 15 20 25 30 ___ ___
2. 2 4 6 8 10 12 ___ ___
3. 5 6 10 11 15 16 20 21 ___ ___
4. 1 2 4 7 11 16 22 29 ___ ___
5. 5 3 4 6 4 5 7 ___ ___
6. 1 2 4 8 10 20 22 ___ ___
7. 12 15 19 23 28 33 39 ___ ___
8. 20 17 15 14 11 9 ___ ___
9. 1 4 9 16 25 36 ___ ___
10. 3 6 12 24 48 ___ ___
11. 42 45 15 18 9 ___ ___
12. 6 7 14 15 16 32 ___ ___
13. 1 4 8 16 19 38 76 ___ ___
14. 20 15 20 30 20 60 ___ ___
15. 11/12 5/6 3/4 2/3 7/12 1/2 5/12 1/3 ___ ___
16. 4 5 7 11 19 35 67 131 ___ ___
17. 1/48 1/24 1/12 1/6 1/3 2/3 1 1/3 ___ ___
18. 92 46 44 22 20 10 ___ ___
19. 1 3 7 15 31 63 127 255 ___ ___
20. 1 3 8 19 42 89 ___ ___

Cancellation Test. (PERCEPTUAL ABILITY)

Instruction Sheet.

This test consists of a sheet of numbers arranged in a haphazard order. At the top of the sheet you will find a number written. You are to cancel or put a stroke through as many of those numbers as you can in the time allotted to you. For example, if the number written in at the top is "7" you would do the following:

Example: 4 7 3 2 0 8 1 4 9 7 5 6 2 7

Start at the left hand side of the page and work toward the centre line of the sheet. Do the left hand section first.

CANCELLATION TEST

7 9 6 2 A 1 3 4 0 5 8 4 2 5 9 3 8 6 0 7 9 4 0 8 1
1 6 8 9 0 5 3 7 4 2 B 1 9 4 7 5 3 0 2 6 8 0 4 7 3
0 7 3 4 2 9 1 8 6 5 9 6 1 2 C 8 7 0 5 3 1 9 8 3 0
4 7 6 8 1 3 2 5 9 0 6 3 0 7 5 9 4 8 1 2 D 4 8 5 9
6 5 9 7 3 2 8 4 0 1 0 3 8 6 1 4 9 7 2 5 2 5 3 4 6
8 3 5 0 9 4 7 2 8 1 5 7 0 2 1 3 9 4 6 5 2 1 0 8 4
1 6 9 7 0 5 3 2 4 2 7 8 4 6 5 1 3 9 0 3 1 2 6 9 5
2 0 4 8 5 7 6 1 3 9 7 1 6 8 0 2 5 4 3 9 6 0 1 4 2
4 1 2 5 6 8 0 9 7 3 5 9 3 7 6 2 1 8 4 8 6 9 7 5 1
5 2 1 3 4 0 9 6 8 7 3 4 2 B 8 0 6 5 7 1 7 3 6 5 2
5 1 6 8 4 9 2 3 7 0 1 2 7 5 0 4 8 6 9 3 4 1 8 0 2
7 8 0 5 1 3 4 2 6 9 2 4 0 9 7 6 1 5 3 8 3 2 0 4 1
3 5 9 7 8 4 6 1 0 2 5 1 8 2 3 7 4 9 6 0 8 5 9 3 2
2 7 3 9 6 5 0 8 1 4 9 7 3 6 1 5 0 2 8 4 0 4 8 5 9
4 2 5 3 0 1 7 9 8 6 3 8 6 0 9 1 5 4 7 2 9 3 6 7 4
9 4 7 3 8 5 6 2 1 6 0 9 3 8 2 7 1 4 5 P 7 8 1 0 9
0 9 8 2 5 6 1 7 4 3 8 3 5 4 6 R 9 2 0 1 7 6 0 2 1
1 0 4 6 2 7 9 5 3 8 S 0 6 2 8 4 3 9 7 5 1 2 7 4 5
8 6 1 4 9 T 2 3 0 5 7 4 5 1 7 2 8 6 3 0 9 1 9 5 6
6 3 2 1 7 0 8 4 9 5 7 9 Z 1 5 0 3 8 2 6 5 6 3 2 7

CANCELLATION TEST

7 2 6 3 5 2 6 8 3 0 5 1 4 9 7 5 9 4 8 0 7 6 2 3 1
8 6 5 9 1 9 0 3 6 8 2 7 1 5 4 7 2 0 3 5 9 4 1 6 8
6 5 4 7 2 1 5 7 9 3 4 8 2 6 0 8 3 5 9 7 2 6 4 0 1
7 3 1 2 0 6 7 1 0 2 9 6 3 5 8 3 4 7 1 6 5 2 8 9 0
E 9 0 1 8 7 5 4 1 7 2 8 3 9 0 6 1 2 6 8 3 0 7 4 8
7 6 3 9 F 2 7 4 5 1 9 0 6 8 3 6 8 9 7 1 0 3 5 2 4
8 7 4 0 4 8 2 0 5 G 1 6 3 7 9 4 1 8 0 5 6 9 3 7 2
3 9 5 8 0 6 9 2 7 3 2 8 1 5 H 2 0 1 6 4 8 7 9 5 3
4 0 2 3 8 3 5 1 6 7 9 0 4 2 9 6 2 4 3 A 1 5 0 8 7
0 9 8 1 4 3 9 6 8 4 0 5 7 2 1 0 7 3 2 9 4 8 6 1 8
5 6 3 7 1 7 5 6 0 8 9 2 4 3 7 8 6 9 0 G 4 3 1 2 8
5 7 9 6 8 4 8 1 2 6 7 3 9 0 5 L 3 7 9 0 6 5 2 1 4
4 1 0 7 9 3 4 5 2 F 0 8 6 1 7 9 3 1 6 7 5 8 4 0 2
6 2 1 3 E 0 9 3 1 5 6 4 8 7 2 4 2 3 5 6 7 9 0 8 1
D 8 0 1 2 5 6 4 9 3 1 2 0 7 5 8 6 2 7 4 9 0 5 3 8
6 4 3 5 2 5 2 7 9 4 1 6 3 8 0 1 0 4 8 2 3 7 9 5 6
3 7 9 5 8 4 2 1 8 4 9 5 7 0 3 6 0 9 2 1 8 6 7 4 3
6 0 3 8 9 1 5 0 7 8 4 2 1 6 9 5 6 8 1 9 2 4 3 7 6
8 3 7 4 0 8 6 2 0 7 3 5 4 9 1 2 4 7 3 5 0 1 8 6 9
1 8 4 0 9 7 0 6 8 3 9 1 5 2 4 8 5 0 4 3 1 2 6 9 7

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Factored Aptitude Series

DEXTERITY

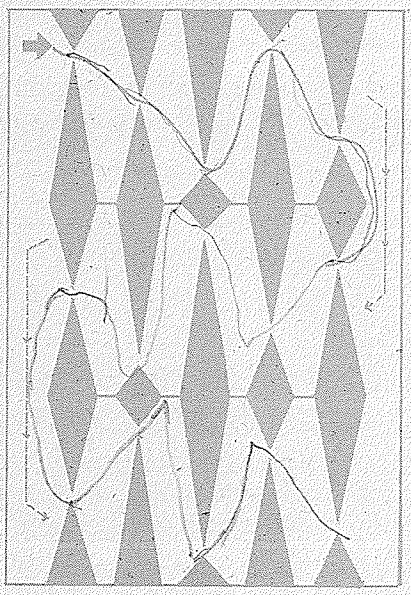
EDITION A

Prepared by Joseph E. King, Ph.D.

CONFIDENTIAL

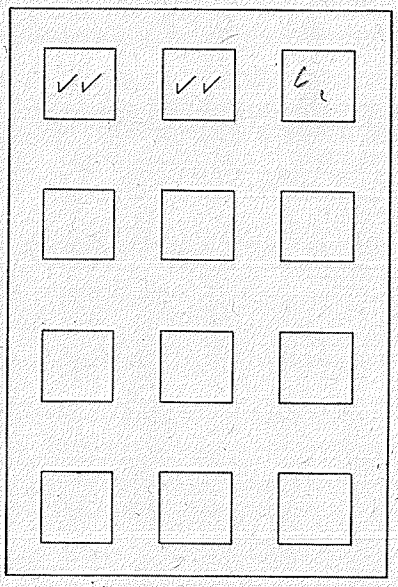
This is a test of your manual dexterity. You will do three tasks with your pencil (newly sharpened). Now work the samples below for practice.

1 **Trace a line through the maze:**



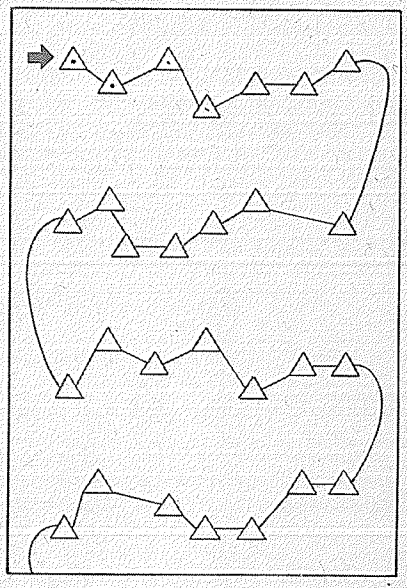
Your line should *not* touch any of the points, and should be continuous.

2 **Make 2 checks in each square:**



You should have only 2 checks in each square. Your checks *may* touch the sides of the squares.

3 **Put 1 dot in each triangle:**



Your dots should *not* touch the sides of the triangles.

* * *

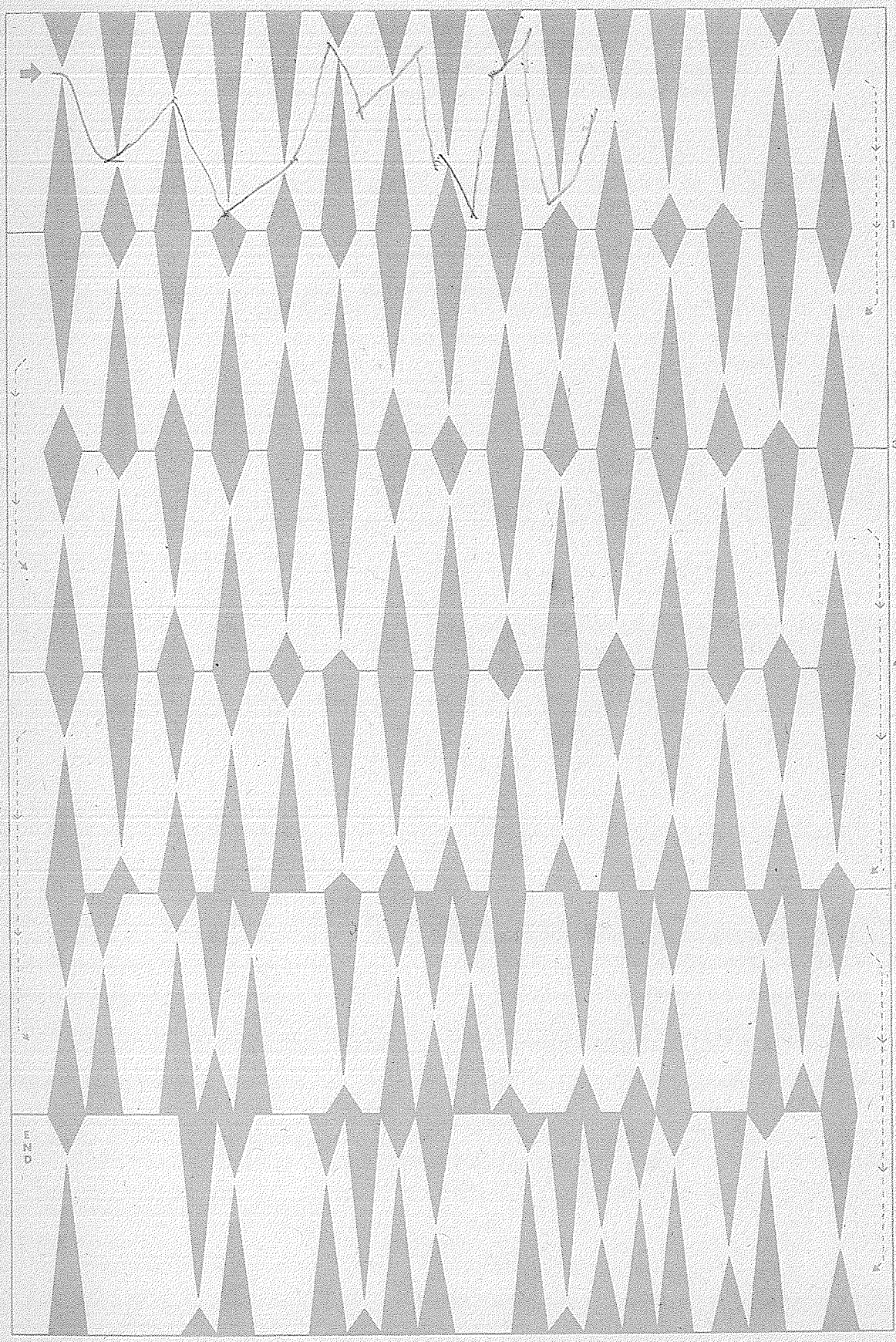
Be sure you understand what you are to do. When the signal is given, you will take the timed tests. Each of the three tests will be timed separately. Each test is very short (1 minute). You are to work QUICKLY, but be ACCURATE. ***Speed is very important.***

Now PRINT your name, group and the date in the boxes on the left margin.

STOP HERE—WAIT FOR SIGNAL

1 Trace a line through the maze *(Do NOT touch points)*:

1

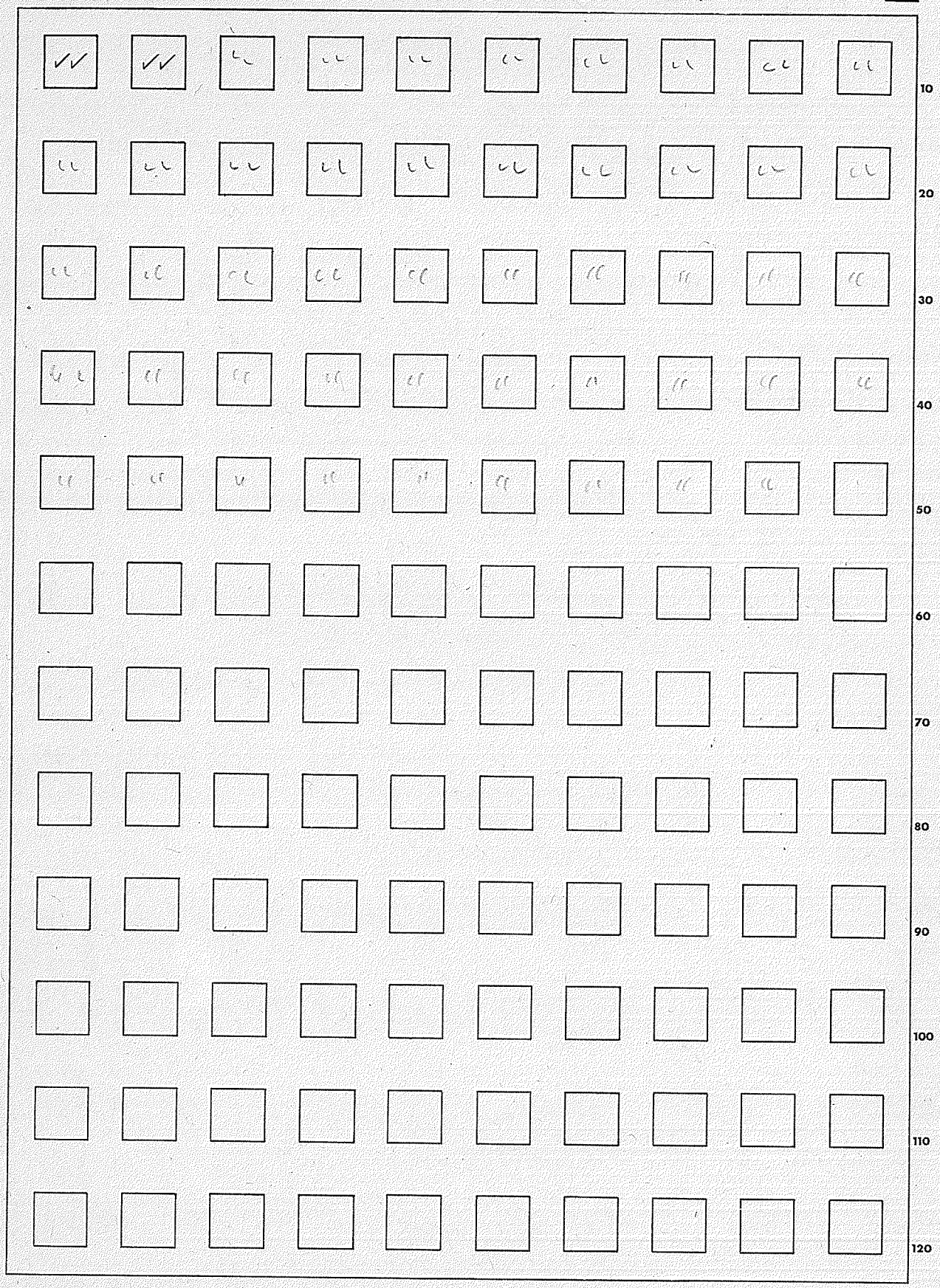


Raw Score is number of openings passed (without touching points)—15 openings to row..... **RAW SCORE**

For Rank, see Conversion Table for Dexterity-Maze... **RANK**

❷ Make 2 checks in each square *(Try to stay within squares, though not necessary)*:

1

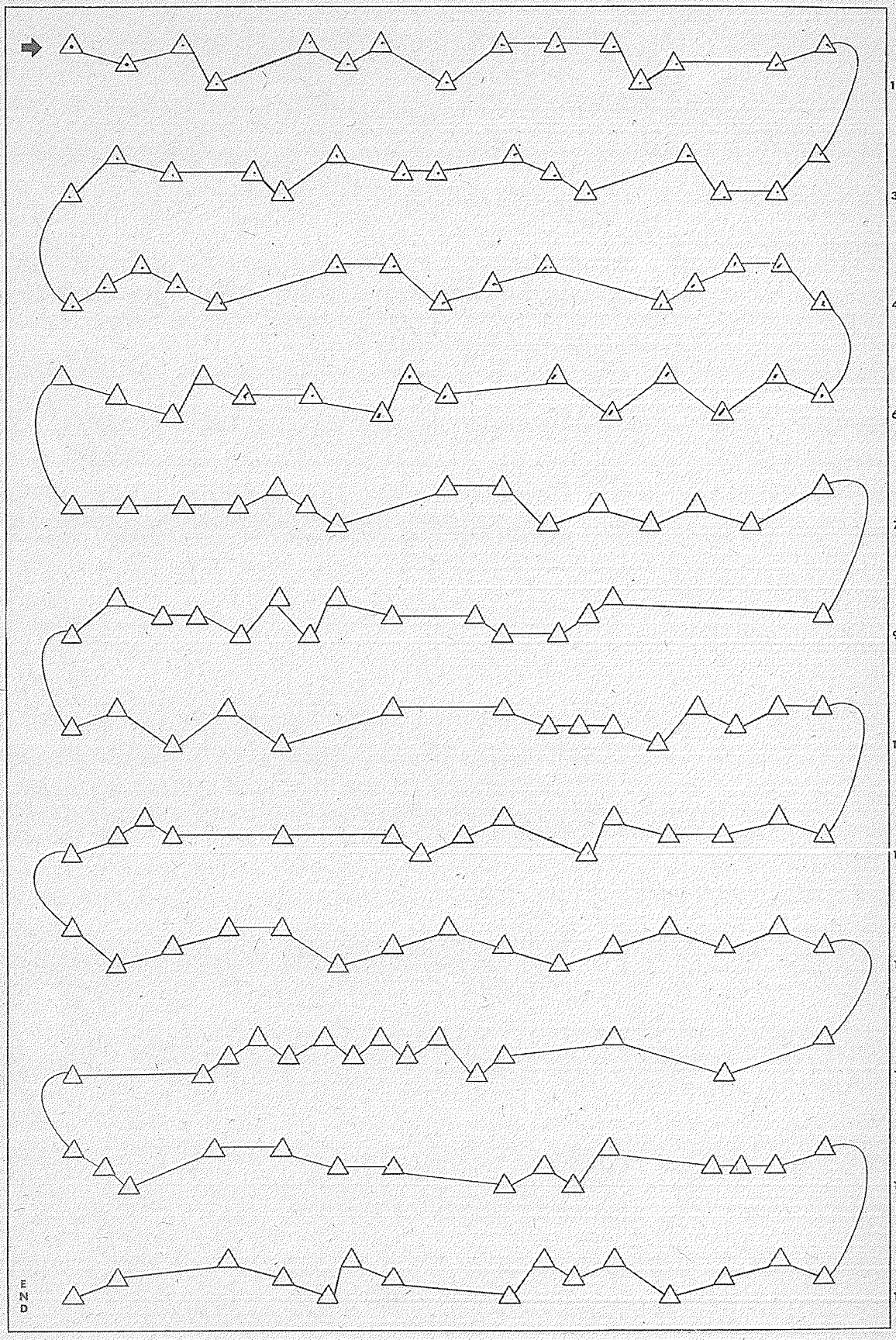


Raw Score is number of squares completed (checks may touch squares)—10 squares to row..... **RAW SCORE** ☐

For Rank, see Conversion Table for Dexterity-Checks **RANK** ☐

❸ Put 1 dot in each triangle *(Do NOT touch sides of triangle):*

1



Raw Score is number of triangles dotted (without touching sides) — 15 triangles to row..... **RAW SCORE** ☐

For Rank, see Conversion Table for Dexterity-Dots... **RANK** ☐

To obtain Dexterity Rank, add Ranks for Maze + Checks
Divide this sum by 3. Nearest whole number is DEX
RANK. Enter this Rank on first page.

RANKS: **MAZE** ☐ + **CHECKS** ☐ + **DOTS** ☐ ≐ ☐/3 = ☐

D

Recall and Recognition Test (Learning)

Instruction Sheet

This test consists of 3 pages. The first page contains a list of 20 nonsense syllables; the second page is blank; the third page contains 50 nonsense syllables.

Start with the first page. When the experimenter tells you to begin you are to memorize as many of these nonsense syllables as possible. When he tells you to stop, turn to the next page, the blank one, and write down as many of the syllables as you can remember. Tell the experimenter when you start and when you finish. Turn to the third page. Here the original 20 nonsense syllables (from page 1) are mixed with 30 other nonsense syllables. See how many you can recognize from the first page. Circle those you recognize. Tell the experimenter when you start and when you finish.

N.B. The experimenter will tell you when to begin the first page and when to stop. However, you will tell the experimenter when you begin the second page and when you finish. You will also tell the experimenter when you begin the third page and when you finish it.

1. luj
2. xuw
3. guf
4. baf
5. fij
6. tuq
7. deb
8. lon
9. jom
10. fud
11. jol
12. vex
13. kij
14. qip
15. sut
16. zey
17. qes
18. nem
19. sor
20. caf

1. sut
2. zey
3. sor
4. kil
5. nem
6. nim
7. len
8. jik
9. naq
10. kij
11. hej
12. lon
13. fic
14. teq
15. jol
16. vis
17. bod
18. gid
19. qes
20. qun
21. caf
22. yox
23. hij
24. guf
25. qur
26. fih
27. loj
28. vex
29. baf
30. vox
31. jom
32. xuw
33. qip
34. t_as
35. xat
36. ziy
37. noz
38. deb
39. yux
40. jef
41. boc
42. luj
43. fij
44. fud
45. mul
46. gij
47. tuq
48. sev
49. qat
50. jul