

THE EFFECT OF ONE DAY OF SENSORY DEPRIVATION ON A BATTERY
OF RELATIVELY UNSTRUCTURED COGNITIVE TESTS

A Thesis
Presented to
the Faculty of Graduate Studies and Research
University of Manitoba

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

by
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October, 1968



ABSTRACT

The Effect of One Day of Sensory Deprivation on a Battery of Relatively Unstructured Cognitive Tests

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The purpose of this thesis is to determine whether performance on a battery of unstructured or "open-ended" cognitive tests will be significantly impaired by one day of sensory deprivation, a duration falling within the suggested critical range for optimal deprivation effects.

The Guilford battery of creative thinking, consisting of ten subtests, all of an open-ended nature, was administered to a group of 18 experimental subjects before and at the end of one day of sensory deprivation (darkness and silence). The results were compared with those of 18 ambulatory controls who had received the same test battery and at the same time intervals as the experimentals.

A series of two-tailed t-tests, involving a difference of differences analysis, revealed no significant changes in performance between the two groups of subjects on 9 of the 10 subtests. On the one test, associational fluency, the experimentals performed significantly worse than did the controls. This single positive finding may represent either a genuine effect or a chance occurrence resulting from the calculation of numerous t-tests of significance.

Four possible explanations were offered for the essentially

negative results. These relate to the critical range for optimal deprivation effects, the duration of the test session, the degree of unstructuredness of the tests employed, and the use of a written rather than an oral test response procedure.

TABLE OF CONTENTS

CHAPTER		PAGE
I	THE PROBLEM, INTRODUCTION, AND HISTORICAL BACKGROUND.....	1
	I. Statement of the Problem.....	1
	II. Introduction.....	1
	III. Historical Background.....	3
II	EXPERIMENTAL METHOD AND RESULTS	14
	I. Subjects.....	14
	II. Isolation Chamber.....	14
	III. Tests.....	16
	IV. Procedure.....	18
	V. Results.....	19
III	DISCUSSION AND CONCLUSIONS.....	22
	BIBLIOGRAPHY.....	27
	APPENDIX A - TEST SAMPLES AND INSTRUCTIONS.....	30
	APPENDIX B - RAW DATA.....	41

LIST OF ILLUSTRATIONS

TABLE		PAGE
I	Mean scores of the experimental and control subjects on ten cognitive tests administered before and at the end of one day	20
FIGURE		
I	A cross-sectional view of the University of Manitoba isolation chamber	15

CHAPTER I

THE PROBLEM, INTRODUCTION, AND HISTORICAL BACKGROUND

I. Statement of the Problem

In a recent test of the Goldberger and Holt (1958) and Suedfeld (in press) hypothesis, stating that unstructured or "open-ended" cognitive tests will be significantly impaired by an impoverished sensory environment, Fuerst and Zubek (1968) reported that a three-day period of sensory restriction produced no significant changes in performance on the relatively unstructured tests of the Guilford (1964) battery. Since there are some suggestions in the literature indicating that deprivation periods of one or two days sometimes produce greater cognitive and perceptual changes than do longer durations, Fuerst and Zubek suggested that a significant impairment on the "open-ended" tests of the Guilford battery may have occurred had the battery been administered on perhaps the first rather than on the third day of the deprivation period. The purpose of the present study was to test this hypothesis.

II. Introduction

Since the original McGill research (e.g., Bexton, Heron, & Scott, 1954) numerous studies have been concerned with an appraisal of the cognitive effects of sensory and perceptual deprivation. The cognitive tests employed in these studies have generally consisted of subtests of standard I.Q. tests or measures of learning, retention, and various primary mental abilities e.g., abstract reasoning, verbal reasoning, and

space visualization. Only a few have employed a different type of cognitive measure viz., tests of an open-ended nature requiring a variety of possible answers. A differential pattern of results, indicating that certain measures of cognitive functioning are impaired, others are unaffected, while still others are improved, has been reported (see reviews of Schultz, 1965; Suedfeld, in press; Zubek, 1964).

In an attempt to account for these differential cognitive effects, Suedfeld (in press), in a recent survey of this literature, has suggested that this complex pattern of results may be related to differences in the degree of "structuredness" of the cognitive tasks being employed. According to Suedfeld, a structured or "closed-end" task is one whose solution is dependent upon the use of overlearned, logical steps to reach a definite, clear answer. On the other hand, a cognitive task may be considered unstructured or "open-ended" if "new combinations must be made, uncertain approaches tried, new material generated on the way to an unknown, self-defined, unstructured goal." Furthermore, Suedfeld has suggested that performance on such highly structured tasks as arithmetic problems, digit span, or rote learning will be least impaired, or even improved, by deprivation while relatively unstructured tasks such as word-making, the Uses test, and story-telling in response to TAT-like cards, all resulting in a variety of possible answers, will show considerable impairment of cognitive functioning. A similar hypothesis based, however, on somewhat limited data was advanced in 1958 by Goldberger and Holt who stated that probably any task involving "active reflection and

manipulation of ideas" rather than highly overlearned sets of operations (e.g., arithmetic problems) or requiring passive receptivity (e.g., digit span, rote learning) would be most interfered with by reduced sensory stimulation.

Although numerous studies have indicated that performance on structured cognitive tests is largely unaffected by conditions of sensory restriction (Suedfeld, in press), little is known about performance on unstructured tests. Furthermore, the studies that do exist have largely been restricted to measures of story-telling and word-making. In view of this, further research using a wide range of such open-ended tests appeared to be warranted. The Guilford factor-analyzed battery of creative thinking, consisting of ten subtests was, therefore, employed in the present study.

III. Historical Background

Since a voluminous literature exists on the cognitive effects of sensory restriction (see reviews of Schultz, 1965; Suedfeld, in press; Zubek, 1964), this historical review will be restricted to experiments employing unstructured or open-ended cognitive tests in which a variety of answers are possible. For organizational purposes, the review will be presented in two sections: the first describing short-term studies of less than one day and the second, long duration studies of a day or longer. This division is important since the results of these two types of studies are not always in agreement. Furthermore, some doubts exist as to whether certain of the changes which occur after only a few hours

can properly be attributed to reduced sensory input (Cameron, Levy, Ban, & Rubenstein, 1961; Jackson, & Pollard, 1962). In describing the various studies, a differentiation will be made between sensory and perceptual deprivation, a two-fold division first advocated by Kubzansky (1961). Sensory deprivation will refer to a condition of darkness and silence and perceptual deprivation to a condition employing constant unpatterned light and white noise (or some other masking sound). This differentiation is also of some importance since these two conditions are not always equivalent in either their behavioral or physiological effects (Zubek, 1964).

Short-Duration Studies

In the first study to be considered, Goldberger and Holt (1958) perceptually deprived a group of subjects for eight hours. Since a control group was not employed the data were analyzed in terms of the "pre- and post-test" performance of the experimental group. The results indicated a significant impairment on the Watson-Glaser logical deductions subtest but no change on tests of arithmetic reasoning, digit span, and story recall. On the basis of these results the authors concluded that unstructured cognitive tasks, such as the logical deductions subtest, requiring "active reflection and manipulation of ideas" would be impaired whereas structured tasks requiring the "use of highly over-learned sets of operations" would be least interfered with by isolation. A second eight-hour perceptual deprivation study by Pollard, Uhr, and Jackson (1963) also employed the Watson-Glaser logical deductions subtest.

A control group was added for comparison purposes. In this study both the experimental and control groups performed worse on the retest, showing decrements of about the same magnitude. Although this negative finding throws considerable doubt on Goldberger and Holt's (1958) interpretation of their data, it does not necessarily invalidate their hypothesis because, according to Suedfeld (in press), the Watson-Glaser logical deductions subtest, a test of a multiple choice nature, is essentially a structured test involving the selection of an easily identified answer.

A projective type of test situation has been employed in three studies attempting to assess the cognitive effects of deprivation procedures. In a study employing a control group and a group which had been perceptually deprived for eight hours, Goldberger (1966) administered two relatively unstructured tests viz., making up stories from a verbal description of TAT-like cards and presenting a ten-minute monologue on a given topic. No significant differences in either story length or affective tone were observed between the experimental and control groups on either test. In the second study, employing 45 minutes of sensory deprivation, Sipprelle, Long, and Lucik (1963) instructed subjects to tell a five-minute story involving the subject, the experimenter, and two other people. The results of this study, contrary to those reported by Goldberger (1966), indicated a significant post-deprivation decrease in overall productivity. Furthermore, deprivation produced fewer environment-directed and more self-directed responses.

In the third study, Robertson and Martin (1961) investigated the effect of three hours of perceptual deprivation on projection. A dim spot of light, approximately one millimeter in diameter and nine feet away from the subject, was flashed on a screen. The subject was to look at the moving pinpoint of light and when it went off he was to state what it made him think about. The results revealed no significant differences between the control and experimental groups on measures of response productivity, proportion of original responses, or proportion of popular and stimulus-bound responses. These results appear to provide partial confirmation of the Goldberger (1966) story-telling data in which no significant change in story length was noted following eight hours of perceptual deprivation.

Several investigators have studied the effect of short-term deprivation upon word-association ability and word-making ability (ability to produce words containing a specific number of letters of the alphabet or beginning with a certain letter). Zuckerman, Albright, Marks, and Miller (1962), who confined subjects for seven hours in a tank respirator, found that performance on the Kent-Rosanoff word-association test (number of popular responses) was not affected, a finding also reported by Robertson and Browning (1963) in a three-hour sensory deprivation study. However, word-making ability and verbal productivity in a free-association test were significantly reduced in comparison to that of a control group. In contrast to these latter results, Pollard et al. (1963) and Goldberger (1966) have reported no change in word-making ability following eight hours of perceptual deprivation. Goldberg (1961) has also

reported no significant change on a somewhat related verbal fluency test viz., a test consisting of seven sentence building items, following two hours of sensory deprivation produced by the water-immersion technique.

Long-Duration Studies

Several long-term studies have employed tests of an open-ended nature viz., word-making ability, as part of batteries consisting mainly of structured tests. These studies, using durations of 3 to 7 days, (Bexton et al., 1954; Myers, Murphy, Smith, & Windle, 1962; Scott, Bexton, Heron, & Doane, 1959; Zubek, Sansom, & Prysiazniuk, 1960; Zubek, Aftanas, Hasek, Sansom, Schludermann, Wilgosh, & Winocur, 1962) have all reported a poorer performance on this measure of word-making ability. Since this ability does not appear to be consistently affected by short deprivation periods, as indicated in the preceding section, these findings suggest that duration may be an important variable in determining the presence or absence of cognitive decrements on open-ended tests. There is, however, the possibility that the results obtained in the long-term studies are confounded by the fact that the test batteries took perhaps an hour to administer and were comprised of both structured and unstructured tests. Since the test batteries were relatively long, impairments might be expected because of such variables as fatigue and decreased motivation.

Recently, several studies have been concerned with the effects of sensory or perceptual deprivation on unstructured tests alone. These studies will now be reviewed.

Perhaps the clearest evidence in support of the hypothesis that unstructured tests will be affected by deprivation has been provided by Suedfeld, Grissom, and Vernon (1964). These investigators orally presented a TAT-like scene to subjects before and after a 24-hour period of either normal activity, sensory deprivation, or social isolation. The subjects were instructed to make-up as detailed and elaborate a story as possible in relation to the TAT-like scene described. The story was tape-recorded. The results indicated no change in story length from the pre- to the post-test for the control group, the sensory deprivation group significantly decreased the length of its stories, while the socially isolated subjects increased their story length. Speech rate decreased in all the groups from the pre- to the post-test but the difference was significant only in the sensory deprivation group. Similar results were obtained in a replication of this study (Suedfeld, Vernon, Stubbs, & Karlins, 1965) in which the subjects were assigned to the three groups in such a way as to equate the groups for the average length of their initial stories. Finally, this study also indicated that the effects of sensory deprivation can be negated through adaptation since cognitive decrements were not observed when the subjects underwent a second deprivation session a week after completing the first.

Two studies by the Japanese investigator Oyamada have produced partial support for the findings of Suedfeld et al. (1964, 1965). In the first study, Oyamada (1966a) visually presented four TAT-like cards, consisting of three figure cards and a blank card, to subjects who had been perceptually deprived for either 18 or 24 hours. Responses to the

cards were recorded on a tape-recorder. Scoring of the responses was in terms of initial reaction time to the cards and time spent in story telling. On all except the blank card, the 24-hour group showed a significantly longer initial reaction time than did the control group. The 18-hour group also exhibited a longer reaction time but only the difference on the blank card was statistically significant. On the other measure viz., time spent in story telling, there were no significant differences between the controls and either of the experimental groups. An examination of trends, however, revealed a shorter duration of story telling in the 24-hour group relative to the controls while the 18-hour subjects, surprisingly, showed a slightly longer duration of story telling.

In the second study, Oyamada (1966b) again presented the same four TAT-like cards to subjects who had been perceptually deprived for 18 or 24 hours. The results revealed no significant differences in story length (total number of syllables) between the controls and either of the experimental groups. A noticeable trend, however, was evident in the performance of the 24-hour group. These subjects produced shorter stories in response to all cards than did the controls. An analysis was also made of productivity as measured by the number of syllables spoken in a second. The findings indicated that both experimental groups were less productive than the controls in response to the blank and three figure cards. However, the only significant difference was in the 24-hour group's response to the blank card, a finding which may be related to its totally unstructured nature.

One possible variable which may account for the differences obtained by Suedfeld et al. (1964, 1965) and Oyamada (1966a, b) may relate to the fact that in the former studies the TAT-like scenes were presented orally while in the latter they were presented visually. The second, and perhaps most important variable, is a difference in time of test administration. Suedfeld administered the post-test during the deprivation period whereas in the Oyamada studies the second test was not presented until approximately two hours after termination of the experimental condition, a delay which could conceivably produce a dissipation of any possible effect. This procedural difference, together with the fact that post-release testing generally produces smaller effects than testing during isolation (Suedfeld, in press), suggests that statistically significant results, similar to those reported by Suedfeld, may have been obtained if the story telling task had been administered immediately after the deprivation period, particularly since Oyamada's 24-hour experimental group tended to produce shorter stories than did the controls.

Finally, in the only other relevant Japanese study, Sato and Oyama (1963) administered the Rorschach (complete series) to a group of subjects after two days of perceptual deprivation. Scores were obtained for number of total responses, reaction time for a single response, and reaction time of initial response. On none of these measures was there a statistically significant difference between the experimental and control subjects. It is important to note, however, that the tests were administered 20 to 30 minutes after the termination of deprivation, a

delay which could again produce a dissipation of effects.

Apart from the research by Suedfeld et al. (1964, 1965), the only other investigators who have made a specific attempt to test the hypothesis that unstructured tests would be impaired by deprivation are Fuerst and Zubek (1968). In the first study, a group of 18 subjects were perceptually deprived for three days. Two equivalent forms of the unstructured Guilford battery of ten creativity tests were administered before and at the end of the deprivation period. The tests consisted of word fluency, ideational fluency, associational fluency, expressional fluency, alternate uses, consequences, match problems, making objects, decorations, and possible jobs. No significant differences were obtained between the experimental and control groups on any of the tests. The experimental group did, however, perform at a lower level on all the tests except expressional fluency and associational fluency. In the second study, 18 subjects were exposed to three days of sensory deprivation. The same tests were administered and at the same time interval as in the perceptual deprivation study. Once again, no significant changes resulted although the experimental group did perform at a lower level than did the control group on all tests except alternate uses and possible jobs. Since no significant differences were found either within or between the two studies, the data were combined and a series of t-tests were performed on the pooled difference scores of the two experimental and two control groups. This analysis revealed that the experimental subjects performed significantly worse than did the controls on a test of ideational fluency. This single positive finding, however,

may represent a chance phenomenon resulting from the performance of numerous t-tests of significance.

According to Fuerst and Zubek (1968), one possible explanation of the negative results obtained may pertain to the time of test administration i.e., at the end of the third day. There are some suggestions in the literature indicating that the greatest deprivation effects, on certain cognitive and perceptual-motor measures, sometimes occur within a period ranging from one to two days. Beyond this "critical range" the effects appear to diminish, presumably as a result of adaptation to the restricted sensory environment. For example, Vernon (1961) has observed a strong facilitatory effect on rote learning after 24 hours of sensory deprivation but not after 48 or 72 hours. Scott et al. (1959) also obtained a significant impairment on tests of anagrams, number series, and word-making after a one-day period of perceptual deprivation but not after longer durations.

Two studies employing sensory and perceptual-motor measures have also indicated the existence of a critical period. Vernon, McGill, Gulick, and Candland (1959) reported that greater impairments occur on tests of color perception, mirror drawing, and rotary pursuit after two days than after either one or three days of sensory deprivation. Doane, Mahatoo, Heron, and Scott (1959) also reported a greater increase in tactual acuity and a poorer performance on tactual form discrimination after two than after three days of perceptual deprivation.

In view of this evidence on the possible existence of a critical range for certain deprivation effects, it is possible that significant

deficits on the unstructured cognitive tests employed by Fuerst and Zubek (1968) may have occurred if the test battery had been administered on perhaps the first rather than the third day, particularly since the trends on almost all the tests, and in both studies, revealed a poorer performance by the experimental subjects.

The purpose of this thesis is to replicate the Fuerst and Zubek (1968) study, using a one-day period of deprivation. Only one experimental condition viz., sensory deprivation, will be employed because (a) Fuerst and Zubek observed no significant differences between the effects of sensory and perceptual deprivation and (b) Suedfeld et al. (1964, 1965) have reported a significant impairment on an unstructured story-telling test after one day of sensory deprivation.

CHAPTER II

EXPERIMENTAL METHOD AND RESULTS

I. Subjects

The experimental group consisted of 19 male students from the University of Manitoba who had volunteered to spend one day under a condition of sensory deprivation (darkness and silence). Of this group, 18 successfully endured the prescribed period while one subject was unable to do so, terminating the study after 7 hours. The control group consisted of 18 male students, all of whom had initially volunteered for the experimental condition. The mean ages of the 18 successful experimentals and the 18 controls were 19.6 and 19.4 years, respectively. The subjects were paid for their services.

II. Isolation Chamber

The experimental subjects were placed individually in an isolation chamber consisting of a translucent plexiglas dome measuring 7 ft. in height, 9 ft. in diameter, 7.5 ft. at the base, and housed inside a semi-soundproofed enclosure (see Fig. 1). For purposes of sound reduction the outside surface of the dome is lined with two layers of fiberglas insulation. Toilet facilities, a food compartment, a two-way intercom system, and an air-conditioning unit are built into the floor of the dome making it unnecessary for the experimental subject to leave the chamber for any purpose during the isolation period. The only piece of furniture is a mattress on which the subject is required to lie quietly. Entrance to the isolation chamber is through a double trap-door with the

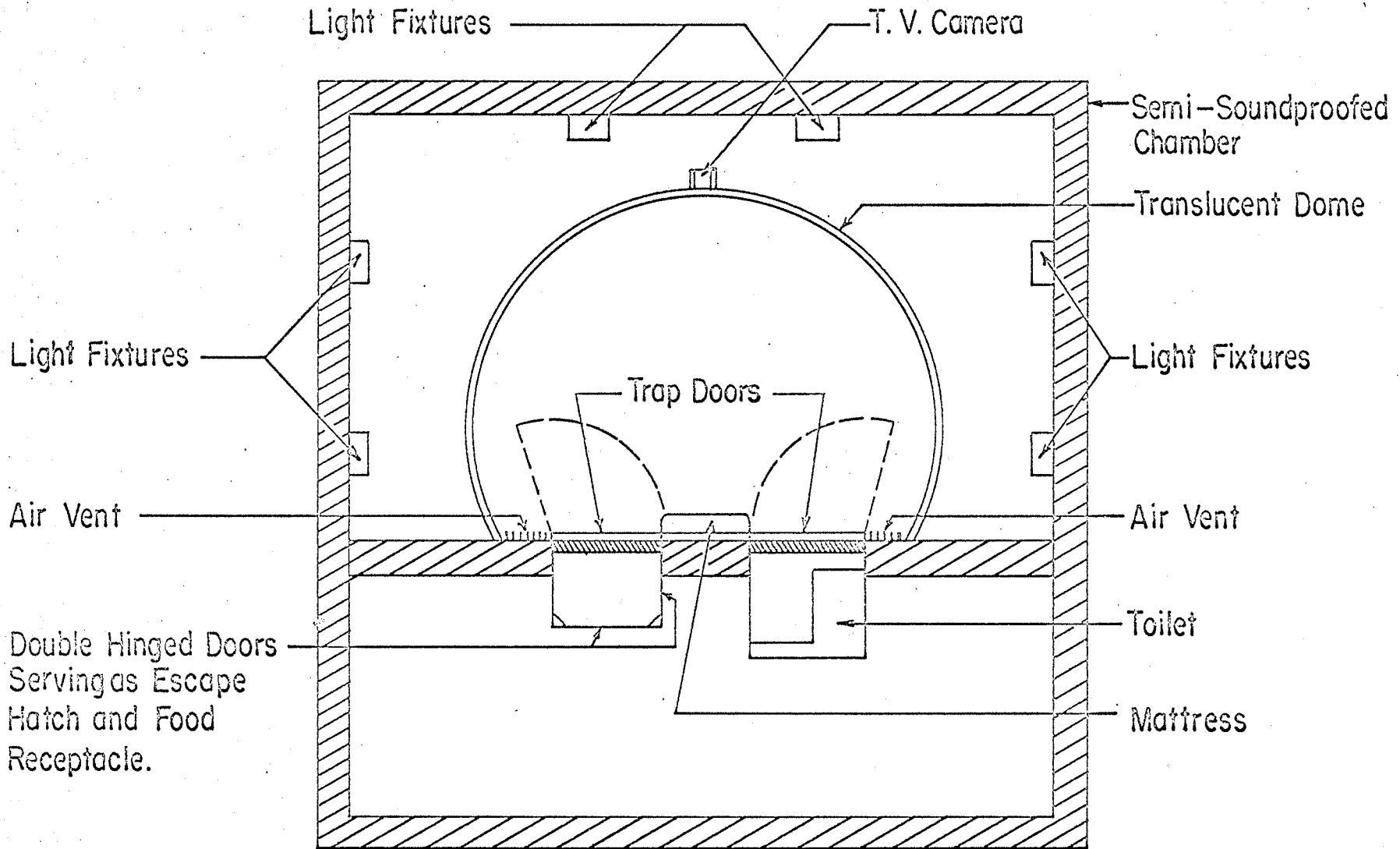


Figure 1

space between the two trap-doors serving as a food chamber. The diet of the subjects consisted of a variety of sandwiches supplemented by fruit juices, tea and coffee.

III. Tests

The Guilford factor-analyzed battery of creativity tests, consisting of ten subtests varying in degree of "open-endedness" and requiring the generation of a wide range of possible solutions rather than one correct answer, was administered before and after 22 hours of a one-day sensory deprivation period. These tests, measuring the cognitive factors of fluency, flexibility, and elaboration, are believed to appraise diverse aspects of creative thinking (Guilford, 1964).

Measures of fluency. Four of the ten tests measure the ability to produce a number of ideas in response to a situation. They are as follows:

(a) Word fluency. Given a letter of the alphabet, the subject writes as many words containing that letter as possible, in a time limit of 4 minutes.

(b) Ideational fluency. The task is to write, in 6 minutes, as many things as possible that belong to certain classes.

(c) Expressional fluency. The task is to write, in 4 minutes, as many four word sentences as possible. Each word must begin with a certain given letter.

(d) Associational fluency. The subject is required to write, in 2 minutes, as many words as possible that are similar in meaning to a given word.

Measures of flexibility. Three of the ten tests measure spontaneous and adaptive flexibility in thinking.

(a) Alternate uses. In this test of spontaneous flexibility, diverse uses for a common object are to be listed in 5.33 minutes.

(b) Consequences. In 10 minutes, the subject is to think of a large number of ideas in connection with new and unusual situations e.g., What would happen if books were suddenly destroyed? This test measures adaptive flexibility.

(c) Match problems. Drawings of matches laid out in patterns are shown. The task is to remove, in 7 minutes, some of the matches so that the remainder form new, specified patterns.

Measures of elaboration. The final three tests of the battery measure the ability to elaborate upon information in a number of ways.

(a) Making objects. In 3 minutes, specified objects must be made up from a combination of simple figures. Figural elements must be organized into patterns of some degree of complexity, with emphasis on the use of the same elements in different ways and in different combinations.

(b) Decorations. Subjects must decorate outline drawings of given objects in 6 minutes.

(c) Possible jobs. Emblems which could indicate a variety of jobs are given. The subject, in 5 minutes, is then required to generate a variety of implications from the given information by thinking of as many jobs as possible that could conceivably be suggested by the emblems.

Two equivalent forms of this battery were used (see Appendix A for

test samples and instructions). Scoring of the answers was carried out according to the instructions provided in Guilford's manual. The total administration time, exclusive of instructions, was 52.33 minutes.

IV. Procedure

The experimental subjects were placed individually in the isolation chamber, under a condition of darkness and silence, for a period of 24 hours. The subjects could terminate the experiment at any time if they found it unbearable. Before entering the chamber the subjects were instructed to lie quietly on the mattress and not to engage in any gross physical activity. They were allowed to sit up only when eating, using the toilet facilities, or while taking the test batteries. Subjects were monitored by means of a microphone. An experimenter was on duty at all times and communication with the subject was kept to a minimum.

During the test administration period, the chamber was illuminated by means of a 150 W lightbulb in the ceiling of the dome. This light source could only be manipulated by the experimenter.

The two equivalent forms of the Guilford battery (Forms A and B) were administered before and approximately two hours prior to the end of the one-day period. The second battery was presented prior to rather than at the end of the one-day period in order to minimize the possibility of subjects rushing through the test battery with hopes of being released sooner.

The order of administration of the three types of Guilford tests

i.e., fluency, flexibility, and elaboration was presented in a counter-balanced order, with the same order given to the same subjects on the first and second test sessions. Within each of the three types of tests, the subtests were presented in a fixed order. The tests were presented visually and the test instructions were read, by the experimenter, over the intercom system in order to achieve a greater uniformity of reading time and to guard against the subjects omitting any part of the test instructions.

The 18 ambulatory control subjects were tested inside the chamber at the same time intervals and on the same tests as were the experimental subjects.

V. Results

Table I shows the mean scores of the experimental and control subjects on the ten cognitive tests administered before and at the end of the one-day period. A series of two-tailed t-tests for independent samples, involving a difference of differences analysis, revealed no significant changes in performance between the two groups of subjects on 9 of the 10 subtests. On the one test, associational fluency, the experimentals performed significantly worse than did the controls ($p < .01$). Although only one test showed a significant effect, an examination of trends on the other tests revealed an interesting pattern of results. On the three other measures of Guilford's fluency factor i.e., word, expressional, and ideational fluency, the experimental subjects performed worse than the controls on all three tests, while the trend on the three tests measuring the factor of flexibility (Alternate Uses, Match Problems, Consequences)

TABLE I

MEAN SCORES OF THE EXPERIMENTAL AND CONTROL SUBJECTS ON TEN COGNITIVE TESTS ADMINISTERED BEFORE AND AT THE END OF ONE DAY

Tests	Experimentals	Controls	t	p
Word Fluency				
Before	41.94	42.39		
During	40.22	42.83		
Difference	1.72	- 0.44	0.74	N.S.
Expressional Fluency				
Before	4.17	3.83		
During	3.94	4.72		
Difference	0.23	- 0.89	1.05	N.S.
Associational Fluency				
Before	10.00	8.39		
During	6.83	7.33		
Difference	3.17	1.06	2.93	< .01
Ideational Fluency				
Before	24.27	22.38		
During	31.61	32.00		
Difference	- 7.34	- 9.62	0.92	N.S.
Alternate Uses				
Before	10.11	9.56		
During	10.11	8.28		
Difference	0.00	1.28	1.07	N.S.
Consequences				
Before	23.78	25.22		
During	24.11	25.00		
Difference	- 0.33	0.22	0.34	N.S.
Match Problems				
Before	6.05	6.56		
During	5.28	5.22		
Difference	0.77	1.34	0.69	N.S.
Making Objects				
Before	21.72	20.94		
During	22.50	24.11		
Difference	- 0.78	- 3.17	0.97	N.S.
Decorations				
Before	35.50	39.44		
During	34.27	37.38		
Difference	1.23	2.06	0.34	N.S.
Possible Jobs				
Before	10.50	10.33		
During	10.06	11.06		
Difference	0.44	- 0.73	1.12	N.S.

indicated an improvement in the performance of the experimental subjects relative to that of the controls. No consistent trend was evident on the tests measuring the factor of elaboration: performance was better on one of the tests (Decorations) and worse on two (Making Objects and Possible Jobs).

CHAPTER III

DISCUSSION AND CONCLUSIONS

The results of this experiment have provided little support for the hypothesis advanced by Goldberger and Holt (1958) and Suedfeld (in press) that performance on unstructured or open-ended cognitive tests will be impaired by deprivation. This is surprising, especially since the test battery was administered at the end of a one day period, a duration falling within the critical range for optimal effects as indicated in some of the literature.

Of the ten tests of the Guilford battery, only performance on the associational fluency test was significantly impaired. This single positive finding, however, may represent a chance occurrence resulting from the calculation of numerous t-tests of significance. On the other hand, this result may be genuine particularly since the experimental subjects tended to perform worse than did the controls on the three remaining fluency tests (word, expressional, and ideational). Furthermore, it is relevant to note that Fuerst and Zubek (1968) also reported a significant impairment on one of these tests viz., ideational fluency, when they combined the data from the two groups of subjects who had been exposed to three days of either sensory or perceptual deprivation. In order to differentiate between these two alternative interpretations it might be fruitful to replicate the present experiment using only the test of associational fluency or perhaps all four measures of Guilford's fluency factor.

While the results on the fluency tests appear to provide some experimental support for the hypothesis that unstructured tests should be impaired by deprivation, those derived from the tests measuring the factor of flexibility in thinking tend to contradict the hypothesis since the trend on all three of these tests indicated an improved performance in the experimental relative to the control subjects. Furthermore, no consistent trend was observed on the tests measuring Guilford's elaboration factor; the experimentals performed better on one test and worse on two. Thus, these results appear to suggest that the cognitive effects of deprivation on the unstructured tests of the Guilford battery are essentially similar to those previously reported for structured tests i.e., some performance tasks are impaired, others are unaffected while still others are improved (see reviews of Schultz, 1965; Suedfeld, in press; Zubek, 1964).

Four possible explanations may be offered for the failure to substantiate the hypothesis being tested. First, since the critical period for optimal effects appears to fall in the range of one to two days, the use of a two rather than a one-day period may have yielded a more positive picture. This hypothesis would possess more merit if the performance of the experimental subjects had tended to be worse on all or almost all of the ten subtests. Unfortunately, this was not the case since their performance was better on four of the subtests (Decorations, Alternate Uses, Consequences, and Match Problems). Second, these essentially negative results may be related to the length of the test battery. In the present study, the battery of ten tests required a completion time of

approximately one hour whereas in the other relevant studies, in which impairments were reported, the test duration ranged from a few to approximately 15 minutes. Again, it is doubtful whether this factor is of any great importance, particularly since there is no evidence in the deprivation literature indicating that test duration plays a significant role. Furthermore, on an a priori basis one might expect no effect on a short test battery to which a subject can devote his full attention and perhaps some impairment on a longer battery, such as Guilford's, in which such variables as fatigue and decreased motivation might be operative.

A third, and probably more likely explanation for the failure to substantiate the hypothesis, pertains to the greater degree of unstructuredness, and thus of greater response productivity, possessed by the cognitive tests employed in the Suedfeld et al. (1964, 1965) and Japanese studies (Oyamada, 1966a, b). Since these studies, which have provided the strongest evidence for a cognitive impairment on unstructured tests, have all employed a story-telling task in which the response measure was the total number of words spoken, an almost infinite number of answers (words) to the TAT-like cards is possible. Furthermore, in these studies total productivity was enhanced by the use of a no time limit procedure. On the other hand, the Guilford battery, employed in the present study, imposed a greater number of restrictions on the subjects' responses, for example, a fixed time limit, thus limiting considerably the total possible number of answers. Therefore, in terms of the total test situation the Guilford battery appears to be much more structured in nature than

the story-telling tasks and this factor could account for the different results. Some experimental support for the hypothesis that the degree of unstructuredness may play an important role has been provided by Oyamada (1966b) in an experiment in which three TAT-like cards and one blank card were administered to a group of subjects after one day of perceptual deprivation. Although the experimental subjects revealed a decrease in speech rate in response to all four cards, only the results on the totally unstructured blank card were statistically significant. In view of these results further research, employing single tests varying in degree of unstructuredness would appear to be warranted in order to determine the importance of this variable.

The final, and perhaps most relevant explanation pertains to the use of an oral versus a written test response procedure. In both the Japanese and the Suedfeld studies the subjects responded to the TAT-like cards by relating the stories orally over the intercom system, the stories being tape-recorded. On the other hand, the subjects in the present experiment wrote their answers in the test booklets provided. This difference in administration procedure may be an important factor since not only Suedfeld et al. (1964, 1965) but numerous other investigators (e.g., Freedman & Greenblatt, 1960; Myers, Murphy, Smith, & Goffard, 1966; Oyamada, 1966b; Zuckerman et al., 1962) have uniformly reported a considerable decrease in speech rate in isolated subjects. This impairment of the speech process, which is not a confounding variable in the present experiment, may, therefore, be largely responsible for the decrease in story-length reported in the various studies employing TAT-

like cards. In view of this, a replication of these studies, using a written rather than an oral response procedure, might prove fruitful. Furthermore, as an additional test of this speech impairment hypothesis, the present experiment should be repeated, employing an oral response procedure. While the three pictorial subtests (Match Problems, Making Objects, and Decorations) could not readily be adapted for this purpose, the remaining ones could be.

Since various hypotheses have been proposed to account for the results, it is obvious that a considerable amount of further research is required in order to determine under what conditions unstructured cognitive test performance can or cannot be affected by sensory and perceptual deprivation. Some examples of future research have already been suggested. In addition, some attention might be paid to the possible role of the length of the test battery employed and the use of timed versus untimed tests.

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APPENDIX A
TEST SAMPLES AND INSTRUCTIONS

WORD FLUENCY

Form A

By Paul R. Christensen and J. P. Guilford

NAME _____ SEX: M _____ F _____
 (Print) Last First Middle

ORGANIZATION _____ SCORES: I _____

II _____

GROUP _____ DATE _____ Total _____

In this test you are to write words that contain a certain letter of the alphabet. This will be a different letter in each item of the test.

SAMPLE ITEM:

Write words containing the letter O.

<i>load</i>	<i>provide</i>	_____
_____	_____	_____
<i>spot</i>	<i>fought</i>	_____
_____	_____	_____
<i>over</i>	<i>loss</i>	_____
_____	_____	_____
<i>too</i>	_____	_____
_____	_____	_____

All the words written above contain the letter "O" at least once.

WAIT FOR THE SIGNAL BEFORE TURNING THIS PAGE.

Avoid using a word more than once; avoid even different forms of the same word, such as "bond" and "bonded." Your score will be the number of words that you write containing the given letter during limited time, so work rapidly.

There are two parts to this test. You will have 2 minutes for each part.

Are there any questions?

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

EXPRESSIONAL FLUENCY

31

Form A

By Paul R. Christensen and J. P. Guilford

NAME _____ SEX M _____ SCORE I _____
(Print) Last First Middle F _____ II _____
III _____
IV _____

GROUP _____ DATE _____ Total _____

In this test you are to write sentences each made up of four words. Each word must begin with the letter indicated.

SAMPLE ITEM:

Keep *u* *ps* *y* *our* *i* *nterest*

Kill *u* *seless* *y* *ellow* *i* *nsects*

Kidnapping *u* *psets* *y* *oung* *i* *nfants*

K *u* *y* *i*

The task in this item is to write sentences using words that begin with the given letters: K, u, y, and i, in that order. The test contains items similar to this one. You will be required to write as many four-word sentences as you can, using words that begin with the given letters.

WAIT FOR THE SIGNAL BEFORE TURNING THIS PAGE.

All sentences should make sense and be complete. Avoid using the same word twice. Your score will be the number of acceptable sentences you write in the time allowed.

There are ^{two} ~~four~~ parts to this test. You will have 2 minutes for each part. Are there any questions?

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

ASSOCIATIONAL FLUENCY I

Form A

By Paul R. Christensen and J. P. Guilford

NAME _____ SEX: M _____ F _____
 (Print) Last First Middle

ORGANIZATION _____ SCORES: I _____

II _____

GROUP _____ DATE _____ Total _____

In this test you are to write words similar in meaning to the given word.

SAMPLE ITEM:

Write words similar in meaning to the word HARD.

HARD:

<u>difficult</u>	<u>severe</u>
<u>solid</u>	<u>unfeeling</u>
<u>tough</u>	_____
<u>stiff</u>	_____

Notice that the words written above are all somewhat like the word HARD in meaning. In the test you are to write as many words as you can that are similar in meaning to the given word.

WAIT FOR THE SIGNAL BEFORE TURNING THIS PAGE.

Write as rapidly as you can. Avoid using a word more than once. Your score will be the total number of words you write (similar in meaning to the given word).

There is one part to this test. You will have 2 minutes for it. At end of 1 min., tell S to go to second item if he has not already done so.

Are there any questions?

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

IDEATIONAL FLUENCY I

33

Form A

By Paul R. Christensen and J. P. Guilford

NAME _____ SEX: M _____ F _____
(Print) Last First Middle

ORGANIZATION _____ SCORES: I _____
II _____
III _____
IV _____
Total _____

GROUP _____ DATE _____

In this test you are to name things that belong in certain classes.

SAMPLE ITEM:

Name FLUIDS that will
BURN.

gasoline
kerosene
hydrogen
alcohol

In this sample item, the task is to make a list of fluids that will burn. Four such fluids have been listed by way of example. Of course, there are many other answers that could be listed.

For this test, a fluid is any non-living thing that is liquid or gas. A solid is any non-living thing that is not liquid or gas.

The items in this test will be somewhat like the sample item above. Your task will be to write as many things as you can that belong to certain classes. If you are not certain whether a thing fits the class, write it down anyway and try to think of another suitable thing.

WAIT FOR THE SIGNAL BEFORE TURNING THIS PAGE.

There will be ^{two} ~~four~~ parts to this test. You will have 3 minutes per part. Are there any questions?

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

ALTERNATE USES

34

Form A

Paul R. Christensen, J. P. Guilford, Philip R. Merrifield and Robert C. Wilson

NAME _____ SEX: M _____ SCORES: I _____
F _____ II _____
Total III _____

GROUP _____ DATE _____

In this test, you will be asked to consider some common objects. Each object has a common use, which will be stated. You are to list as many as six other uses for which the object or parts of the object could serve.

EXAMPLE:

Given: A NEWSPAPER (used for reading). You might think of the following other uses for a newspaper.

- a. start a fire
- b. wrap garbage
- c. swat flies
- d. stuffing to pack boxes
- e. line drawers or shelves
- f. make up a kidnap note

Notice that all of the uses listed are different from each other and different from the primary use of a newspaper. Each acceptable use must be different from others and from the common use.

Do not spend too much time on any one item. Write down those uses that occur to you and go on to the others in the same Part. You may return to the incomplete items in a Part if time for that Part permits.

There is one part to this test, with four items per part. You will have 5.33 minutes for each part.

If you have any questions, ask them now.

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

CONSEQUENCES

FORM A

By P. R. Christensen, P. R. Merrifield, and J. P. Guilford

NAME _____ SEX ^M _____ I-V _____
(Print) Last First Middle ^F _____ SCORES VI-X _____
GROUP _____ DATE _____ Total _____

This is a test of your ability to think of a large number of ideas in connection with a new and unusual situation.

Look at a sample item.

SAMPLE ITEM:

What would be the results if people no longer needed or wanted sleep?

SAMPLE RESULTS:

1. Get more work done
2. Alarm clocks not necessary
3. No need for lullaby song books
4. Sleeping pills no longer used
5. _____
6. _____

Of course, there are many more possible results that could have been written.

There will be ⁵~~10~~ different situations somewhat like the one above, each one on a separate page. Four examples will be included for each item. You will be given two minutes on each page to write down other possible results. Write as many different consequences or possible results of the change as you can. Your answers need not be complete sentences. Your score will be the total number of different consequences that you write in the time given you.

Are there any questions?

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

MATCH PROBLEMS

Form A

Raymond M. Berger and J. P. Guilford

36


NAME _____ SEX: M _____ SCORES:
 (Print) Last First Middle F _____ Part I _____
 Part II _____
 GROUP _____ DATE _____ Total _____

In this test you will see drawings of headless matches laid out in patterns. You are to remove some of the matches so that the ones left form new patterns.

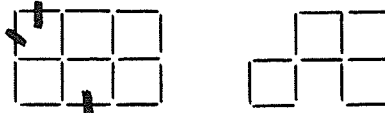
Look at this example:

TAKE AWAY 3 MATCHES
LEAVING 4 SQUARES

Given



Solution A




Your instructions for each item appear at the left. The drawing under "Given" presents the pattern of squares with which you start. To indicate a solution, mark through the matches you want removed. In the example, the solution marked would look like the pattern at the extreme right if the matches were actually removed. Note that only complete squares are left.

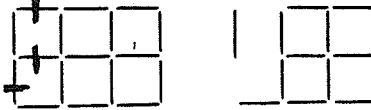
The attempt below is not an acceptable solution.

TAKE AWAY 3 MATCHES
LEAVING 4 SQUARES

Given



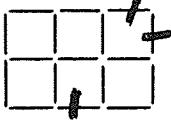
Wrong




This attempt is wrong because it leaves two matches that are not parts of the required four squares. You must remove matches so that exactly the required number of complete squares remain, with no matches left over.

In this test you will add to your score by giving additional different solutions to each problem. Here are some other possible ways of doing the same problem.

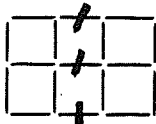
B



C



D



Notice that B and C use the same rule as solution A in the first example—two matches from a corner and the middle match from the opposite side. In getting really different solutions you apply different rules. Here B and C would not be counted.

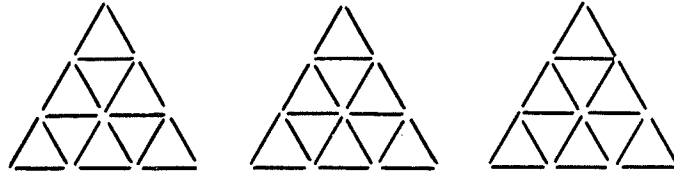
D uses a rule different from that in A, and also meets the instruction that all matches remaining are parts of remaining squares, so D is counted as a second acceptable solution.

GO TO THE NEXT PAGE FOR FURTHER INSTRUCTIONS.

(Instructions continued)

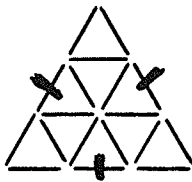
Here is another problem, this time using triangles. Try to find three different solutions.

TAKE AWAY 3 MATCHES
LEAVING 6 TRIANGLES

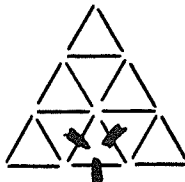


Three solutions are shown below. Notice especially that each solution is in some way a pattern different from the others. All the triangles are complete, no matches being left over.

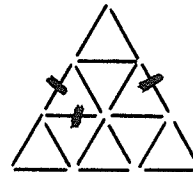
E



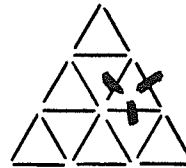
F



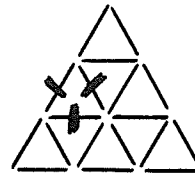
G



Suppose you had given solution F and also



or



You would not be given credit for either additional solution since the pattern is the same as for F. Patterns must be different in order to receive credit.

There ^{is one} ~~are two~~ parts to this test, with 5 problems ~~in each part~~. You are to find different solutions to each problem.

You will be allowed 7 minutes ~~per part~~. Work rapidly. If you have difficulty with one problem, go on to the others and return later if time permits. Use a pencil. If you wish to change a solution, erase completely the marks you want to remove.

If you have questions, ask them now.

STOP HERE. WAIT FOR FURTHER INSTRUCTIONS.

MAKING OBJECTS

38

Form A

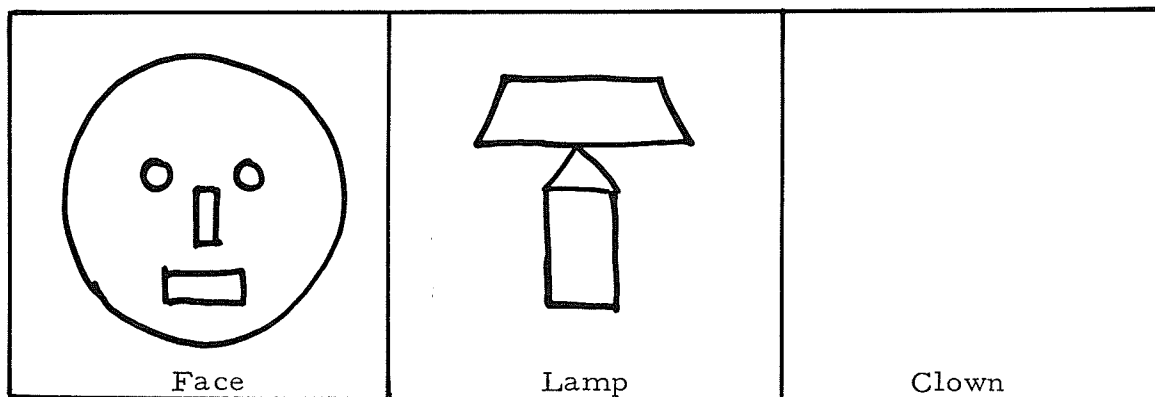
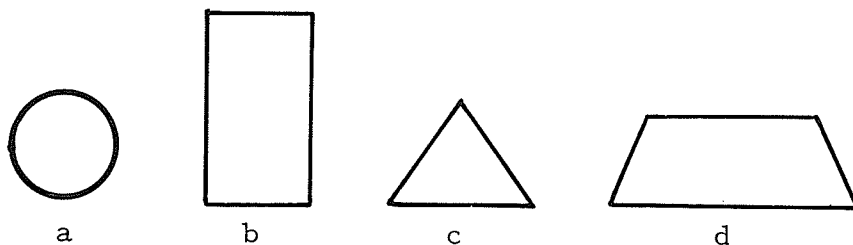
Sheldon Gardner, Arthur Gershon, Philip R. Merrifield, and J. P. Guilford

NAME _____ SEX M _____ Scores: I _____
(Print) Last First Middle F _____ II _____
GROUP _____ DATE _____ III _____
Total _____

In this test you will be given some simple figures. You are to combine some of the figures to make certain objects. Follow these rules:

1. You may use only the given figures; do not add any other lines.
2. You may change the size or position of any given figure, but NOT its shape.
3. You may use a figure more than once in making the same object.
4. You do not need to use all the figures in the same object, but use more than one.

For example, given these simple figures, make the objects named in the squares.



Notice that only a and b were used in making this face.

b, c, and d were used here.

If you wish you may practice on this object.

Artistic quality is not important. Just try to use the given figures in as many different ways as possible.

You will be told when to begin work and when to stop work on each page. Work rapidly. No questions will be answered. Look again at the rules above.

You will HAVE 3 MINUTES.

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DECORATIONS

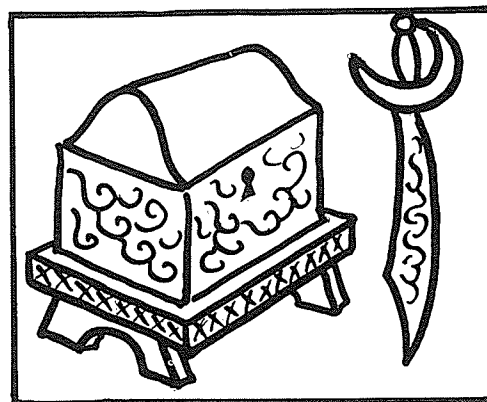
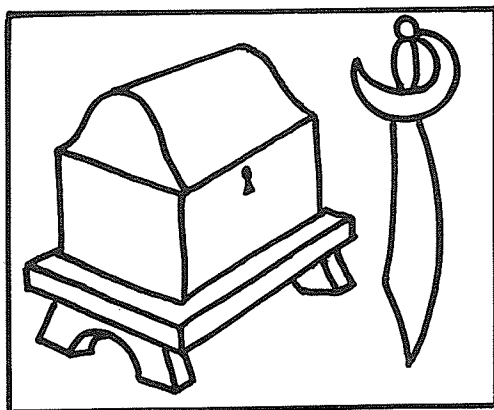
Form A

39

Arthur Gershon, Sheldon Gardner, Philip R. Merrifield, and J. P. Guilford

NAME _____ SEX M _____ Scores: I _____
(Print) Last First Middle F _____ II _____
GROUP _____ DATE _____ III _____
IV _____
Total _____

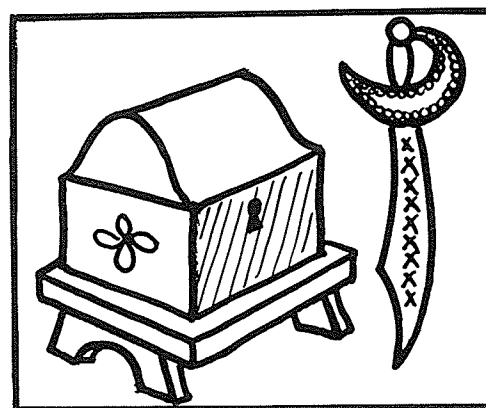
In this test you will see some outline drawings of objects. You are to decorate the objects as you think desirable. At the left, below, is an example of an outline drawing. At the right is the same drawing with some decorations added.



Notice that the decoration on the chest and the sword is the same. Only one of them would be counted in scoring. You are to make different decorations for the objects in the picture. Artistic quality and drawing accuracy are not important.

In the test you are to make different decorations for each of two identical drawings. Your decorations should be different from one drawing to another.

In the drawing on the right, the decoration on the blade is the same as the decoration on the edge of the bench in the decorated drawing above, so it would not be counted toward the score in this one. Notice that there are different decorations on the two sides of the chest. Both will be counted.



There are ^{two} ~~four~~ parts to this test, with two sets of outline drawings in each part. You will have 3 minutes to work on each part. You will be told when half the time has passed, so you may move on to work on the second drawing in the same part. If you have questions, ask them now.

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POSSIBLE JOBS

40

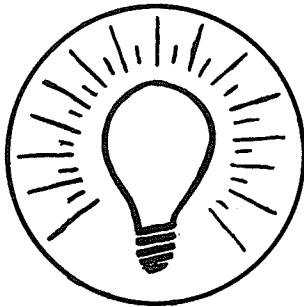
Form A

Arthur Gershon and J. P. Guilford

NAME _____ SEX M _____ Scores: I _____
(Print) Last First Middle F _____ II _____
GROUP _____ DATE _____ Total _____

As the Inter-Planet Express prepared to land on Mars, the tourists were discussing a new custom developed by the Martians. Since the first settlers had arrived from earth, the Martians had taken to wearing emblems to show what each person's job is.

As the tourists looked through the videoscope, they saw one Martian wearing the emblem shown below.



"Electrical engineer," said one of the tourists. "Light bulb manufacturer," said another. "Maybe a bright student," a third tourist suggested.

In this test you will see more of the emblems that the Martians wore. Imagine that you are one of the tourists. Think of as many possible jobs as you can which might be indicated by the emblems. If you are not sure whether one of your ideas is reasonable, write it down anyway and try to think of another idea.

There ^{is one} ~~are two~~ pages in this test with three emblems ~~on each page~~. You will have 5 minutes to work ~~on each page~~, and will be told when 2 minutes remain ~~for each page~~.

If you have questions, ask them now.

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APPENDIX B

RAW DATA

RAW SCORES FOR EXPERIMENTAL SUBJECTS

Subject No.	Word		Express.		Assoc.		Idea.		Altern.		Conseq.		Match.		Obj.		Dec.		Poss.J.	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1.	32	31	5	3	10	8	19	28	10	16	20	25	5	2	30	23	47	45	13	11
2.	32	39	6	6	16	9	36	49	20	15	35	39	7	11	40	30	30	34	13	12
3.	46	36	5	3	12	9	26	30	8	14	32	33	4	2	11	23	56	46	9	13
4.	35	27	5	5	11	7	20	37	12	14	20	21	3	7	24	40	41	45	15	8
5.	51	35	6	3	9	4	16	17	6	8	19	15	7	8	14	18	30	30	8	9
6.	24	47	3	1	10	5	15	29	5	11	25	28	8	4	17	19	33	34	8	10
7.	49	55	3	2	9	7	33	29	12	11	35	26	7	4	28	22	36	32	9	15
8.	37	39	2	4	11	5	12	22	11	6	20	21	4	4	21	25	38	35	11	7
9.	34	18	4	3	5	4	14	21	6	5	22	20	8	5	23	15	20	21	11	7
10.	49	56	4	4	11	5	15	41	7	6	19	15	5	4	15	32	23	33	6	8
11.	41	35	3	4	8	8	20	30	9	11	18	23	11	11	21	12	35	34	9	12
12.	49	41	1	4	11	7	30	37	9	10	15	20	5	3	20	25	37	32	9	8
13.	34	29	5	5	9	9	17	23	2	6	10	18	4	3	23	24	38	16	12	6
14.	42	45	3	4	5	6	41	40	11	9	33	30	9	9	15	16	30	28	10	10
15.	34	28	3	4	8	5	23	27	18	11	22	18	6	6	31	18	46	46	15	12
16.	61	59	4	2	11	9	27	26	13	11	25	28	5	6	12	19	28	28	10	9
17.	56	55	5	7	14	8	36	39	12	10	29	33	6	2	23	24	43	38	8	13
18.	49	49	8	7	10	8	37	44	11	8	29	21	5	4	23	20	28	40	13	11

RAW SCORES FOR THE ISOLATION QUITTER

Word		Express.		Assoc.		Idea.		Altern.		Conseq.		Match.		Obj.		Dec.		Poss. J.	
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
46	45	7	4	8	9	26	25	11	9	30	24	4	3	28	28	30	26	14	12

RAW SCORES FOR CONTROL SUBJECTS

Subject No.	Word		Express.		Assoc.		Idea.		Altern.		Conseq.		Match.		Obj.		Dec.		Poss. J.	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1.	29	37	6	6	8	6	27	23	6	5	23	21	5	5	17	9	36	33	8	7
2.	42	47	3	6	8	7	18	35	10	8	30	25	3	6	25	24	45	48	13	16
3.	50	58	5	4	10	8	15	28	11	8	17	21	7	8	16	20	47	31	12	7
4.	41	32	4	4	7	4	23	23	9	9	21	21	7	7	16	18	30	22	9	10
5.	41	25	6	3	6	6	13	17	8	7	18	15	6	3	24	27	26	26	13	13
6.	46	47	2	6	7	6	26	30	12	14	36	38	7	6	23	32	49	46	13	16
7.	38	31	5	4	10	9	24	30	9	13	25	25	4	5	26	25	34	30	13	11
8.	43	37	1	6	7	7	16	33	13	6	27	20	6	2	15	18	36	27	6	7
9.	33	40	2	5	5	6	25	30	14	7	27	24	6	7	16	19	31	43	5	10
10.	46	53	5	4	9	10	38	47	18	15	40	45	11	7	31	44	49	38	13	12
11.	45	52	5	3	14	10	21	43	10	7	35	32	6	4	29	27	75	64	13	14
12.	31	28	2	3	8	6	15	24	9	10	11	19	6	6	24	20	16	19	7	10
13.	46	47	5	6	6	8	14	28	3	6	21	28	5	4	18	17	41	58	12	11
14.	42	58	4	6	12	9	26	33	10	4	19	26	10	6	18	33	48	48	14	12
15.	48	47	4	5	8	8	19	33	8	7	25	22	6	6	17	20	33	36	7	10
16.	53	52	4	7	9	11	51	49	8	7	35	27	9	4	20	24	34	28	12	12
17.	40	42	3	3	7	6	17	34	7	10	27	23	8	6	19	27	37	36	8	10
18.	49	38	3	4	10	5	15	36	7	6	17	18	6	2	23	30	43	40	8	11