THE PERCEPTUAL EFFECTS
of
PROLONGED ISOLATION

A Thesis

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ABSTRACT OF THESIS

Recent experiments on the effects of sensory isolation have aroused a great deal of interest. It is known that these conditions have a detrimental effect upon intellectual, perceptual and temperamental processes. However, most of the research has employed short periods of isolation of three days duration or less. Furthermore most of it has utilized conditions of low illumination and low noise level. The purpose of the present experiment is two-fold: (a) the use of isolation periods of a week or longer, and (b) the measurement of various perceptual abilities before and after a prolonged period of darkness and silence.

Tests measuring size constancy, depth perception, perception of lines and reversible figures, color perception, visual vigilance and auditory discrimination were administered to subjects before and immediately after a week of isolation. While in isolation, the subjects were required to estimate various periods of time at daily intervals.

Significant impairments were found in visual vigilance ability and the ability to estimate longer periods of time. Indications of impairment were also found in size constancy and depth perception. There were no impairments in auditory discrimination, reversible figures, and the ability to estimate shorter intervals of time. Another indication of abnormalities in brain function was the presence of visual and auditory hallucinations and unusual imagery. Upon emergence from isolation, there were momentary changes in perception. These, however, were not drastic or widespread.

It appears that prolonged isolation has a differential effect upon perceptual abilities, with some being impaired while others are better able to withstand these conditions.

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CHAPTER I

THE PROBLEM AND INTRODUCTION

I. STATEMENT OF THE PROBLEM

It has been known for a long time that isolation produces strange effects upon individuals. Anecdotal literature stemming from autobiographies of castaways and northern isolates, as well as reports of prisoners in isolation for a long period of time has mentioned changes in personality, decreased intellectual abilities, and impairments in perception.

Only recently, however, has scientific investigation of this phenomenon been initiated, with the first study being organized at McGill in 1951. Since then, research has been carried on at Princeton, Boston, Massachusetts, Connecticut and Ohio. However, reports from these studies have shown conflicting results. Furthermore, the conditions of isolation in each experiment have varied so greatly that many of the results are not directly comparable. In addition, most of the experiments have been of short duration, seldom exceeding three days confinement.

For these reasons it was necessary to initiate a study of the effects of prolonged isolation (a week or longer) to determine whether any significant changes or impairments in an individual's perceptual abilities occur after isolation under conditions of darkness and silence.

II. INTRODUCTION

It appears that with the increasing automation of our society the human being will not play a decreasing role, but rather, will still maintain his central position in one very important aspect. It will still be a human individual who will press the button and operate the machine. Consequently, the position of the individual in the midst of machinery away from other humans must be studied, for now it appears that the human operator will work for long hours in isolation with only his job, which is very often of a routine and monotonous nature, to occupy and stimulate him. Thus men in Arctic military stations, radar operators, pilots, submarine crews, truck drivers, etc., who remain in these conditions for several hours must operate at peak efficiency form. However, it appears that men who remain in these working conditions for long periods of time often become affected by their low sensory environment, and mistakes through misperceptions and faulty thinking, creep in.

In view of the many situations where individuals are required to work under relatively restricted and monotonous conditions, more knowledge is required as to how these conditions will affect the various capacities of the individual. What abilities are impaired and which ones are not? If there are impairments, how can they be alleviated or minimized? What type of people can best tolerate these conditions? These are some of the questions that must be answered. The present experiment on the effects of prolonged isolation is designed to help answer some of these questions.

The thesis begins with a discussion of the historical background of the problem and presents some of the findings of previous research. Following this, the apparatus, method, and subjects are described. The results are then presented and their implications are discussed.

III. HISTORICAL BACKGROUND

It has long been known through anecdotal and autobiographical writings that shipwrecked individuals, explorers, aviators, and other people who undergo isolation for many days, often experience peculiar psychological changes such as hallucinations and feelings of depersonalization. It is only within the last 10 years, however, that the effects of isolation have been subjected to experimental study. These laboratory investigations are now quite numerous. This review of the literature will begin with a survey of some of the autobiographical writings and conclude with the more recent experimental studies. In the review of the experimental literature, the emphasis will be placed on the perceptual changes with which this study is concerned.

Autobiographical Reports

Admiral Byrd (Byrd, 1938) has written of his experiences while he manned Bolling Advance Weather Base in Antarctica alone during the winter nights of 1934. He knew that changes, in the sense that we know it, would be non-existent. "The day would be the repeated pattern of the hour; the week, the repeated pattern of the day; and one would be scarcely distinguishable from the other." However, he accepted the opportunity partly through necessity, and partly to accept the opportunity to live within himself, to study, to think, and to live through an unusual experience. He found that he became very irritable and depressed and experienced fleeting hallucinations. He felt that his mind could not remain sensitive due to the numbing effect of the continual repetition.

He concluded that "man needs sights and sounds as much as he needs phosphorous and calcium to survive."

Another report of isolation in polar regions has been provided by Christiane Ritter (Ritter, 1954). She spent a winter in Spitsbergen, during which time she spent as many as 14 days alone. Often while alone, she heard ski strokes and voices. Besides these auditory hallucinations, she also experienced depersonalization, in which it seemed to her that she and her companions consisted of moonlight. These and other feelings are described by the natives as "rar," a strangeness which overcomes many people who spend the night in polar regions. Mrs. Ritter found that strict routines of work and exercise helped her to overcome these feelings and the oppressive threat of the monotonous environment.

Hallucinations also occur to people who are alone at sea for lengthy periods of time. Captain Joshua Slocum (Slocum, 1948) spent 72 days alone sailing around the world. He experienced acute loneliness attacks, and once when ill, experienced a very realistic hallucination. While the small sloop was sailing in a storm, a man appeared at the helm and appeared to guide the boat safely. The man apparently introduced himself as the pilot from the Pinta. He returned at various times when his help was needed. Captain Slocum appeared to accept this presence with very little concern or question. It should, perhaps, be noted that Captain Slocum was reading the life of Columbus at that time.

A more recent example of an isolate upon the ocean was provided by Dr. Alain Bombard, (Bombard, 1953) who crossed the Atlantic alone in 65 days on a collapsible raft to prove that shipwrecked people can survive at sea. He too experienced very intense loneliness, in which everything seemed unreal and mocking and even inanimate objects, hostile. He longed greatly

for a companion who could confirm his impressions or argue about them, for he felt quite incapable of distinguishing between the false and the true. Like the other isolates, Dr. Bombard planned his day's schedule in advance otherwise aimlessness overwhelmed him.

Many other autobiographical accounts could be given, but these selected clearly indicate the types of reactions shown by most isolated individuals.

Experimental Reports

Studies Using Low Illumination and Noise Level

The first experimental work on the effects of isolation was begun at McGill University in 1951 (Bexton, Heron & Scott, 1954) under a research grant from the Defence Research Board of Canada. Almost all of their work in isolation was carried out under conditions of constant diffuse light and constant unpatterned noise. The subjects were confined in a small room in which the only piece of furniture was a small cot. They wore a pair of translucent goggles which only transmitted diffuse unpatterned light. Auditory stimulation was reduced by a partially sound proofed chamber and a U-shaped pillow surrounding the subject's head. Furthermore, auditory masking was produced by the hum of a fan, the air conditioner, and an amplifier attached to earphones in the pillow. Gloves and cardboard cuffs reduced tactile stimulation. The subject lay on a bed in the lighted cubicle for 24 hours a day, being allowed to leave the room only to eat and to go to the toilet, to which they were guided by the experimenters. There were 22 male subjects who were isolated for periods of two to three days.

Under these conditions, the subjects reported a variety of perceptual changes after isolation, usually of a momentary nature. They reported difficulty in focussing, fuzziness of objects, a deeper saturation

of colors, and a tendency for the environment to appear two-dimensional as objects did not stand out from their background. There was also an abundance of hallucinatory activity during isolation, largely visual, with some auditory, kinesthetic, and somesthetic hallucinations. Visual hallucinations ranged from simple brightening and darkening of the visual field, to dots and lines and simple patterns, to integrated scenes of an animated nature such as prehistoric animals walking in a jungle. Body hallucinations usually consisted of feelings of "otherness and strangeness" and distortions.

Later work at McGill (Doane, Mahatoo, Heron, & Scott, 1959) employing 17 subjects, again wearing translucent goggles, revealed a decrease in size and shape constancy and an increase in various after-effects of stimulation, eg. enhanced color and after-images. A considerable amount of hallucinatory activity was also reported.

One further study carried out at McGill (Heron, Doane, & Scott, 1956) involved three subjects who were confined under conditions of diffuse light and unpatterned noise for six days. As might be expected these subjects perceived perceptual changes which were of a more pronounced nature than those previously reported. The subjects reported gross perceptual changes after isolation, such as the apparent movement of objects associated with head or eye movements of the observer, distortion of shapes of objects, accentuation of after-images and contrast effects, perceptual lag and enhancement or increased vividness of colors. There was also an abundance of hallucinatory activity, of the same nature as reported previously.

The McGill experimenters have suggested that a constant variation of sensory stimulation to the brain is essential for the maintenance of normal perceptual and intellectual functioning. Furthermore, they feel that a lack of variety of stimulation is more important than any actual lessen-

ing of the total input to the brain. This, apparently, is responsible for the effects of isolation that they have reported—hallucinations, impairment of thought processes, and sensory and perceptual dysfunctioning.

Two other studies support the McGill findings on the effects of constant low illumination and noise level. The first concerns nine polio patients placed in tank type repirators for periods up to nine hours (Mendelson and Foley, 1956). All the patients developed visual and auditory hallucinations, as well as delusions regarding their bodies. The second study was an early one by Hochberg (Hochberg, Triebel and Seaman, 1951) who in the course of an experiment on color adaptation in a homogeneous field, placed ping-pong balls over the eyes of their subjects. A number of the subjects reported lights and patterns of such a realistic nature that they insisted they were part of the experiment.

Studies Using Darkness and Silence

The second group of studies are concerned with the effects of constant darkness and silence. These were largely carried out at the Princeton laboratory. In the first experiments at this laboratory (Vernon, McGill, & Schiffman, 1958) two types of isolation were employed. In the first, confinement was in a small dark sound proofed cubicle. The subjects wore ear plugs and gauntlets in an attempt to reduce stimulation which would come from the subjects themselves. They were required to spend the entire time of isolation lying on a bed in the cubicle, except for three meals a day, which were given in the cubicle, and toilet needs, for which purpose it was necessary to leave the cubicle and go down a hall. Nine subjects remained for three days under these conditions. The second condition was more rigorous as the subjects were not allowed to leave the

cubicle at any time. Food and toilet needs were entirely attended to within the room. Eleven subjects were used under this condition; five were confined for 72 hours, three for 48 hours, and three for 24 hours.

From their subjects' reports of hallucinatory activity the experimenters were able to formulate a criterion of hallucinations and also a system for the classification of types of hallucinations. According to their criterion, an experience had to have an "out-thereness" quality, its appearance and disappearance had to be independent of the subject's volition, and the subject, at least at the beginning, had to be convinced of its reality. As to the matter of classification, there are three categories. Type I contains hallucinations which are unstructured and usually occur in the peripheral visual field. This category includes flashes of light, flickering lights, dim, glowing lights, etc. Type II hallucinations are characterized by definite shapes, usually of a simple, geometric nature, such as squares, lines, dots, circles, etc. Type III hallucinations are highly structured, complex scenes of faces, animals, and other objects, which are integrated and which may be animated and in color. Using this criterion and this classification, the first set of conditions produced many more reports of hallucinations than did the second. Six out of the nine subjects in the first condition reported hallucinations of the type I and II variety, while only one out of the 11 subjects in the second condition reported any hallucinatory activity.

From these results the authors appear to conclude that the number and complexity of hallucinations increases with the length of time in isolation and that conditions permitting much visual stimulation short of pattern vision produce the greatest number and variety of hallucinations.

Other work performed at Princeton (Vernon, McGill, Gulick & Cand-

land, 1959) has been an attempt to investigate the effects of sensory deprivation on motor and perceptual skills. In this case, nine subjects who were confined for 24, 48, and 72 hours in darkness and silence, showed a significant loss of accuracy in color perception, some loss in rotary pursuit ability, and mirror tracing after 48 hours, and gross motor behaviour impairments as determined by rail walking, especially after 72 hours of isolation.

One of the most drastic methods of reducing sensory stimulation was employed by the National Institute of Mental Health (Lilly, 1956). In this experiment, the subject was suspended with only the top of his head not immersed, in a tank of slowly flowing water at 94.5°F. The subject wore a black-out mask which enclosed the whole head. Auditory stimulation was very low, with only one's own breathing and faint water sounds being heard. Immersion in the water removed the usual pressures on the body caused by gravity, while the temperature of the water removed thermal stimulation. The total number of subjects was three, with the longest period of sensory deprivation being 3½ hours. It was found that thought processes appeared to regress to fantasies and reveries very quickly, with much emotional and personal matters being mulled over. Hallucinations appeared after about 2½ hours, with the darkness opening into a three-dimensional tunnel, with forms and objects appearing. No other research project has been able to bring about such striking changes within such a short period of time.

This last experiment would appear to suggest that reduction of stimulation to an absolute minimum is sufficient to produce impairment in human capacities to think and perceive within a very brief time. However the other experiments have shown that continued exposure to a dull mono-

tonous flow of stimulation, whether unpatterned or somewhat reduced, is also sufficient to produce such impairment, though not within such a brief period.

Studies Comparing Different Conditions

The studies which have been reviewed so far have been concerned with the effects of low illumination and low noise level or of darkness and silence. The experiments which will be described now are those which compare the effects of various types of isolation. The first of these was carried out at the Aerospace Medical Laboratory in Ohio (Freedman & Greenblatt, 1959). The conditions employed consisted of unpatterned visual and auditory stimulation, visual deprivation and auditory unpatterned stimulation, and finally, social isolation. The subjects consisted of 30 students and six personality deviants, who were isolated for eight hours. Results as shown on tests for size constancy, reversible figures, pursuit-rotor, depth perception and perceptual lag indicated no impairments for the last condition but decrement and distortions for the first two conditions. However, these results were not statistically significant.

Research at Brandeis (Held & White, 1959) was performed in an attempt to follow up work at McGill (Heron, Doane, & Scott, 1956) where subjects reported a perceptual lag. Seven subjects were exposed for eight hours to four types of confinement conditions: patternless, dark, hyperstable and noisy. A patternless visual field was achieved by having the subject wear translucent plastic goggles, which provided a homogeneous, nonpatterned field of vision. The dark visual field was achieved by placing the subject in a dark cubicle. The noisy visual field was achieved by displaying a continually changing display of dots on the

face of a television tube, producing randomized visual stimulation. The hyperstable visual field was produced by stimulation with minimal temporal variation, that is, exposure to a fixed pattern. After eight hours exposure to the hyperstable visual field, the subjects significantly overestimated the speed of a rotating laboratory clock arm. After eight hours exposure to the dark, patternless, and noisy visual fields, the subjects significantly underestimated the speed, thus successfully elaborating on one of the McGill findings of perceptual distortions.

All these reports serve to confirm certain hypotheses put forward by Jasper, Walter and Sharpless regarding the functioning of the brain. Jasper, 1941, and Walter, 1953, have suggested that the brain maintains its alertness and readiness to respond through the arousing effect of the sensory stimuli which are continually bombarding it. Sharpless and Jasper, 1956, have added to this, by suggesting that not only is stimulation necessary, but also variations in that stimulation itself are necessary, otherwise the brain becomes less alert through monotony. Reduction of the amount of stimuli going to the brain has been accomplished by the Princeton experiments and by the work of Dr. Lilly. Both have shown that this has had a detrimental effect on the brain's abilities. Reduction of the variety of stimuli entering the brain has been accomplished by the McGill experiments, and this too has resulted in impairments of the brain's capacities. It appears as though the brain needs stimulation continually and a vast variety of it, in order to function properly.

CHAPTER II

METHOD

I. THE PROBLEM

The historical review of the literature has shown that conditions which restrict either the amount or the variety of stimulation entering the brain can produce impairments of various perceptual and motor processes. Most of the studies, however, have utilized relatively short periods of isolation—three or four days duration. Only one study has employed periods as long as six days (Heron, Doane, & Scott, 1956). This study, however, was of an exploratory nature involving only three subjects. Furthermore, no objective measurements of test performance was made.

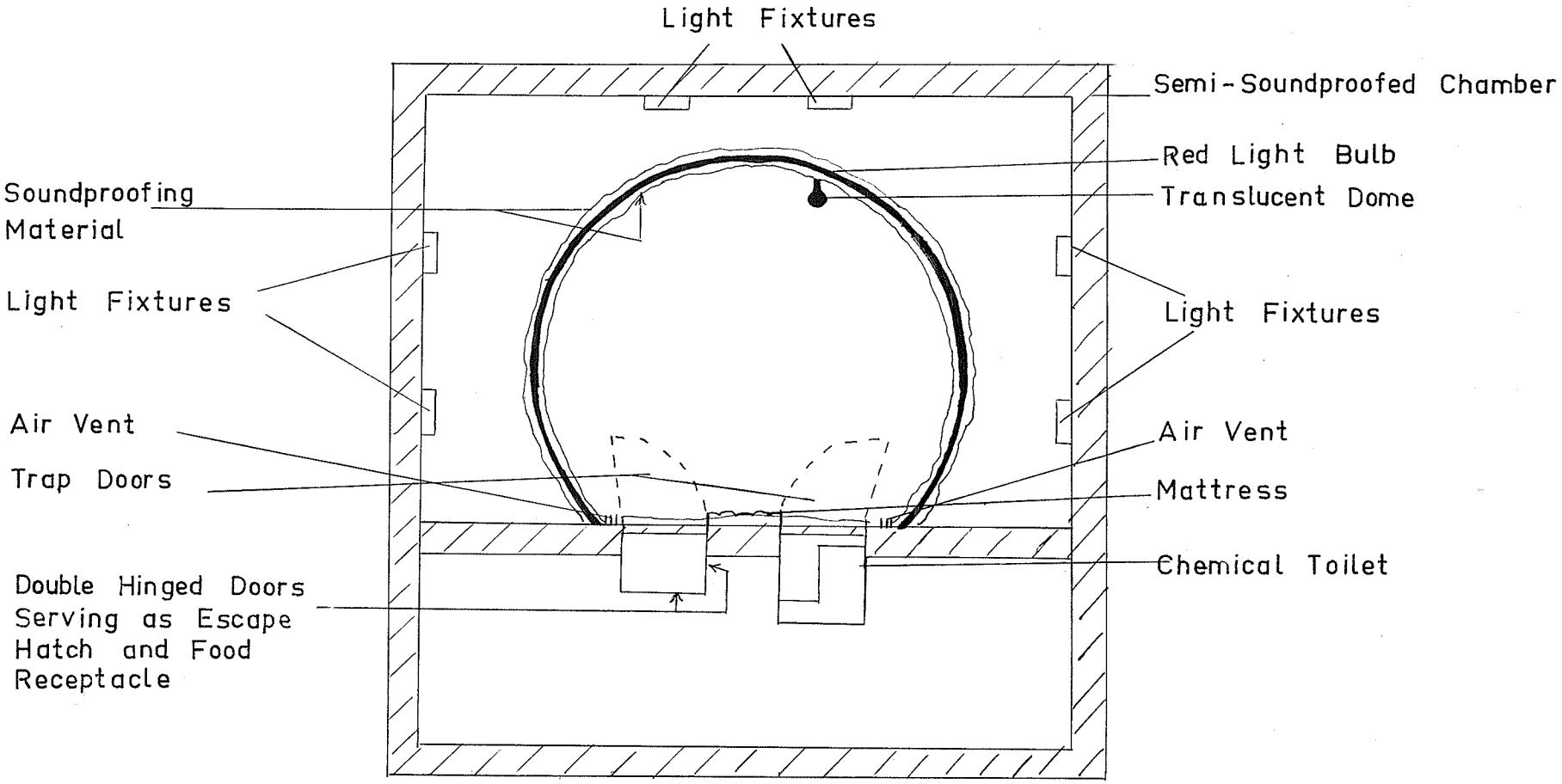
The purpose of the present experiment is three-fold: (a) the use of isolation periods of a week or longer and (b) the measurement of performance on various perceptual-motor tasks before and immediately after isolation and (c) the appraisal of various subjective experiences during isolation.

II. APPARATUS

The Isolation Chamber

Figure 1 shows a cross-sectional view of the isolation chamber. It consists of a translucent plexiglass dome measuring 7 ft. in height, 9 ft. in diameter, and $7\frac{1}{2}$ ft. at the base. It is surrounded on five sides by a system of flourescent and incandescent lights by means of which the interior of the dome can be flooded with diffuse light of any intensity or wavelength. This complex lighting system was not utilized in the present

FIGURE I


Light Fixtures
Semi-Soundproofed Chamber
Red Light Bulb
Translucent Dome
Soundproofing Material
Light Fixtures
Light Fixtures
Air Vent
Trap Doors
Air Vent
Mattress
Chemical Toilet
Double Hinged Doors Serving as Escape Hatch and Food Receptacle

experiment on darkness and silence. In order to sound proof the chamber, the inside and outside surfaces of the plexiglass dome, as well as the floor, were lined with an 8 inch layer of sound absorbing material. Toilet facilities, a food chamber, a two-way intercom system, and an air-conditioning unit are all built into the floor of the dome making it unnecessary for the subjects to leave the chamber for any purpose during the isolation period. The only piece of furniture in the dome is a plastic inflated mattress on which the subject lies. Entrance to the dome is via a trapdoor in the floor, which also serves as a food chamber. The plexiglass dome and its external lighting system are housed inside a semi-sound proofed chamber measuring 14' x 14' x 14'. The inside of the dome is sound proofed to the extent of 70 db. attenuation.

Tests

A perceptual battery of tests was administered to the subjects before and after isolation. These tests are listed below.

1. Visual Vigilance This was measured by a modified Mackworth clock test. It consisted of an electric laboratory clock (8 inches in diameter) with a single rotating hand which was stopped for 0.10 seconds at eight irregular time intervals during each 30 minute period. The "breaks" or signals were presented at intervals of 2, 2, 3, 1, 6, 7, 3 and 5 minutes. This 30 minute cycle was repeated four times. The subject indicated the presence of a signal by pressing a button.

2. Auditory Discrimination While the subject was performing the vigilance

task, he was presented with a continuous tone of 1100 cycles whose frequency and intensity were periodically increased or decreased in magnitude. Six frequency (50 cycles) and six intensity (5 db) changes were made in each of six 20 minute periods. The 12 changes or signals were presented at random time intervals in each of the six time periods. The subject again indicated the presence of a signal by pressing a button.

3. Depth Perception This was tested with the Howard-Dohlman apparatus. Each test of depth perception was the mean of four binocular trials with half of the trials started with the movable rod in front of the standard and the other half with it in back. The subjects were at a distance of 12 feet from the apparatus. Scores are recorded in terms of the mean separation, in cm., of the variable rod from the standard (taken as zero).

4. Size Constancy A black equilateral triangle, of variable height, was presented at 15 ft. The subject was required to adjust the height of this triangle until it looked the same in size as the near one, the standard triangle. This triangle was 20 cm. high and was presented at a distance of 4 ft. Four trials were given.

5. Reversible Figures The subject was asked to fixate a point at the center of an ambigious figure (reversible blocks) for 60 seconds, pressing a counter each time the figures appeared to change. Three trials were given. The score was the average number of reversals per minute.

6. Perception of Lines The subject was shown a horizontal black line, 10

inches long and $\frac{1}{2}$ inch wide with a fixation point located 3 inches above and below the center of the line. He was then shown two parallel vertical black lines, each 10 inches long and $\frac{1}{2}$ inch wide, separated by $2\frac{3}{4}$ inches with a fixation point located between the two parallel lines. These two sets of lines were presented on a white background at a distance of 3 feet from the subject. The subject was instructed to "tell me what each figure looks like to you—not what you think it really is, but what it looks like subjectively."

7. Perception of Colors The subject was shown 6 colored squares of paper, 5 inches x 5 inches—red, green, yellow, blue, black and white, and asked to report any changes in brightness and/or richness.

In addition to these perceptual tests which were given before and immediately after isolation, or after a week in the case of the controls, the experimental subjects were required to estimate various intervals of time at daily periods during isolation. These time estimates were always given shortly before the daily intellectual battery. Starting at the sound of a buzzer the subjects were asked to signal when 1, 3, 5, 15, 30, 60 and 120 minutes had elapsed. All the time estimates were from zero, that is, the subjects making a five minute estimate, for example, were told to signal when they felt a total period of 5 minutes had elapsed rather than the passage of a 2 minute period after the 3 minute estimate. During all the time estimates the subjects were told to refrain from any intellectual activity and to keep their minds as blank as possible. In several instances the subjects fell asleep during the test. When this occurred the time estimates were repeated a little later.

III. SUBJECTS

The experimental group consisted of 16 subjects. It was composed almost entirely of university students, most of whom were engaged in post-graduate studies in the biological and psychological fields, and air-force personnel drawn from the RCAF base in Winnipeg. The subjects were screened by the use of psychological tests and interviews, and were also checked for normalcy of EEG patterns. All the subjects were paid volunteers, and as payment was made on an all or none basis, the strongest possible motivation for staying the full 7 days was ensured. Out of 22 subjects tested, 16 remained for the full time, with one female subject remaining in isolation for $8\frac{1}{2}$ days, and one male subject for 10 days. Four of the 16 subjects were females. The mean age of the group was 24.1 years with a range from 19 to 34 years.

A control group of 16 subjects (selected out of an initial sample of 22) had the same proportion of graduate students, air force personnel, and the two sexes as the experimentals. Furthermore, they were also matched for age and intelligence scores, as determined on the Henmon-Nelson Intelligence Test. The mean age of this group was 23.4 years with a range from 19 to 30 years.

IV. PROCEDURE

The subjects were given, prior to entrance in the dome, a battery of psychological tests to appraise personality and temperment; an EEG session to check normalcy of brain wave patterns, and a series of tests to appraise perceptual functioning. Immediately upon release from the dome,

the subject again performed the perceptual tests and had a second EEG session.

Inside the dome, the subject wearing loose clothing, was instructed to restrict his movements as much as possible and to lie on his back on the air mattress, refraining from talking to himself, whistling, humming, etc. Earmuffs, to reduce any noise made inside the chamber, were worn continuously and the dome was in complete blackness except for a short interval of time (approximately 45 minutes) once a day, when a 15 watt red bulb was turned on enabling the subject to see the intellectual test problems given to him. During this test session, the subject was also asked to report on his emotionality, imagery, hallucinations, physical well-being, ability to concentrate, etc. All other communication, including other reports, requests, food, etc., were one-sided conversations, with the experimenter responding only by means of a buzzer system. The subject was fed a liquid diet concentrate supplemented with coffee and fruit juice. In cases where the diet disagreed with the subject, sandwiches were given. An experimenter was on duty constantly and through a microphone in the chamber could audit the subject continually. A log was kept and all reports and requests were noted. Immediately upon emergence the subject was again administered the battery of perceptual tests.

The control subjects were tested under conditions which were as similar as possible to the experimental ones. For both the perceptual and time perception tests the time intervals between tests were the same as for the experimental subjects. Most of the time estimate controls were tested in the isolation chamber. The remainder were tested in a quiet room wearing black goggles and earmuffs. At the completion of the time estimates,

the subjects were kept in the laboratory for a period of time before being allowed to go home. This was done in order to prevent knowledge of results unduly influencing the daily time estimates.

CHAPTER III

EXPERIMENTAL FINDINGS AND DISCUSSION OF RESULTS

I. RESULTS

The statistical test which was used to appraise the reliability of the differences in scores is the t test of significance for matched groups (Edwards, 1946). A difference is considered to be significant if the p value is at the .05 level or better. P values between .05 and .10 are interpreted as indicating a trend.

Test Performance

Figure 2 illustrates the performance of the experimental and control groups on the auditory discrimination test in terms of percentage detection of signal changes occurring in the six successive 20 minute intervals of time. Statistical comparison of the mean difference scores between the pre-isolation and post-isolation tests of the two groups reveals no significant differences in performance for either the entire 120 minute period ($p>.10$) or any of the six 20 minute periods, with the exception of the last period where the poorer performance of the experimentals borders on significance ($.05<p<.10$).

The scores for the visual vigilance test reveal an entirely different picture. Figure 3 compares the before and after scores of the experimental and control groups in terms of percentage detection of signal changes occurring in each of the four successive 30 minute periods. It can be seen that after a week, the overall vigilance performance of the experimentals is much poorer than that of the controls ($p<.001$). Furthermore,

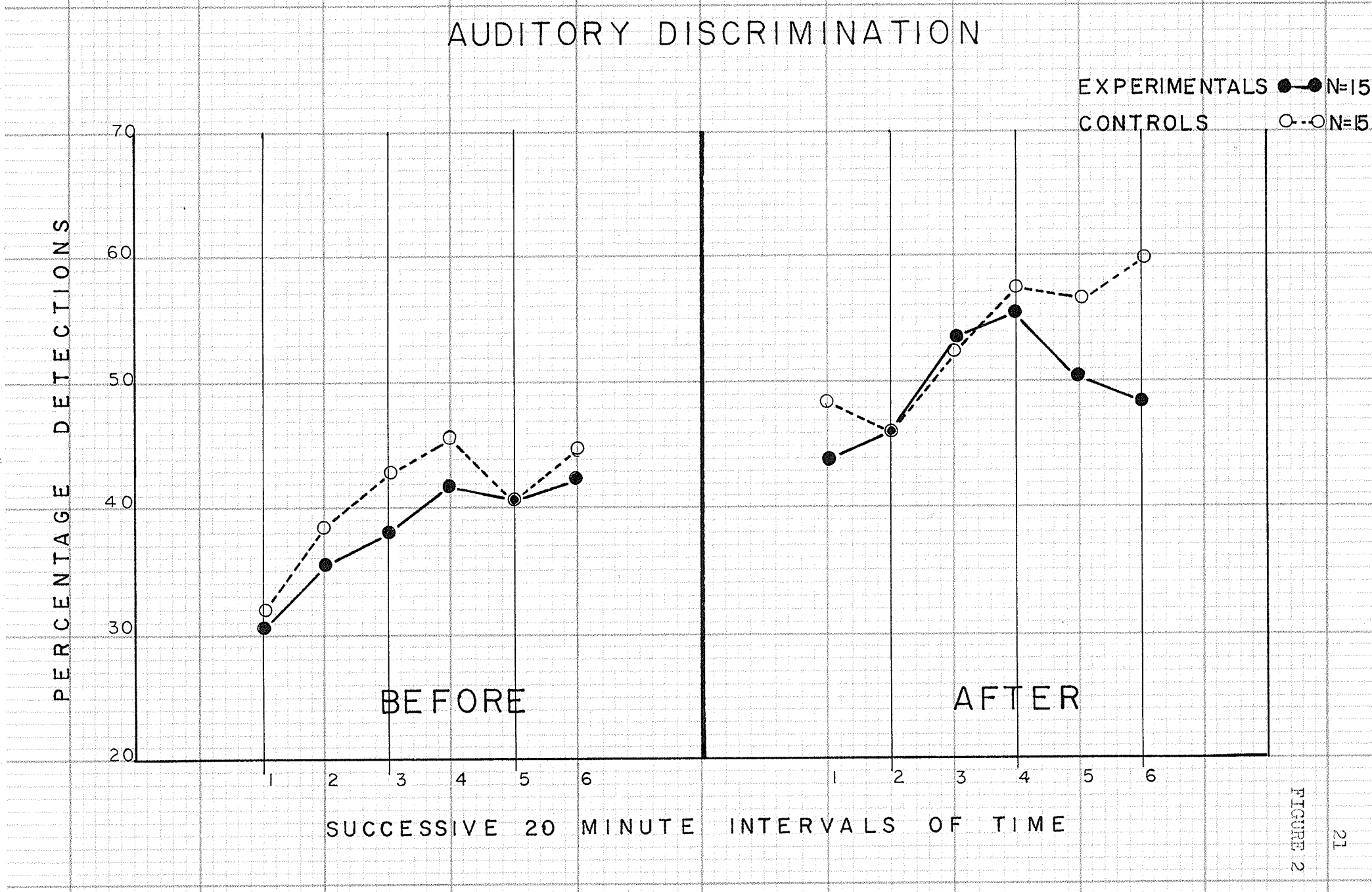

AUDITORY DISCRIMINATION
EXPERIMENTALS N=15
CONTROLS N=15
PERCENTAGE DETECTIONS
70
60
50
40
30
20
BEFORE
AFTER
1
2
3
4
5
6
SUCCESSIVE 20 MINUTE INTERVALS OF TIME

FIGURE 2

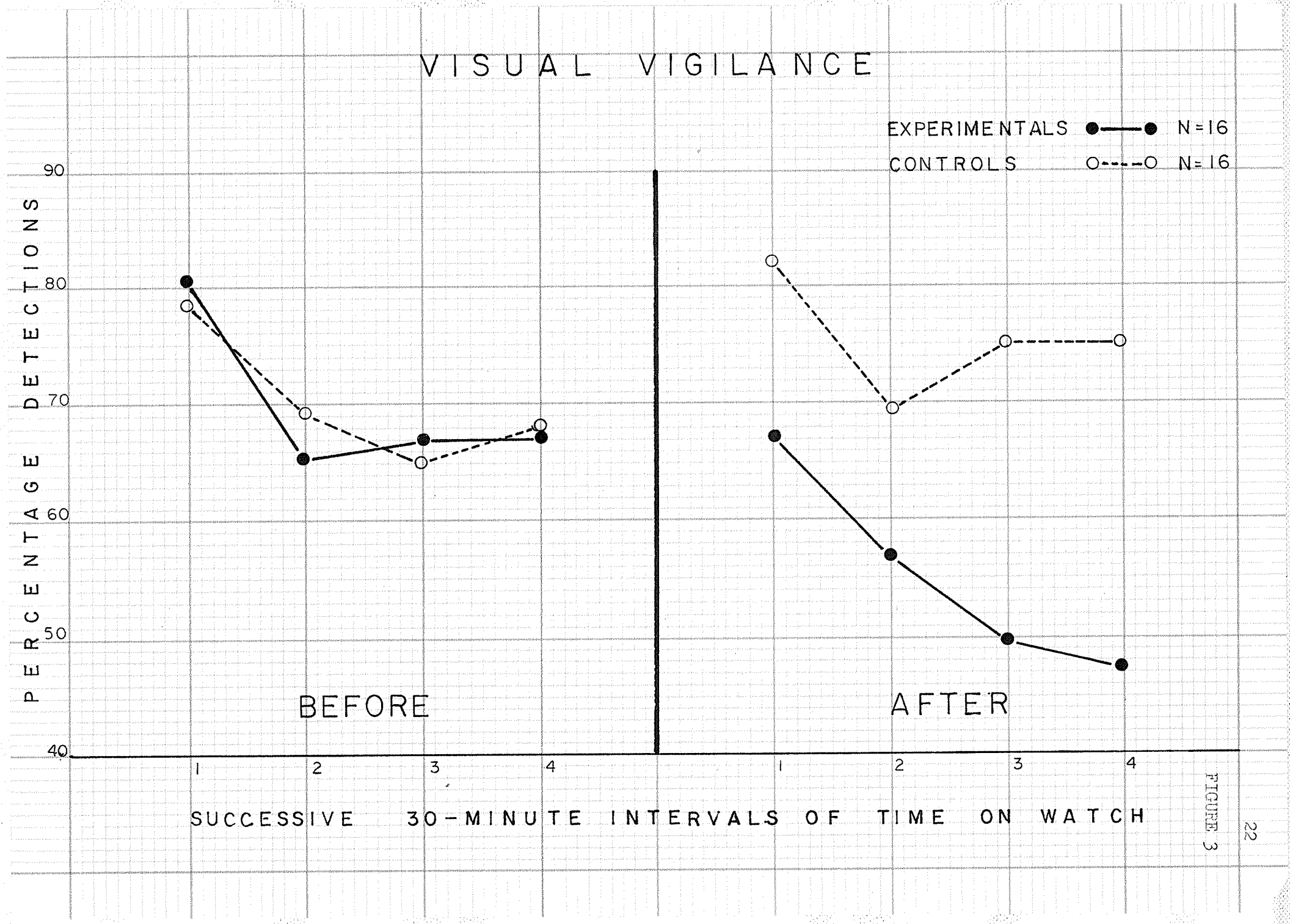

VISUAL VIGILANCE
EXPERIMENTALS N=16
CONTROLS N=16
PERCENTAGE DETECTIONS
90
80
70
60
50
40
BEFORE
AFTER
1
2
3
4
1
2
3
4
SUCCESSIVE 30-MINUTE INTERVALS OF TIME ON WATCH

FIGURE 3

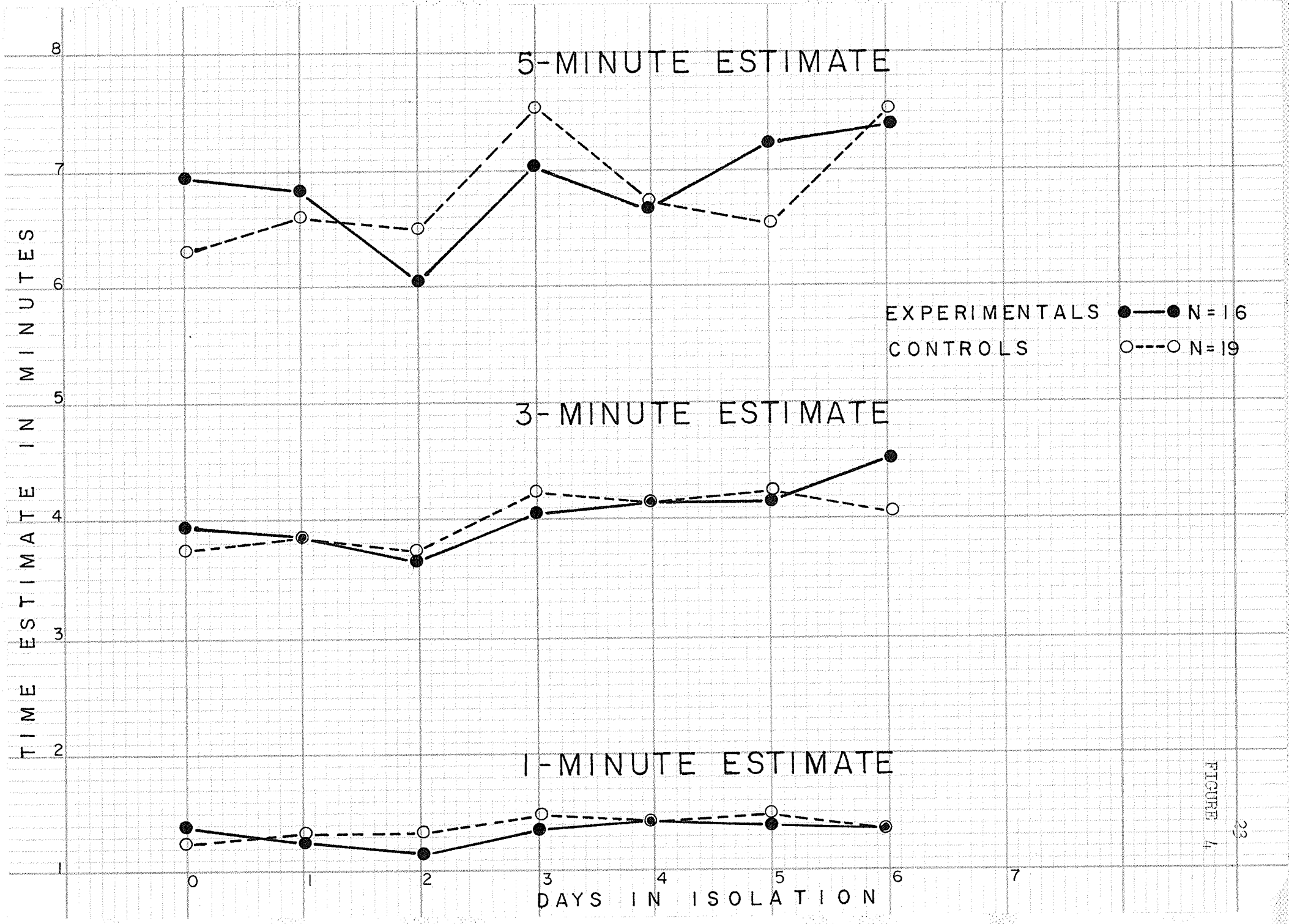

5-MINUTE ESTIMATE
3-MINUTE ESTIMATE
1-MINUTE ESTIMATE
EXPERIMENTALS N = 16
CONTROLS N = 19
TIME ESTIMATE IN MINUTES
DAYS IN ISOLATION
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7

FIGURE 4

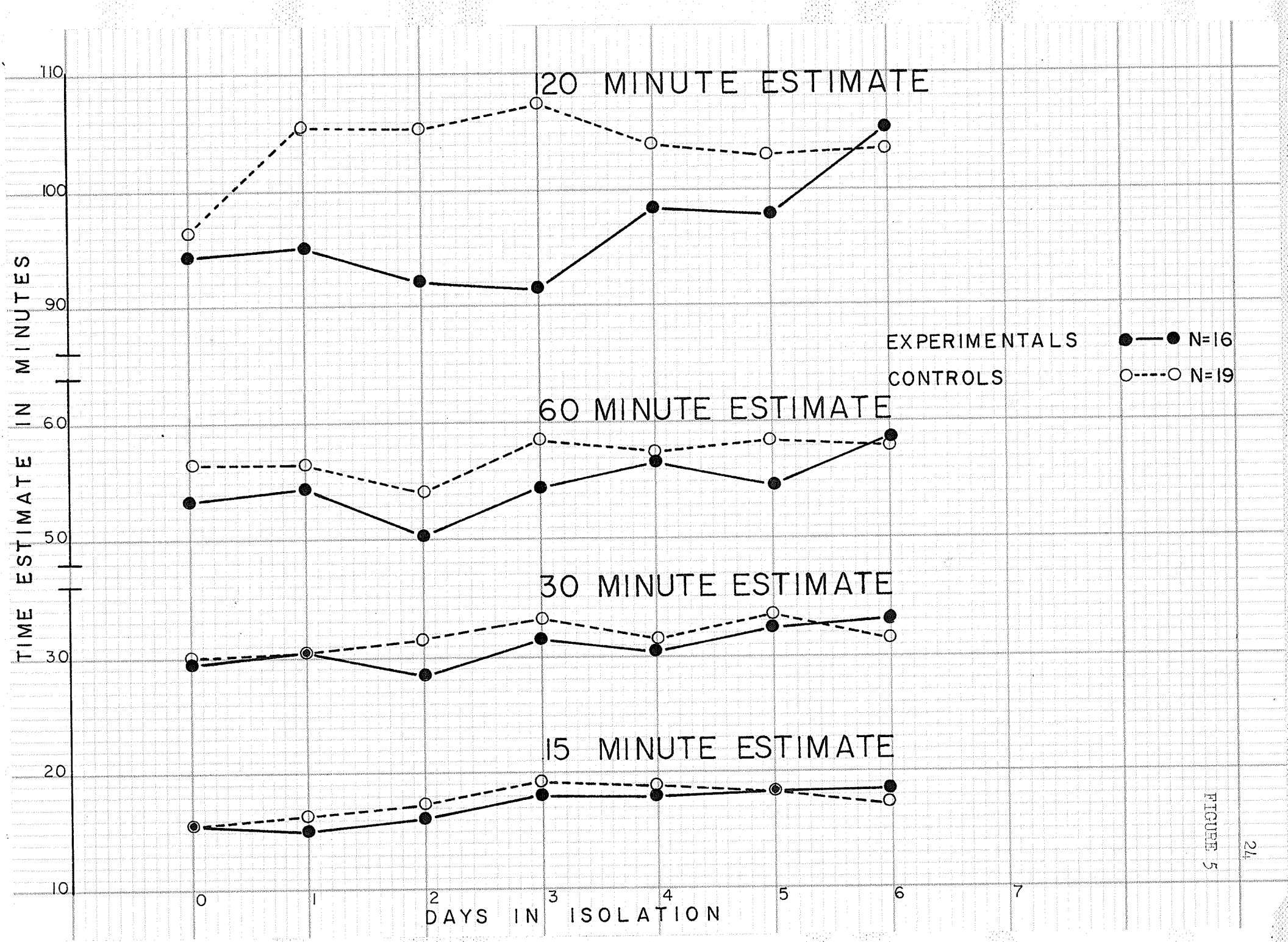

120 MINUTE ESTIMATE
60 MINUTE ESTIMATE
30 MINUTE ESTIMATE
15 MINUTE ESTIMATE
TIME ESTIMATE IN MINUTES
110
100
90
60
50
30
20
10
0
1
2
3
4
5
6
7
DAYS IN ISOLATION
EXPERIMENTALS N=16
CONTROLS N=19

FIGURE 5

their performance in each of the four successive 30 minute test periods is significantly poorer than that of the controls.

Figures 4 and 5 show the ability of the experimental and control subjects to estimate the passage of 1, 3, 5, 15, 30, 60, and 120 minutes at daily intervals during a period of a week. It can be seen that both the experimental and control groups overestimate the short durations of time, that is, the 1, 3, and 5 minute periods. Both estimate fairly accurately the 15 and 30 minute intervals. However, none of the differences between the two groups are significant. On the longer time intervals, that is, the 60 and 120 minutes, both groups of subjects show underestimation with the experimentals showing more underestimation, that is, less accuracy, than the controls. However, only in the case of the 120 minute estimate is this difference statistically significant ($.01<p<.02$).

Table I shows the results of the experimental and control subjects on the tests of depth perception, size constancy, and reversible figures administered before and after a week of isolation or an elapse of a week. The statistical analysis is based on the differences between the mean scores of the two groups relative to their earlier scores. It can be seen that on depth perception the experimental group did poorer than did the controls. This difference, however, is not significant ($.05<p<.10$). On the size constancy test, the experimentals chose larger comparison triangles than did the controls, suggesting a decrease in constancy, but this difference again is not statistically significant ($.05<p<.10$). However, since these two sets of results border on significance they do indicate a trend which might have

reached statistical significance if a larger N had been used. Finally, on the reversible figures the experimental group showed fewer figural reversals per minute than the controls but this difference again is not significant ($p > .40$).

The tests of line perception and color perception were not designed to yield quantitative data and so will be dealt with in the qualitative or subjective section of this chapter.

TABLE I

MEAN SCORES ON DEPTH PERCEPTION, SIZE CONSTANCY

REVERSIBLE FIGURES

	Depth Perception			Size Constancy			Reversible Figures		
	N	Before	After	N	Before	After	N	Before	After
Exp.	16	2.00 cm.	2.83 cm.	15	21.9 cm.	23.9 cm.	15	15.8/min	13.4/min
Con.	16	1.97 cm.	1.56 cm.	15	20.3 cm.	20.5 cm.	15	15.3/min	15.2/min

Qualitative Observations During Isolation

During isolation, the subjects reported many interesting perceptual experiences that could only be reported and classified in a qualitative manner. These experiences include hallucinations of a visual, auditory, and tactual type, unusual imagery, and unusual dreams.

Undoubtedly the most fascinating experiences which were reported by the subjects were hallucinations. In order to qualify as a hallucination, the experience had to have an "out-thereness quality," its appearance and disappearance had to be entirely spontaneous and independent of the subject's volition, and the subject, at least at the beginning, had to be convinced of its reality. These were the criteria employed by Vernon, McGill, and Schiffman in 1958 in their paper on visual hallucinations occurring during perceptual isolation, which were previously described.

Table 2 summarizes the types, times of first appearance, and the number of subjects who had visual, auditory, and tactual hallucinations. Out of 16 subjects, eleven reported hallucinatory activity. Out of these eleven, ten reported type I hallucinations, three reported type II hallucinations, and two reported type III. In general there was an increase in the intensity and number of the hallucinations rather than a change in their quality with increasing time in isolation. The hallucinatory activity usually lasted for a very brief length of time, about 5 to 10 seconds, although some hallucinations continued intermittently for longer periods of time. By and large, however, the hallucinatory activity did not generally occupy a great deal of the subject's time. Furthermore, it generally did not appear prior to the third day.

The auditory hallucinations were varied in content and in the amount of structure. Some subjects heard dogs barking, others, alarm clocks and telephones ringing, and typewriters typing. Still others heard tuneless

TABLE 2

HALLUCINATIONS

	Visual			Auditory	Tactual
Day	Type I	Type II	Type III		
1					
2	1				
3	5	2	1	4	
4	4			1	
5			1	1	1
6		1			

N reporting visual hallucinations	11
N reporting Type I	10
N reporting Type II	3
N reporting Type III	2
N reporting Type I & II	3
N reporting Type I & III	1
N reporting Type I, II & III	1
N reporting auditory hallucinations	6
N reporting tactual hallucinations	1

whistles, faint mutterings of indistinguishable voices, and aimless humming. There were six reports of auditory hallucinations, four of which occurred on the third day, one on the fourth and one on the fifth day. The one tactual hallucination occurred on the fifth day.

There were some suggestions that the female subjects may be less prone to having hallucinations than males. Of 12 male subjects, ten had hallucinations, while out of four female subjects, only one experienced them. Her hallucinations were of the Type I variety and occurred relatively infrequently. Although this sample is too small to draw any conclusions from, nevertheless these sex differences are suggestive and should warrant further investigations from workers in the field of sensory deprivation.

In addition to reporting hallucinatory activity, many subjects reported an increased richness of imagery. Imagery, as distinct from hallucinations, had to be at least partially controlled by the subject, and was initially recognized as stemming from within the self. Eight out of the 16 subjects were able to report experiences that met this criterion. They reported that the imagery they experienced was of a brightness and clarity that was very unusual for them. Colors were much more vivid and distinct than in real life situations, and contours were very sharply defined. Animated images and little sequences of stories or themes were very common. Some subjects reported visualizing scenes that they had not witnessed for years, as well as faces that they had not been able to remember for a lengthy period of time. All these subjects agreed that this imagery was much more vivid than any that they had ever had before.

An attempt was made to record as many dreams as the subjects could remember. They generally were centered about themes relating to their present circumstances or about themes concerning escape and flight. Thus these subjects reported dreams of being in fox holes in battlefields, of living in a cramped miniature-size apartment, of being swallowed by God into hell, etc. All these dreams appear to be a direct reflection of the uncomfortable nature of the living quarters of the dome, and the fear and hostility that was felt by some of the subjects at various times towards the project and the experimenters. Subjects also reported such dreams as running away from an igloo, of being back home, and of travelling; which seem to reflect the desire to escape from the chamber. Many of these subjects reported that they did not dream as much under normal circumstances.

Qualitative Observations After Isolation

Many of the subjects reported some perceptual changes upon their emergence from the dome, with two reporting changes on the lines test, and eight reporting changes on the color test. The lines appeared to lengthen, bulge, waver, or thicken, but this was very transitory. The squares of colored paper appeared much richer and more intense. This again, was of a very momentary nature.

The other reports concerned slight dizziness, slight nausea, more sharply defined contours, and a much richer appearance of people, colors, and objects. There were no drastic changes in the visual field as reported in previous literature (Heron, Doane, & Scott, 1956) where

distortions and instability of the visual field appeared to be quite pronounced. The distortions that our subjects reported concerned only parts of the visual field and were very fleeting.

Some of the subjects also reported a very pronounced hyperacuity to sounds, with each little noise being very noticeable, particularly at night. There were no reports of particular irritation with noise, but rather the subjects reported a desire to listen to noise and music more keenly than usual.

II. DISCUSSION OF RESULTS

The results have shown a significant impairment in visual vigilance or alertness and the ability to estimate longer periods of time (two hours). Disorganization in brain function has been indicated by the appearance of visual and auditory hallucinations and unusual imagery. Upon emergence there were momentary changes in perception, such as the richer appearance of colors and the more sharply defined contours of objects. However, there were no significant impairments in auditory discrimination, size constancy, and depth perception, nor in the reversible figures test. Nor were there any signs of impairment in the ability to estimate shorter periods of time (under two hours). There were also no drastic changes in the perception of the environment upon emergence from isolation, such as fluctuation of the visual field, the apparent distortion of the shapes of objects, and the apparent movement of objects.

A direct comparison of these findings with those of others in

the literature is difficult because of the preoccupation by most investigators with short intervals of isolation ranging from several hours to two or three days. Furthermore, some of the abilities investigated in this study have not been studied by other investigators. Despite these difficulties an attempt will be made to relate our results to those of other workers in this field.

Visual vigilance and auditory discrimination are two tasks which have not been studied by other investigators. The finding that auditory discrimination is not impaired while performance on the visual vigilance task is seriously impaired, is puzzling in view of the similarity of the two tasks, that is, both tests require detections of signal changes. These results, however, do have a practical application in that they suggest that personnel working in confined monotonous situations should rely more on auditory rather than visual signals.

The results for the tests of depth perception, size constancy, and reversible figures, appear to support previous research. Test results from subjects who were isolated at the Aerospace Medical Laboratory (Freedman and Greenblatt, 1959) under conditions of blackness and low noise level revealed no trend for either faster or slower alteration on the reversible blocks figure. Similarly, work done at McGill (Doane, Mahatoo, Heron & Scott, 1959) under conditions of low illumination and low noise level with Necker cubes revealed no significant differences. These results, therefore, are in line with the present ones where no significant impairment was found.

Results from the Aerospace Medical Laboratory also failed to reveal any significant impairment of depth perception after isolation. Furthermore, research performed at Princeton (Vernon, McGill, Gulick, and Candland, 1959) under conditions of darkness and silence also did not show any significant impairment in depth perception. However, a trend towards impairment was shown. This is in line with the present results.

In regard to size constancy, the results are not clear cut. At McGill it was found that there was a significant decrease in size constancy, while at the Aerospace Laboratory there was only a suggestion of a decrease. Our results also indicated a trend towards the lessening of size constancy with subjects choosing larger triangles. However, the results were not significant ($.05<p<.10$). A possible explanation of these results may lie in the fact that the McGill experiments involved constant light and noise, whereas the Aerospace Laboratory and the Manitoba experiments involved darkness and silence. Since different sensory conditions were used, some behavioural differences might be expected.

We are unable to relate our results on the time estimation tests to those of other investigators since none of them asked their subjects to estimate specific periods of time.

Although hallucinations were reported by the majority of our subjects they were largely of the simple type I variety, were, in general, of short duration, occurred relatively infrequently, and only appeared

after two days in isolation. These findings are supported by the Princeton investigators, where in one study involving only two days of darkness and silence no hallucinations were reported (Vernon and Hoffman, 1956), while in the second, involving periods up to three days, some hallucinatory activity of the type I variety was reported (Vernon, McGill and Schiffman, 1958). From these results it is clear that if hallucinations do appear under constant darkness and silence, they are usually of a simple nature and occur relatively infrequently. However, under conditions of low diffuse light and low noise level, the hallucinatory experiences are more frequent and complex in nature. This was most clearly demonstrated at McGill (Bexton, Heron and Scott, 1954) where subjects were kept in isolation for periods up to three and four days. These subjects reported some striking hallucinations, many of which were of the more complex types II and III variety. It is of interest to note, however, that when some of their good hallucinators were placed in darkness their hallucinations either completely disappeared or else were greatly diminished. Upon exposure again to diffuse light, the hallucinations returned to their original level of intensity. These results suggest that exposure to diffuse light is an important factor in the production of hallucinatory activity. They also help to account for the relative infrequency and simplicity of the hallucinations of our subjects while in darkness.

One of the most striking findings of the McGill studies on diffuse light and noise (Heron, Doane, and Scott, 1956) was the presence

of gross perceptual disturbances within the first half hour after emerging from isolation. These disturbances were characterized by fluctuation, drifting and swirling of objects and surfaces in the visual field and by the distortion of the shapes of objects, lines and edges. These changes were so pronounced that feelings of nausea were reported by many of the subjects. No such gross changes were ever experienced by any of our subjects including the $8\frac{1}{2}$ and 10 days subjects. There were some distortions of lines, but these were very slight and of very short duration. It is possible, however, that our occasional intrusions with a dim red light, permitting some degree of pattern vision, may partly be responsible for the absence of these gross perceptual distortions.

It is clear from the above discussion that prolonged darkness and silence can produce various psychological changes such as the appearance of hallucinations, unusual imagery, poorer time-estimation, and the impairment of certain perceptual-motor tasks. However, these changes or impairments do not appear to be as drastic, as widespread, or as long lasting as those produced under conditions of diffuse light and unpatterned noise. Although these differences may be due to a number of factors, it is believed that they are largely due to differences in central nervous activity brought about by the two types of sensory conditions. This view is supported by some exploratory work in our laboratory which points to different patterns of EEG activity for these two conditions. This can best be illustrated by reference to one subject who at the end of 10 days of darkness and silence showed an EEG pattern characterized mostly by fast activity of 12 to 20 c.p.s., to-

gether with an abnormal amount of theta activity particularly in the temporal lobes. However, this same subject, when retested a year later showed, after 10 days of diffuse light and unpatterned noise, a quite different pattern of EEG activity. It was now characterized by a slowing of the alpha by several cycles together with an excess of theta activity in the temporal lobes. Fast activity of 12 to 20 c.p.s. was nowhere in evidence. In view of the differences in these patterns of neural activity, some behavioural differences might be expected under the two types of isolation.

CHAPTER IV

SUMMARY AND CONCLUSIONS

This investigation has been concerned with the effects of a week's isolation in darkness and silence upon the perceptual abilities of human subjects. Previous research in this area has not used such long periods of isolation, nor were any quantitative measurements of perceptual functions recorded in many cases.

In this project 16 subjects were isolated for a week or longer under conditions of darkness and silence. Perceptual tests of size constancy, depth perception, reversible figures, line and color perception, visual vigilance and auditory acuity were administered to the subjects before and immediately after isolation. A group of control subjects took the same tests at the same time intervals as the experimentals. Furthermore, while in isolation the subjects were required to estimate various intervals of time.

The results have shown a significant impairment in visual vigilance and the ability to estimate longer periods of time (two hours). There was also an indication that size constancy and depth perception may be impaired. However, there were no impairments in auditory discrimination, depth perception, size constancy and reversible figures, nor in the ability to estimate shorter periods of time (under two hours). Disorganization in brain function was indicated by the appearance of both auditory and visual hallucinations and unusual imagery while in isolation. Upon emergence from isolation, there were momentary changes in perception such as the increased richness of colors and the more sharply defined contours of objects and lines.

However, there were no drastic long lasting effects, such as fluctuation of the visual field and distortion of the shapes of objects.

From these results it is possible to conclude that certain perceptual abilities, such as auditory discrimination will withstand the effects of isolation in darkness and silence to a greater degree than will other abilities, such as visual vigilance. Furthermore, the fact that our subjects reported fewer perceptual impairments than those reported under conditions of light and noise suggests that constant light and noise are more disturbing to brain function than constant darkness and silence.

APPENDIX

A SUBJECT'S REPORT ON EXPERIENCES DURING ISOLATION

One evening in November, 1959, I entered the dome filled with apprehension. After my orientation period, my fears were allayed so that I spent a comfortable night, sleeping well with no dreams or further apprehensions.

My first days in the dome were extremely fascinating; my whole visual field was a mass of undulating brilliant colors, animals, objects, etc., which came and went, danced or ran at the merest thought. Faces appeared, receded, changed, with the slightest effort. I was watching a cineramic fantasy of colors, people, objects, and animals which had no limits. As well as these images, my mind produced light flickers, similar to those seen when standing on a profoundly dark prairie and seeing lightning flashes many miles away at the extremity of the visual field.

The subsequent nights produced much dream activity, some of which was extremely disturbing. The days began to drag and my fascination with colors and images began to wane. Light flickerings increased and became continuous, but my interest in them was depleted. Neither imagery nor hallucinations were interesting now.

Previous to my entry into the dome, I had determined that little word games, singing to myself, etc., would alleviate boredom. However, decadence set in, and I could not be bothered entertaining myself. Only brief moods of well being and good humor now inserted them-

selves into my day. The intellectual tests, which were administered daily, were the high spots of my days. They were looked forward to with the same expectancy as a good play, book, or concert. These tests, at which time a light was on, also gave me a chance to re-orient myself within my drab confines and to straighten out the mess of my previous 24 hours.

Estimating the time of day was an enjoyable past time. This was done by mentally summoning my clock to come forth. A dot would appear at a distance and by coaxing would swiftly come forward, revealing as it did so the face of a clock, sometimes round, sometimes octagonal, with either arabic or roman numerals.

After completing the tests one day, I saw an area devoid of everything but a midnight blue sky broken only by a white canopy overhead, encompassed by a fluffy, white material. Several light sources gave steady beacons of various colors but no light. Then these emerged to one point of light that approached to reveal a regular geometrical pattern of some interest. The pattern then changed and repeated itself several times. A yellowy-white light source, with a fluctuating pattern of red and blue around it presented itself and then began going away. (See figures 6 and 7 for illustrations of other hallucinations by this subject.)

Light flickerings continued, becoming brighter and stronger. They were completely unmanageable. Sounds became apparent; a dog barking, a tuneless whistle, muted voices.

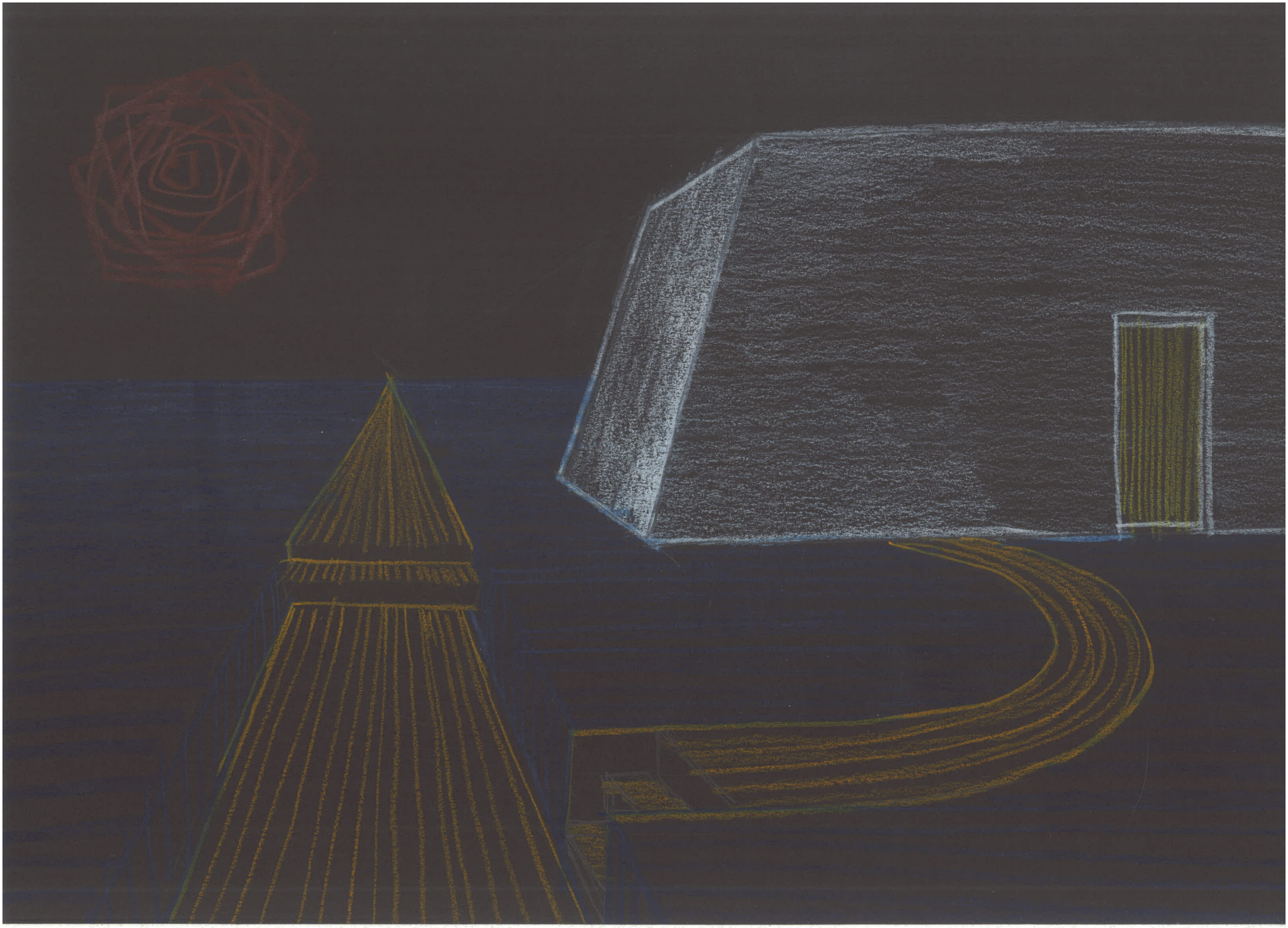
On the last morning after a particularly uncomfortable night,

I woke up highly irritable. I lay on the floor of the dome with my head propped up, then a strange tension seemed to grip and swell within me. I looked at myself and could see my body. I was there, but every joint in my body was non-existent; my hand, which I could move, was unattached to my wrist. My whole body was there in components, but with no links. Then I felt myself rise. My whole body stretched out horizontally, and began to rise and float away. I tried to stop and was let down again.

I was extremely dejected when my hallucinations started again. Suddenly everywhere I looked I could see eyeballs, large ones, small ones, sneaky ones, cat-like ones, and horror-stricken ones. I heard voices and sounds. This experience was very frightening.

On leaving the dome after adjusting to the light, colors vibrated around me. Black objects showed all their component shades—blues, greens, reds, appeared in an obvious manner. Faces became alive with colors in individual patches rather than blending into a whole. Properties of objects that I had not noticed before appeared very striking. However, this only lasted for a few minutes.

FIGURE 6



A SUBJECT'S REPORT ON EXPERIENCES AFTER LEAVING ISOLATION

After leaving the dome all objects in the lighted room appeared extremely bright and vivid in color. Common everyday objects seemed to have a certain strangeness and complexity about them, creating a desire to handle and re-familiarize myself with them.

Not only were objects vivid and seemingly complex, but I had an almost insatiable desire to experience all the sensory stimulation that the situation could offer. Music from the radio seemed unusually delightful, and all sounds were rather loud and somewhat startling. When I tried to stand still, I felt as though I was swaying. Walking seemed to be a new delightful experience, although occasionally I had to sit down for fear of falling. I found that I had to stop and think about each step when walking up and down stairs, before attempting to move.

When I was driven to the hospital approximately three hours after leaving the dome, people and cars hurried along in what seemed to be organized confusion, but I must add that this new experience was most delightful and rewarding.

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