CHANGES IN THE PERCEPTION OF TACHISTOSCOPICALLY PRESENTED INCOMPLETE FIGURES IN PATIENTS RECEIVING ELECTRIC CONVULSIVE THERAPY

TOM C. BIRD

SUMMARY

Ten patients and eleven controls received three equivalent tests before, during, and after ECT, or a similar lapse of time. The tests involved the tachistoscopic presentation of Street's Gestalt Figures; the number correctly recognized being the score used. Conclusions reached are: (1) A significant drop is found in learning and remembering the test material. (2) No cumulative effect of the number of convulsions is seen on test performance, and (3) A convulsion tends to produce the greatest drop when it occurs before reproduction rather than before learning. An historical survey of previous work on the psychological effect of ECT on humans is included.

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TOM C. BIRD

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ABSTRACT

Ten patients and eleven controls received three equivalent tests before, during, and after ECT, or a similar lapse of time. The tests involved the tachistoscopic presentation of Street's Gestalt Figures; the number correctly recognized being the score used. Conclusions reached are: (1) A significant drop is found in learning and remembering the test material, (2) No cumulative effect of the number of convulsions is seen on test performance, and (3) A convulsion tends to produce the greatest drop when it occurs before reproduction rather than before learning. An historical survey of previous work on the psychological effect of ECT on humans is included.

PREFACE

The work reported here was done at the Allan Memorial Institute of Psychiatry, D. Ewen Cameron,M.D., Director. The testing was carried out with the permission of the doctors and internes of the Institute, and with the cooperation of the nursing staff. No assistance was received except for the manuscript criticism of Dr. G.A.Ferguson, thesis director.

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CHANGES IN THE PERCEPTION OF TACHISTOSCOPICALLY PRESENTED INCOMPLETE FIGURES IN PATIENTS RECEIVING ELECTRIC CONVULSIVE THERAPY.

HISTORICAL INTRODUCTION.

This study is an attempt to develop a technique capable of tracing the change, shock by shock, produced by electric convulsive therapy (ECT).

Briefly ECT is the passage of current through the brain of the patient by means of external electrodes in sufficient strength to produce a grand mal siezure, the procedure being repeated about three to twenty times in most cases. As a method of treatment it was introduced by Cerletti and Bini to replace the metrazol induced convulsion of Von Meduna around 1938. Since then it has become a recognized method of treatment and is described in many standard texts, (6), (13), (17), Its effectiveness has been substantiated in many studies, (7), (12), (17), and about all that remains to be done is to understand just what it does, and how it does it.

The strongest clinical impression, produced by ECT, outside of the startling change of mood, is the confusion and loss of usual abilities of orientation and memory, especially after three to ten convulsions. Most of the work of a psychological nature on ECT has been devoted to its effect on memory. Since the work has been highly varied it will be reviewed here in terms of the methods used, and later summed up in terms of the results achieved.

The most direct and obvious approach is the implantation

of material before a convulsion, testing for the material afterward, and then evaluating the resulting drop by means of various controls. In chronological order, the following workers have used this technique.

Using pictures for material Hemphill (5) showed eight pictures thirty minutes before convulsion; one hour after he asked patients if they had seen any pictures before treatment. All could remember seeing the pictures and could recall at least three of them, some being able to describe all of the pictures. He describes no controls and gives no results other than those mentioned, but concludes that his study provides no evidence for retrograde amnesia as a result of a convulsion.

A repetition of the Hemphill study was carried out by Mayer Gros, (18). Using only four pictures but showing them for fifteen seconds each in the last minute before convulsion, Mayer Gros got the following results. (Table revised from original; data in %, giving correct response).

TIME	TYPE OF	PICTURES IN ORDER OF PRESENTATION			
PERIOD	TEST	1	2	3	4
3-8 hours	Recall	53	46	28	18
(N = 23)	Recognition	34	35	30	24
24 hours	Recall	86	86	74	58
(N = 17)	Recognition	61	63	57	54

Here there appears to be a retrogressive effect on recall and recognition though it is not complete and diminishes with time. This rules out a thoroughgoing retrograde amnesia, for

nothing is completely forgotten, and what is lost at first is partially regained later on. He suggests that the convulsion works in a manner similar to retroactive inhibition.

Another type of material is nonsense syllables or words. This technique was used by Zubin and Barrera (40); in this study they paired a commodity with a fictitious brand name. In the week before treatment the patients learned such material to two correct repetitions in the morning, and were tested in the afternoon. This procedure was repeated during treatment and again in some patients after treatment. When a convulsion occurs between the two learning sessions, no significant saving appears, and even a trend of loss. Learning ability, it is claimed, does not suffer; but recall with interpolated convulsions is significantly less. (In a study by Purcell, (22), mentioned in Kalinowsky and Hoch, (13), it is claimed that under apparently similar conditions no significant loss in relearning was found, in direct contradiction to Zubin and Barrera's conclusion).

In addition to this experiment, Zubin and Barrera describe another experiment in which two brand names were learned to the same set of commodities, one the night before, and the other just before shock. There was a significant drop in recognition between shock and non shock, though recognition was still greater than chance. In the control series recent learning had some advantage over remote learning, but ECT decreased markedly this differential. This Zubin believes is evidence for disorganization rather than destruction of memory traces, or engrams.

In a later paper Zubin (38) associated one set of words A with another set B, and later associated a third set C with the first set A. With a convulsion occurring between the two learning sessions, there was an increase in the "interference" in learning to associate set C to set A.

Worchel and Narciso, (37), used nonsense syllables in a standard experiment using the anticipation technique. The two subjects were tested in the following manner:

(1) shock following immediately criterion is reached.

(2) shock following one hour after criterion.

(3) no shock but the same five hour period before relearning.

These three procedures were carried out in a randomly rotating manner until the seventh shock. The procedure had to be stopped at this point as the two subjects could no longer learn a series of nonsense syllables. When treatment of the two subjects was finished, procedure three was maintained for nine more days. They conclude: (1)the effect of shocks is mainly cumulative, (2)this effect is reversible with cessation of ECT, (3)differences of one hour make no effect on relearning, (4)a shock during learning does not produce complete amnesia, and (5)impairment of learning occurs, and depends on the nember of shocks administered. This last conclusion contradicts the findings of Zubin and Barrera.

Rodnick, (24), used a simple habit system in testing the differential effect of a metrazol shock on immediate and remote learning. Forty two schizophrenics were trained to move a finger left at a five hundred cycle tone and right at a seven hundred cycle tone. Twenty four hours later, this habit was reversed. (The amount of training in the second session was

designed in a previous control study to produce a slight preponderance of the more recent habit in the third session). Half of the schizophrenics were given a metrazol shock one hour after the second habit was established. Testing both groups two and one half hours after the second habit was established produced the following results:

	Less than 50% reversals to Habit 1	Greater than 50% reversals to Habit 1
Control	17	4
Metrazol	7	14

$\chi^2 = 7.88, P < 0.01$ (with Yate's correction for continuity)

The above indicates that a single metrazol shock tends to favour the older of two mutually conflicting habits in post shock performance. This supports the work of Mayer Gros.

In a study reported in both Stainbrook, (28), and Worchel and Narciso, (37), Flescher, (1), taught eighteen schizophrenics some form of material before shock. Following shock he tested for the material over a period of time ranging from three minutes to seven hours after shock. Flescher concludes that material not appearing spontaneously, by association or by recognition at the end of this time is permanently lost.

Another type of investigation is to test before, during, and after treatment with a single type test. Under suitable conditions any changes found in the test performance might be attributed to the treatment. Sherman, Mevgener, and Livitin, (26), used this technique giving tests involving designs, directions, and a reading paragraph. They found a slight improvement in their

test scores after treatment was concluded. Wittman and Russel (36) used standard tests of intelligence. They found improvement of the test scores up until the ninth metrazol shock. Part of the improvement is attributed to a change of the attitude on the part of the subjects to the test. Luborsky, (16), gave twenty two tests to twelve patients before, during, and after electroshock. He concluded that schizophrenics showed a decrease in test scores on the "before-during" contrast, and an even larger on the "before-after" contrast. Depressives on the other hand showed large score increases on the "before-during" contrast, and maintained this trend on the "before-after" contrast.

Stone, (30), used Wechsler's memory scale with the addition of an alternate form of his own construction. One group of fifteen patients took scale I one day before the first shock, and scale II one day after the last shock, and showed a significant loss. Using the same scales, fourteen other patients were given scale I one day after the last shock and two weeks later were tested with scale II. This second group showed a significant gain. Neither of these differences could be attributed to the differences in the two tests. Memory scores were found to be highly related to the Army Alpha Tests given at the same time.

In a symposium Zubin, (39), reported upon some further work using word associations. Here there were straight forward associations and complex or emotional associations. The latter seemed to suffer more in terms of recognition and feeling of familiarity than the former. Zubin concludes that the effect of ECT on memory might be regarded as a rise in the threshold of familiarity.

In a w

In a symposium Janis, (8), reported on some of the work carried out on emotion and memory with ECT, but since he reported more fully in a later series of three papers, (9), (10), (11), only these will be reported here. In (9), nineteen patients and eleven controls were interviewed before treatment about events in their personal history. Rather full notes were taken of these interviews. After treatment three more interviews were carried out at varying times up to three months. Definite and circumscribed amnesias were found after ECT, but not in the controls after an equivalent period of time. Some of the amnesias persisted for the period investigated (two to three months). Some of the amnesias did clear up and Janis feels that with motivation all could be cleared up. He suggests that situations involving guilt, lowered self esteem, or other painful affective reactions may be recalled less easily than other situations.

In the second paper, Janis, (10), gave seventeen patients and seventeen controls a word association test which used standard and emotionally toned words. No significant differences in reaction time were found. Three types of deviant associations gave a significant increase for the experimental group; these were: (1) remote or idiosyncratic, (2) stimulus repetitions, and (3) multi-word responses. The ECT groups also exhibited a statistically reliable increase in defective reproductions of the word association response. Janis concludes that these results are due to an inability to maintain a "task-set" which is necessary for the production of the usual associations in the prescribed manner. This suggestion is in contrast to Zubin's suggestion, (22), of a changed "threshold of familiarity".

Four interview type scales, devised by Janis, (11), were

given to patients and controls to find changes in affective disturbances with ECT. The four scales are named: (1) feelings of anxiety, (2) disturbing memories, (3) feelings of personal inadequacy, and (4) current psychologic symptoms related to emotional disorders. When the patients and controls were re-examined four weeks after ECT or eleven weeks later the ECT group showed a reliable decline in affective disturbances as here measured, especially symptoms of the "depression" syndrome. This still was the case when clinical improvement was held constant. Janis suggests that post ECT amnesias are linked with the reduction of affective disorders but are not the cause. It might be that ECT aids repression or that it blots out the disturbing material long enough to allow the patient to readjust.

Another method of studying the effect of ECT is to survey extensively the abilities of individuals having many convulsions. Perlson, (20), reports on an individual who had two hundred and forty eight electric shocks. This individual was given the following tests: Otis Employment Test I, the American Council on Education, Psychological Examination, 1940 College Edition, the Ohio State University Psychological Examination Form 21, the Bennett Test of Mechanical Comprehension Form AA, the Likert and Quasha Revised Minnesota Paper Form Board Test, Series AA, and the Kuder Preference Record, Test Form BB. He showed up well on all the tests; no sign of mental or emotional deterioration was seen.

Rabin, (23), studied six chronic schizophrenics who had received between one hundred and ten to two hundred and thirty four separate convulsions. Apparently there were some other patients but their cooperation could not be secured. Their Rorschach records portrayed them as individuals who are,

". . .mentally impoverished, and emotionally dilapidated,. . . dull, vacuous, and repetitive in their productions, with little or no regard for reality, and by and large, non conformists out of harmony with their environment". Since all patients were schizophrenic, their records were examined for signs of organic damage. Three showed a definite organic trend, two were doubtful, and one showed no organic trend at all. Rabin concludes that the number of treatments by itself does not produce organic damage, and that the reaction to it depends on the individual.

Projective tests also have been used to study changes in function with shock. Stainbrook, (27), using a modification of the Rorschach technique, presented three cards to the patient every five minutes for a period of about an hour immediately after convulsion. By maintaining this for three days, Stainbrook was able to assemble a composite protocol for each five minutes after shock. He found a progressive increase in accuracy of form conceptualization and productivity, and a progressive decrease in perseveration, and colour naming responses. There was a change from mainly form-colour (FC) responses to mainly colour-form (CF) responses. Movement (M) responses were always the last to appear.

Piotrowski, (21), was able to find signs diagnostic of patients likely to benefit upon receiving ECT. The prediction based on these signs was eighty seven per cent efficient. The findings in this study indicate that ECT has its curative effect on the "secondary or compensatory personality changes, but not upon the primary regression of the schizophrenic process".

Stainbrook and Lowenbach, (29), used the Bender Gestalt Test. They obtained repeated drawings of the various figures

at different intervals after shock. They noted at least five tendencies: (1) perseveration, (2) substitution of circles and loops for points, (3) substitution of curves for angles, (4) substitution of uninterupted lines for dotted lines , (5) rotation of figure parts, and (6) separation of gestalt units. They further noted that the patients reacted to the whole figure, loops being used to represent various parts of the figure. Only after several hours did connected figures appear.

The same authors studied handwriting responses after convulsion. Despite tremors there was a direct relation in handwriting style pre and post shock; however perseveration appeared and a signature was usually the only phrase the patient would actually finish right after shock. Names associated with childhood and adolescence appeared, married women frequently wrote their maiden names, and sometimes printed letters and capitals appeared.

There have been many animal experiments on ECT, probably more than human experiments, but they will not be reviewed in this study. A good review of most of the material presented here is found in Stainbrook (28).

(A) From the array of experimental material reported here, only a few conclusions can actually be drawn. Those conclusions directly relevant to this experiment are discussed below.

(1) There is some disagreement on whether or not convulsions produce a memory loss. Hemphill, (5), and Mayer Gros,(18), showed losses, but without controls; Zubin and Barrera,(40),

claimed a significant loss. Opposed to this Purcell,(22), and Worchel and Narciso,(37), found no evidence of loss. Worchel and Narciso did find a loss of the ability to learn with increasing number of convulsions, but they report on only two cases, and Purcell's work is not available for criticism. It will be concluded, therefore, that patients receiving ECT will probably suffer some memory loss for a period up to six hours after, of material experienced one to two hours before a convulsion. Clinical opinion supports this conclusion.

(2) The cumulative effect of convulsions is studied by Worchel and Narciso,(37); Perlson,(20), and Rabin,(23), who studied it only indirectly. Worchel and Narciso conclude that there is a cumulative effect of closely spaced convulsions upon performance. The work of Perlson and Rabin on individuals having many convulsions seems to imply that the total effect depends upon the particular individual. (They do not report upon the spacing of the convulsions; and Rabin's work suggests that many convulsions have a tendency to produce organic damage). Thus the existence of any cumulative effect lacks sufficient evidence to support it.

(3) There are varying suggestions and evidence as to how a convulsion produces the effect seen on the patient. There is the theory that the convulsion destroys the trace or engram. This seems to be the theory with which Hemphill,(5), disagreed. The results of Hemphill, Mayer Gros,(18), Zubin and Barrera,(40), Janis,(9), and Zubin,(38),(39), all show that previously learned material still shows an effect on post-convulsion experience. . . though in a less efficient form than usual. The suggestion of

Mayer Gros that the action is similar to retroactive inhibition, and the suggestions of Zubin, (a) that the traces are disorganized, (b) that there is an "interference", and (c) that there is a rise in the "threshold of familiarity", can all be interpreted as being much the same in essence. If one assumes a theory of brain operation like Hebb's,(4), thetabove four suggestions can be viewed as different aspects of the same mechanism. This is one of the assumptions used in designing the work to be reported here.

(B) Other reliable conclusions are: (1) following the period of dissolution after shock, there is a gradual reintegration of the individual, (2) the effects of ECT in terms of confusion and memory loss, do not appear to be permanent. (3) ECT seems to produce a retrogressive effect on the memory for events just previous to the convulsion, (4) finally there is a great deal of evidence that ECT improves patients' well being, especially those suffering from "depression".

* * * *

In the above review of the experimental work on ECT, many different techniques have been described. The present study uses material first described by Street,(31). This material consists of sillouettes of objects in black or white on a white or black ground. (Some examples of these pictures are given in Appendix B). With this material Street constructed a test which he expected would measure what he called "completion"- an aspect of intelligence. He first standardized a test on school children, then gave this test along with the Kuhlman

Anderson Intelligence Test, a sentence completion test, the Healy Picture Completion Test, a dissected words test and a dissected sentences test to some other school children. The highest correlation was 0.280 with the Healy picture completion. Street concludes that the material measures a specific capacity involving the visual process. He notes parenthetically that whatever it measures, it seems singularly lacking in patients of mental clinics.

Leeper,(14), next used this material in a study designed to elucidate the effect of learning on sensory organization. He reported that the figures required some effort to organize, but once organized were very stable. He also found that a very general identification of the object markedly increased the probability of its being organized quickly and correctly.

In a series of experiments designed in the main to test Thouless's suggestion of a "constancy trait", Sheehan,(25), used Street's test. She found a slight positive correlation with a size weight illusion and suggests that they have in common individuals whose primary sensory experience is less completely transformed to resemble the object. Thus those individuals showing the least amount of constancy in shape, size, and whiteness perception, show up best on Street's test.

Moore,(19), used Street's Gestalt Completion Test in a comparison of a patient's performance in a mild hypoglycemic state, and pre-treatment performance. He found less interpretations of the Gestalt figures during treatment, and the appearance of

descriptive answers, such as, "black and white spots". He concludes as a result of this and other tests that analytic and synthetic thinking was impaired with greater dependence placed upon sensory impressions. This conclusion is consistent with the conclusion reached by Sheehan,(25).

Thurstone,(32), in a broad study of perception by factorial analysis technique, found Street's test to have a principal common factor variance in two factors. Factor A, he suggests, is concerned with the ability of an individual to maintain in his mind a given configuration over a period of time. Street's test had a higher loading on factor F, which Thurstone interpreted as the speed of perception; this he denies is reaction time, and implies that it involves some aspect of meaning. Street's test was scored in this study by counting the number of correct responses taking three seconds or more, plus the number of incorrect replies.

Verville and Cameron,(34), showed ten new Street figures to four groups - old and young men and women. They found: (1) quicker reaction time with youth, (2) older men were faster than older women, and (3) various differences in individual pictures for both age and sex. They suggest that other factors in correctly perceiving the figures are (a) ability to eliminate the set of the previous picture and (b) the emotional effects, such as previous successes and failures, and apprehension as to the purpose of the test. In a further study, Verville,(33), attempted to assess the effect of emotion. The presentation of the nine incomplete figures followed various tasks designed to promote the

following emotional attitudes: (1) Control (no tasks), (2) Tension, (3) Complete failure, (4) Failure by norms, (5) Success by norms, and (6) Threat of a personality test. Verville hoped to find differences in reaction times as a result of these tasks. She found two groups, (1) quickly reacting (control, success, failure by norms), and (2) slow reacting (failure, and personality). Tension was midway between the two groups. She further found the mere mention of a personality test, sufficient to slow up reactions. She found no reversals of the different incomplete pictures in terms of difficulty with different attitudes. Verville concludes that the effect of emotion on recognition time is dependent upon the meaning of the emotion.

From the above material the following conclusions can be make about the meaning of results of Street's Gestalt completion test: (1) It has no obvious correlation with intelligence as measured by the Kulman Anderson Intelligence Test, certain tests of completion, Street,(31), and Thurstone's,(32), primary mental abilities test, (with the exception of the space test.) (2) Scores on this test are probably influenced by emotion; Street's mention of the failing of mental patients and Verville's study,(33). (3) High scores on this test indicate a fluid relationship between the object and the percept, according to Sheehan,(25), and Verville and Cameron,(34). Thurstone's two factors, especially factor F, are sympathetic with this interpretation. (4) Leeper,(14), notes that some effort is required to organize the figures, but once organized the figures are

very stable.

PROCEDURE.

The purpose of this experiment is, 1) to find changes in performance on the test to be described here attributable to the effects of ECT, and given this, 2) to identify variables associated with this change. Of the two methods previously mentioned of working on this problem, this experiment will use the method of testing afterwards for material learned just before convulsion. Two methods of comparison will be used to evaluate change; 1) On the assumption of the comparability of the performance of the experimental and of the control populations on the test, differences can be evaluated upon retest, and 2) On the assumption of the comparability of two tests, performance on the second can be compared to performance on the first.

Scheduling of Tests.

A test schedule was designed to take advantage of the two types of comparison mentioned above. Employing three forms, A,B, and C, of a test to be described later, the test schedule was drawn up as follows:

1) Before any treatment, both an experimental population and a control population are given test A. 2) During treatment, the experimental group is given test B and retested for test A; the controls receive the same tests after an equivalent lapse of time. 3) After treatment, the experimental group receives test C, and is retested on tests A and B. The control group is tested in the same way, after the same period of time. The two assumptions can be checked in the following manner:

(1) the similarity of the control and experimental performance may be found by testing the significance of the difference of the scores of the two groups on test A. (Even if the controls have a significantly greater score, the similarity of their reactions can be determined by correlating the difficulty of each item of the test for the two groups). (2) The similarity of the two tests can be assured by a systematic variation of the test material, and by examining the continuity of the performance of the controls.

Use of Incomplete Pictures.

The incomplete pictures were chosen for test material on the basis that they involved both learning and meaning to a greater extent than previously used material. It was also hoped that the ability to identify these figures correctly over a period of time required the integrity of large and numerous units of the central nervous system - along the line of Hebb's,(4), theorizing in general. (Not his theorizing about ECT itself.) On the assumption that ECT would render the normal functioning of these units less probable if sensory support was at a mimimum, a tachistoscopic method of presentation was used.

The material has other advantages: 1) large numbers of items can be easily made, 2) they are quite amendable to statistical treatment, and 3) the procedure of learning is simple, short, and apparently pleasing to most individuals.

In order to conform to the problem-answer form of test, and to make sure the subject knew what the incomplete pictures were intended to portray, pairs of complete and incomplete pictures were made up from illustrations in various magazines. From about eighty of these pairs, fifty six were chosen on the

basis that two thirds of a group of the staff in the Institution recognized them easily and unambiguously. These fifty six pairs were then divided in five different ways into three tests A, B, and C, containing eighteen pairs each. The five different methods of presenting the pairs of pictures were devised to determine the effects of practice, anticipation of order, and similarity of the material. Complete details on this technique are in Appendix C.

Design of Individual Tests.

The learning of the material consisted in showing the subject an incomplete picture for as long as thirty seconds. If the subject did not guess what the picture was in this time, he was shown the complete picture which is identical in terms of size and position. (A thirty second period was used since it had been previously established that over ninety five per cent of the pictures were identified in the first twenty seconds.) If the subject identifies the incomplete picture within thirty seconds, the time is noted and he is shown the complete picture; this was done in order to put both those who identified the picture, and those who didn't on the same footing for later tests. This procedure is repeated until all eighteen slides are shown. The test involved showing the same pictures tachistoscopically ei eighteen to twenty four hours later, and recording the number of correct replies. Speed of presentation is 1/100 of a second.

In order to assess what happens during the learning session, the slides are first presented tachistoscopically, and a record made of the number correctly recognized - these are obviously not learned. Then in order to see how many have been learned

and thus to assess a drop in performance later on, the same slides are shown tachistoscopically immediately after the learning session, the number correctly identified again being recorded. Thus there are four parts to each test, with repetitions of the last part at the time of other tests.

Nomenclature of Sub Tests.

The various tests have been named in the following way: 1) sub test one, the subject is shown the material for the first time by means of a tachistoscope; 2) sub test two, the same material is shown for as long as thirty seconds, and then the "answer" to the problem is shown; 3) sub test three, again the same slides are shown tachistoscopically, this score is assumed to be maximum achievement; 4) sub test four, shown tachistoscopically eighteen to thirty hours later, is the test of the amount retained; 5) sub test five, is a retest of sub test four shown at the time of the next test; and 6) sub test six is a retest shown at the time of the test following after that. The following table should make the relationships clear.

SCHEDULE OF TESTS

TIME	BEFORE		DURING		AFTER	
SESSION	I	II	III	IV	V	VI
Sub Tests of Test A.	1,2,3	4		5		6
Sub Tests of Test B.			1,2,3	4		5
Sub Tests of Test C.					1,2,3	4

T

The instructions are given in Appendix A, the contents of the slides is given in Appendix B, and the various orders in which the slides were presented is given in Appendix C.

Variables Influencing Timing of Test Schedule.

In order to find out 1) if there was any cumulative effect of ECT, and 2) if a convulsion occurring before learning had a greater effect on the test performance than a convulsion following learning but before the test, test B was given at a definite time in the sequence of treatment. Five subjects were taught the material of test B before their first convulsion, and tested the day after, and five others were taught the material of test B after their first convulsion and tested before their second convulsion. (This procedure was possible because convulsions were given every second day). Two further groups of five patients were tested in the same way with respect to the sixth convulsion, and two more groups with respect to the third convulsion. This adds up to a total of thirty patients, and with five patients not receiving ECT and five normal individuals acting as controls, this brings the total number of subjects desired up to forty.

Since every five similar subjects would receive a different method of slide presentation, no single individual would be tested in exactly the same way. However, it was expected that the various methods of slide presentation would make little or no difference. Given the requisite number of people the experiment was designed to take full advantage of the efficiencies of the analysis of variance technique.

RESULTS.

The raw scores obtained from the tests are given in Table I and the mean scores are given in Table II. It will be seen that there are ten experimental subjects, six controls, and five normal subjects, and that eight of this number did not receive the full schedule of tests. (Both of these numbers are due to the great difficulty of obtaining patients who fit the criteria.) Nonetheless, even with these few subjects, reliable conclusions may be made. Since so few subjects have received test C, no test of significance has been attempted which involves this test.

The assumption of the similarity of the control groups is not born out in Table III. In Graphs I, II, and III, this difference also appears quite clearly. The two control groups, both separately and together, are always distinguishable from the experimental group. However the curves joining the scores on sub tests 1, 2, 3, and 4, for all tests and groups are of the same form, indicating that the controls can be expected to point out the general trend that might be expected with no treatment. Further, in Table VII, Part B, correlations for the difficulties of all the slides for the various groups are high enough to show that the slides are handled in essential y the same manner by all three groups. It will therefore be concluded that the control group are comparable in terms of the trend of scores, despite the fact that they have consistently higher scores.

Since both forms of controls show an upward trend with the three tests, it will be assumed that except for a slight practice effect, the various tests are equivalent. This is

further supported by the data in Table VIII, where equivalent difficulty scores are found for all forms of the test. (There is a slight tendency for test B to be a little more difficult - in four out of five methods of presentation.

In Tables I, II, and III, and on Graphs I, II, and III, Part I there can be seen a marked dip involving sub tests 4, 5, and 6 of Test A of the experimental group. There is only a minor counterpart of this tendency in the patient controls, and none in the normal controls. This dip is therefore taken to be the results of treatment, and in Table IV this drop in performance on sub test 4, and retest 5 has been tested. It will be noted that the probability of this drop occurring by chance is less than 0.01 for the experimental group, but only 0.20 for the control group.

Similarly, in Tables I, II, and III, and on Graphs I, II, and III, Part II, the performance of the experimental group on test B is poorer than the performance on test A, and this is not the case with either set of controls. In Table IV this difference is tested for both groups on sub tests three and four. The probability that there is a real drop is only significant for sub test four, though there is a similar tendency for sub test three. The controls, on the other hand, show a trend of increase as evidenced by the mean difference, and by the number of actual score increases. This effect is also assumed to be due to treatment.

These differences are indicative of both the extent of the effect of a convulsion, and the sensitivity of the test employed here. A longer time interval was used in this study, (eighteen to thirty hours), due to the hospital situation, than

TABLE I

NO. OF CORRECT RESPONSES BY SUBJECTS AND BY SUB TESTS.

Experimental Group.

	TEST A						TEST B					TEST C			
	1	2	3	4	5	6	1	2	3	4	5	1	2	3	4
I 1	4	7	13	9	10	-	1	11	12	9	-	3	10	12	-
I 2	0	3	8	8	1	6	0	3	5	5	4	1	7	12	2
I 3	1	4	3	8	3	-	2	1	5	1	-	-	-	-	-
I 7	5	14	15	17	12	14	5	13	14	10	10	7	12	15	14
I 8	2	3	8	8	3	-	1	4	3	5	-	-	-	-	-
I 11	2	7	11	12	8	6	1	6	10	9	5	2	6	7	11
I 12	3	10	11	8	9	8	3	7	9	8	5	2	8	12	10
I 13	6	13	16	17	14	11	2	10	10	8	8	5	8	13	12
I 14	3	10	12	13	10	12	1	7	15	12	9	2	9	12	12
I 17	1	4	3	5	2		1	0	4	3					
Patient Control															
I 5	1	9	7	7	5	-	4	5	7	7	-	-	-	-	-
I 6	1	12	14	14	13	12	6	9	17	16	12	7	15	14	13
I 9	3	11	10	12	10	-	4	11	14	13	-	-	-	-	-
I 10	2	10	14	10	8	-	3	11	12	14	0	-	-	-	-
I 16	2	11	13	13	13	12	6	13	14	14	8	7	14	17	12
I 18	3	11	17	14	16	15	7	6	15	17	16	3	16	16	17
Normal Control															
C 1	3	9	18	18	17	14	1	10	15	15	11	3	14	17	16
C 2	8	14	18	18	18	-	7	17	18	17	-	6	18	17	-
C 3	5	18	16	16	16	16	10	16	17	15	16	7	17	18	18
C 4	3	13	15	16	15	15	4	17	17	18	14	6	15	17	17
C 5	5	9	14	15	15	13	3	8	12	15	13	2	10	13	14

TABLE II

		A		B		C	
Sub	Statistic	First testing		Second testing		Third testing	
Test		Exp.	Control	Exp.	Control	Exp.	Control
1	N	10	11	10	11	7	8
	M	2.70	3.18	1.7	5.00	3.14	4.88
	SD	1.79	1.96	1.35	2.37	1.53	1.96
2	N	10	11	10	11	7	8
	M	7.5	11.54	6.20	11.18	8.57	14.88
	SD	3.88	2.57	4.07	3.99	1.41	2.26
3	N	10	11	10	11	7	8
	M	10.00	14.18	8.70	14.36	11.85	16.12
	SD	4.27	3.18	4.05	3.02	2.26	1.61
4	N	10	11	10	11	6	7
	M	10.50	13.91	7.00	14.64	10.16	15.29
	SD	3.88	3.18	3.22	2.80	3.85	2.12
5	N	10	11	6	7		
	M	7.20	13.27	6.83	12.85		
	SD	4.35	3.86	2.27	2.64		
6	N	6	7				
	M	9.50	13.85				
	SD	3.08	1.43				

TABLE III

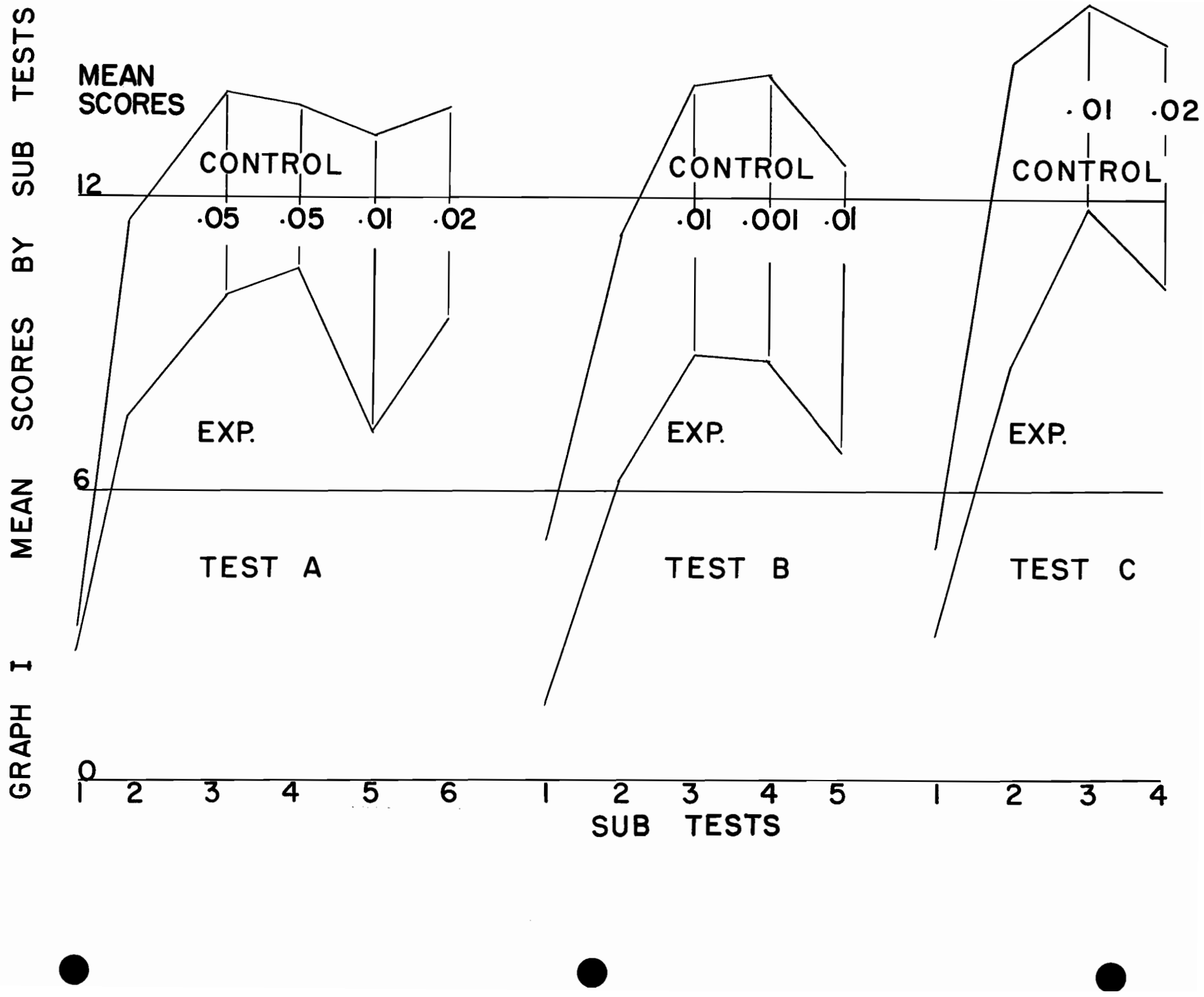
SIGNIGICANCE OF THE DIFFERENCE BETWEEN CONTROL AND EXPERIMENTAL GROUPS

Test	Mean Diff.	S	T	df.	P
A 1	0.5	0.89	0.56	19	.4-.3
2	4.0	1.50	2.67	19	.02-.01
3	4.2	1.72	2.44	19	.05-.02
4	3.4	1.62	2.10	19	.05-.02
5	6.1	1.89	3.23	19	.01-.001
6	4.35	1.41	3.05	11	.02-.01
B 1	3.3	0.90	3.78	19	.01-.001
2	5.0	1.85	2.70	19	.02-.01
3	5.7	1.63	3.50	19	.01-.001
4	7.6	1.38	5.51	19	.001-
5	6.0	1.50	4.00	11	.01-.001
C 1	1.8	1.09	1.83	13	.1-.05
2	4.3	1.15	5.48	13	.001-
3	4.2	1.07	3.92	13	.01-.001
4	5.1	1.84	2.77	11	.02-.01

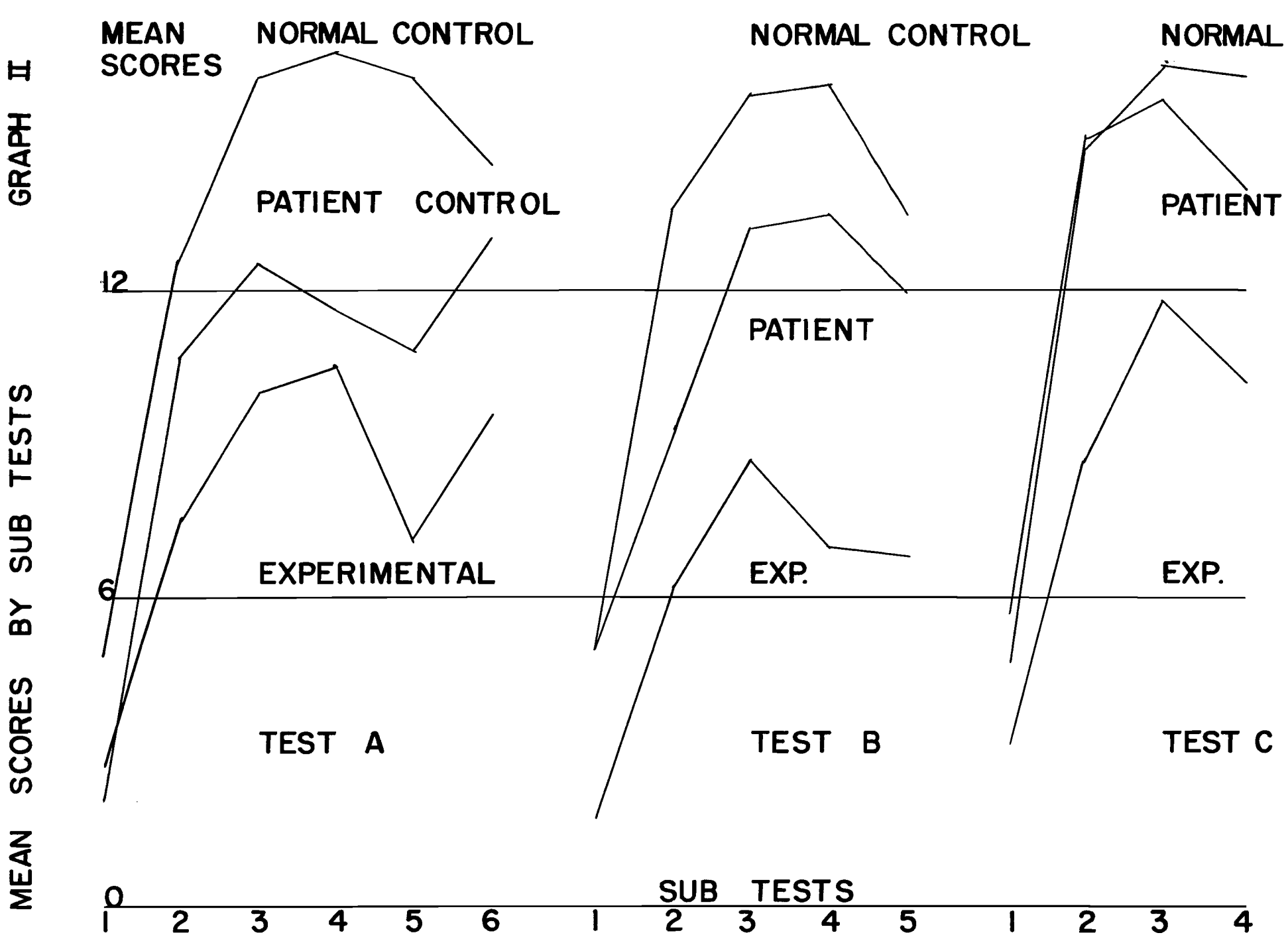
TABLE IV

DIFFERENCES IN PERFORMANCE BEFORE AND DURING ECT. (CONTROLS FOR COMPARISON).

Difference Between	Mean Diff.	S	T	Df	P	No. of increases
Ex perimental						
Test A,B. sub test 3	1.30	0.91	1.43	9	.2-.1	3
Test A,B. sub test 4	3.50	0.99	3.53	9	.01-.001	0
Test A. sub test 4,5.	3.30	0.82	4.04	9	.01-.001	2
Control						
Test A,B. sub test three	-0.18	0.68	0.27	10	.8-.7	5
Test A,B. sub test 4	-0.73	0.60	1.20	10	.3-.2	6
Test A. sub test 4,5.	0.64	0.36	1.76	10	.2-.1	1


GRAPH I MEAN SCORES BY SUB TESTS
MEAN SCORES
12
6
0
CONTROL
·05 ·05 ·01 ·02
EXP.
TEST A
CONTROL
·01 ·001 ·01
EXP.
TEST B
·01 ·02
CONTROL
EXP.
TEST C
1 2 3 4 5 6 1 2 3 4 5 1 2 3 4
SUB TESTS

GRAPH II

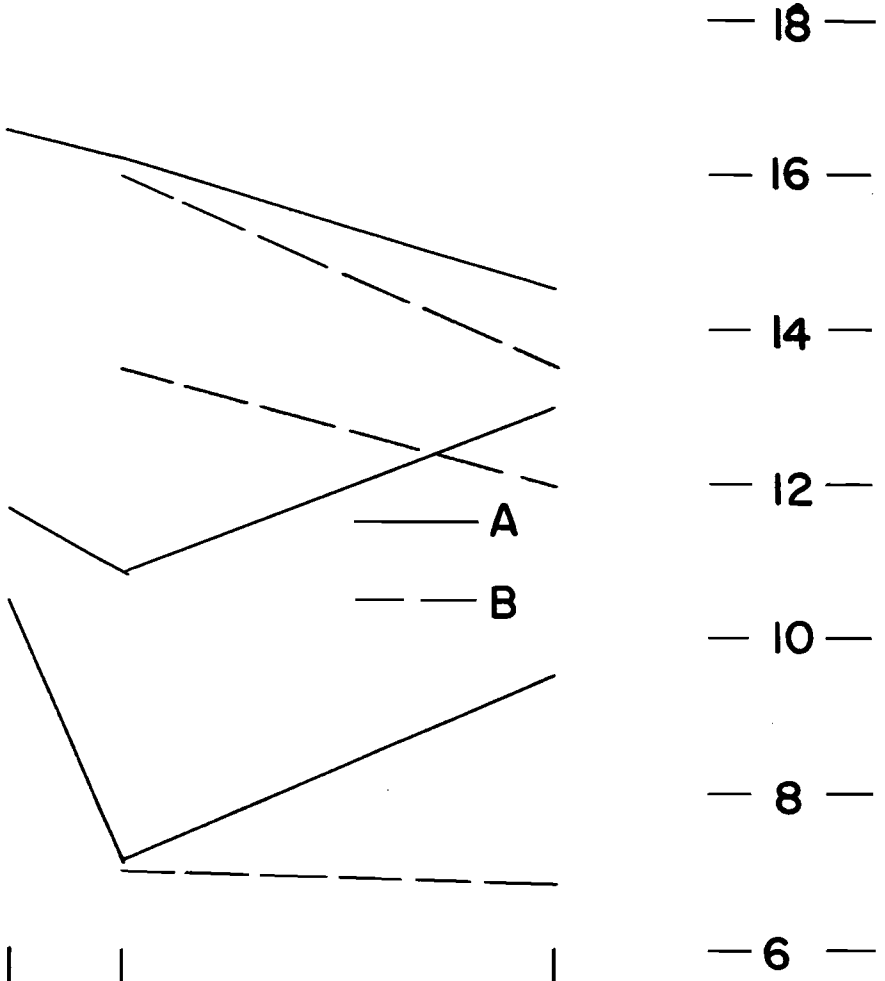

MEAN SCORES
NORMAL CONTROL
NORMAL CONTROL
NORMAL
PATIENT CONTROL
PATIENT
12
PATIENT
EXPERIMENTAL
EXP.
EXP.
6
TEST A
TEST B
TEST C
MEAN SCORES BY SUB TESTS
0
SUB TESTS
1 2 3 4 5 6
1 2 3 4 5
1 2 3 4

(22)

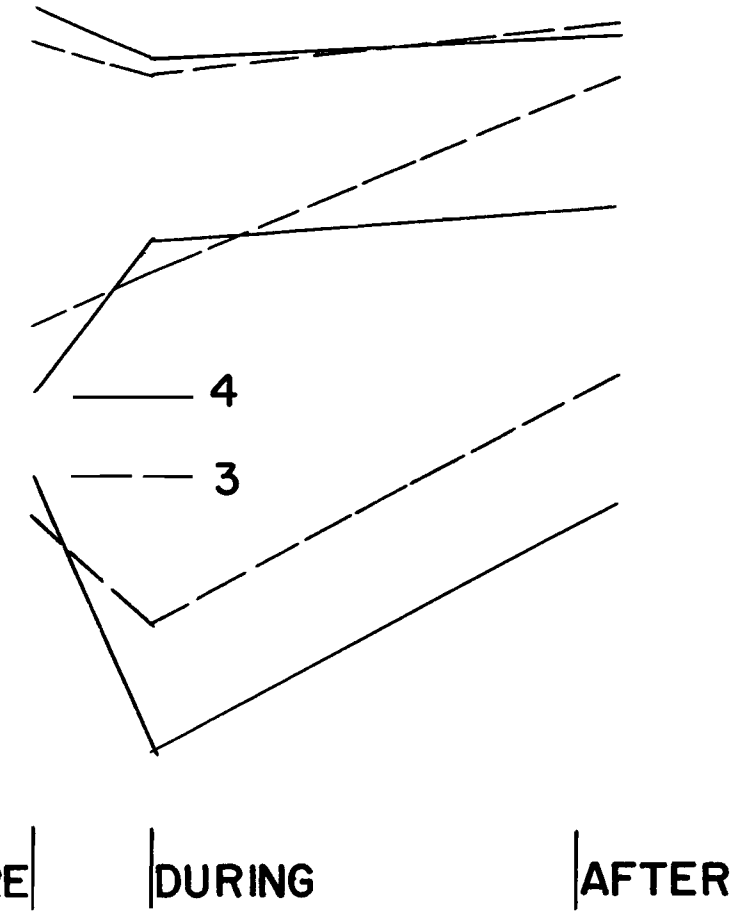
GRAPH III

PART I
RETESTS OF TESTS A & B

MEAN SCORES



PART II
SUB TESTS 3 & 4 OF ALL TESTS



was used in any previously reported study. That these differences appear so clearly with so few subjects, is a strong argument that such effects do persist over such a period.

Two more trends may be noted in Graph III. In Part I the normal group show a fairly constant drop in score with elapsed time as evidenced by the straight line for test A and the equivalent slope for test B. The experimental group, on the other hand, show first, a sharp drop on test A, (the result of treatment), and then a rise which brings the "After" score close to the "Before" score. This final rise is partly due to the fact that more low scorers did not take test C than high scorers. Using only individuals who completed the full test battery, the curve for both groups is still much the same, except that the difference between "Before" and "After" is equivalent for both experimental and normal control groups. In other words, despite the high initial loss produced by treatment, the final score on the experimental group is approximately the value that would be expected if they followed the same trend as the normal group. Certainly this favours the "disorganization" theory employed here, rather than the idea of destroyed engrams. The patient controls show somewhat the same effect as the experimental patients. While this is also influenced by the dropping out of low scorers on test C; the mild dip remaining is easily explained by the action of various forms of insulin treatment.

A second tendency to be noticed, is what might be called the predictability of the normal controls. In Part I of Graph III they start at about the same level for test A and B, and then they forget at about the same rate. In Part II of Graph III, their performance on all three tests remains at about the same level,

and there are no large differences between sub tests three and four. This is in marked contrast to the behaviour of both types of patients.

In Table VI are the variables that might possibly account for, or be associated with the drop in performance. The extent of drop is indicated by the difference between test A and B on sub test four, as there were no reversals, or increases. With so few subjects, the only tendency found was that convulsions occurring after learning cause a greater drop than convulsions occurring before learning.

Convulsion Occurring	Drop less than 3	Drop of 3 or more
Before learning	3	1
After learning	1	5

There is no other tendency with these figures, neither a cumulative tendency with the number of convulsions, nor a tendency to recover with time after the shock.

In an attempt to determine just what aspect of the individuals' performance was being tapped by this form of test, a list of the possibly relevant variables is recorded in Table V. In part B of Table V is recorded the correlations between the mean correct responses on all the sub tests, and the variables presented in Part A. Age is reliably correlated with the total mean score, but this coefficient is probably influenced by the youthfulness of the normal controls. The reliability of the correlation with the total number of responses on the Rorschach test is probably more reliable than the probability figure indicates, as it is based on the smallest number of pairs.

TABLE V VARIABLES POSSIBLY RELATED TO TEST SCORES.

PART A

M - mean of correct scores on all sub tests.

WB - score on abbreviated Wechsler Bellevue Intelligence test

R - total number of responses given on Rorschach Test.

O - order of presenting slides.

Subject	M	WB	R	Age	O	Sex
Experimental.						
I 1	8.4	-	-	28	4	F
I 2	4.3	93	9	48	2	M
I 3	3.1	(110)	-	66	2	M
I 7	11.8	128	32	44	1	F
I 8	4.1	97	-	61	5	F
I 11	6.9	(120)	-	42	4	F
I 12	7.5	(100)	-	59	3	F
I 13	10.2	(105)	-	51	3	F
I 14	4.3	83	10	26	3	F
I 17	2.6	104	3	61	5	F
Patient Control.						
I 5	5.8	113	12	71	5	F
I 6	11.7	119	-	45	1	F
I 9	9.8	126	35	40	3	F
I 10	9.3	94	25	35	4	M
I 16	11.3	93	10	43	1	M
I 18	12.6	117	26	35	2	F
Normal Control.						
C 1	12.1	(115)	-	(22)	3	F
C 2	14.7	(115)	-	(22)	2	F
C 3	14.7	(135)	-	23	1	F

TABLE V, PART A (cont.)

Subject	M	WB	R	Age	O	Sex
Normal Control.						
C 4	13.5	(135)	-	33	5	F
C 5	10.7	(135)	-	22	4	M

PART B.

CORRELATIONS BETWEEN VARIABLES AND TEST SCORES.

	WB		R		Age	
	r	p	r	p	r	p
M	0.56	0.1	0.75	0.02	-0.60	0.01

TABLE VI

VARIABLES POSSIBLY RELATED TO PERFORMANCE LOSSES.

L - difference between scores on test A and B, sub test 4.

N - number of convulsions received at the time of the test.

T - time elapsing between convulsion and test.

S - the sub test following the convulsion.

O - order of presenting slides.

Subject	L	N	T	S	O
I 1	0	3	6.00	III	4
I 2	3	6	3.00	III	2
I 3	7	6	2.00	IV	2
I 7	7	1	2.50	IV	1
I 8	3	3	6.75	IV	5
I 11	3	1	8.00	IV	4
I 12	0	6	5.50	III	3
I 13	9	1	10.50	IV	3
I 14	1	1	7.00	IV	3
I 17	2	6	7.00	III	5

TABLE VII

PART A

DIFFICULTY OF SLIDES. (Values given are mean time in seconds taken to identify the slide in sub test 2).

E - Patients Receiving ECT. NC - Normal, not Patients.

PC - Patients not Receiving ECT. T - Total.

slide	E	PC	NC	T	slide	E	PC	NC	T
1	16.7	14.3	16.6	15.3	29	28.8	25.4	20.4	25.7
2	27.1	19.8	19.4	23.3	30	25.2	23.5	9.2	20.0
3	26.6	24.5	25.8	25.9	31	17.0	-	30.0	20.7
4	9.8	3.0	8.4	7.2	32	24.2	14.0	15.0	19.4
5	30.0	25.7	15.6	25.4	33	15.9	17.4	5.6	13.2
6	24.9	16.8	16.2	20.4	34	25.5	22.3	17.0	21.4
7	30.0	30.0	24.6	28.3	35	18.2	2.5	11.6	12.6
8	16.6	14.2	6.2	13.2	36	20.6	16.2	17.6	19.4
9	18.6	9.0	8.4	13.2	37	26.4	24.1	14.0	22.4
10	27.3	21.2	11.4	20.9	38	24.4	11.5	3.3	14.8
11	22.2	18.2	10.4	18.8	39	11.2	3.2	6.6	7.8
12	21.1	18.2	19.4	20.0	40	14.5	4.0	6.0	9.2
13	22.6	13.8	14.8	18.2	41	22.1	20.5	9.8	19.2
14	30.0	30.0	21.2	27.9	42	9.0	2.6	3.0	5.8
15	7.0	2.2	3.4	4.6	43	30.0	30.0	24.6	27.4
16	11.7	2.0	2.3	5.3	44	21.4	19.0	18.8	21.6
17	30.0	25.5	19.4	25.8	45	23.0	21.0	11.0	16.6
18	30.0	30.0	30.0	30.0	46	27.2	25.5	5.4	21.9
19	30.0	16.8	21.8	24.6	47	10.5	3.6	7.0	8.8
20	28.2	16.2	16.2	20.3	48	20.5	3.8	2.4	11.2
21	18.0	5.8	9.6	12.6	49	29.3	18.6	10.2	21.6

TABLE VII, PART A (cont.)

slide	E	PC	NC	T	slide	E	PC	NC	T
22	12.1	14.8	5.0	11.0	50	30.00	30.0	7.6	24.4
23	20.3	19.0	10.2	17.8	51	4.2	1.7	2.4	3.2
24	27.7	25.0	20.6	25.2	52	20.4	14.8	10.4	16.6
25	20.0	2.8	5.8	11.7	53	23.8	9.8	13.4	16.4
26	17.4	8.2	8.6	14.4	54	4.4	3.3	8.6	5.5
27	23.8	25.0	17.4	22.0	55	18.3	11.6	11.2	15.4
28	27.5	22.3	18.4	23.0	56	18.2	11.7	5.4	12.8

PART B.

DIFFICULTY OF ALL SLIDES.

	E	PC	NC
Number of Slides	56	55	56
Mean Difficulty	21.2	15.8	12.7
S.D.	7.0	8.8	7.2

Correlation between Groups.

	PC		NC	
	r	p	r	p
E	0.846	o.001	0.616	0.001
PC	-	-	0.686	0.001

TABLE VIII.

PART A

DIFFICULTY OF TESTS.

(Values given are the means of the difficulty of the slides making up the test. See Table VII.)

Slide order	Test	Exper. Group	Patient Controls	Normal Controls	Total
1,5,	A	20.8	16.5	11.8	17.2
and 2	B	22.0	15.1	11.5	17.5
reversed	C	20.8	16.6	13.1	16.9
3	A	20.5	14.5	11.9	16.5
	B	23.0	18.4	13.5	18.6
	C	20.6	17.4	14.3	18.3
4	A	21.9	17.4	12.6	18.12
	B	21.7	14.6	13.2	17.7
	C	20.6	17.3	13.6	17.5

PART B.

CORRELATIONS BETWEEN THE THREE GROUPS ON THE TESTS.

	Patient Controls		Normal Controls	
	r	p	r	p
Experimental Group	0.250	0.4	-0.034	0.9
Patient Controls	-	-	0.576	0.2

Unfortunately most of the Rorschach protocols were very meager, and so no further investigation was attempted. There is a tendency of intelligence, as measured here, to be positively related, but only further evidence could make any positive statements possible.

In Tables VII and VIII are given the difficulties of slides and the various tests. It is noticeable that the slides used here vary quite widely in difficulty for all three groups of subjects. The experimental group is clustered mainly around the upper end of the scale, the patient controls around the middle, and the normal controls around the lower end, (see Part B of Table VII).

The correlations given in Part B of Table VII show that all three groups had much the same reactions to the individual sl slides despite treatment and individual differences. This lends further support to the assumption that the control groups give a valid indication of the trend of performance.

The impression given in Table VIII is that all forms of slide presentation had about the same difficulty, and that the three different tests were all of the same order of difficulty. (Except as has been previously mentioned, test B has a slight tendency to be more difficult.) The correlations between the three groups, however, show that they were operating in different ways. It is assumed that this is also the effect of treatment, though this conclusion must be tempered by a regard for the low significance of the correlation coefficients.

The very reliable differences found between the control group and the experimental group, shown in Table III, are very puzzling. None of the data offers a foothold for an hypothesis.

A good guess as to the reason for these differences, is given by Moore,(19), and Goldstein,(2). The differences are probably explained by the two methods of function implied by the terms "concrete" and "abstract attitude". This guess depends upon evidence which has not yet been systematically tabulated. In the experimental patients, many symptoms were observed which have been reported in connection with aphasia and other types of brain damage. (See Goldstein,(2), Head,(3), and Weisenberg and McBride, (35).) This brings up the suggestion which has often been made, that ECT works in a similar way to the effect of prefrontal lobotomy, (see Hebb,(4), and others.). However, some real evidence is necessary for any definite statements.

SUMMARY AND CONCLUSIONS.

This experiment was designed to examine, (1) the effectiveness of a new technique in studying the effects of ECT, (2) to see if there was any cumulative effect of ECT as measured here, and (3) to determine which is most disrupted by ECT: learning or reproducing material. The technique used here is the tachistoscopic presentation of incomplete pictures at various times during the patient's stay in hospital. Scores on the test are taken to be indicative of the function of memory. Incomplete figures, first described by Street,(31), are silhouettes of objects, shown as black on white, with enough parts removed to render immediate recognition difficult.

Reliable results were found with ten subjects and eleven controls. These are: (1) the technique employed here is sensitive to differences as the result of a single convulsion over a longer period of time than is reported elsewhere, and (2) there are two

forms of drop, namely a reduced ability to recognize the test material, and a definite increase in the rate of less of material learned.

Several other tendencies have been noted. (1) A convulsion tends to produce the greatest drop in score when placed before reproducing the material rather than when placed before learning it. (2) No cumulative effect of ECT upon test performance was seen. (3) Evidence is given supporting the "disorganization" theory of the effect of ECT on "memory traces". (5) It is suggested that the large differences found between experimental and control groups are due to "concrete and abstract attitudes" of functioning.

The report is rounded out with an historical introduction.

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APPENDIX A.

INSTRUCTIONS GIVEN TO SUBJECTS.

The experimental work was carried out in a large room which was usually darkened after the patient came in. The patient sat in a large easy chair about six feet away from a screen two by three feet, and just above his midline of vision. The experimenter sat behind the patient and began the session by projecting and then reading the following instructions:

> This is a study to find out gow well you can see or identify pictures of objects under difficult conditions. This session is divided into three parts, and since each part depends on the others, you must pay close attention to the instructions in order to do well on the test. The instructions will be presented like this to make certain that you understand what you are to do. Although this session is being recorded, and I shall be taking notes, please pay no attention to either.

After the patient had comprehended this, the slide was changed to:

> You are going to see some pictures on the screen, just like these instructions. However, these pictures are only outlines, and they have many bits cut out of them. To show you what to expect, you will now see, first, a sample incomplete picture, and then, the original picture from which it was made.

When the patient was ready a sample incomplete picture was shown for about ten seconds, and named. The advertisement from which the incomplete figure had come was then shown for ten seconds and also identified. The incomplete and complete

APPENDIX A. (cont.)

pictures were again shown for comparison purposes, followed by more instructions.

> When you see these incomplete pictures they will appear for only 1/100 of a second. . just a flash. When I say "ready", you must pay close attention to the screen; the picture will appear just after I say, "now". Here is the sample incomplete picture you just saw, only this time at 1/100 of a second.

The screen was darkened, the precautionary words given, and the incomplete picture was flashed on the screen. The patient was always asked to describe what he saw. All the patients in this paper could describe accurately what they saw. Finally the patient was shown the last slide:

> You are now going to see eighteen incomplete pictures at 1/100 of a second each. You are to try to guess what each picture might be. Do not be afraid to guess, as it doesn't matter how many mistakes you make; only right answers count.
>
> Is there anything that you are not certain about, now, before we start?

After the patient had understood what was to happen, the eighteen incomplete figures were flashed on the screen, always leaving twenty to thirty seconds for the patient to respond, before showing the next slide.

The ninteenth slide to be shown was the instructions for sub test two.

APPENDIX A (cont.)

You will now see the same incomplete pictures for thirty seconds each. Again you are to guess at what they might be, and again wrong answers don't count, so please say anything you think it could possibly be.

If after thirty seconds you still have not guessed the right answer, I will show you the original picture, that is, the right answer. Even if you do guess the right answer, you will be shown the original picture.

Is there anything you are not certain about, now, before we start?

Immediately after, a slide of an incomplete picture was shown followed by a slide of the complete version of the same picture. This was done twice, and done at a pace which was thought to be in agreement with the patient's ability. When sub test two was completed the following instructions appeared:

In the last part of the study you will see the same eighteen incomplete pictures. This time you will see them for 1/100 of a second each. However, when I say, "ready", pay close attention to the screen, as the picture will come just after I say, "now". Tell me what you think each picture might be.

Is there anything you are not certain about, now, before we start?

Sub test three was identical in form to sub test one, except that the patient performed quite differently. When this sub test was finished the patient was dismissed but retested eighteen to thirty hours later, at which time the instructions were:

APPENDIX A (cont.)

This is a repetition of the third part of the original experiment. You will see, as before, eighteen incomplete pictures for 1/100 of a second each. Remember that you will do better if you guess at each one. I will again be taking a recording and notes of the session.

Is there anything you are not certain about, now, before we start?

Sub test four was essentially a repetition of sub test three, and is considered the main indicator of performance. Sub tests five and six are a repetition of sub test four, and as such used the same instructions. The experimentor further told the subject from which of the main tests, (A or B), the material came. These sub tests occurred after sub test of tests B and C.

APPENDIX B

CONTENT OF SLIDES

1) Baby in a bath.
2) Car battery.
3) Bear rampant.
4) Riderless bicycle.
5) Binoculars.
6) Man in telephone booth.
7) Camel.
8) Candle in fancy holder.
9) Cannon.
10) Car, (1950 Nash).
11) Cellist playing.
12) Modern design chair.
13) Chimp eating a leaf.
14) Package of cigarettes.
15) Coffeepot.
16) Crown.
17) Witch doctor.
18) Hound dog's head.
19) Decoy duck.
20) Freighter loading at dock.
21) Herald on horseback.
22) Horses rearing with rider.
23) Front of 3 story house.
24) Cigar store indian.
25) Modern electric iron.
26) Modern electric kettle.
27) King of spades card.
28) Camera.
29) Cigarette lighter, (Zippo).
30) Monk in a store.
31) Mountie on horseback.
32) Movie camera.
33) Five people talking.
34) Pianist playing grand piano.
35) Old fashioned house pump.
36) Rabbit sitting up.
37) Rack, (man hanging his hat on it).
38) Rose.
39) Sailboat in full sail.
40) Boy on a scooter.
41) Scottie dog on hind legs.
42) Running setter.
43) Golf shoe.
44) Snail.
45) Telephone table.
46) Table cigarette lighter.
47) Teapot.
48) Receiver being put on telephone.
49) Television set.
50) Modern diesel train.
51) Royal portable typewriter.
52) Usher, or ticket taker.
53) Electric washer.
54) Wineglass.
55) Woman with axe.
56) Wristwatch.

NUMBER 1

Incomplete

Complete

NUMBER 45

Incomplete

Complete

APPENDIX C

ORDER IN WHICH SLIDES WERE PRESENTED, (see procedure.)

Order Numbers 1 and 2 Reversed.

Order	Sub test 1			Sub test 3			Sub test 4			Sub test 5			Sub test 6		
Presented	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1	1	35	45	50	38	3	12	56	27	1	35	45	50	38	3
2	52	28	20	41	42	47	41	42	47	49	19	48	24	23	7
3	22	14	51	13	26	17	32	46	21	32	46	21	6	37	29
4	24	23	7	1	35	45	15	44	16	50	38	3	13	26	17
5	13	26	17	34	25	54	5	39	30	52	28	20	4	11	53
6	8	43	9	5	39	30	49	19	48	24	23	7	55	10	2
7	41	42	47	22	14	51	22	14	51	6	37	29	52	28	20
8	33	40	36	15	44	16	55	10	2	12	56	27	22	14	51
9	12	56	27	8	43	9	52	28	20	15	44	16	12	56	27
10	15	44	16	4	11	53	4	11	53	33	40	36	1	35	45
11	49	19	48	33	40	36	13	26	17	13	26	17	15	44	16
12	34	25	54	6	37	29	24	23	7	34	25	54	32	46	21
13	4	11	53	49	19	48	6	37	29	55	10	2	34	25	54
14	5	39	30	24	23	7	33	30	26	41	42	47	41	42	47
15	6	37	29	55	10	2	1	35	45	5	39	30	49	19	48
16	55	10	2	52	28	20	34	25	54	22	14	51	33	40	36
17	32	46	21	32	46	21	50	38	3	8	43	9	5	39	30
18	50	38	3	12	56	27	8	43	9	4	11	53	8	43	9

(For sub test 2 see order number 5).

Order Numbers 3,4 and 5.

Order	3			4			5		
Presented	A	B	C	A	B	C	A	B	C
1	29	46	14	37	29	21	6	37	29
2	41	18	42	32	39	30	32	46	21

APPENDIX C (cont.)

Order Numbers 3,4 and 5 cont.

Order	3			4			5		
Presented	A	B	C	A	B	C	A	B	C
3	15	47	26	1	19	49	15	44	16
4	37	52	6	52	46	22	41	42	47
5	32	28	5	28	20	17	50	38	3
6	3	13	7	40	44	48	13	26	17
7	56	2	43	6	14	31	52	28	20
8	39	20	23	5	23	24	5	39	30
9	9	8	27	33	36	51	24	23	7
10	30	17	24	41	15	3	4	11	53
11	44	19	36	11	25	45	34	25	45
12	11	34	55	10	56	9	8	43	9
13	45	12	54	18	47	13	1	35	45
14	25	53	35	34	53	12	33	40	36
15	1	40	33	4	2	8	49	19	48
16	49	48	51	42	26	7	22	14	51
17	4	10	50	55	35	54	55	10	2
18	21	22	31	50	43	27	12	56	27