EFFECTS OF E.C.T. UPON PSYCHOMOTOR SPEED AND THE "DISTRACTION EFFECT" IN DEPRESSED PSYCHIATRIC PATIENTS*

By

M. B. SHAPIRO, M.A., Ph.D.

Senior Lecturer
Department of Psychology, Institute of Psychiatry, Maudsley Hospital, London

D. CAMPBELL, B.A., Ph.D.

Lecturer
Department of Psychology, University of Auckland, New Zealand

A. HARRIS, M.A., M.D., D.P.M.

Consultant Physician
Bethlem Royal and Maudsley Hospitals, London

and

J. P. DEWSBERY, B.M., B.Ch., M.R.C.P., D.P.M.

Consultant Physician
Maudsley Hospital, London

INTRODUCTION

THE investigation described in this paper had two aims. The first of these was to determine the effects of E.C.T. on psychomotor slowness. As has been reported elsewhere (Shapiro and Nelson, 1955), psychiatric patients of the major diagnostic categories have been found to be slower than normal subjects on psychomotor tests. In addition it has been found that such slowness is correlated with subjective estimates by psychiatrists of degree of illness. As E.C.T. is given in order to improve the clinical condition of depressed patients, it was of interest to ascertain the effect of E.C.T. upon slowness.

The second aim was to determine the influence of E.C.T. upon the "distraction effect" in the Porteus Maze test. This test consists of a series of mazes printed on paper. The subject has to trace his way out of each maze, using a pencil. Foulds (1952), using this test in a modified form, found that depressed patients, when they had to carry out the test under conditions of distraction, speeded up to a greater degree than did a group of psychopaths and hysterics. The distraction consisted of the subject counting aloud, after the experimenter, at the rate of about one number every two seconds, while he was doing the test.

Foulds had been led to this observation from a consideration of possible explanations of the beneficial effects of E.C.T. One possible explanation was that E.C.T. inhibited the preoccupations of depressed patients. Foulds thought that these preoccupations could be regarded as a cause of slowness in dysthymic patients, and that there was an analogy between the presumed effects of E.C.T. and the use of distraction stimulation. He suggested that both acted to inhibit

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the preoccupations, and both enabled the patient to pay more attention to the task in hand. It follows from this analysis that the distraction effect should be smaller after E.C.T. than before.

If this explanation is correct E.C.T. ought to speed up depressed patients, and lessen the distraction effect. Foulds did in fact report that patients were considerably faster after E.C.T. on Raven's Matrices, and that the distraction effect was less on the Porteus Mazes (Foulds, 1952). He did not, however, use a control group in this part of his experiment, and it was therefore of interest to repeat the experiment with a control group.

General Procedure and Selection of Subjects

Two groups of patients were used in the experiment. The experimental group was given a battery of tests, to be described later, and then received E.C.T. The treatment was ended on purely clinical grounds and then the battery was given once again. The control group was also tested twice, but did not receive E.C.T. between the two test sessions. There were 15 subjects in the experimental group and 15 subjects in the control group.

The subjects were all patients of the Maudsley and Bethlem Royal Hospitals. Some were in-patients, others were day-hospital patients who spent weekdays at the hospital, but went home each evening. A patient was selected for the experiment if the consultant in charge of the case (Dr. Harris or Dr. Dewsbery) agreed that E.C.T. was necessary for the treatment of his depressive illness.

The indication for the administration of E.C.T. was a state of depression which had lasted for at least a month, and was showing no tendency to improve or was getting worse. The existence of depression was presumed from the patient's general air of misery, from his subjective complaints of feeling low, and from such features as ideas of guilt and self-reproach or delusions of impending disaster. There was a tendency for those patients whose depression was severe to be given E.C.T. earlier in the course of their illness than those patients whose depression was milder.

The patients were allotted at random to the two groups, independently of the doctors, by one of the psychologists (D.C.) with the exception of the first five subjects, who were all put in the experimental group. The doctors were asked to proceed with treatment of patients in the experimental group, and to defer the treatment of patients in the control group.

The E.C.T. technique for these patients was standardized throughout the two hospitals; the Strauss-McPhail "Plexacon" apparatus being used at the time of the experiment.

Modification was achieved with suxethonium bromide (Brevidil "E") and thiopentone, intravenously. The current administered was usually biphasic and at about 30–35 joules, but varied somewhat with individual patients. If no convulsion was obtained with the first shock, a second shock was administered. Only in isolated cases was a third shock delivered.

Anoxia was avoided by administration of oxygen with 7 per cent. CO_2, as soon as the convulsion had ceased.

Only co-operative patients were tested. Testing was begun on five patients who later refused to continue with the tests. In these cases, persuasion was of no avail, and the battery was abandoned. In other cases a great deal of encouragement was given which warded off further refusals. The majority of patients appeared to be very co-operative.

The intelligence of the two groups was assessed by the use of three sub-tests of the Wechsler Intelligence Scale: Vocabulary, Similarities and Block Design. Yates (1954) has reported that the pro-rated score on these tests correlates highly (r = ·97) with the full scale I.Q. The two depressive groups are alike with respect to their mean intelligence which fell in the average range. The means and sigmas are given in Table I.

TABLE I

Wechsler Pro-rated I.Q.s and Ages of Depressive Groups

		Mean	S.D.	Range	t
Experimental	Pro-rated I.Q.	103·00	14·55	85–127	1·154
Control		108·93	13·52	83–139	
Experimental	Age	49·13	11·47	29–68	2·616
Control		38·00	11·78	19–54	

Nor are there significant differences between the two groups on the sub-test weighted scores (Campbell, 1957). The sub-test scores are a more direct measure of performance, as they do not include a correction for age. The mean age of the experimental group was 49·1 years with a standard deviation of 11·47 and a range from 29 to 68. The control group had a mean age of 38 years, with a standard deviation of 11·78 and a range from 19 to 54. The difference between the mean ages of the two groups was significant at the 5 per cent. level. We cannot explain how this came about, and this difference will have to be taken into account in assessing our results.

In addition to the tests of distraction and slowness, other measures were made. We needed to know if the E.C.T. was having the expected effect on our patients, and therefore we applied ratings of clinical state, made by the psychiatrists, and questionnaire measures of degree of depression. These will be described later.

The average gap between the two test sessions was 33 days in the experimental group (range: 51–21 days) and 29 days in the control group (range: 52–22 days). The patients in the experimental group received an average of 5·9 shocks (range: 3–10 shocks).

SLOWNESS

1. *The Measures*

Fourteen tests of psychomotor speed were used in this experiment, and they provided 30 scores. The enlarged number of scores arises out of the fact that in some tests, both starting time and working time were measured. "Starting time" is the time elapsing between the instruction to begin the test, and the time at which the subject actually begins. In addition, some tests provided separate scores for different parts of the test, and for the Mazes both total time and rate were recorded.

(a) *Porteus Mazes.* This test was described briefly in the introduction. Both starting time and tracing time were recorded. There were no instructions concerning speed of work in this test. The Mazes were given twice before treatment and twice after it. The second trial on each occasion was carried out with distraction, whereas the first trial was carried out under ordinary conditions. The scores for each of these trials in this experiment were calculated

in two ways: average time and average rate. The latter was obtained by dividing the distance traced (as measured by an opisometer) by the time taken in seconds. All the Maze scores reported in Table III are based on average scores for each subject, i.e. each subject's total score divided by 11, the number of mazes completed by each subject.

(b) *Cancellation Test.* In this test the subject is shown six lines of capital letters in which 50 A's are distributed randomly. The subject is required to strike out each A as he reads through the letters. The scores taken are starting time and working time. Details of this test are given by Kessell (1955). The test was given twice before E.C.T., and the same number of times after E.C.T. In each pair of trials one was given with distraction and one without. The distraction was supplied by a pure tone of 1,000 c.p.s. which the subject heard through headphones at a volume of 60 db. above his threshold. The signal was sounded intermittently for a second at intervals of one second. The threshold was taken as the average of one descending and one ascending trial.

(c) "*Error Free*" *Babcock Tests.* These were seven short tests from the Babcock-Levy Mental Efficiency Scale. They had been found by Shapiro and Nelson (1955) to discriminate between normal and abnormal subjects, and to give measures of psychomotor speed which were free from errors. In every test but two the subject is required to complete, as quickly as possible, a simple manual task. These tasks were: tracing a simple maze, writing his name, writing "United States of America", writing a simple sentence, and the digit symbol test. The exceptions are tests in which the subject has to name everyday objects held up before him, and to name colours appearing on a card.

Fourteen scores were derived from these tests, some consisting of starting times and others of working times. In some cases (for example, the Digit Symbol Test), working times were given for different parts of the same test. The working times were scored in terms of Babcock's weighted scores (1940). Note that a high weighted score indicates a fast performance and a low weighted score a slow performance.

(d) *U.S.E.S. Manual and Finger Dexterity Tests.* (U.S. Employment Service, 1947). The first of these tests involves moving as many small wooden pegs as possible from one set of holes to another, and the reversing of a number of pegs in their holes. The second test requires the assembly and disassembly of bolts and washers. The score for each test is the amount of work done in a set time. The subject is instructed to work as fast as possible. These tests had been found to differentiate between psychotic and non-psychotic subjects (Eysenck, 1955).

(e) *Slowness of Writing.* In this test the subjects are asked to write the word "Rhythm" as *slowly* as they can. It is one of the few tests involving a motor response which showed a significant change after E.C.T. in Callagan's study (1952). The score is the amount of time taken to write the word.

Several of these tests have been given to groups of patient subjects in other experiments. It was possible, therefore, to compare the results of our own subjects with those from other experiments, and thus obtain an indication of the general applicability of our findings.

2. *Test Characteristics of the Subjects*

(a) *Comparison with Other Samples.* On the measures where comparisons were possible between the subjects of this experiment, and subjects used in

TABLE II

Means and Standard Deviations of U.S.E.S. Scores—Manual and Finger Dexterity

	N	Mean	S.D.	t	Mean	S.D.	t	Mean	S.D.	t	Mean	S.D.	t
Our combined depressives ..	30	74·77	8·15	5·10	86·60	12·81	3·49	22·63	3·84	3·52	24·53	4·02	4·94
S. Eysenck's psychotic depressives	55	63·93	11·24		76·48	12·69		19·33	4·60		20·11	3·79	
Our psychotic depressives ..	18	73·33	8·54	1·29	86·72	14·07	0·16	22·89	3·46	0·657	23·56	3·59	1·496
Our neurotic depressives	11	77·36	7·38		85·91	11·64		21·91	4·53		25·82	4·49	

Key: M = Weighted score for three trials Manual Dexterity (Displacing pegs).
N = Weighted score for three trials Manual Dexterity (Reversing pegs).
O = Weighted score for Assembly Finger Dexterity.
P = Weighted score for Disassembly Finger Dexterity.

TABLE III

	Control Group				Experimental Group				
	First Test		Re-Test		First Test		Re-Test		t's for Difference Score
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	
St.T. Porteus Mazes (O)	4·96	5·60	2·93	2·21	8·97	5·83	6·97	4·09	·016
Tr.T. Porteus Mazes (O)	62·70‡	31·58	43·42‖	22·73	100·99	49·07	76·44†	38·91	·386
Rate Porteus Mazes (O)	·59	·23	·91‖	·37	·36	·22	·49‖	·29	2·526*
St.T. cancellation (O)	·99	·58	1·00	·42	2·38	2·30	1·57	1·01	1·462
Working time cancellation (O)	74·27‡	20·62	65·43	21·44	105·40	32·88	89·18	25·14	·810
St.T. Porteus Mazes (D)	3·63	3·28	2·23†	1·62	3·94	2·87	3·80	1·82	1·170
Tr.T. Porteus Mazes (D)	47·81	31·90	31·22†	14·50	72·86	37·86	54·86†	30·32	·264
Rate Porteus Mazes (D)	·82	·41	1·18‖	·55	·49	·28	·64‖	·34	2·105
St.T. cancellation (D)	·83	·53	·79	·38	2·08	1·98	1·12	·87	1·453
Working time cancellation (D)	71·10	28·69	58·62	16·17	84·89	30·62	71·35†	17·20	·119
Object naming, weighted score	10·27	2·84	12·20†	2·73	8·60	2·64	10·07	3·17	·446
Writing U.S.A., weighted score	13·47	5·38	13·67	5·14	13·47	2·72	13·33	3·06	1·209
Writing name, weighted score	12·60	1·68	12·87	3·16	12·13	3·38	12·20	3·01	·070
Writing sentence, weighted score	16·00	3·14	15·80	2·98	14·93	2·66	14·53	3·25	·214
Maze 1, St.T.	1·15	1·21	·62	·45	1·09	·72	1·12	·90	1·281
Maze 1, Tr.T.	11·45	4·58	12·12	8·26	15·71	7·03	15·73	6·39	·372
Maze 1, weighted score—errors	16·33‡	4·69	16·87	5·88	12·40	4·72	12·47	5·21	·405
Maze 2, St.T.	·69	·43	·63	·30	1·39	1·24	·80†	·43	1·818
Maze 2, Tr.T.	10·82	3·96	10·73	6·44	13·07	4·37	13·80	4·38	·556
Maze 2, weighted score—errors	16·20	5·20	17·47	5·98	13·67	4·61	12·60†	4·29	·164
Colour naming, St.T.	1·10	1·15	1·01	·38	·98	·37	·93	·51	·171
Colour naming, weighted score, line 1	12·93	3·17	14·40	3·27	13·57	4·18	14·20	3·61	·679
Colour naming, weighted score, line 2–5	12·13	2·70	14·60	1·66	13·14	3·90	14·20	3·84	·030
Colour naming, weighted score—errors	12·07	2·96	13·87	3·85	13·07	3·75	13·73	4·03	·719
Digit symbol St.T.	1·09	·51	1·31	·49	1·49	·21	1·64	1·23	·002
Digit symbol, weighted score, line 1	13·47‡	3·44	12·93†	3·43	10·27	3·10	10·53	3·58	2·769§
Digit symbol, weighted score, line 2–5	11·40	3·38	12·00	3·48	10·20	3·26	10·33	3·48	·381
Digit symbol, weighted score—errors	10·80	3·95	11·27	3·97	8·73	5·01	9·47	3·68	·993
U.S.E.S. finger dexterity	78·60	19·04	99·07‖	17·75	69·93	17·35	67·33	26·24	2·333*
U.S.E.S. manual dexterity	65·93	17·67	83·50‖	26·50	64·07	29·14	71·60	24·20	2·441*

St.T. = Time elapsing between instruction to commence and time at which subject actually begins.
Tr.T. = Time elapsing from beginning to end of tracing.
(O) = Ordinary conditions.
(D) = Distraction conditions.

* = Differences significant at 5 per cent. level.
† = A Test-Retest difference at 5 per cent. level.
‡ = Significant difference between control and experimental on first test.
§ = Differences significant at 2 per cent. level.
‖ = A Test-Retest difference at 2 per cent. level.

other experiments, the scores were alike. There was only one clear exception to this—the U.S.E.S. Manual and Finger Dexterity Tests.

The Combined Babcock Score on the seven tests resulted in a mean of 12·32 and a standard deviation of 3·89 for the control and experimental depressive groups taken together. Shapiro and Nelson (1955) reported a mean of 11·59 and a standard deviation of 3·8 for depressives.

On the Porteus Mazes the combined depressive group produced a mean total tracing time of 900·295 seconds, with a standard deviation of 494·714. Foulds' mean for reactive depressives and melancholics was equivalent to 886·35 seconds with a standard deviation of 671·7. Foulds' starting time was 87·62 seconds with a standard deviation of 169·57. The combined depressives of this experiment produced a mean total starting time of 76·58 with a standard deviation of 65·71. While the means of the groups are very similar, the variances are significantly different and exceed the 1 per cent. level. Some of Foulds' subjects must have been producing starting time scores which were very different from ours.

The only results which were available for comparison on the U.S.E.S. Manual and Finger Dexterity tests were those kindly provided privately by S. Eysenck. She had given these to 55 depressives in the course of another investigation. Her results and our results are given in Table II. It should be noted that there are two scores for the Manual Dexterity test (M and N) and two for the Finger Dexterity test (O and P). This arises from the fact that each of these tests had two parts, which were described above. It is clear from this Table that our subjects are faster than Eysenck's, all the differences being significant at well above the ·001 level.

All Eysenck's depressives were diagnosed as psychotics. Neurotics had been carefully excluded. Our own group consisted of 18 psychotic depressives and 11 neurotic depressives. The final diagnosis of the 30th subject was unobtainable at the time of writing. We calculated the means and standard deviation of these two groups separately on each of the four dexterity tests. These are also given in Table II. Our psychotics are slightly slower on two of the sub-tests, and slightly faster on the other two. Our psychotic depressives are still a good deal faster than those of Eysenck.

In the light of these results we must conclude that our depressives are not as slow as *all* other depressives so far measured. It is possible, therefore, that generalizations arising from the work reported in this paper might have limited application. We can, however, say on the basis of the Porteus Maze tracing time results and the Babcock test results, that our groups are comparable for psychomotor speed, with those of Foulds (1952) and of Shapiro and Nelson (1955). Our research is following up findings derived from these two groups.

It should be noted that errors were made by the depressive subjects in doing the supposedly "error-free" Babcock sub-tests. It is unlikely that these mistakes made any material difference to the results. The average number of errors made by each subject was 3·3. The errors were evenly distributed over all the seven sub-tests, and therefore effects due to error in any one score would be small.

(b) *Comparison of Experimental and Control Groups.* When the results of the experimental and control groups were compared, it was found that on four scores (Porteus Mazes Tracing Time ordinary condition, Cancellation Working time ordinary condition, Maze 1 Weighted Score, and Digit Symbol

Line 1 Weighted Score) among the working time scores, the experimental group was significantly slower than the control group (see Table III). The other results showed the same tendency, though in no other cases were the differences significant. The fact that the two groups are consistently different with respect to their initial status on speed sets a problem which will be considered when we assess the results of this experiment.

In retrospect it seems that the type of patient tested appeared to change during the course of the experiment. It will be remembered that the first five patients were assigned to the experimental group. It is possible that the subsequent 25 patients were less seriously ill. There might have been a tendency to avoid notifying the very ill patients to the psychologist when it was realized that it might result in their being held off treatment for a period of time.

3. *Results*

(a) *Main Results.* In the first place both experimental and control groups show an increase of speed on a majority of tests when they are re-tested. Out of 30 variables, 22 show an improvement in the experimental group, and 25 show an improvement in the control group. Nine of the variables on which the control group showed an improvement, and seven of the variables on which the experimental group showed an improvement, gave significant results (see Table III). Note that the Porteus Maze speed is given in both time and rate.

In the second place the amount of improvement in speed was on the whole greater for the control group than for the experimental group. This was demonstrated by calculating, for each subject, the difference between the scores of the first and second performance of each test. For the rest of this paper such differences will be referred to as difference scores. The control group achieved larger improvements than the experimental group on 21 of the speed scores. The "t's" for the difference in improvement are given in Table III. Four of these differences between the means of the improvement scores reached or exceeded the 5 per cent. level of significance. Three of these differences were found in Porteus Maze rate, under ordinary and distraction conditions, and the U.S.E.S. Finger and Manual Dexterity tests. The experimental group showed a significantly larger improvement on only one of the scores from the speed tests. This was the first line of the Digit Symbol Test. This result arises out of the fact that the control group obtained a worse score on re-test, while the experimental group improved slightly. This is possibly a chance effect of an unreliable measure, and would have to be observed in another study before it could be accepted as a reliable result.

(b) *The Influence of Initial Differences in Speed between the Experimental and Control Groups.* It might be argued that the greater improvement shown by the treated group was due to the fact that it was initially the slower group. This argument is, however, contrary to the actual relationship between initial speed and gain on re-test. It has been found by Campbell (1957) that there is in fact a positive correlation between initial speed and gain on re-test. The *slower* the initial performance the *more* the subject gains on re-test. For example, in the case of the Porteus Maze Tr.T. eta (calculated instead of r because of non-linearity of regression) between initial score and improvement, was ·77 ($p = ·01$). The two measures have 59 per cent. of their variance in common.

The initial time score from each of the other 29 variables was similarly correlated with gain on re-test (Campbell, 1957). All the correlations were in the same direction as that found for the Porteus Mazes. Thirteen of them

reached the ·01 level of significance. These correlations were, of course, only computed for the control group. These results indicate that the experimental group, as the initially slower group, should have gained more than the control. In fact they gained less. We must conclude, therefore, that the experimental group was slower on the re-test than it would have been without E.C.T.

(c) *Influence of Age on Improvement.* It was pointed out above that the control group was, on the average, eleven years younger than the experimental group. The greater improvement scores in the control group might be attributable to this difference. The possibility was examined by computing rank-order correlations between age and the scores on which the control group had shown a significantly larger improvement. None of the correlation coefficients reached the 5 per cent. level of significance. The largest coefficient was $r = \cdot 38$, and the mean of the coefficient was $-\cdot 060$, that is, about zero. It is unlikely, therefore, that the difference in age influenced the results.

Distraction Effect

1. *The Measures*

Only the results on the Porteus Mazes will be discussed in this part of the paper, as we were not able to find a sufficiently reliable distraction effect in the Cancellation Test (Campbell, 1957). Foulds' procedure was adopted. The distraction, which consisted of having the subject count out aloud after the tester while he was tracing through the mazes was applied in the second set of mazes. The counting began as soon as the maze was placed before the subject, so we have a measure of the distraction effect on both starting time and tracing time.

2. *Test Characteristics of the Subjects*

The score on the distraction trial was expressed by Foulds as a percentage of the score on the trial given in the ordinary way, for both starting and tracing time. These will be referred to as the "tracing time percentage score", and as the "starting time percentage score". The mean tracing time percentage score was 73·52 for the combined depressive group, with a standard deviation of 18·46. Foulds' dysthymic group produced a mean of 70·3 with a standard deviation of 18·75. In this respect Foulds' and our groups seem to be identical.

The mean starting time percentage score for the combined depressives was 76·32 with a standard deviation of 66·34. For Foulds' dysthymics it was 66·33 with a standard deviation of 29·32. Foulds' groups appear to be more homogeneous than ours in the distraction effect on starting time. Given that they were initially more heterogeneous, it seems that the distraction effect on starting time was considerably greater for some members of Foulds' group than for any of our own.

3. *Results*

Tracing time percentage score showed no reaction to practice or E.C.T. as Table IV shows.

For the purpose of the analysis of starting time percentage score, we excluded an outstandingly slow subject from the control group. This subject had a mean starting time score on the first test of 30·55 seconds. The next slowest subject, also a member of the control group, had a mean starting time score of 17·18 seconds. The mean for the whole group was 4·96. To equalize the numbers, we also excluded one subject from the experimental group.

The basis of this second exclusion was merely the fact that the subject had been assigned the same code number as the subject who was excluded from the control group. The results are given in Table IV. The initial mean starting time percentage score of the control group is greater than that of the experimental group, i.e. the control group speeds up less than the experimental group. The difference produced a "t" of 2·053 which is just short of the 5 per cent. level of significance.

TABLE IV

Porteus Maze Distraction Effects in Terms of Percentage Scores

		Experimental		Control	
		Mean	S.D.	Mean	S.D.
Test	Starting time	51·172	34·096	84·934	51·453
	Tracing time	74·251	17·669	72·793	19·821
Re-test	Starting time	62·889	33·237	83·734	23·857
	Tracing time	74·880	22·836	79·630	25·485
Difference scores*	Starting time	138·366	39·360	148·554	44·248
	Tracing time	149·355	25·829	145·151	28·084

* 150 has been added to each score to get rid of minus signs.
St.T. N=14.
Tr.T. N=15.

Examination of Table IV will show that E.C.T. did produce a change in the starting time percentage score in the expected direction. The distraction effect was decreased in the experimental group, being demonstrated by a rise in mean starting time percentage score from 51·172 to 62·889. This change produced a correlated "t" of 1·113 which does not approach an acceptable level of significance. The control group showed no change in means but a reduction in standard deviation.

To complete the analysis the difference scores were calculated and contrary to expectation the mean difference score is smaller for the experimental group than it is for the control group. However, the direction of the difference has no implication here as the "t" is only 0·646. This last finding could not be an artefact of the initial difference between the experimental and control groups, because the experimental group did not, in the first place, show a significant reaction to E.C.T. The results must be accepted therefore as being clearly negative.

AFFECT AND CLINICAL STATE

1. *Measures*

It was necessary to obtain an indication of the extent to which the E.C.T. was having the desired effect on the patients' symptomatology. Two measures were used for this purpose. In the first place the consultant in charge of the case was asked to assess the degree of illness shown by each patient on a five-point rating scale. The criteria were those given by Shapiro and Nelson (1955). The definition of the values on the scale were:

(i) Apparent full remission.
(ii) Depression without gross depression in the patients' appearance.
(iii) Simple depression.
(iv) Severe depression with delusions and hallucinations but in good contact.
(v) Barely suitable for testing.

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The second measure used was the Hildreth Feeling Scale (1946). In this test the subject is shown a set of statements, and is asked to indicate the statements which come nearest to describing how he feels. The statements are arranged in eight sets and each contains between eight and ten statements. Only four of the sets are obviously concerned with affect. The first two of these are concerned with feeling, containing statements such as "never felt better in my life" and "couldn't feel worse". The third set is concerned with energy, containing statements like "completely worn out" and "full of pep". The fourth set is concerned with optimism about the future and contains such statements as "insecure" and "the future doesn't look bad". The four remaining sets are concerned with the subjects' assessment of his mental efficiency, his attitude to his work (one set each) and to other people (two sets). Scores from the first four sets are combined to give a "Feeling" score and from the second four sets to give a total "Attitude" score.

2. *Characteristics of the Subjects*

The mean scores showed that the patients' self-ratings of their level of affect were all below the means reported by Hildreth for a mixed neuropsychiatric medical population, i.e. they were more depressed. Similarly, they gave on an average, lower scores than a group of normal undergraduates tested by Hunt and Lehner (1948). The data are given in Table V.

TABLE V

Hildreth Feeling Scale and Clinical State: Results for Experimental and Control Groups

		Experimental		Control		t	
		Mean	S.D.	Mean	S.D.	Difference	
Test	Feeling scale ..	3·723	1·017	3·493	1·671	·457	—
	Attitude scale	5·307	1·232	4·591	·783	1·813	—
	Clinical state ..	3·200	·414	3·286	·612	·448	—
Re-Test	Feeling scale ..	5·650	1·663	3·953	1·509		
	Attitude scale	6·000	1·171	4·707	1·504		
	Clinical state ..	2·200	·941	2·733	·960	1·532	
Difference scores	Feeling scale ..	1·920	2·030	·457	1·378	2·308	†
	Attitude scale	·690	1·361	·041	1·058	1·436	—
	Clinical state ..	1·000	1·000	·574	·938	·410	—
		Sandler's A Test					
Significance of difference between test and re-test	Feeling scale ..	·136	*	·653	—		
	Attitude scale	·309	—	27·797	—		
	Clinical state ..	·116	†	·250	—		

Key: * = Difference significant at 5 per cent. level.
† = Difference significant at 1 per cent. level.

Data were also available from the Hildreth Feeling and Attitude Scales given to a group of 15 normal subjects (Campbell, 1957). The combined depressives showed lower Feeling and Attitude scores than the normal controls. The difference reached the 1 per cent. level of significance for both scales. The differences between the experimental and control group on the two scales did not reach an acceptable level of significance, giving "t's" of ·457 and 1·813 respectively.

On the rating scale used by the psychiatrists, all patients received either a 3 or 4 rating on the five-point scale. The experimental and control groups were given the same mean rating.

3. *Results*

The mean score of the experimental group after E.C.T. was significantly greater than before E.C.T. on the Hildreth Feeling scale but not so on the Hildreth Attitude scale. The control group showed little change on either scale. The difference in the amount of change, as measured by the difference score, between the experimental and control group was significant at the 5 per cent. level for the Hildreth Feeling Scale.

The most depressed patients on the Hildreth Feeling Scale improved most after E.C.T. on that scale. This is shown by a significant negative rank correlation of $-\cdot 50$ on the Hildreth Feeling Scale between initial score and improvement after E.C.T. The six largest improvements were produced by patients who had scores below $3\cdot 7$, and the three cases who became worse had initial Hildreth scores above this point. We should note that two of the cases of the control group who showed a considerable improvement also had an initial score which was below $3\cdot 7$, while one of the cases with an initial score above $3\cdot 7$ showed a considerable deterioration.

The clinical status of the patients, as assessed by the doctors, also showed an improvement after E.C.T. the difference reaching the 1 per cent. level of significance on Sandler's (1957) A test. Nine of the experimental group were improved, including 5 total remissions. In the control group, 5 cases were rated as improved, including 2 remissions. The difference in the amount of change between the control and experimental group did not however, reach an acceptable level of significance.

The rank-order correlation between amount of change, as measured by the Hildreth Scale and the amount as measured by the clinical assessment, was small for the experimental group. It was $\cdot 47$ which does not reach the 5 per cent. level of significance for an N of 15 subjects.

It is not relevant to the purpose of this paper to discuss the full implications of these results. It suffices for our purpose that we are able to conclude at least on the basis of the Hildreth Scale results, that the E.C.T. did have the desired effect at an acceptable level of statistical significance upon our patients. It follows therefore, that the findings reported in the previous two sections concerning slowness cannot be ascribed to a failure of therapy.

Conclusions and Discussion

1. *Conclusions from the Experiment*

Two main results emerge from this experiment. Firstly, E.C.T. did not lead directly to a relative improvement in the psychomotor speed of depressed patients; but in fact, to a relative reduction. Secondly, E.C.T. did not reduce the distraction effect. E.C.T. did, however, decrease the depression of the experimental group.

Two conclusions arise if we take these findings at their face value. First of all, the finding that slowness is correlated with subjective estimates of degree of illness (Shapiro and Nelson, 1955), is now, at best, of limited applicability. It really must be confirmed in further studies before it can be accepted with confidence. The second conclusion is that no analogy can be drawn between the distraction effect and the ameliorative effects of E.C.T.

As against these conclusions it might be argued that the relative slowing down of our experimental group was caused by post-E.C.T. confusional state, and that once this had cleared up, the patients would show the expected increase in speed and decrease in distraction effect.

This explanation appears to us to be unlikely, as our experimental group did not significantly increase their errors compared with the control group (see Table III). However, it is necessary to conduct another study in which the period elapsing after treatment is longer than the interval used in this experiment.

Our conclusions might also be open to question on the grounds that our sample of depressives was unrepresentative. This seems to us to be unlikely. Our samples were very similar to those of Foulds (1952) on the Porteus Maze Tracing Time, in both ordinary and distraction trials. It was also very similar to those of Shapiro and Nelson (1955) on the Babcock speed tests.

2. *Conclusions from the Literature*

In order to throw light on our findings, we scanned the literature. We found four studies which were of some relevance, in that the effects of E.C.T. on speed of psychomotor function had been measured, and that a control group had been used. These four studies were by Hetherington (1956), Callagan (1952), Janis and Astrachan (1951), and Scherer (1951).

The first study, that of Hetherington (1956), produced findings which, at first sight, appeared to contradict our own. He reported that a group of depressed patients were speeded up by E.C.T. on 4 psychomotor tests. Hetherington's findings may be explained by the fact that he used normal subjects in his control group. These subjects were initially faster than the depressives, and therefore we would expect then to gain less than the depressives on re-test, even without the use of E.C.T. This expectation arises out of the findings, reported above, of a negative correlation between initial speed and gain on re-test. Judging by our own results, Hetherington would have got his depressives to improve even more, compared with his normal controls, if he had refrained from giving them E.C.T.

The second study is that of Callagan (1952) who included in his battery seven tests which were comparable with our own. He had 25 depressed patients in his experimental group and 25 depressives in his control group. None of the differences he found in the seven tests, however, reached an acceptable level of significance when compared with the control group; nor was there a definite trend of improvement or deterioration after E.C.T. Callagan's treated group did improve clinically, as compared with the control group. In addition it should be noted that they were tested 7 days after the cessation of treatment, a period which is comparable with our own which varied from 3 to 8 days. The outstanding difference between Callagan's and our conditions is the number of treatments. His experimental group received E.C.T. a mean number of 8·68 times, while ours received E.C.T. for a mean number of 5·9 times. If anything, this should have made his experimental group slow down even more than ours. It is clear that we are not in a position to explain the difference between Callagan's and our own results.

The third study is that of Janis and Astrachan (1951). This study cannot be regarded as strictly relevant, because only two of the nine members of the experimental group, and five of the eight members of the control group, were depressives. Two variables in this experiment were analogous to our own. The first consisted of times taken to begin answering questions in a life history questionnaire. The second consisted of the response time for the utterance of the whole reply. On both measures the scores deteriorated for most of the experimental group and improved for most of the controls, the difference between the two groups reaching the 1 per cent. level of significance. This

study is similar to our own in demonstrating a relative deterioration in speed of performance; but disagrees with ours in demonstrating an absolute deterioration for the experimental group. This finding might be due to the fact that talking is a highly practised activity, and therefore all subjects are very near to their asymptotes for speed on this function. Any factors which made for the lessening of speed might therefore be more readily demonstrated. Two other factors might be responsible for the findings of Janis and Astrachan. In the first place their treated group received an average of 18 treatments compared with our own average of 5·9 treatments. In the second place they differed diagnostically from our groups. The second testing of the experimental group took place not less than four weeks after the last treatment.

The fourth study, that of Scherer (1951) also cannot be regarded as strictly relevant to our own. Of the 41 members of the experimental group only seven were classified as depressives (controls not described). The experimental group was re-tested between 2 and 6 weeks after the last treatment. No change was observed on those tests which were comparable to ours. These tests were the Minnesota Rate of Manipulation test, and the Wechsler Bellevue Digit Symbol test. We ourselves found no change on the last test.

The one generalization which emerges from these four studies and our own, is that E.C.T. does not increase, and may decrease, speed of psychomotor function. This generalization may have some clinical importance. Slowness is a characteristic of the mentally ill, especially the depressed. But it appears that E.C.T. has an ameliorative effect only upon the mood of the patient and does not have a similar effect upon slowness.

In view of these findings it is interesting that the medical collaborators in this research have *not* found that patients return soon after their treatment to complain that they are still as slow as ever, even though their depressions have lifted. Yet, as Lewis (1934) has pointed out, depressed patients complain considerably about their retardation. It is necessary to find out what happens to the retardation of a successfully treated patient after he has left the hospital, and what effect it has on his personal and occupational adjustment.

3. *Implication for Future Research*

Past research upon the effects of E.C.T. has tended to concentrate on cognitive and motor functions, possibly because they appear easier to investigate than affect, and because it is possible to deduce explanations of the effects of E.C.T. from its effects on such functions. For example we have the theory of Janis and Astrachan (1951) that the general impairment of memory by E.C.T. is followed by a selective revival of memories. Less pleasant memories are not so quickly or completely revived after E.C.T. Another example is the argument that there is a tendency to lose recently acquired habits. Hence those associated with a recently acquired depression might be selectively affected by E.C.T.

The concentration, in the research into effects of E.C.T., on cognitive functions, need not necessarily lead to an understanding of the efficacy of E.C.T. The results of this experiment suggest that the cognitive and motor effects of E.C.T. might be relatively independent of changes of other characteristics. In view of this, it might be more fruitful to investigate affective and other symptomatic changes directly, and not to assume that they are the by-products of changes in cognitive processes.

At first sight, research into affect appears to be very difficult. However, the questionnaire approach to affective change might provide useful leads. This

is shown by the significant negative correlation obtained between initial depression and the amount of change after E.C.T. on the Hildreth Feeling Scale, and by the fact that the Hildreth Feeling Scale appeared to be more sensitive to E.C.T. than our clinical ratings. At present there are no experimentally based data showing how the various aspects of a depression, such as sadness, fatigue, pessimism, retardation and delusion, are related to each other. Nor do we know how these relations vary in different stages of the illness, and in different patients. It would seem to us that these questions would need to be answered before launching into further experiments on the effects of E.C.T. on cognitive function alone.

Summary

This paper reports an investigation of the effects of E.C.T. upon two aspects of psychological function: psychomotor slowness and the distraction effect. Fifteen depressed patients were used as an experimental group and 15, who had also been prescribed E.C.T. for depression, were used as controls. Both groups were tested and re-tested with the same battery of psychomotor tests and Foulds' distraction tests upon the Porteus Mazes. The main outcomes were:

1. E.C.T., if anything, increased relative slowness and had no effect on the distraction effect.
2. E.C.T. had a significant effect on the patients' complaints as measured by the Hildreth Feeling and Attitude Scale.

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