# PSYCHOLOGICAL CHANGES DUE TO E.C.T. AS MEASURED BY A BATTERY OF TESTS GIVEN REPEATEDLY.*

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## INTRODUCTION.

THE majority of investigations into psychological changes due to E.C.T. have been undertaken to assess the effect of treatment on the patient's memory. Sherman, Mergener and Levitin (1941), testing for retention of material assimilated on the same occasion as it had to be recalled or recognized, found no significant effect of E.C.T. upon memory. Zubin and Barrera (1941) found that E.C.T. removed the saving that would otherwise have occurred between learning and re-learning paired associates. They also reported that the effect of treatment on the recognition of material was less severe than on its recall, and this was confirmed by Mayer-Gross (1943).

The present paper reports psychological changes which have been found to take place *during* a course of treatment with E.C.T. as well as before and after. The investigation is a development of a pilot experiment undertaken with Dr. M. Roth which was briefly reported at the International Congress of Psychiatry, Paris, 1950.

## METHOD.

The difficulties involved in repeating a battery of tests several times concern practice effects with material used repeatedly and transfer of training effects with similar material substituted in later sessions. These difficulties can largely be avoided by assessing the effect of E.C.T. on a learning curve obtained by the repeated use of a small battery of tests.

### *The Spacing of the Treatments and Test Sessions.*

The battery was given four times in all. The first test session was always given before the start of the course of E.C.T., either on the same day, or on the day before the first treatment. The second session was given the day after the fourth treatment, the fifth treatment taking place on the following day. In three cases this second session was given between the fifth and sixth treatments. The third session was given two or three days after the final treatment, and the fourth session ten days to a fortnight later. Eight patients received six treatments, one received five treatments and one ten treatments.

### *The Depressive and Control Groups Tested.*

The cases tested consisted of ten patients for whom the diagnosis was depression. There were nine women and one man, none below average intelligence (i.e., all with a score of at least Grade III on Progressive Matrices). The mean age of this group was 41·5 years (S.D. 7·7).

Two groups of people were used as controls. The first was a group of five male and five female nurses working at the Crichton Royal. Their mean age was 23·2 years (S.D. 5·6), and all had a Matrices Score of at least Grade III. This group was given the whole battery, except the tests of intellectual ability, four times at weekly intervals. They were not, of course, receiving treatment. The second control group consisted of fifty male A.R.P. workers, with a mean age of 36·9 years (S.D. 15·5), who were tested and re-tested in 1943 with the tests of intellectual ability at

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an interval of about a month. These two groups being neither depressed nor undergoing treatment were not, of course, controls in the strict sense of the word, but were used to assess normal practice effects with the tests used.

*The Test Battery.*

The battery was designed to assess output of mental work, hand-eye co-ordination, speed of muscular work, and retentivity. It could be completed in less than 40 minutes. In addition, each patient was given a test of intellectual ability before the treatment started and again after the course was completed.

*Output of accurate mental work* was measured by asking the patient to add seven

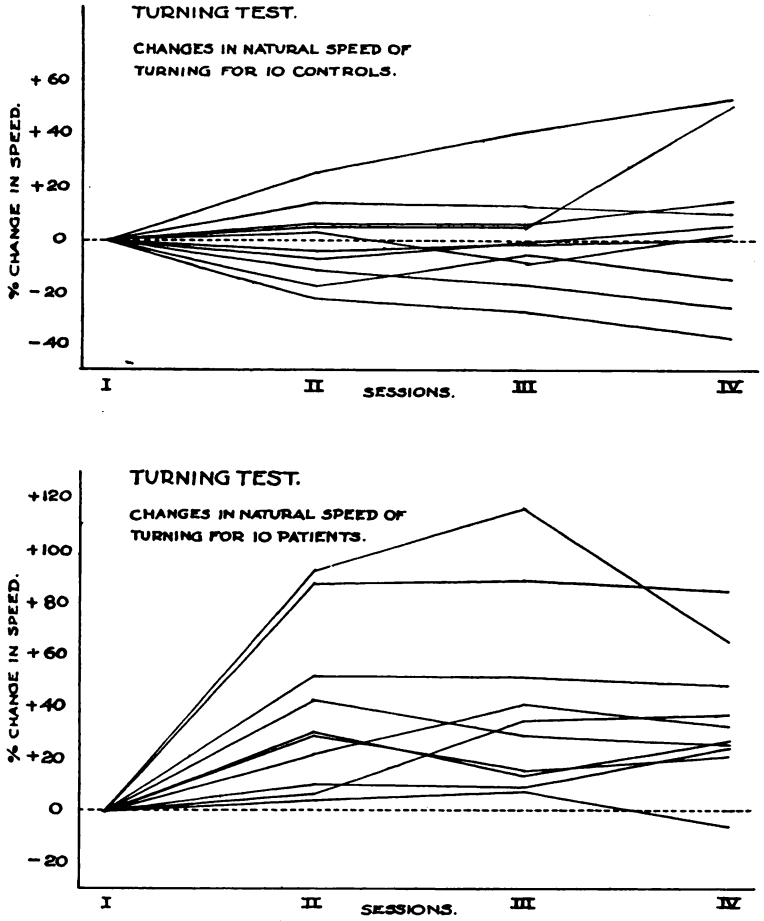



FIG. 1.

to each of a series of numbers printed on a sheet of paper. The number of sums accurately completed in three minutes constituted the score of the test. *Hand-eye co-ordination* was assessed by means of the Track Tracer (Vernon and Parry, 1949), and the total time taken to complete five runs constituted the score. The number of mistakes made on each run was also noted. *Speed of muscular work* was measured by asking the patient to turn a handle, first of all at his natural speed and later at his fastest possible speed. In each case the rate was recorded on a speedometer. *Immediate recall* was assessed by the Digit Span Test. *Immediate recognition* was assessed by asking the patient to select from a pack of forty cards those bearing names he had seen on a list of twenty names which he had studied for twenty seconds immediately beforehand. The number of cards accurately and wrongly

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recognized were noted separately. The number of cards correctly chosen less the number wrongly selected constituted the score of the test. *Immediate recall and recognition* of non-verbal material was assessed by asking the patient twenty questions about a picture he had studied for three-quarters of a minute immediately beforehand. The pictures used were those of the Terman-Merrill revision of the

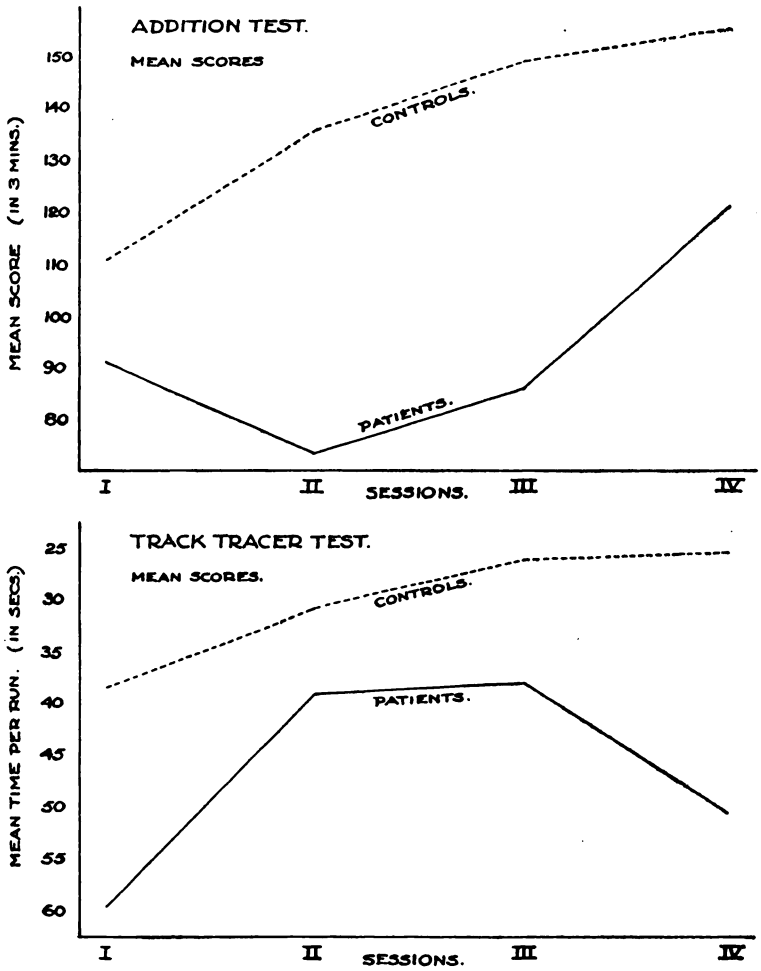



FIG. 2.

Stanford-Binet Test, numbered L. III–6, 4A, 4B, 4C ; M. III–6, 4B (Terman, Merrill, 1937). The number of questions correctly answered constituted the score of the test. *Recent recall* was measured by reading a short story at the first Session which the patient had to recall about ten minutes later. The story was " The War of the Ghosts " (Bartlett, 1932). It was then immediately read a second time. At each of the following sessions the same story had to be recalled, after which it was read once again. The number of statements correctly recalled constituted the score of the test. *Recent recognition* was assessed by asking the patient whether he recognized the pictures he had seen in previous sessions. He was also asked whether he recognized each test as one he had done the session before. *Intellectual ability* was assessed by means of Progressive Matrices and the Mill Hill Vocabulary Scale (Raven, 1948).

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## Results.

In assessing the results of these tests the two main considerations are firstly whether there are any trends over the four Sessions in either of the groups tested, and secondly, whether there are any significant differences between the two groups at each session.

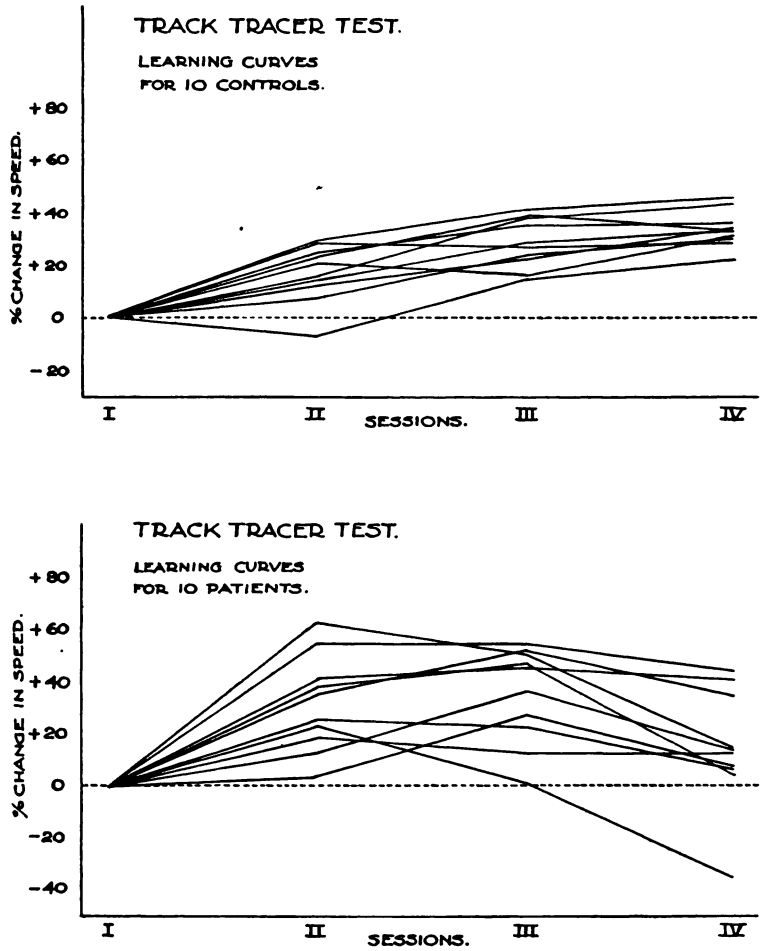



FIG. 3.

*Tests for Intellectual Ability.*

The increases in mean score in both *Matrices* and *Mill Hill Vocabulary Scale* for the Depressive group before and after the course of treatment were not statistically significant. There was no evidence of intellectual impairment before or after treatment as assessed by comparing the scores of the two tests. The mean scores of the Depressive and Control groups in both tests were statistically indistinguishable. It is interesting to note, however, that the mean time taken to complete the Matrices test in the case of the Depressive group both before and after treatment was significantly greater than the comparable mean time for the Control group.

*Tests of Efficiency.*

Some striking differences between the Control and Depressive groups were noticed with these tests. In the *Addition* test the Control group produced the expected learning curve. Nine out of ten patients produced a falling off of output of accurate work in Session II. This was followed by a normal learning curve in Sessions III and IV (Fig. 1). It is of particular interest to note that the one atypical

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case which showed a more normal learning curve was the only member of the Depressive group who was markedly retarded, and was the one who produced the greatest percentage increase of speed (93·1 per cent.) in the Turning test between Sessions I and II (Fig. 3). It would appear that in this case the effects of the remitting psychosis outweighed the more usual effects of the treatment. The difference between the mean scores of the Depressive and Control groups was statistically significant in Sessions II and III (Fig. 4).

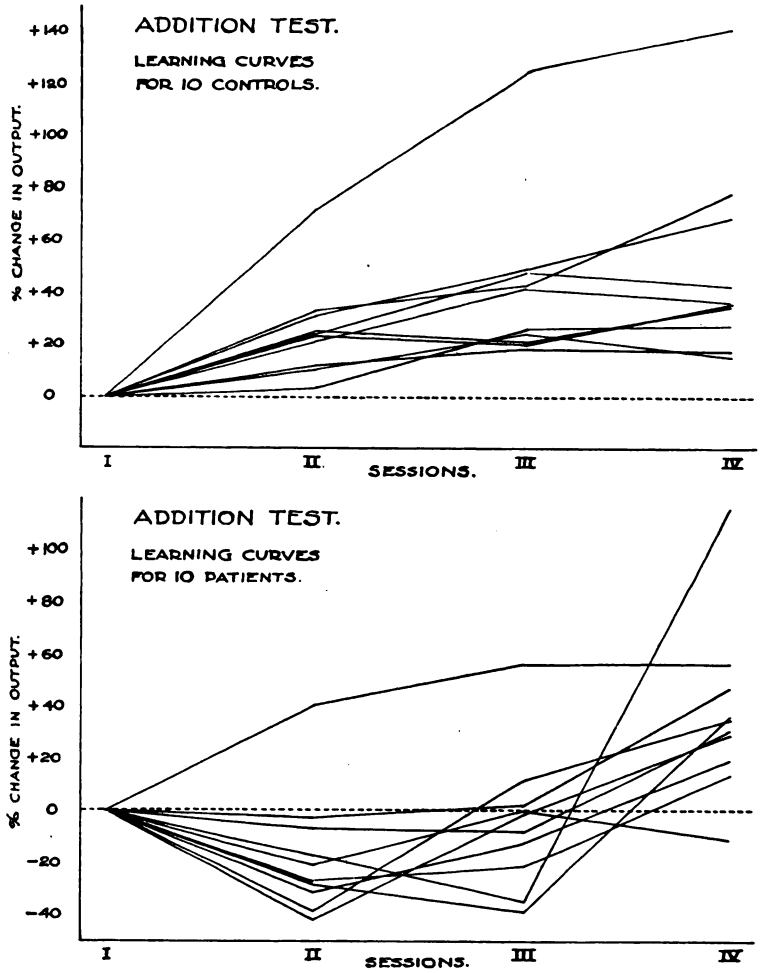



FIG. 4.

These results are in marked contrast to those obtained with the *Track Tracer* test. The expected learning curve for speed was obtained with the Control group. For the Depressive group the initial increase in speed was greater, and was followed in every case by a falling off in efficiency in Session IV (Fig. 2). The difference between the mean scores of the two groups was significant in Sessions I and IV (Fig. 4). Similar curves for accuracy on the Track Tracer test were less distinctive, but in the main the Control group became less accurate over the sessions and the Depressive group more so. It might seem, therefore, that the loss in speed in the case of the Depressive group in Session IV was due to their greater accuracy. This does not seem, however, to be the case, since in this group the correlation between speed and accuracy over the four Sessions was only −0·155, which is not significant. The correlation in the case of the Control group was only −0·393, which is only just significantly different from zero.

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In the tests for *Natural Speed of Turning* the Control group produced a steady rate of turning which varied little from Session to Session, although there were comparatively wide individual differences. About the same number of cases increased speed slightly over the Sessions as decreased speed. In the Depressive group, however, every case increased speed between the first and second sessions (Fig. 3). The mean speeds at each session for the two groups were not significantly different. There was, however, a significant increase in the mean speed of the Depressive group between Sessions I and II.

In the test for *Maximum Speed of Turning* there seemed no homogeneity in the scores of either group, although their means were significantly different in Sessions I and III. The technique of giving this test must be improved.

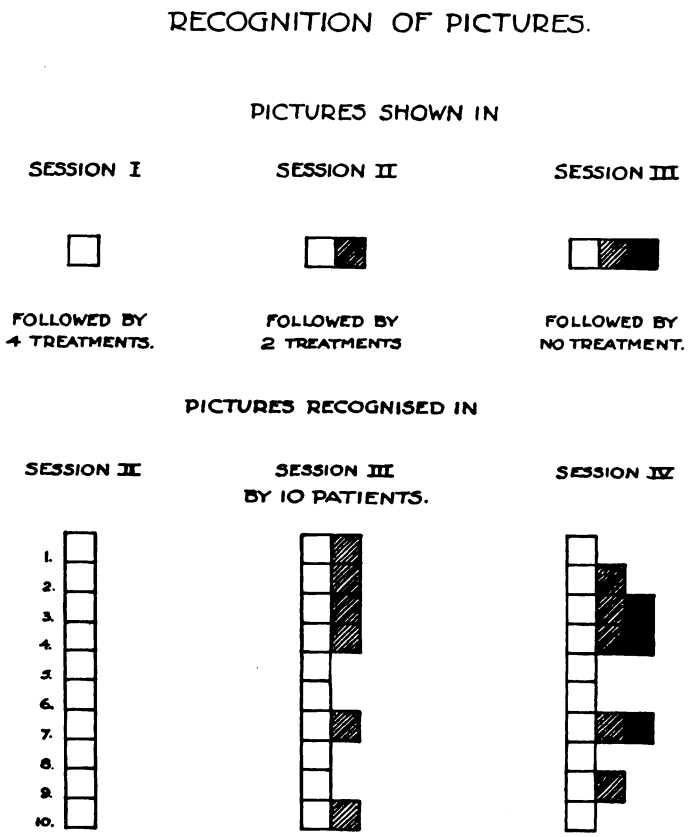



FIG. 5.

*Tests of Retentivity.*

As already stated, these tests were divided into those assessing *Immediate Recognition and Recall*; and those assessing recognition and recall of material assimilated immediately before or during the course of treatment, and recalled or recognized about a week later. These latter tests have been named tests of *Recent Recognition and Recall.*

*The Digit Span Test for Immediate Recall* produced no significant difference between the two groups nor between the four sessions. This was almost certainly due to the insensitivity of the test. For more accurate assessment this test will have to have many more items and a much wider range of scores.

*The Names Test for Immediate Recognition* produced a fall in score in 9 out of 10

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cases in the Depressive group in the second Session. A similar fall in every case was noted in the *Picture Test for Immediate Recall and Recognition* of non-verbal material. In neither of these tests did the Control group show any significant variation of mean score over the sessions, and in each case it was statistically differentiated from the Depressive group in Session II.

In the *Story Test for Recent Recall* there was a dramatic, though expected, fall in score in 9 out of the 10 cases in the Depressive group after the beginning of treatment, while the Control group produced the expected learning curve. The mean scores of the Depressive and Control groups were significantly different at every Session. In the test for *Recent Recognition of tests* done in previous Sessions the loss in mean score in the case of the Depressive group was less severe and more quickly made up than in the test for recent recall.

The test for *Recognition of Pictures*, although not psychometrically rigorous, produced some interesting qualitative results, which indicated that the treatment seemed to produce an amnesic effect for some days after its completion (Fig. 5). Pictures which were seen *after* the completion of treatment were forgotten, while the one picture seen *before* treatment was started, was always retained. It seems that, as a result of poor attention, it is the process of assimilation rather than retention as such which is impaired.

## Comments.

The finding of Sherman, Mergener and Levitin (1941) that E.C.T. has no significant effect on memory has not been supported by this investigation, which indicates that treatment seems to have a definite and demonstrable effect on the recognition and recall of material assimilated immediately beforehand. The findings of Zubin and Barrera (1941) that E.C.T. impairs both the recognition and recall, after treatment, of material assimilated beforehand is, however, well supported; and so is their finding, confirmed by Mayer-Gross (1943), that recall of material is affected more than its recognition. This, however, may only be another way of expressing the well-known fact that recognition is an easier process than recall.

The tests used in the present investigation appear to differentiate between tasks involving intellectual activity, such as accurate mental work (i.e., addition) and retention (i.e., names, picture, story) on the one hand, and those involving motor response, such as muscular work (i.e., turning) and hand-eye co-ordination (i.e., track tracer) on the other. The former seem to be temporarily impaired during treatment and the latter to be improved (Fig. 4).

Since there is evidence that it is the process of assimilation rather than retention as such which is affected by treatment, remembering as well as rate of mental work may suffer from the lack of concentration and increased distractibility so characteristic of the patient during treatment. On the other hand, the increase of speed of muscular work which takes place during treatment argues the removal of retardation, which again is a characteristic effect of E.C.T. This would also explain the improvement in hand-eye co-ordination where relatively little intellectual activity is required.

Three lines of inquiry seem to be suggested by these results. The first is to discover more precisely the nature of the temporary impairment manifested during treatment in the tests for intellectual efficiency and retentivity. The second is to ascertain the effects of the removal of retardation on various types of performance. The third is to confirm by more rigorous tests the suggestion that E.C.T. temporarily impairs the process of assimilation rather than retention as such, and to find out how long after the end of treatment such impairment lasts. In this last line of inquiry tests of attention should provide valuable information.

## Summary.

The results of a small battery of tests given repeatedly to 10 depressed patients undergoing a course of E.C.T. and 10 controls suggest that the treatment produces two effects working in opposite directions, namely, a decrease in rate of accurate mental work and a simultaneous increase in the rate of motor response. Which of these two effects predominates depends upon the type of task involved.

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