PRELIMINARY REPORT OF CHANGES AFTER PREFRONTAL LEUCOTOMY.*

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INTRODUCTION.

CONSIDERABLE material is available about the effect of leucotomy on intelligence. There are, however, few reports of objective measures of changes after leucotomy in the non-intellectual aspect of personality, those changes of temperament and character which are so striking to the clinician. In order to make a small contribution to filling this gap, at the suggestion of Dr. Desmond Curran an investigation has been carried out at St. George's Hospital and its In-Patient Unit at the Atkinson Morley Hospital, London.

On examining the literature, and reading of the changes that have impressed themselves upon clinicians, psychologists, and the family and friends of patients, the hypothesis was formulated that the changes noted embraced at least three aspects of personality. These were, intelligence, degree of neuroticism, and degree of neurotic introversion; that is the intensity of the anxious and depressive traits. It was further thought that the changes would be in the direction of a decrease in intelligence, a decrease in neuroticism and a movement away from extreme introversion, towards the extravert end of the scale. The results presented here lend support to these expectations.

SAMPLE.

Since the beginning of 1947 each patient recommended for leucotomy at the above-mentioned hospitals has been examined on an extensive group of personality and intelligence tests. This report deals with differences found on 20 patients (4 males and 16 females) tested before and two to three months after the operation. The neuro-surgeon was Mr. Wylie McKissock, whose technique is described in *The Lancet* (1943).

The average age of the patients was 41·5 years, and the mean Wechsler I.Q. was 105·87. The patients were described as depressed, anxious, obsessional or paranoid.

It is important to mention that, from the point of view of the study of changes in personality after leucotomy, the type of patient who has been operated on in St. George's Hospital is remarkably accessible, and quite able to behave intelligently and co-operatively throughout the 5 to 6 hours of testing necessitated by this investigation.

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On the cognitive side the tests chosen were the Wechsler scale of verbal and performance tests, Porteus Mazes, and the proverbs from the Stanford-Binet scale. It was hoped by means of these to tap separately different aspects of intelligent activity: for example, learning as distinct from rote memory, timed as distinct from untimed activity, and social common sense as distinct from a capacity to generalize.

On the temperamental side some objective measures of temperament, such as persistence, speed-accuracy and suggestibility, have been shown as the result of work with neurotics in the last few years by Drs. Eysenck and Himmelweit and myself (1946*a*, 1946*b*, 1948), to differentiate the neurotic from the non-neurotic and the affective or dysthymic syndrome from the hysteric syndrome. These were included, and, in addition, some new measures were designed to estimate temperamental changes which had been hinted at in the literature.

Results.

Only those results are reported in which the probability of such a change occurring is less than ·05, that is, would happen less than once in twenty by chance, using Fisher's "T."

(a) *Intellectual changes.*—Significant loss in special types of ability was found; one of these was verbal ability, as measured by a drop of over seven points in the Wechsler Verbal I.Q. Furthermore, it was found on analysis of the four tests contributing to this score that the loss on the comprehension sub-test was significant when taken alone.

It was noted that on the 10 questions comprising this sub-test the loss was very large on those tapping social attitudes, e.g. behaviour to a friend, keeping of promises, behaviour to prevent an accident. This may therefore not only be a change in intellectual ability, but also in attitude towards one's social environment.

This loss on the verbal scale was of sufficient magnitude to show a significant drop in I.Q. on the whole scale of nearly five points, in spite of the absence of significant drop on the performance tests. This differential change between verbal and performance tests is in line with Greenblatt's (1947) finding of more concrete performance and poorer abstraction ability after leucotomy.

In addition to the Wechsler verbal tests, the capacity to generalize was measured by means of six proverbs, the meaning of which was asked of the patient. After the operation the patients showed less capacity for generalisation, confirming a finding reported by Rylander at the recent International Congress of Physicians.

Porteus Mazes were given in the prescribed manner, except that the time taken over each trial was noted. The post-leucotomy results on these showed a loss of 1·82 years in M.A. In addition to this finding of loss of mental age on the Mazes, the number of double mistakes had increased. This seemed to indicate a decrease in learning ability, a phenomenon which may be associated with the poor results reported by Ritchie Russel in lobectomy performed on children.

Besides the quantitative changes on the Mazes, qualitative differences were

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also noted. The performance of the patient after leucotomy differs in two respects from his pre-leucotomy behaviour. He makes more mistakes and is significantly faster. Thus, in spite of the decrease in accuracy and the necessity in this test to do the whole Maze again when a mistake is made, there is a decrease in the time taken over all the trials of 2·72 minutes. I shall refer to this finding again. It will suffice to mention here that our results are in line with those reported by Porteus and Peters (1947) and Robinson (1946).

(b) *Neuroticism.*—Now let us turn to the neurotic indicators. "Body sway suggestibility," originally described by Hull (1933), has been shown to be one of the most efficient screening tests for neuroticism in a population containing both the severe neurotics and the milder forms of illness. The mean decrease in sway on this test after leucotomy was 3·06 inches. (It may be of interest to mention in passing that this test correlates highly with hypnotisability).

The work curve of the neurotic has been shown to be jagged and uneven, and to lack a maintenance of improvement when contrasted with the curve of the normal population. The rate of tapping in four quarter-minute periods was measured, and it was found that before leucotomy the mean deviation from the average was significantly greater than after the operation. A similar picture is produced on eight successive trials on the "Track Tracer," a machine designed as a selection test, which was kindly loaned by Prof. Bartlett from his Cambridge laboratory. Prior to the operation the relapses, that is, the losses in speed in the course of the trials, were greater than after the operation. Thus the curve of activity on both these tasks was significantly smoother.

(c) *Diminished introversion.*—Now if we consider the axis at one end of which is the anxious depressed introverted patient, and at the other, the hysteric, extraverted patient, the following measures have been shown to be characteristic of the anxious and depressed group:

(1) Greater persistence in a situation involving an uncomfortable physical position.

(2) A tendency to go for accuracy rather than for speed.

(3) High perseveration scores on motor tests of perseveration.

(4) Intropunitiveness, that is, a tendency towards self-blame rather than blame of the environment.

(5) A preoccupation with the past rather than with the present and the future.

(6) A high level of aspiration, that is, a tendency to aim at a goal beyond their ability, associated with a tendency to underrate their performance when completed.

I shall now report results of tests used to measure the changes on these criteria.

Our post-leucotomy patients showed a loss in persistence on the "leg-test," which has been successfully used to differentiate the syndromes within the neurotic population. An increase in the number of mistaken answers in relation to the number of correct answers was shown on the following Wechsler tests: Arithmetic, Picture-completion, Picture-arrangement. On a test in which words had to be formed out of a given nine-letter word, there was also a

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greater proportion of mistakes following leucotomy. On the Porteus Mazes, as mentioned previously, the number of mistakes had increased, although the total time taken over all the trials was less by 2·72 minutes. The same picture is presented on the "Track Tracer," where the time of the last try had decreased significantly, although the number of mistakes had increased. Furthermore, the time taken over the arithmetic test and for decision in the rating of pictorial humour had also decreased after leucotomy. Thus we have a distinct tendency for the post-leucotomy patient to go for speed rather than accuracy, in comparison with his pre-leucotomy behaviour. Whether we choose to describe these changes as an increase in impulsiveness, or as a decrease in cautiousness as some authors have done, is a matter of taste.

The pattern of behaviour on the level of aspiration test, for which the "Track Tracer" was used, changes after leucotomy, and moves from that which is typical of the anxious depressed person towards that of the normal individual. The discrepancy between goal and performance was less, and the gap between performance and the judgment had also decreased. The pre-leucotomy records showed that the patients over-estimated what they would do in the future, as well as under-estimating their past performance. After the operation their aspiration of future performance was closer to their real ability, and their estimation of past performance had improved. This indicated a greater reality adjustment on the part of post-leucotomy patients.

A test involving alternating work, which was shown by Cattell (1946) to be most highly saturated with the factor of perseveration, showed reduced P-scores following leucotomy. Judging from this and other measures, there appears to be an increase in flexibility in the performance of motor tasks.

As a measure of the tendency to self-blame, a list of 42 undesirable traits, ascribed to themselves frequently by anxious and depressed patients, was collected. Each of our subjects was asked to state whether he blamed himself for any of these faults. The mean decrease in the number of traits for which the patient blamed himself after the operation was 4·58.

The intensity of self-blame is also considerably less. That is, the diminution in the number of traits on which the patient blamed himself excessively, as opposed to those on which he blamed himself a little or a lot, had a mean of 2·58. The patient's new-found "attitude to the present and future" after leucotomy was shown by their subjective answers to eight standardized questions based on Israeli's work on attitude to time (1936). After leucotomy 22 per cent. more of the patients were most happy about their future, 43 per cent. more were most unhappy about the past. Correspondingly, 26 per cent. had ceased to find the present their main cause of worry, and 36 per cent had ceased to be most unhappy about the present. It is of interest also that prior to leucotomy 22 per cent. more of the patients had stated that they thought least about the present, and that 33 per cent. more had stated that they were most happy about the past.

We have here, then, a picture of a man who tends to leave his past behind him, lives largely in the present and looks hopefully to the future; in contrast to his pre-operative state, which tended to be orientated towards the past.

It is of interest that in contrasting the hysteric with the affective group of

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neurotics, the hysteric showed a relatively low vocabulary score in relation to performance score. Our post-leucotomy population had also lost more on the verbal scale than on the performance scale of the Wechsler: 7·21 as compared with 0·34. This difference in both populations may be partly due to a different temperamental approach to the tasks set, which is penalized on some tests of intelligence and not on others.

(d) *General.*—Among other differences that are of general theoretical and practical interest were the following:—The number of fluctuations on an ambiguous figure in a period of a minute had increased after leucotomy. The significant increase was found on the trial where the patient was asked to try and make the cube change. The patient appears thus to have greater control of the fluctuation. It is suggested by Gordon in an unpublished paper that this control of fluctuation is associated with greater control of imagery in general. This finding may be related also to the greater control of ideo-motor activity shown in the results on the suggestibility test.

Concentration was measured by the ability to remember groups of figures from a series which was interrupted at irregular intervals. After leucotomy there was a slight decrease on this concentration test, but it did not reach the level of significance. On the other hand, a test of "distractibility" was devised, on which the same task was performed, but to the accompaniment of the ringing of a vibrant telephone bell, and on this task there was an improvement of performance after the operation.

It would appear that post-operatively the patient is less bothered by extraneous stimuli. I did wonder whether this finding was related to the decrease in sensitivity to pain described by Fulton and others, as after carefully plugging my ears I had to brace myself to tolerate the intense unpleasantness of giving this test.

Although individually not reaching the level of significance, on two different approaches, time for the patient appeared to go more quickly after leucotomy. That is, a period of 60 seconds passed more quickly and the time taken over the first trial on the "Track Tracer" was underrated. This is mentioned, as it may be related to autonomic changes noted, and to a recent finding that time appears to go more quickly if internal temperature is raised.

The patients' attitudes to their condition also changed after leucotomy. Prior to the operation 75 per cent. thought they were ill, and 25 per cent. thought they would never get better. Afterwards 25 per cent. thought they were ill, but all believed that they would get better. Apart from deciding that they were no longer ill, they also ceased to saddle themselves with a number of unpleasant traits. In addition to a decrease in criticism of their own character a seemingly decreased critical attitude towards the use of language was shown. One of the interesting findings by the wayside was that frequently, after leucotomy, and never before, definitions and answers were produced in which common words were misused, or new words formed. In each case the experimenter pretended not to have heard correctly and repeated questioningly the phrase used. The phrase was then repeated by the patient verbatim. Examples: (Woman, verbal I.Q. 109·5.) A "hero" is a man who has "committed skill." Affliction is an "aside, affectation, people pretending what

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they are not." (Man, verbal I.Q. 120.) A " fable " is " a far-reaching tale " ; on questioning, stated he meant " that it reached far back into history." Dilatory is doing things " in a ship-shop manner." Espionage is " spy-ism " and so on. This seems to suggest a loss in the finer distinctions of language.

Conclusions.

Instead of giving a detailed summary of these findings, I will try to build up a picture of the patient as we have found him after leucotomy. Here is a person in whom neuroticism is less marked, especially as shown by a decrease in suggestibility, a smoother work curve and his attitude towards himself. There is marked decrease in the traits characterizing the anxious, depressive, introverted type. He goes more for speed and less for accuracy. He is less persistent in a situation requiring endurance. He blames himself less for the fewer undesirable traits he still ascribes to himself, now regarding these as inevitable. He lives less in the past, and more in the present and the future. He has lower motor perseveration scores, and the goal he sets himself and his judgment of his performance are closer to reality. He has dropped on verbal intelligence test scores, and on tests where impulsiveness is penalized. Learning is more difficult, but routine tasks once learnt are easier. He is also somewhat less distractible.

The personal effectiveness of a patient has changed after leucotomy as a result of all these changes in the conative, affective and cognitive spheres, and there seems little doubt that other changes will come to light with further research.

It is unjustifiable for us to consider apparent losses in, for example, verbal ability without noticing apparent gains, such as that less variation in performance is shown, that marks are gained for speed and so on.

This is a preliminary report following the first post-leucotomy re-tests, but it would seem to justify intensive further research along these lines. It is hoped to present a second report as soon as the 8-monthly retests are completed. An attempt is also being made to match each patient with another of similar personality, age, intelligence and severity of illness, who is not undergoing prefrontal leucotomy. We have had great difficulty in finding such patients, but the search continues. The general behaviour, however, of the neurotic population on re-testing is known, and no changes, for example, have been found on repeated applications of suggestibility, persistence and level of aspiration tests. On the intelligence tests used, where a change has been found on re-testing, it is, of course, an improvement, and not a loss such as these patients have shown.

These are the results on a group of severe neurotic rather than psychotic cases. The most convincing clinical results, according to some writers, are obtained from leucotomy performed on psycho-neurotics. From the point of view of this investigation, the condition of the patient enabled tests to be carried out to which it would have been very difficult to subject psychotics. Psychotics may, in fact, show the same or similar changes, but they have as yet not been demonstrated.

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Critical Ratios of Certain Differences Found after Leucotomy.

Intellectual Measures.

Loss on Wechsler Verbal Scale I.Q.	4·81
,, ,, Performance Scale I.Q.	0·24
,, ,, Full Scale I.Q.	4·02
,, ,, Comprehension Sub-test	4·42
,, Porteus Mazes I.Q.	3·14

Non-Intellectual Measures.

Decrease in body sway suggestibility	4·81
,, in variation from average in tempo of tapping	2·34
,, in excessive self-blame	3·53
,, in general self-blame	2·53
,, in physical persistence (Leg Test)	2·82
Increase in number of double mistakes in Mazes Test	2·47
,, in motor perseveration scores	1·90
Decrease in time taken over all Mazes	2·47
,, in time taken over final effort on Track Tracer	2·81
Increase in fluctuations of ambiguous figure (with effort)	2·24

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