PORTEUS MAZE CHANGES AFTER PSYCHOSURGERY

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OWING to the use of other therapeutic measures in mental hospitals, interest in brain operations undertaken for the relief of psychotic symptoms has fallen to a minimum. Hence, opportunities for studying the mental effects of such cerebral lesions are now practically non-existent. The investigation by Aaron Smith (1960) of the residual deficits as shown by the Porteus Maze Test in cases who had suffered topectomies eight years previously, as reported in this *Journal* in July, 1960, may very well be the last word on the subject. The time seems opportune, therefore, to make a brief summary of the results of a test that is now considered to be the most sensitive to frontal brain damage.

The failure to find adequate support from other tests for the belief that man's superior intelligence is closely associated with the great development of the pre-frontal regions of the brain was surprising to psychologists. Yet study after study indicated that there were only insignificant changes in standard tests, such as the Binet and Wechsler-Bellevue, following lobotomy. Hunt (1942), Petrie (1952) and others also found inconclusive evidence for declines in the scores of most performance tests. In the Third Research Conference on Psychosurgery (1951) held in New York, Carney Landis summed up the findings of the Columbia-Greystone projects as follows:

"In the test-by-test analysis of the results which were obtained, the only intelligence test which showed a uniform or almost uniform loss during the first month after operation compared to the pre-operative performance in this battery of tests (35 in number) was the Porteus Maze Test. Dr. Porteus had previously reported this sort of loss after lobotomy. We confirmed his finding that a brain operation performed on the frontal lobes gives rise to an immediate post-operative loss in mental age of 1 to 2 years, in some 80 per cent. of psychosurgery cases." He further declared that "there was nothing which showed itself as a systematic change in the tests of intellectual function, the tests of learning, or the tests of memory, with the exception of the Porteus Maze Test".

However, the fact that these losses were almost completely regained in later Maze examinations was interpreted as meaning that they were transient in duration. Relying on this evidence, Landis (1952) described the situation by declaring: "Prior to 1945 it was an accepted belief that higher intellectual functions were mediated by man's frontal lobes. Among the more recent investigators, only Hebb had seriously questioned this belief. . . . Frontal lobe surgery indicated in a conclusive fashion that any changes which were measured by the best standardized tests were transient and that there was no evidence of permanent intellectual damage. . . ." As Smith sums up, the findings of the three Columbia projects were unanimous; "no 'permanent' decrements in intellectual function resulted from psychosurgery." His continued study, however, has upset those conclusions by showing statistically significant losses for operated groups in the Porteus Maze and seven others of the fourteen individual measures.

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The transient nature of the Maze deficits after operation had been questioned by the senior author at the same conference, since the practice effects apparent after repeated application of the same form of the Maze would tend to mask the losses due to the operation. Sheer and Shuttleworth (1952), two of the collaborators in the second Columbia-Greystone project in which a variety of cerebral operations were effected (thalamotomy, venous ligation, thermocoagulation, transorbital lobotomy) gave two pre-operative Maze testings and demonstrated a mean practice gain of 2·1 years. Porteus and Peters (1947) reported a gain in non-operated criminal cases of 1·6 years. Petrie (1952) noted also a significant loss three months after posterior standard lobotomy, but in a second application nine months later, her subjects' losses did not quite reach the level of significance, "probably due to the increased practice effect which is known to be pronounced in this particular test".

In the discussion at the Psychosurgery Conference, Dr. Landis agreed that if a practice-free form of the Maze could be developed, and if it demonstrated greater decline and slower recovery, this would be acceptable as proof of permanent impairment. In 1955 the senior author did develop a new form of the Maze, called the Extension series, and showed that if repeated after the original or Vineland revision, it yielded on the average equivalent scores. However, by this time the advent of tranquillizing drugs in the U.S.A. made psychosurgical procedures so rare that there were too few cases with which to measure the real extent of the deficits.

There was, however, some indirect evidence. Robinson (1950) gave no pre-operative tests, but her examination of 68 Freeman-Watts patients who had undergone standard lobotomies with an average three-year lapse of time since operation yielded a score of only 10·3 years, whereas 12 control patients, improved to the point of discharge from hospital without operation, averaged 13·9 years. This difference of 3·3 years, compared with a Columbia-Greystone gain in controls of 1·6 years, plus a loss of 1·5 years in the operated group, made up a net loss for the latter of 3·1 years. Porteus and Peters (1947) also found a net loss of 3·3 years. These figures are so similar that the agreement does not seem likely to be coincidental. The last named investigators also noted that normal performance in the Maze Test shortly after operation was in some cases followed by a later decline, and suggested that previous mental abilities may persist in operation for some time, "running on their own momentum".

Fortunately Smith's persistence in following up patients has brought about a final solution of the question of the permanency of Maze Test deficits, at least as regards a group of schizophrenics retained in Rockland State Hospital, New York, and retested eight years after psychosurgery. The operations had varied in site. There were superior and orbital groups; the former had Brodmann's area 9 (sometimes part of area 10) and areas 8 and 32 excised; in the latter group, area 11 (sometimes part of area 47) and area 10 and Walker's area 13 were bilaterally excised. Subjects were also divided by age, a younger group averaging 42 years and an older with a mean age of 59 years. The Porteus Maze scores, according to Smith, were "unexpectedly definitive." Of the four aggregate measures and fourteen individual tests, "it was the most sensitive indicator of early and long term post-operative changes".

But one procedure in Smith's presentation had the effect of artificially reducing that sensitivity. He followed the plan set in the New York Brain Study of making a comparison of the first pre-operative Maze scores with the post-operative examination results. But just before operation a second application of the test had been made in which the mean scores of all groups rose as an

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obvious effect of practice. It would seem only reasonable that this second Maze performance should have been the base line of comparison. If we wish to measure how far a man has fallen from a ladder, we should measure from the level at which he stood just before the accident, not from some previous level.

Table I shows the comparative increase in Maze deficits if the score immediately before operation is adopted as the pre-operative base line. As will be

TABLE I

*First and Second Pre-operative Scores Compared with 8-Year Post-operative Performance**

Group	N.	Pre-operative I	Pre-operative II	Post-operative IV	Difference 1 and 4 Years	Difference 2 and 4 Years
Superior ..	17	13·88	14·74	10·00	−3·88*	−4·74†
Younger ..	12	14·67	15·54	10·58	−4·09*	−4·96†
Older ..	5	12·00	12·80	8·60	−3·40	−4·20†
Orbitals ..	10	8·65	11·55	8·45	−0·20	−3·10
Younger ..	7	6·93	9·71	7·57	+0·64	−2·14
Older ..	3	12·67	15·83	10·50	−2·17	−5·33†

* Data from Smith's Table I. S.D.s and Controls omitted.
† Significant at or above .05 level.

seen, the declines are more marked, especially in the orbital cases. Part of the decline is undoubtedly due to deterioration in Maze performance with increased age. However, unoperated patients could not properly be used as controls, unless it were possible to equate them with the experimental groups for speed of the ageing process, which was manifestly impossible.

If it could be proved that the Maze was the type of test in which age deterioration was more marked than in other tests, its greater sensitivity could be called in question. What evidence there is points otherwise.

Loranger and Misiak (1960) selected as subjects 50 out of 140 females, 74 to 80 years of age, resident in eight different homes for the aged. The criterion for selection was the absence of neurological, ophthalmological and psychiatric pathology, or other serious illness. The authors remark that "the atmosphere of institutionalization or isolation from the community was virtually non-existent." The median level of education was 9 years of schooling; the tests applied were the Porteus Maze, the Wisconsin Card Sorting Test, the Raven Progressive Matrices, the Digit-Symbol and the P.M.A. Reasoning Test.

The authors' finding was as follows: "The Porteus Maze yielded a broad range of scores, discriminating better among the elderly subjects than any other tests. Although half of the subjects have mental ages below 10 years, 16 per cent. have mental ages of 15 years or better . . . Practically no elderly person performs as well as the average adolescent and young adult, except on the Porteus Maze." In explanation of this relatively good performance, the authors suggest that foresight and planning capacity are less affected in some individuals by the ageing process than are abstract reasoning and perceptual-motor functions.

The present writers believe that one important factor in resistance to deterioration through age is the frequency of use of the function affected. Language capacity, for example, is resistant because of constant exercise even in old age. Similarly the making of decisions—business, social, family and personal—is frequently required of the elderly, and foresight and planning are

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usually involved. Disuse is probably one important factor in the loss of specific abilities, though of course decline in capacity and disuse interact. In any case, the greater comparative decline in Maze performance as evinced by Smith's data is evidently not due to greater vulnerability of the test performance to the inroads of age.

Willett (1961), in a review of the mental effects of psychosurgery, rightly emphasizes the importance of deciding what is examined by the Maze. "The function measured by the Porteus Mazes", he said, "is of considerable importance since, as we shall see, decreases in performance on this test do regularly follow from the introduction of frontal lobe lesions." He suggests that the Maze does not measure "only foresight and planning ability, but that low scores rather indicate a high degree of extraversion." Anyone who has had experience with the Maze test age scoring could not doubt that foresight and planning, whatever else is measured, are certainly required in successful Maze performance. They appear as evident as they do in a game of checkers or draughts.

Unfortunately, in supporting the suggestion that the Mazes measure extraversion rather than planning capacity, Willett mars an otherwise excellent review by confusing the two different Maze approaches, the test age and the qualitative scores. These have minus correlations of between only ·32 and ·56 (according to the type of subjects) and are thus susceptible to different interpretations of what they measure. Q-scores refer only to executive details of performance so that an individual who enters many blind alleys may get a very good Q-score. The facts that the higher the test age score the better the performance and the lower the Q-score (which is an error score) the worse the performance, have evidently led the reviewer astray.

Willett states that the original work of the senior author was with psychopaths "who regularly scored below normal groups", and goes on to say that this finding has been repeated many times, citing studies by Wright (1944), Doctor and Winder (1954), Purcell (1956) and Fooks and Thomas (1957). If mental defectives are to be considered "psychopaths", the statement as regards test age scores is true, but the researchers cited were not concerned with test ages. Their subjects, being delinquents, had higher Q-scores, almost twice that of normals.

Incidentally, it may be pointed out that R. W. Payne (1961), another contributor to the same volume edited by Eysenck, fell into the same error as Willett in confusing Maze Test ages and Maze Qualitative scores. In his chapter on Cognitive Abnormalities, Payne was reviewing a study by Poull and Montgomery (1929) and a follow-up study by Karpeles (1932) both of which were directed towards examining the present senior author's claim that the Maze was a better discriminative measure of social adjustability than the Binet. These two studies agreed in finding that a group of children at Governor's Island, New York, who were considered "well-adjusted" in conduct, obtained better Maze than Binet scores, while children with "conduct disorders" obtained worse Maze than Binet records. On the basis of these results, Payne makes the peculiar suggestion that the Maze Test is not well-standardized, presumably on the basis of its disagreement with the Binet, overlooking the fact that if agreement had occurred the claim would have been disproved!

His confusion evidently arose from the same basis as Willett's, since he quotes the same investigators and states that "instructions clearly forbid . . . cutting corners, crossing lines, lifting one's pencil and so on, while tracing through the mazes."* But Poull and Montgomery's (1929) and Karpeles' studies (1932)

* *loc. cit.*, p. 229.

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were done ten or more years before any such instructions were published as the basis of arriving at a qualitative score (1942). Hence they could not, as Payne asserts, account for the low scores of delinquents. Again, rare blind alley entrances give high test age scores, while frequent qualitative errors yield high delinquent scores. Had these authors been familiar with these applications of the Mazes they would have avoided any confusion in these matters.

Porteus and Peters (1947) reported that their subjects improved in Q-scores after lobotomy, despite the marked decline in the scores reflecting defects in planning and foresight. The Q-scores entirely depend on the capacity (and willingness) to follow instructions and hence are probably good measures of extraversion. In the mental test age scoring, cutting corners, crossing lines, lifting the pencil, making generally wavy or irregular lines do not affect the scoring one whit, so long as the subject avoids entering blind alleys, which is dependent on the exercise of foresight. Patients with bad tremors may make excellent test age scores, but wretched Q-scores. Eysenck (1955) apparently distinguishes the two approaches when he states: "The disregard for rules shown by criminals, psychopaths, and hysterics on the Porteus Maze Test when infringement of rules against cutting corners, lifting pencils, etc., *are scored independently of intelligence* (italics ours), again show the lack of socialization of the extraverted group (Hildebrand, 1953; Porteus, 1945; Foulks, 1951)."

In any case, the view that psychosurgery brings about deficits in planning capacity is unaffected. On the basis of Smith's data, it is apparent that the site of the operation is an important factor, the lower or more orbital the brain injury the smaller the loss. The age of patients is another factor, though in the superior operations it is not as important as in the orbital. However, the numbers are small, only 5 out of 17 and 3 out of 10 cases being in the older group.

One final consideration should be touched upon and that is the percentage of cases who showed deficits. Smith records that 16 out of 17 (94 per cent.) of the superior operates declined, and of the orbitals only 30 per cent. had deficits. His statement that these latter patients completely recovered eight years later must now be modified, their loss with the more logical scoring approach being 2·14 years.

But in all this, it must be remembered that Smith's subjects had been examined four times with the same form of the Maze. Had the more difficult forms, the practice-free Extension and Extension Supplement series, been available for use, one could have expected a considerable increase in the percentage suffering loss, especially in the orbital group, probably bringing it near 100 per cent.

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