SOME CLINICAL APPLICATIONS OF THE REY-DAVIS PERFORMANCE TEST.

By O. L. ZANGWILL, M.A.Camb.,

Brain Injuries Unit, Edinburgh.

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INTRODUCTION.

PROTAGONISTS of mental tests in clinical practice have hitherto shown a decided preference for methods of examination adapted to study capacities already developed or knowledge already acquired. Relatively little attention has been given to the study of *learning*, despite the fact that this function is so obviously affected in many and various neuropsychiatric conditions. One need only recall the widespread loss of plasticity so characteristic of the dementias and the more specific defects of learning associated with various types of focal lesion, e.g. of the language centres or the visual-association areas (*cf.* Cobb, 1944, pp. 214–5 ; Zangwill, 1945). It may therefore be urged that any technique of studying learning that is objective in character and easily adapted to the needs of routine clinical examination is worthy of attention. One technique which meets these demands will be described in the present paper, together with a small selection of the results obtained on routine psychological testing at the Brain Injuries Centre in Edinburgh.

A. Rey, in 1934, described a new device for studying the acquisition of a simple visual-motor habit. He pointed out that the technique might find a useful application in psychopathology, and reported some observations on individual clinical cases (Rey, 1934, pp. 326–37). The method, christened by Rey the *manual labyrinth*, has since been extended by Russell Davis in Cambridge, and has consequently come to be known among clinical psychologists in this country as the *Rey-Davis Performance Test.**

The test consists of four 6-in. square boards, on each of which are three symmetrical rows of three pegs (Fig. 1). Eight of the nine pegs on each board are removable ; one is fixed. The fixed pegs are in the positions shown in Fig. 1. The examiner presents the boards in a regular sequence, and the subject is required to discover, by trial and error, the fixed peg on each consecutive board. He is then given the boards in the same order and again required to demonstrate the fixed pegs, but this time with the maximum possible economy of choice. The procedure is continued until the subject can indicate unhesitatingly the position of the fixed peg on all four boards on two consecutive trials (Zangwill, 1943). When learning is thus stably acquired, the test may be prolonged (and incidentally made harder) according to Davis's method of rotating the boards progressively through

* I am greatly indebted to Dr. A. Rey, of the University of Geneva, for introducing me to his test in 1939 and for his kind permission to experiment with it further. I have also to thank Dr. D. Russell Davis, of the Cambridge Psychological Laboratory, for acquainting me with his modification of the technique and for so kindly placing some of his unpublished data at my disposal.

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a right-angle. Should the patient fail at any point and again make wrong choices on any board the learning procedure is resumed as before until two consecutive successes have been recorded. A complete test will thus comprise the appropriate number of trials with the boards at the standard position (shown in Fig. 1), together with all further trials with the boards rotated through 90, 180 and 270 degrees respectively. If desired, a final re-test may be given at the standard position. The number and distribution of errors are recorded in detail in the manner advocated by Rey (1934, p. 304). If desired, the duration both of the total learning period and the individual trials may be timed. The method possesses the general advantage of performance tests in providing an interesting setting for the display of various types of personality reaction, and any striking features of test behaviour should be carefully noted.

Rey's original work was devoted in the main to studying the evolution of learning and learning methods in young children. He was led to distinguish five methods of approach to the test problem forming an approximate series of genetic levels. These were termed: (*a*) Isolated choice; (*b*) systematic choice; (*c*) unilateral perseveration; (*d*) limited experimental behaviour; and (*e*) comprehensive experimental behaviour. The five methods of approach may be briefly explained:

(*a*) *Isolated choice:* This is seen in children of under 4. Response is confined to grasping an individual peg at random, and performance betrays no understanding of the real problem. There is consequently no learning. (*b*) *Systematic choice:* This is generally shown by children of between 4 and 5 years. The child tests the pegs on each board in a systematic fashion, but repeats the procedure (which is, of course, appropriate to the first trial alone) on all later trials. Repetition leads to no economy of moves, and there is, in consequence, no learning. (*c*) *Unilateral perseveration:* This form of reaction is seen in children from 5 to 6 years. The child discovers the constant position of the fixed peg on *one* of the boards, but proceeds to attack the others as though his discovery held good for them too. Thus if the board in question is the second (centre peg fixed), the child's first choice on the other three boards is consistently the centre peg. Learning is obviously only partial. (*d*) *Limited experimental behaviour:* This is shown by children over 6. The subject betrays real understanding of the task and its learning possibilities, but confines his analysis of the situation to the individual boards. He does not manage to evolve any kind of scheme linking the reactions on all four boards. Again, learning may be incomplete. (*e*) *Comprehensive experimental behaviour:* This is the normal procedure in older children and in adults. The subject endeavours to relate, in visual or verbal terms, the order and positions of the fixed pegs on the successive boards. The evolution of such a scheme naturally renders learning very easy and, in consequence, the test seldom gives difficulty to a normal adult (Davis, personal communication, 1943). Rey is careful to point out that these five genetic stages, or levels, of reaction are not rigidly discrete, and he does not attempt a systematic analysis along the lines of the Binet Scale. It is the principle rather than the form of the classification upon which he lays stress (Rey, 1934, p. 322).

A short summary of Rey's work in abnormal subjects may now be given. In *mental defectives* he finds that the method of approach displayed by the subject typically corresponds to one of the procedures shown by normal children below six years of age. Thus the level of isolated choice is seldom surpassed by imbeciles, whereas systematic choice is the rule in morons. Direct choice and unilateral perseveration first appear in the high-grade defective, and at this mental level some learning (albeit slow) is, as a rule, observed. Rey considers that the test performance in defectives can be viewed as the persistence of an "inferior" type of response, and reflects the low general level of mental organization (Rey, 1934, p. 329). In cases of

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mental deterioration he suggests that the test may prove distinctly useful in defining the general level of retained cognitive function, and is able to present some interesting individual records from cases of G.P.I. and post-traumatic deterioration in support of his claim (Rey, *ibid.*, pp. 328–37). In conclusion he describes the results given by two cases of *amnesic syndrome* (associated with lesions of the prefrontal areas), and suggests that the method may prove helpful in the differential diagnosis of organic and psychogenic disorders of memory (Rey, *ibid.*, pp. 332–37). Rey's work, although admittedly limited in scope, is an admirable example of imaginative and thoughtful mental testing in the clinical sphere.

Russell Davis's work with the test, unfortunately not yet published, includes studies of normal adults, post-traumatic conditions, and a small group of psychoneurotic subjects. His principal findings, which he was kind enough to communicate to me, may be briefly summarized:

(*a*) *Normal adults:* Davis reports that the test, even when complicated by his rotation procedure, is too easy to evoke much interest. Of 28 normal young adults, 24 mastered the standard sequence and three consecutive rotations in six trials (or even fewer). The largest number of trials required by any one subject to master the four positions was 16. On the other hand, it is only fair to point out that Dr. M. B. Brody reports far greater variability in some preliminary work with the test in normals (Brody, personal communication, 1945). More extensive standardization will obviously be needed before the test can be advocated as a quantitative procedure for clinical use. (*b*) *Post-traumatic conditions:* Stereotyped errors are common, especially those in which the subject insists on several consecutive trials on a choice which had been correct at a previous orientation of any given board. Davis also reports that organic cases are in general "wasteful" of moves and errors greater than in the normal. (*c*) *Psychoneurotic conditions:* In certain cases Davis was impressed by a certain irregularity (or instability) of learning. Such cases may " . . . come very near success and then make an extravagant number of mistakes again" (Davis, personal communication, 1943). Trist (1942) has reported similar observations in neurotic patients, and stressed the fact that a sudden breakdown of performance, associated with a sharp rise in errors and obvious signs of emotional upset, is often precipitated by progressive rotation. The present writer has likewise called attention to anomalies of tempo and procedure commonly observed in testing psychoneurotic cases (Zangwill, 1943).

In view of the fact that this paper will be very largely concerned with Rey-Davis performance in cases of cerebral lesion, a short summary of the present writer's earlier observations on the test in organic conditions is perhaps in place. It was pointed out (Zangwill, 1943) that cases with any degree of retention defect on an organic basis commonly displayed slow learning and a number of qualitative deviations from normal performance. The latter were classified provisionally as follows:

(1) *Stereotyped error:* A pattern of response evolved on any one trial with any given board is repeated without change on several of the following trials with the same board. (2) *Confusions of sequence:* The response appropriate to any one board is consistently elicited by one of the other three. (3) *Unstable learning:* Continued testing (even without rotation) may provoke breakdown after learning appears to be fully established. (4) *Forgetfulness:* Errors occur which appear to be due to momentary absent-mindedness and which are often self-corrected. (A good practical criterion is the reappearance of errors on the second board—centre peg—after at least two error-free trials on this board.) (5) *Breakdown on rotation:* Rapid learning at the standard orientation is followed by breakdown and inadequate re-learning after one or more rotations of the boards.

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It was emphasized in our earlier report that these five traits are not exclusively shown by organic cases, and not every such case can be relied upon to display them. In particular, unstable learning with breakdown on rotation may, as we have seen, be observed in neurotics. But these cases commonly show a marked anxiety reaction to the test as a whole, and their performance is apt to give a very different impression to the experienced examiner. Stereotyped patterns of error, furthermore, are rarely seen in the purely functional case. Indeed Davis has himself been unable to detect them in his own material, and they have seldom been recorded in neurotic conditions by the present writer. At the same time, it must be emphasized that more detailed work is needed before any specific feature of Rey-Davis performance can be regarded as pathognomonic for purposes of differential diagnosis. We venture to hope that the records presented in this paper will provide some broad indications of the types of analysis required, and furnish a background for more specific future studies.

II. Cases.*

The cases included here fall into three groups. The first comprises three cases of concussional head injury tested in the acute state, and re-tested after full recovery from the phase of post-traumatic confusion. The second consists of three cases of post-concussional syndrome. In two there were minor cognitive disabilities but no abnormal emotional reaction. The third was a case of post-traumatic anxiety neurosis without significant organic intellectual disability. The third group comprises three diverse and rather more specialized clinical conditions. The first case presented a number of high-grade visual symptoms associated with a fronto-parietal lesion of the right cerebral hemisphere. The second was a case of gross motor aphasia. The third showed a complicated condition in which hysterical symptoms were associated with an organic syndrome in a case of left frontal cerebral atrophy. These cases are included partly for theoretical reasons, and partly because they illustrate the diversity of material that a clinical psychologist may be called upon to study and assess.

Group I: Acute Concussional Head Injury.

Case 1.—Man, aged 29. High-grade intelligence and secondary education. Sustained concussional head injury with retrograde amnesia 1 hour and P.T.A. 3 days. Showed at first a gross memory retention defect, which rapidly improved during the first week in hospital and cleared up completely before discharge. Air-encephalography showed some degree of post-traumatic brain atrophy. The patient was tested 6, 10 and 20 days after date of injury.

Case 2.—Man, aged 28. Average intellgence and elementary education. Sustained moderately severe concussional head injury: unconscious 90 min. and confused for 4 weeks. P.T.A. 4 weeks. Thereafter good recovery and no residual psychological disability. Tested 3½ and 7 weeks after date of injury.

Case 3.—Officer, aged 28. Intelligence high grade and University education. Sustained very severe concussional head injury. Unconscious 1 week; confused, disoriented and amnesic for 7 weeks. Recovery slow in all spheres. Residual

* I wish to thank Mr. Norman Dott, Director of the Brain Injuries Unit, for his kind permission to study these cases and to reproduce extracts from his records.

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psychological disabilities 8 months after injury were moderate intellectual and memory deficit and some degree of personality change. Tested 8 and 12 weeks after date of injury.

Group II : Post-Concussional Syndromes.

CASE 4.—N.C.O., aged 27. Good average intelligence and elementary education. Sustained concussional head injury with compound fracture of skull; retrograde amnesia 5 min. and P.T.A. a few hours. Displayed post-traumatic syndrome of headache, giddiness, proneness to mental fatigue and very slight executive dysphasia. Tested 3½ months after date of injury.

CASE 5.—N.C.O., aged 32. Good intelligence and highly satisfactory previous work-record. Sustained concussional head injury with fracture of skull; retrograde amnesia 30 min. and P.T.A. 3 days. Two weeks after injury showed post-traumatic syndrome of headache, giddiness, absent-mindedness and slight intellectual impairment. Six weeks later had fully recovered from these disabilities and showed no residual psychological changes. Tested 4½ weeks after date of injury.

CASE 6.—N.C.O., aged 31. Average intelligence level and elementary education. Sustained concussional head injury two years previous to admission to Brain Injuries Unit with chronic post-concussional sequelae. It was concluded that the latter were being maintained on a psychogenic basis and were associated with considerable anxiety and depression. Tested 26 months after injury.

Group III : Special Conditions.

CASE 7.—Man, aged 26; right-handed. Average intelligence and good previous record as a skilled manual worker. Sustained through-and-through bullet wound of head with resulting atrophy of right cerebral hemisphere, especially marked in the frontal region. Chronic left-sided hemiplegia and hemianaesthesia, organic constriction of visual fields, marked disorders of visual space perception (visual-spatial agnosia) and associated constructional handicaps. No defect of general memory, but some intellectual deficit. Tested 8 months after injury.

CASE 8.—Man, aged 38; right-handed. Superior intelligence level, University education and high professional qualifications. Sustained a virtually complete motor aphasia with right hemiplegia from a left-sided vascular lesion. The patient was tested 2½ years after onset of illness, at which time aphasia was still almost total, but the patient had acquired considerable dexterity in the use of the left hand, with which he performed the test.

CASE 9.—Man, aged 37. This patient had a history of left cerebral thrombophlebitis in addition to concussional head injury. There was evidence of left frontal cerebral atrophy, and almost certainly some degree of organic intellectual and personality change. This, however, had been grossly exaggerated on an hysterical basis, giving the picture of pseudo-dementia (Ganser syndrome). The patient was tested 18 months after original hospitalization for present illness.

III. TEST PROCEDURE.

The general procedure, following that of Davis, has been described in the Introduction. Progressive rotation of the boards was practised in every case (with the exception of Case 9), but was not, as a rule, continued if performance broke down badly at any one position. The number and location of errors ("wrong choices") were carefully recorded, together with any qualitative observations (e.g. peculiarities of tempo or anxiety reactions) of special interest. The tests were not timed, and the subjects were encouraged to work at their natural rates. No help or advice was given at any point.

It has been thought convenient for purposes of exposition to number the boards 1 to 4 and the successive orientations I to V. Fig. 1 shows the four boards at the standard orientation, which we call *Position I*. The first clockwise rotation through

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a right angle brings the boards to *Position II*, the second to *Position III*, and the third to *Position IV*. A final rotation, bringing the boards back to the standard orientation, was generally undertaken, and this will be called *Position V*. Positions I and V are of course identical.

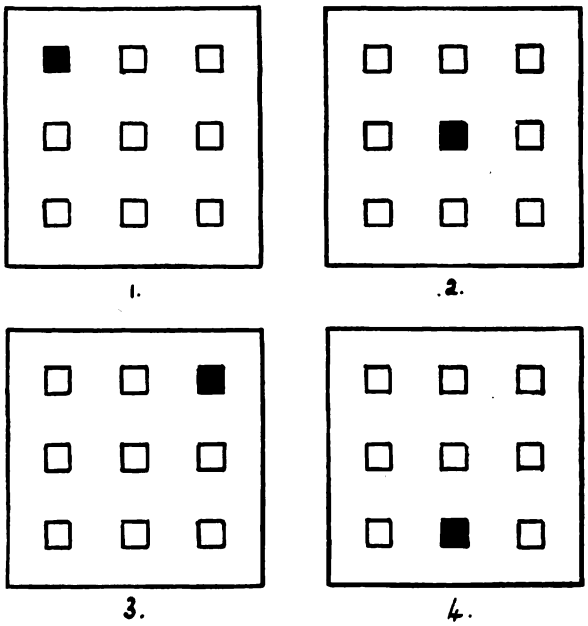

FIG. 1.—The Rey-Davis Boards, showing positions of fixed pegs at the standard orientation.

IV. RESULTS IN GROUP I.

The results in this group show (1) severe disturbances of learning and performance in the post-traumatic confusional state; and (2) marked improvement in test performance following full recovery of ordinary consciousness. The final records in Cases 1 and 2 suggest no residual disability, whereas the corresponding record in Case 3 indicates some persistent impairment of performance. We may briefly describe the main features shown by the individual cases on early and late testing.

Case 1.

Test 1.—The learning curve is shown in Fig. 2 (*a*). Despite the patient's failure to master the task at the standard position in 10 trials, it will be noted that the curve gives some evidence of progressive improvement. Scrutiny of the original record showed that there was only one case of success on two consecutive trials with any one board (Board 3, Trials 8 and 9). An analysis of the patterns of choice-reaction on the individual trials showed that there was a marked *perseverative error-reaction* to Board 2 (normally the easiest choice to learn) from the 4th to the 10th trial inclusive. On all these trials the patient invariably chose first the peg to one side of the fixed peg, while his second choice was correct.

Test 2.—The learning curve for the standard position is given in Fig. 2 (*b*). It will be seen that learning is slow, but the last two trials are error-free. Inspection of the original record showed that there was a marked *differential effect* in the rate at which correct choice to the various boards was acquired. Thus there were no mistakes on Board 1 after the 3rd trial or on Board 2 after the 6th trial, but errors

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persisted on Boards 3 and 4 until the 9th trial. The stereotyped error described above in connection with Board 2 reappeared on the present test, but was eventually eliminated.

Test 3.—It will be seen from Fig. 2 (*c*) that learning of the required pattern of choice is now much more satisfactory. In the first place there is obviously some retention of what had been learnt on the previous test, and no errors were made on Boards 1 and 2 on any trial. In the second place there is good *transfer* of the response pattern with rotation of the boards to Position II. Further rotation was not undertaken in this case.

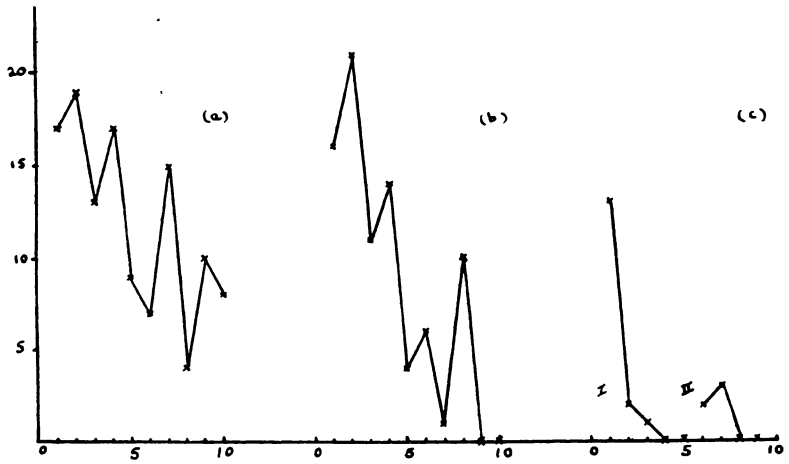

FIG. 2.—Learning curves in Case 1. (*a*) Test 1; (*b*) test 2; (*c*) test 3. Ordinate: Errors. Abscissa: Trials.

This case demonstrates clearly a gross impairment of learning associated with a post-traumatic amnesic state of short duration, and the progressive improvement in performance in the course of its remission. In view of this patient's good intelligence, and his capacity, even whilst confused, to reach a high level on ordinary intelligence tests, his slow learning on Test 1 with failure to master the required response to any board (including the second) is somewhat striking.

Case 2.

Test 1.—The performance in this case gives a rather different picture from that of Case 1. We see from the learning curve (Fig. 3 (*a*)) that errors are rapidly eliminated at Position I and that learning is virtually complete after three trials. There is perfect transfer of response with rotation to Positions II and III, but a *well-marked breakdown on further rotation to Position IV*. Indeed errors at this position are not eliminated completely with as many as eleven consecutive trials. On rotation to Position V (the standard position), on the other hand, the correct responses are rapidly reinstated.

An analysis of the record of errors at Position IV brings out some interesting features. On the first and second trials errors were made on every board except the second, but on the third trial errors were made only on Board 3. On the fourth trial, however, the patient, after having chosen correctly on Board 1, *made a whole series of errors on Board 2*. He tested every peg except the centre one, and several of them more than once. Thereafter, performance remained very defective and betrayed a *persistent confusion between Boards 2 and 4*. Thus in the case of Board 2 the first choice was always that appropriate to Board 4, and *vice versa*.

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Further, a *stereotyped error reaction* was noticed in connection with Board 4 on four consecutive trials. In all these cases the patient's first choice was the centre peg and the second the correct one.

Test 2.—The learning curve is shown in Fig. 3 (*b*). The high aggregate of errors on the first trial indicates that there has been little, if any, retention of what was learnt on Test 1. On this test, however, learning is rapid, and transfer is effected very satisfactorily with progressive rotation.

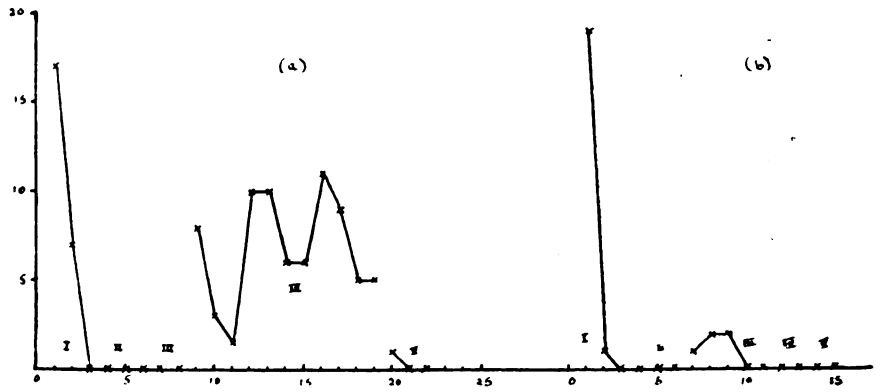

FIG. 3.—Learning curves in Case 2. (*a*) Test 1 ; (*b*) test 2.

The main points of interest in this case are (1) the profound disruption of performance following rotation to Position IV, and the patient's virtual inability to re-learn the required sequence at this position ; and (2) the marked improvement in performance associated with recovery from the post-traumatic confusional state. The results on Test 2, indeed, can safely be said to lie within the normal range.

Case 3.

Test 1.—Fig. 4 (*a*) shows that learning at the standard position is rapid, and that transfer to Position II is reasonably adequate. On rotation to Position III, on the other hand, there is a very marked breakdown after the first trial. Our record in this case indicates that the breakdown was precipitated by an *unexpected error*

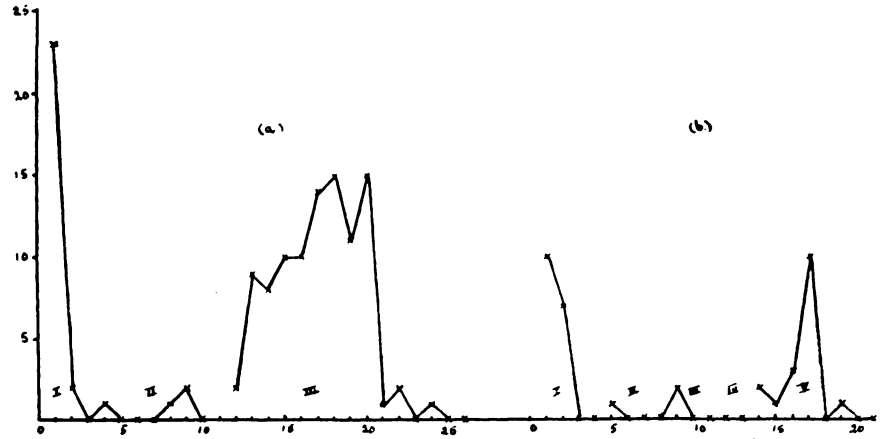

FIG. 4.—Learning curves in Case 3. (*a*) Test 1 ; (*b*) test 2.

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on Board 1, which had been dealt with correctly on the previous trial. Before discovering the fixed peg, the patient tested every loose peg on the board, several of them more than once. On the following trial he made mistakes on *every* board. This suggests that the behaviour pattern acquired at Position I and carried over without undue difficulty to Position II had undergone complete disruption. The correct responses were reacquired very slowly, and ten trials were required before a complete success on all boards was once again registered. It was noticed that from the 5th to the 9th trial at this position the patient's first choice on Board 1 was invariably the bottom right-hand peg. This is another example of what we have called *stereotyped error*. In view of the patient's evident fatigue, the test was given up after the 26th trial.

Test 2.—The results are shown in Fig. 4 (*b*). It will be seen that learning is rapid at Position I, and the pattern of response adequately maintained until Position V had been reached. There was, however, a marked increase in errors on the 4th trial at this position. Analysis of the errors showed that no fewer than four out of the 21 trials were marked by one or more errors on Board 2.

This case resembles Case 2 in showing a marked disruption after rotation with obvious difficulty in re-learning the required sequence. The re-test, on the other hand, gives evidence of fairly marked residual disability. One need mention only the transient increase in errors at Position V and the relatively large number of errors on the second board. This case, as we have said, not only sustained by far the most severe head injury, but also displayed residual defects in a number of high-grade performance fields.

V. Results in Group II.

The results in this group show (1) some characteristic effects of a mild organic post-traumatic condition on Rey-Davis performance; and (2) special features associated with a psychoneurotic reaction (Case 6).

Case 4.

The record is given in Fig. 5. One may note (*a*) that learning is rapid at the standard position; (*b*) that there is excellent transfer to Position II, and *on the first trial* to Position III; and (*c*) that the errors on the remaining trials at the latter position show progressive increase. The deterioration at Position III was almost certainly precipitated by an unexpected mistake, in this case on the second trial with Board 4. On the following trial errors were made on two of the boards which had been dealt with correctly on the previous trials (disruption effect), and thereafter no trial was wholly free from errors on at least one board. Even Board 2 was involved in one case. The test was eventually discontinued in view of the patient's evident distress at his failure to re-learn what had at first been learnt so readily.

The main interest of this record lies in the fact that it shows that disruption of performance with rotation is by no means confined to acute conditions (as in Cases 2 and 3). The disruption effect in this case, moreover, is especially striking in view of the rapid initial learning and the relatively mild character of the patient's symptoms.

Case 5.

The complete record is given in Fig. 6. It will be seen that 38 trials were required to complete the test despite the low general level of errors after the first trial. At Position III no fewer than 12 consecutive trials were needed to register two consecutive successes, although the very first trial at this position had been

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free from errors, and the maximum number of errors on any one trial was only three. Thus it is plain that the pattern of response showed a rather marked instability. Of the first 26 trials, moreover, no less than seven involved errors on Board 2. This suggests a degree of absent-mindedness far in excess of the normal.

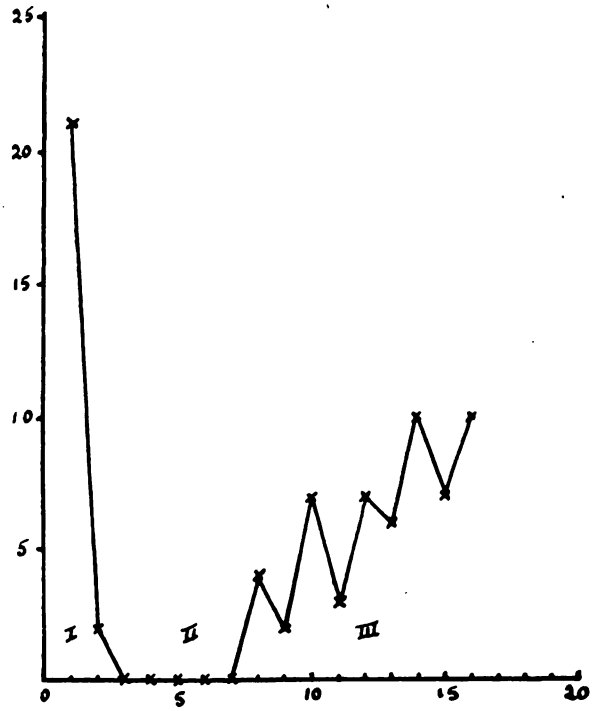

FIG. 5.—Learning curve in Case 4.

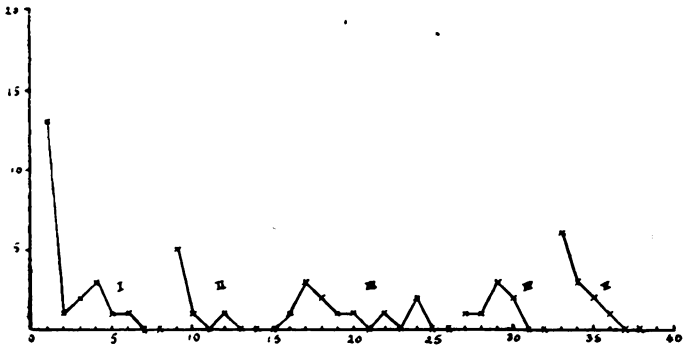

FIG. 6.—Learning curve in Case 5.

In other cases errors appeared to be due to transient perseverative reactions, and in some cases betrayed an insistence on a position which had been correct at a previous orientation of the boards.

The main features shown by this case are thus (1) a high aggregate of errors but a low proportion of errors per trial; (2) frequent errors on the second board; and (3) a certain instability of the choice reactions when once acquired. It

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was noteworthy that this patient was exceptionally keen to acquit himself well on the test, and much surprised by his slow learning and irregular performance.

Case 6.

The record, shown in Fig. 7, bears some resemblance to that of Case 4. The curve is more irregular, however, and the total of errors considerably higher. The most striking features of this performance, which cannot be represented graphically, were the *marked anomalies of tempo and procedure* shown on every trial after the first. As each successive board was presented, the patient surveyed it anxiously for a considerable period (often more than a minute) before venturing to select a peg. He then made a sudden, rapid, darting movement and, if the choice were wrong, either repeated the delay, or tested the remaining pegs with an almost feverish rapidity. This peculiar " hover-and-pounce " reaction was shown even in the case of Board 2, on which the patient made no mistakes of choice after the first trial. It was not therefore called forth by true uncertainty. The patient often re-tested a

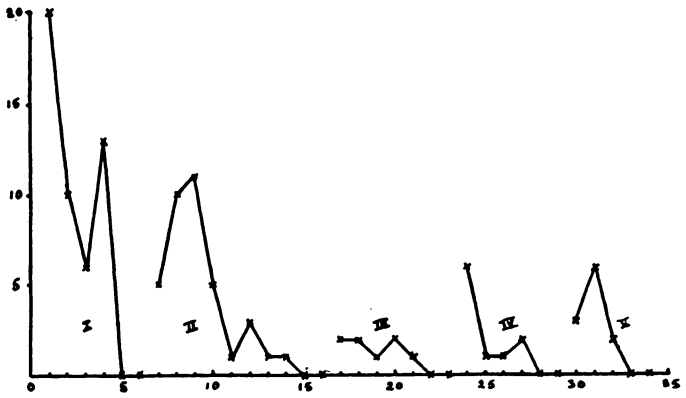

FIG. 7.—Learning curve in Case 6.

given peg more than once on the same trial, and on one occasion tested the same peg twice in succession! He displayed obvious anxiety in the test situation, and had to be constantly encouraged to persevere. In this case, unlike those tested by Trist (1942), the anxiety reaction was not appreciably exacerbated by rotation of the boards.

In this case the peculiarities of tempo (" hover-and-pounce " reactions) and the marked anxiety dominated the test picture. Indeed the insecurity shown by the patient in his choice reactions was at times so marked as to suggest a larval *folie de doute* reaction. Although learning was admittedly slow and errors many, there were none of the clear-cut confusions and stereotyped errors which have been described in the earlier cases. The abnormal traits in this case can be ascribed with very fair certainty to a psychoneurotic anxiety state.

VI. RESULTS IN GROUP III.

The records in this group illustrate the effects of some rather more specialized neuropsychiatric conditions upon test performance. The first case demonstrates the way in which a specific defect of visual cognition may lead to gross abnormality in the test setting. This patient, although not actually

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disoriented in central vision, experienced much difficulty in counting scattered objects and in appreciating high-grade spatial relations.* There was also some evidence of a specific memory defect for visual material. The record in this case is included partly in view of its intrinsic interest and partly on account of its superficial resemblance to a psychoneurotic reaction. The second case has been included to give an indication of the test performance of a highly intelligent patient with a very gross disorder of language. This patient was totally aphasic apart from a very few automatic and reactive responses. The third case, which showed hysterical as well as organic mental symptoms, is included in view of its bearing upon practical problems of differential diagnosis in the psychological sphere.

Case 7.

The patient's learning at Position I was very slow, 14 trials being needed. He was quite unable to transfer the pattern of response to Position II, and the test was discontinued after a few trials in this position in view of the difficulty it caused him. It was very noteworthy that the patient was at first *unable to appreciate that the position of the fixed central peg on Board 2 was unaffected by rotation.* He remarked spontaneously *à propos* of this Board after rotation that: "It was the centre, but it wouldn't be the centre now it's turned round." This is a good example of the patient's grossly defective grasp of a very simple spatial relationship. It was also noted that the patient's difficulty in *systematic ocular exploration* led him from time to time to re-test pegs which he had already found to be movable a second or two before. Unlike Case 6, however, this tendency was due to his organic disability, and did not depend on an anxiety reaction in the sense of *folie de doute*. In view of this patient's gross ocular and perceptual disabilities it is creditable that he managed to learn the task at all.

Case 8.

This patient was twice tested with an intervening interval of three months. On the first test he learnt the required responses rapidly at the standard position (4th and 5th trials correct), but performance broke down badly after the first rotation. Only the response to Board 1 showed transfer, and errors were frequent on the remaining boards throughout the 11 trials at this position. In three cases errors appeared on Board 2. On the second test the patient was a good deal slower in achieving two consecutive error-free trials at the standard position and 11 trials were required. Boards 1 and 2 were quickly learnt, and there were no errors on either after the first trial. But errors on the other two boards were eliminated very gradually.

Case 8 was an extremely well-endowed patient, and still reached a high level on performance tests of intelligence. It is therefore tempting to correlate his poor performance on the Rey-Davis test with his inability to formulate the sequence and relationship of the required responses. At the same time it must be borne in mind that comparable records are quite often obtained from cases of organic deterioration without aphasia, and that certain aphasic cases we have had occasion to test have performed very much better than this patient.

Case 9.

The record given by this case at Position I is shown in Fig. 8. The patient was given 18 consecutive trials at this position, but succeeded only in learning the response to Board 2. After he had learnt this, he approached every board on the

* For an account of the general nature of the disability in a case of this kind, see Paterson and Zangwill (1944).

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succeeding trials by testing the centre peg (Rey's *unilateral perseveration*). The total of errors per trial shows considerable fluctuation, but there was no evidence of a tendency for errors to diminish after Board 2 had been learnt. The patient's attitude to the test was apathetic, and betrayed no real effort to learn. Rotation was considered superfluous in this case.

This case is not altogether easy to assess. The tendency to unilateral perseveration is, of course, a low-grade response, and not inconsistent with an organic deterioration. The apathy and lack of any real effort to succeed, on the other hand, suggest an emotional disorder. The diagnosis reached in this case was organic deterioration with pseudo-dementia.

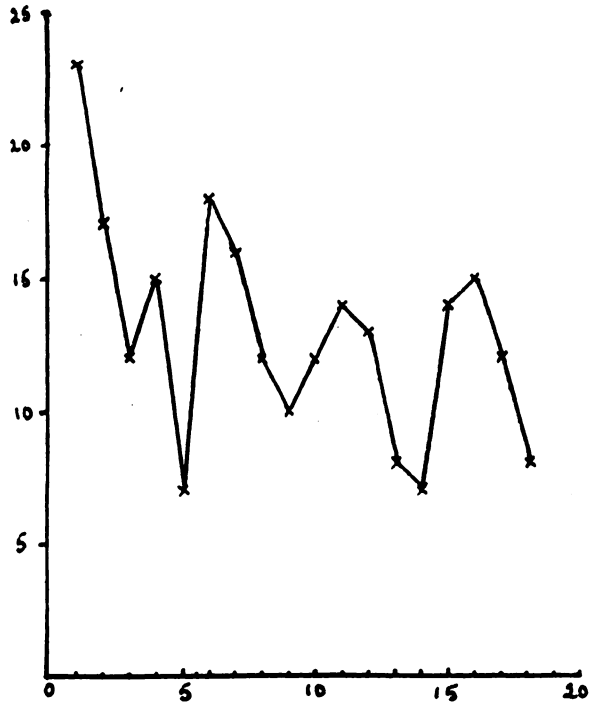

FIG. 8.—Learning curve in Case 9.

VII. DISCUSSION.

Let us consider first the results in the *acute* traumatic conditions. We have seen that only one of the three patients in Group I failed to learn the task at the standard orientation of the boards, and so gross a failure is (in our experience at least) somewhat exceptional. Both the other patients in this group learnt the task rapidly at the standard position, and their performance deteriorated only with progressive rotation of the boards. A comparable breakdown on rotation is extremely common in cases of head-injury and, as we have seen from Case 4, is by no means restricted to the acute condition.*

* Dr. E. Guttmann, who has a wide experience of the Rey-Davis test in post-traumatic conditions, has noted the tendency for performance to break down after rotation in a large proportion of his material (Guttmann, personal communication, 1943).

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We have noted that the breakdown commonly follows upon an *unexpected error* on the part of the patient, and the resulting disruption of response can probably be viewed as a *catastrophe reaction* (Goldstein, 1939). The latter is probably provoked by the increasing difficulty in adapting the original pattern of response to the changing positions of the boards, and no doubt precipitated by the sudden and unexpected error of choice. The fact that comparable breakdowns are observed in neurotic patients (Trist, 1942) is no real objection to this point of view. The psychoneurotic subject, more especially one of the anxious type, is prone to catastrophe reaction in much the same way as the organic case, although in his case the reaction as a rule bears a less close relationship to the degree of difficulty of the task, and the justification of real intellectual handicap is, of course, lacking. From the practical point of view it may be borne in mind that disorders of tempo and procedure of the type described in Case 6 are extremely common in psychoneurotic cases, and in practice it is seldom difficult to judge whether a specific breakdown on the test is or is not due to a purely affective condition.

It is notable that the *learning procedure* in our acute cases betrayed no obvious reversion to the "inferior" types of response and procedure distinguished by Rey (1934). All our patients attacked the task in a more or less systematic manner, and the type of approach displayed was truly on the "experimental" level. Their relatively poor performance (especially after rotation) appeared to derive, not from faulty grasp of what was required, but from simple perseveration of incorrect responses and abnormal difficulty in eliminating specific errors of choice. Thus in errors of the kind which we have called "confusions of sequence," it was plain that mere repetition did not permit the subject to correct the dislocation that had crept into his verbal (or motor) scheme of response. The influence of perseveration is seen even more clearly in what we have called "stereotyped error patterns." Here specific errors of choice are not eliminated after one or two trials, as in the normal, but persist in exactly the same form through a whole series of trials. One may conclude that in patients of this type deterioration is shown, not in faulty and low-grade procedure, but in specific difficulties of learning and execution. The *method* of procedure is intact, but its *realization* is defective.

The records given by two of our three cases of *post-traumatic syndrome* are quite representative of a large number of our records of patients with history of concussional head injury. In the more severely impaired cases (as in Case 4) breakdown on rotation with defective re-learning is surprisingly common. In the less severely handicapped cases (of which Case 5 is an admirable example), the record typically shows a relatively large number of trials with a relatively small proportion of errors per trial. In these cases, further, a certain *forgetfulness* (as shown, e.g., by a relatively large number of isolated errors on Board 2 after it has once been learnt) is commonly in evidence. The general impression given by such cases is one of *inefficiency* rather than true deterioration. Superficially at least, their behaviour has much in common with that of the normal person in a state of extreme fatigue. Our third case in Group II has been chosen to illustrate a psychoneurotic *anxiety reaction* in the context of a post-concussional syndrome. In this case it was seen that learning was slow and

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errors many, and that a number of striking deviations from normal procedure were displayed. These comprised erratic tempo, ill-balanced exploration, and an anxiety relating to correct choice so pronounced as to suggest a larval *folie de doute*. Behaviour of this kind is extremely common in anxiety states with or without history of head injury.

The findings in our third group of cases, though of considerable interest individually, are too scanty to permit us to draw any general conclusions. Case 7 is a particularly good illustration of the manner in which a focal defect of visual perception can influence the results on a test of this kind. This patient, as we have shown, had the greatest difficulty in exploring the pegs in a systematic manner, and was unable to appreciate the simple fact that the fixed (central) peg on Board 2 would not change its position on rotation of the board through a right angle. This defect of spatial judgment, so gross as to suggest malingering to the unwary tester, is quite consistent with the nature of the lesion in this case. Our aphasic patient (Case 8) is of interest in showing that absence of formulation does not *necessarily* affect learning on this test (at the standard position at least), but that it probably interferes with transfer. Certainly many normal subjects make much use of verbal formulae in dealing with progressive rotation, and it is reasonable to suppose that an aphasic patient would sustain some handicap in this respect. Our last case (Case 9) provides a good illustration of the more difficult type of condition that a clinical psychologist may be called upon to investigate. Although the almost complete absence of learning in this case suggested an hysterical reaction, it must be borne in mind that a reaction of this kind may effectively mask a true organic disability (Zangwill, 1943). In such a case the mental tester is advised to interpret his findings with the utmost caution.

It may be said in conclusion that the Rey-Davis method has considerable possibilities in the objective study of organic intellectual disabilities. In addition to being a test of learning in its more mechanical aspects, it gives us a good opportunity of sampling the patient's intellectual approach to a novel and relatively high-grade problem. Further, it provides an interesting setting for the display of personality reactions, as seen, for example, in the tempo of exploration, the method of choice, and the affective attitude to success and failure. From the more strictly practical point of view, the test has proved of real (if limited) service in the assessment of post-traumatic disability and in the differential diagnosis of organic and psychogenic *sequelae* of head injury.

VIII. Summary.

(1) Individual performance on the Rey-Davis learning test is described in nine selected neuropsychiatric cases. They comprise three cases of acute head injury, three cases of post-traumatic syndrome (one with marked anxiety features), two cases of special intellectual deficit-syndromes associated with focal lesions (visual-spatial agnosia and motor aphasia), and one case of cerebral atrophy with hysterical complications.

(2) The three cases of acute head injury showed marked impairment when first tested, but considerable improvement on re-testing after remission of the

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post-traumatic confusional state. The progressive nature of the improvement is well brought out in one case. In two cases learning ability was fully restored, but in one there was definite residual impairment. These findings were in good agreement with clinical opinion.

(3) Some characteristic features of performance often associated with mild organic *sequelae* of head injury in the cognitive sphere are illustrated in two cases. These are contrasted with the test behaviour of a case of post-traumatic anxiety-neurosis without significant organic disability.

(4) The influence of a visual-agnostic condition on test performance is described in one case. It is stressed that the performance of a case of this kind must be carefully distinguished from a psychoneurotic reaction, which it superficially resembles.

(5) Performance in a gross case of motor aphasia is described and discussed. Although learning was clearly impaired, it is pointed out that the record does not greatly differ from that of a deteriorated patient without aphasia. The influence of aphasia on a test of this kind cannot therefore be assessed on present evidence.

(6) The close relation of learning defects to catastrophe reaction is emphasized in a number of the cases. It is pointed out that re-learning is commonly impaired following catastrophe breakdown, and performance is thereafter marked by various types of perseverative reaction. These are described and analysed in the individual cases.

(7) It is concluded that the patients, with one exception, betrayed no reversion to the more primitive types of test procedure defined by Rey. In general, the attitude adopted towards the test was high-grade and the procedure experimental.

(8) Some tentative applications of the Rey-Davis method to neuropsychiatric assessment and diagnosis are briefly considered.

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