A PSYCHOMETRIC METHOD OF DETERMINING INTELLECTUAL LOSS FOLLOWING HEAD INJURY.

By W. R. REYNELL, D.M.Oxon., F.R.C.P., Major R.A.M.C.,

Psychiatrist at a Military Hospital for Head Injuries; Senior Physician, West End Hospital for Nervous Diseases.

ABOUT 15–20 per cent. of cases of head injury of moderate or severe degree are followed by persisting intellectual impairment, causing loss of efficiency often increased by psychoneurotic symptoms arising from such incapacity. Deterioration of powers of sustained attention, of recent memory and of emotional control are characteristic of post-traumatic states after severe head injury, but ignorance of the patient's previous capacity and personality makes it difficult to assess psychological and physical factors—to distinguish between the patient who is ineffective because he is neurotic and the one who is neurotic because he is ineffective—as a result of cerebral damage. Therefore any reliable index of damage to the "matrix of the mind" will be helpful in prognosis and in deciding disposal.

The method of testing for the presence of intellectual loss about to be described has been used by me at a military hospital for head injuries during the past eighteen months. It takes about 20–30 minutes to test a patient and appears to give results which are significant. The test is based on the assumption, now fairly well established by the work of Shipley (2), Brody (3), Babcock (1), Clark Conkey (4), Wechsler (5) and others, that certain abilities or attainments, such as vocabulary, general information, and powers of comprehension suffer less in deterioration than do such capacities as reasoning ability, attention, recent memory, and "relational thinking."

The method is one using a differential test score based on tests described in Wechsler's *Measurement of Adult Intelligence*. Differential testing for the presence of intellectual impairment has been described by the above-mentioned writers (1), (2), (3), (4), (5). Shipley (2) tested several hundred cases in private and state hospitals and 1,046 normals by measuring the discrepancy between scores on vocabulary and on an "abstraction" test. He concluded that "the vocabulary level of the early deteriorated patient is affected relatively slightly, but his ability to see abstract relationships declines rapidly."

Babcock (1) determined the mental age by a vocabulary test and compared this with the mental age assessed by a group of memory motor and learning tests, and used the difference between the two mental ages as an index of deterioration.

Brody (3) tested a large number of psychotics by estimating the discrepancy between the vocabulary score and the mean of five sub-tests and expressing the difference as a percentage of the vocabulary score. His conclusions were that such a test could be used as an adequate measure of dementia.

Clark Conkey (4) found that his results in testing cases of head injury agreed with Goldstein's in that all performance test scores were lower, and that diminished ability to perceive abstract relationships was characteristic of the patient with head injury.

Wechsler (*Measurement of Adult Intelligence*, 2nd edition, 1941) has claimed that cases of organic cerebral injury or disease showed lower scores on arithmetical reasoning, digit retention (forwards, and especially backwards), and "relational thinking" (similarities test) than in vocabulary, general information, and comprehension, and that such differences could be used as an index of intellectual impairment. He found that organic cerebral cases gave consistently lower scores in performance tests than in verbal tests, and that the best performance test was Block Design (Koh). Wechsler used a battery of ten tests, of which I have selected

https://doi.org/10.1192/bjp.90.380.710 Published online by Cambridge University Press

six. Three of these, called the A Series, have all been found to " hold up " well in cerebral injury and disease; the remaining three—the B series—all tend to " fall away " in such conditions.

A. Series of Tests.

(From Wechsler—slightly modified for British subjects.)

1. *Vocabulary*—a list of 42 words of increasing difficulty, as follows:

1. Apple	15. Fable	29. Catacomb
2. Donkey	16. Brim	30. Spangle
3. Join	17. Guillotine	31. Espionage
4. Diamond	18. Plural	32. Imminent
5. Nuisance	19. Seclude	33. Mantis
6. Fur	20. Nitroglycerine	34. Harakiri
7. Cushion	21. Stanza	35. Chattel
8. Shilling	22. Microscope	36. Dilatory
9. Gamble	23. Vesper	37. Amanuensis
10. Bacon	24. Belfry	38. Proselyte
11. Nail	25. Recede	39. Moiety
12. Cedar	26. Affliction	40. Aseptic
13. Tint	27. Pewter	41. Flout
14. Armoury	28. Ballast	42. Traduce

Maximum score 42. Average 20–24. Any recognized meaning of the word is acceptable; if only vaguely known half credit is given.

2. *General Information*—25 questions graduated in difficulty:

1. Who was Prime Minister before Winston Churchill?
2. Where is London?
3. How many pints make a quart?
4. From what is rubber obtained?
5. What is a thermometer?
6. How many weeks are there in a year?
7. What is the capital of Italy?
8. What is the date of Armistice Day?
9. What is the average height of a woman?
10. Who invented the aeroplane?
11. How far is it from Paris to New York? (2,000–3,000 miles).
12. Where is Brazil?
13. Who wrote " Hamlet " ?
14. Who discovered the South Pole?
15. What is the Vatican?
16. What is the capital of Japan?
17. What does the heart do?
18. What is the population of Great Britain?
19. Who wrote *Pickwick Papers?*
20. Where is Egypt?
21. What is the Koran?
22. Who wrote " Faust " ?
23. What is Habeas Corpus?
24. What is ethnology?
25. What is the Apocrypha?

Maximum score 25. Average 13–14.

3. *General Comprehension:*

1. What is the thing to do if you find in the street an envelope that is sealed, stamped and addressed?
2. What should you do if while sitting in a cinema you were the first person to discover a fire (or see smoke and fire)?
3. Why should we keep away from bad company?
4. Why should people pay taxes?

https://doi.org/10.1192/bjp.90.380.710 Published online by Cambridge University Press

5. Why are shoes made of leather ?
6. Why does land in the city cost more than land in the country ?
7. If you were lost in a forest in the daytime, how would you go about finding your way out ?
8. Why are laws necessary ?
9. Why does the state require people to get a licence in order to be married ?
10. Why are people who are born deaf usually unable to talk ?

Two or one marks are given for each answer that is correct or approximately correct (specimen answers of each kind are given in the Wechsler book to guide the examiner in marking all of the tests). Maximum score 20. Average 10–12.

B. Series of Tests.

1. *Arithmetical Reasoning :*

1. How much are four pence and five pence ?
2. If you have ten shillings and spend six, how much is left ?
3. Take 8 from 25.
4. If an orange costs fourpence, how many can you get for three shillings ?
5. How many hours will it take a man to walk 24 miles at the rate of 3 miles an hour ?
6. Take 14 from 50.
7. If seven pounds of sugar cost one shilling, how many pounds can you get for four shillings ?
8. A man bought a second-hand car for two-thirds of what it cost new. He paid £400 for it. How much was it worth new ?
9. Eight men can finish a job in six days. How many men will be needed to finish it in half a day ?
10. If a train goes 150 yards in ten seconds, how many *feet* can it go in one-fifth of a second ?

An extra mark is given for each of the last two questions if answered correctly within 15 seconds. Maximum score 12. Average 7–8.

2. *Digit Retention.*

The score is the total number of digits repeated correctly forwards added to the number repeated backwards. Maximum score 17. Average 7 + 5.

3. *Similarities.*

A list of 12 pairs of words designed to test the capacity for " relational thinking." for seeing abstract relationships. The patient is asked, " In what way are these two things alike ? " The pairs are: Orange—banana; coat—dress; dog—lion; wagon—bicycle; daily paper—wireless; air—water; wood—alcohol; eye—ear; egg—seed; poem—statue; praise—punishment; fly—tree.

Responses are scored 0, 1 or 2, depending upon the degree and quality of the generalizations. A criteria sheet is used for evaluating the responses.

Maximum score 24. Average 12.

The Differential Test.

The patient's intelligence quotient (Wechsler's *Measurement of Adult Intelligence*) is assessed first on his performance on Vocabulary, General Information, and Comprehension (A Series of Tests), and again on his Arithmetical Reasoning, Digit Retention (forwards and backwards), and Similarities (B Series of Tests). The I.Q. is obtained by adding the three " weighted scores " obtained in each series of tests, multiplying by 5·3 (because the I.Qs. are calculated on *five* tests) and looking up the corresponding I.Qs. in the table at the end of the book. The B Series of Tests measures reasoning ability, attention, recent memory, and capacity for " relational thinking "—all of which " hold up " badly in cases with intellectual deterioration. If the difference between the two I.Qs. reaches double figures the result is considered as " positive " for intellectual loss. This is an

https://doi.org/10.1192/bjp.90.380.710 Published online by Cambridge University Press

arbitrary figure, but it has been found to be one which is, in a great majority of cases, significant of intellectual impairment if the testing is done two months or more after injury.

The test is not difficult to apply by those with some experience in psychometric testing, but the reliability of such a method as a clinical instrument depends to some extent, like that of all clinical instruments, on the experience of the user. About 10 per cent. of cases with clinical evidence of intellectual loss may pass through the "sieve," but in doubtful cases other tests—especially Kohs' Block Design Tests and the Digit Symbol, which also "hold up" badly in association with intellectual deterioration, should be used as supplementary tests. Tests for "retardation," retentivity, reading comprehension, Test 33 (National Institute of Industrial Psychology), Cattell's Tests A and B, and others may be used in doubtful cases, especially in those of higher I.Q., before a final diagnosis of the presence or absence of intellectual loss is arrived at. In border-line cases it is important that the *result of the tests as a whole* should be considered in forming an assessment, but in a large majority of cases a positive result on the A and B Series is a significant "pointer," if the patient is tested two months or more after injury.

In more recent cases a positive result is less significant, and the discrepancy between the two test scores may later diminish or disappear. If the test is positive two months or more after head injury, the prognosis for further service in the Forces would appear to be poor—80 per cent. of 100 such cases were invalided as permanently unfit on general clinical grounds, whereas 80 per cent. of 90 cases of moderate or severe head injury which gave a negative result on the test were returned to duty.

Results of Testing.

Five hundred and twenty consecutive cases of head injury, of which 95 per cent. were "closed," referred for psychiatric examination and testing because their mental integrity, adequacy, or stability were in question, gave the following results. I have for simplicity taken the nearest round figure—e.g. 120 for 117, 300 for 303—rather than state exact numbers, implying a degree of accuracy unattainable in psychiatric cases, which inevitably overlap to some extent. Nearly 1,000 cases have now been tested, but the results of later cases have not been followed up and are not included in the following figures:

120 cases gave a positive result on the A and B Series, i.e. a difference of 10 or more between the I.Qs. calculated on the two series of tests. Ninety-five of these were cases of moderate or severe head injury.

300 cases gave no significant difference between the two test scores; 90 of these were cases of moderate or severe head injury (Group II).

100 cases were found to be "dull and backward," i.e. with Intelligence Quotient 60–85. The results of differential testing in these cases were not considered to be of great significance.

Of the 120 cases which gave a positive result on testing, 20 were recent cases, i.e. less than two months after head injury, some of which became negative later on. The remaining 100 cases (Group I) were tested two months or more after receiving their head injury, and of these 80 (80 per cent.) were invalided as permanently unfit on general clinical grounds, long duration of symptoms, absence of improvement with treatment, personality changes, etc. Of the 20 (20 per cent.) who were returned to duty—mostly in a lower category—10 were "euphoric," a condition which we have learned to associate with a bad prognosis, as many such cases subsequently return with headaches, depression, retardation, etc.

Of the 90 cases (Group II) of moderate or severe head injury, i.e. with post-traumatic amnesiae of a few hours up to six weeks, 72 (80 per cent.) were returned to duty. Of the 18 patients who were invalided from this group the great majority had been many months in hospital and had chronic "anxiety" symptoms.

It will be seen that, with two series of cases of comparable severity, of patients showing a positive on psychometric testing 80 per cent. were invalided, and of those showing a negative 80 per cent. were returned to duty. I am told by a statistician (Dr. P. E. Vernon), who kindly looked through my figures, that the chances of such a result being fortuitous are more than a million to one.

https://doi.org/10.1192/bjp.90.380.710 Published online by Cambridge University Press

Analysis of differential and " weighted " scores was as follows :

	Average difference in I.Q. in A and B Series.	Average " weighted " scores.					
		A Series.			B Series.		
		Vocab.	Gen. inf.	Compr.	Arith.	Digits.	Similarities.
100 cases (Group I), 80 per cent. invalided as permanently unfit	14	11·7	11·0	11·6	9·9	7·9	9·8
90 cases (Group II), 80 per cent. returned to duty	2·1	11·4	11·0	11·8	10·8	10·8	11·5
" Control " group of 50 " psychoneuroses "	1·2	12·0	11·8	12·5	12·1	11·5	12·3

It will be seen that in the Group I cases there was a marked " falling-away " in the average score in each of the three tests of the B Series ; in the Group II cases there was only a slight discrepancy between the A and B Series, and in the Control Group there was no significant difference.

A deterioration in the ability to repeat digits *backwards* appears to be both frequent and significant in cases of intellectual loss. Thus the average number of digits repeated backwards by the Group I patients was 4·1, varying from 3 to 6, and of 40 " dull and backward " patients it was 4·0, with the same limits of variation. In a control group of 50 psychoneurotic and normal patients the average number of digits repeated backwards was 5·3, varying from 4 to 8. It would appear, therefore, that if a patient can only repeat four digits backwards it is probable that he is either dull and backward or he has suffered intellectual impairment.

A positive result on differential testing two months or more after head injury appears to be of greater significance in prognosis than a post-traumatic amnesia of one week's duration, which has been considered a criterion of " severe " head injury. In Groups I and II there were 40 cases with post-traumatic amnesia of more than one week. Of these, 20 (50 per cent.) were permanently invalided, and 20 (50 per cent.) were returned to duty (25 per cent. of these had post-traumatic amnesia of more than three weeks).

Of 80 cases of Group I which gave a positive result on the differential test (A and B Series), 80 per cent. were permanently invalided. Thus it was found that of cases with a post-traumatic amnesia of one week or more 50 per cent. were invalided ; but of cases giving a positive differential test two months or more after head injury, 80 per cent. were found unfit for further service. Symonds and Ritchie Russell (7) found that 60 per cent. of cases with post-traumatic amnesia of one week or more were subsequently invalided.

It is not suggested that such tests are a short cut to assessment of " total personality loss," which must always be made from a consideration of the whole clinical picture. Investigation of such loss is too complex a matter to be reduced to the comparatively simple methods of psychometric testing.

About 80 per cent. of all cases of head injury of all degrees of severity will show no clinical evidence of intellectual loss, and in such cases a negative result on testing will support a favourable prognosis arrived at on general grounds. Similarly psychometric evidence of intellectual impairment will give weight to an unfavourable prognosis indicated by general clinical assessment. It is often difficult to describe in words how much efficiency has been impaired, but if testing shows a performance say 15 per cent. below the average and perhaps 30 per cent. below what would be expected from the score on the A Series, we have some measure of the damage sustained. Furthermore, we have in such figures and performance on Koh's Blocks, etc., a standard by which to assess improvement, should this take place, thus providing a record of progress which is encouraging to the patient and an aid in treatment.

Results of Differential Testing in Cases of Cerebral Disease.

Five out of six cases of persistent headache after cerebrospinal meningitis gave positive results on testing with A and B Series. Ten cases of cerebral tumour,

https://doi.org/10.1192/bjp.90.380.710 Published online by Cambridge University Press

five of chronic cerebral abscess, one of cerebral thrombophlebitis, one of acute "encephalitis" and one of subdural haematoma (of twelve months' duration) gave similar evidence of intellectual loss.

Results in Affective Disorder.

Of a group of 50 consecutive psychoneurotic cases who had had trivial or no head injury, 46 showed no significant differences in the scores obtained on the A and B Series. Purely affective disorders rarely show a positive on differential testing—although depressed and retarded patients will, of course, obtain poor scores on performance and timed tests, none of which is included in the A and B Series.

Besides giving indications of the presence or absence of intellectual impairment, psychometric testing provides in itself a valuable psychiatric interview. The great majority of patients are co-operative and willing to be tested and show an interest in the tests. Shyness and self-consciousness are soon lost, and much useful information may be gained by observing the patient at work, for instance, on Kohs' Block Design tests—the slow, patient, but effective plodder; the impulsive, slapdash, "accident-prone" individual, who seems not to realize or care much about his mistakes; the timid and hesitant; the over-confident; the irritable; the "catastrophic reaction" type; the tremulous; the dysmetric and clumsy; the careful planner with foresight; the carefree and careless with no plan and no foresight—all tend to give themselves away in a manner that might not occur in an ordinary face-to-face interview. Thus a good deal of information is gained about a patient's temperament, personality, and "reaction type" which is useful in the final assessment—whether the results indicate the presence or absence of intellectual impairment. In many cases of head injury, especially those of the "closed" variety, it may be more important to determine what kind of a patient has had an injury than the kind of injury the man has had. The latter must often remain indeterminate in the absence of positive neurological findings by X-rays, electroencephalography, air encephalography, and examination of the central nervous system. The length of the post-traumatic and retrograde amnesia often gives important information about the severity of the trauma, but this is not always a reliable index. Of 200 cases with post-traumatic amnesia of seven days or more no less than 50 returned to duty with no signs of intellectual loss on differential testing, and some of those with post-traumatic amnesia as long as six weeks were able to return to full flying duties.

Sgt.-Pilot V—, R.A.F., aged 24, had a post-traumatic amnesia of six weeks following an air crash with fractured skull. Tested eight weeks after injury: A Series 128, B Series 125. He returned to full flying duties fourteen weeks after injury.

Sgt.-Pilot S—, aged 27, had a post-traumatic amnesia of three weeks after an air crash with fractured skull. Tested ten weeks later: A Series 132, B Series 130. He returned to full flying duties.

Sgt.-Pilot S—, aged 20, had a post-traumatic amnesia of six weeks. Tested sixteen weeks after head injury (no fracture): A Series 129, B Series 127. Returned to full duty.

The patient's symptoms are manifestations of a psychosomatic reaction to an injury, and may be affected by (1) previous personality and adjustment to surroundings, home, and to life generally at the time of the injury; (2) the cerebral damage sustained (this cannot be accurately assessed, but air encephalograms, electroencephalogram and neurological examination, together with psychometric and psychiatric findings, may all give significant "pointers"); (3) all that has happened since the injury, memory of the circumstances (unless obliterated by retrograde and post-traumatic amnesia), effects of long stay in hospital, many investigations, "medical suggestion," possible, probable, or imagined effects of his injury upon his future life and capacity, "Y" listing, with consequent new unit, new work and companions, and a host of other factors, domestic, personal and financial.

The final assessment will be psychosomatic. Body, mind, and morale may all have been affected, and psychogenic and physiogenic factors are usually inextricably mixed. What we want to know is, "How much has this man been damaged?" and psychometric testing gives relevant information. We have no absolute criteria of "total personality loss," unless it be the patient's capacity to do the job he was doing before the injury and his capacity to do new jobs. Such tests

https://doi.org/10.1192/bjp.90.380.710 Published online by Cambridge University Press

cannot usually be applied, and many factors, such as loss of confidence, " regression," and results of hospital life, make it difficult to reconstitute the *status quo ante* after a severe head injury.

It seems therefore that the most significant correlation of the results of psychometric testing is with the final disposal of the patient. As stated above, 80 per cent. of positive cases were found on general clinical grounds to be unfit for further service, and 80 per cent. of cases negative on testing (after head injury of moderate or severe degree) were returned to duty.

Doubtless the tests selected for the A and B series could be modified, added to, or improved upon, but it has been thought worth while to publish the results of using such a battery as a differential test in the hope that further research will lead to more efficient methods, and become more generally used in assessing the results of head injury.

It is important that the instructions given in Wechsler's book be accurately followed in administering the tests and in assessing the answers. I have made two or three slight alterations to suit British rather than American subjects (e.g., " Who wrote *Pickwick Papers* ? " instead of " Who wrote *Tom Sawyer* ? ") in the general information test, and English money for dollars and cents in the arithmetic tests.

It is not supposed that reliable results will ever be possible without psychiatric experience, or that tests will be devised that can be applied by inexperienced persons and yield dependable results, but this applies to all clinical tests and not to psychometry alone.

A positive result on the A and B series—like a positive finding on air encephalography—may be taken as a significant " pointer " of cerebral damage, but a diagnosis of intellectual loss should not be made unless the result is confirmed by further tests of a more time-consuming kind. All such cases should be tested with Kohs' Blocks, digit symbol, Matrix, the Babcock sentence, Rey-Davis board and, at the higher levels, such tests as Test 33 of the National Institute of Industrial Psychology, Cattell's Test IIIA or B, and if necessary other tests before a diagnosis of intellectual loss is arrived at—the most significant of all findings in closed head injury cases.

Psychomotor activity may be increased or diminished—the patient may be garrulous and restless or depressed, retarded, unresponsive, and have " difficulty in thinking." Patients with " hypomanic " symptoms and those who were retarded and depressed, but who showed no evidence of intellectual loss on differential testing, almost always had personal or familial tendencies to such " reactions," and the prognosis was considered better in such cases than in those showing intellectual loss.

Retardation, or loss of speed in thought and action, is perhaps the most constant finding in post-traumatic impairment. Almost every case showing a positive on differential testing gave impaired scores on Kohs' Blocks, digit symbol, Test 33 and other " timed " tests. In a small proportion of cases this loss of speed was the only evidence of cerebral damage, but in my experience a large proportion of cases showing retardation of some months' duration gave a positive result on the A and B series, and on Test 33 or Cattell's IIIA or B gave results below what would be expected from the series (vocabulary, general information and comprehension) and by what would be expected from their educational and work record before the injury.

Retardation may be gross, but of short duration, and may give on superficial examination a false impression of intellectual impairment.

Pte. C. T— sustained a head injury in a motor-cycle accident. Post-traumatic amnesia four days. No fracture. His M.O. reported " very poor intelligence ; it is impossible to get a reasonable history from him." He scored 50/60 on Raven's Matrix in 1½ hours, and on the A Series his I.Q. corresponded to 125. On Kohs' Blocks he did all the designs without difficulty, but took three times the standard time in doing them. This was only four weeks after his accident, and after another four weeks he showed no retardation and no intellectual loss on the differential test.

Considerable deformation of the brain, as shown by dilatation and alteration in shape of the ventricles on air encephalography, is compatible with little or no evidence of intellectual loss, as shown by the following case :

https://doi.org/10.1192/bjp.90.380.710 Published online by Cambridge University Press

Pte. C—, R.A.O.C., clerk, aged 33, had a motor-cycle accident in 1939. He was unconscious seven days, with fracture of occipital bone. Post-traumatic amnesia seven days; retrograde amnesia two days. Returned to work six months later—same work, but with more responsibility. Was a keen amateur operatic singer in his spare time and continued to do this, although he gave up "producing." Four months after being called up early in 1943 he had "influenza" and two days later he developed *status epilepticus*. He had had two fits in infancy, but none since. Air encephalogram (6.vi.43) showed dilatation of both lateral ventricles, especially left anterior horn. Electroencephalogram was abnormal—"consistent with epilepsy." Psychometric testing: A Series 130, B Series 126, showed no evidence of intellectual loss. Block Design score corresponds to I.Q. 128. Raven's Matrix 47/60. Test 33 (N.I.I.P.) 150/193.

On the other hand, severe intellectual loss is often found after head injury without evidence of cerebral atrophy demonstrable by air encephalography. Nevertheless, the correspondence between positive results on differential psychometric testing and air encephalography was high in the cases I have investigated. Of 40 cases with abnormal findings in air encephalogram, 75 per cent. showed positive results on A and B series.

More than 90 per cent. of the cases in Groups I and II were cases of closed head injury. Only a small proportion of these—less than 10 per cent.—show neurological signs of cerebral damage. The following are examples:

Cpl. W. A—, aged 22; motor-cycle accident 10.x.41. Fractured parietal bone. Post-traumatic amnesia two weeks. Was symptom-free when returned to full duty 3.ii.42. Had increasing difficulty in doing his work as instructor; was forgetful and had fainting attacks. Readmitted 1.vii.42. Electroencephalogram abnormal. Air encephalogram indicated cerebral atrophy. A Series 135, B Series 119. Discharged Category E.

Drvr. W. B—, aged 22. Lorry accident 7.v.42. Fractured parietal bone. Post-traumatic amnesia seven days. 8.vi.42: Electroencephalogram normal. 18.vi.42: Air encephalogram indicated left cerebral atrophy. Patient garrulous and euphoric. A Series 116, B Series 104. Discharged to duty in Category C; prognosis doubtful.

Cpl. G. C—, aged 32. Car crash 17.xii.41. Left fronto-parietal fracture. Right side spastic. Post-traumatic amnesia seven days. Slight dysarthria. Poor memory. A Series 108, B Series 98. Block Design, reading comprehension and retentivity very poor. Discharged Category E.

A.C.1 D. C—, aged 32. Knocked out of boxing ring 13.viii.42. Unconscious some hours. Post-traumatic amnesia twelve hours. Followed by right-sided weakness lasting two days. Pupils unequal. 25.xi.42: A Series 107, B Series 88; Block Design 75. Discharged Category E.

Cpl. D. M—, aged 33. Motor-cycle accident 7.iii.42. Fractured right frontal bone. Post-traumatic amnesia three days. Discharged Category C 8.ix.42, but developed headaches on returning to duty. Readmitted 1.x.42: Knee and ankle jerks absent. A Series 120, B Series 99; Block Design 85; Matrix 21/60. Discharged Category E.

Tpr. R. I. M—, aged 23. Lorry accident 17.iv.42. Post-traumatic amnesia five hours. 30.viii.42: Bitemporal hemianopia. Electroencephalogram grossly abnormal. Right-sided anosmia. A Series 135, B Series 116; Block Design—complete failure. Patient is euphoric and feels perfectly well and fit for duty. Discharged Category E.

Neurological findings are often completely negative in cases of severe head injury, as in the following cases:

L.-Cpl. A. D—, aged 22. Motor-cycle accident 4.iv.42. Fractured base of skull. Tested 13.viii.42: Euphoric. Central nervous system, electroencephalogram, air encephalogram: All N.A.D. A Series 116, B Series 104; Block Design—was able to complete only three of seven tests.

Gnr. E. McL—, aged 36. Fell off lorry 12.vii.41. Fractured parieto-occipital region. Returned to duty in Category C, but developed headaches, was slow and depressed. Lost confidence. Poor memory. Readmitted 22.viii.42. A Series 96, B Series 84. Boarded Category E.

Gnr. F. M—, aged 32. Car accident 24.iv.42. Fractured frontal bone. Post-traumatic amnesia thirteen days. Electroencephalogram, central nervous system: N.A.D. Returned to duty five weeks after injury. Developed severe headache and was admitted for investigation 1.vi.42. A Series 123, B Series 102; Block Design 104. Symptoms cleared up and patient was returned to duty in Category C. Prognosis doubtful.

Personality Change.

Next to intellectual loss the most significant change following head injury is change of personality—some think that such change is even more important, but this is not my view—in any case it is more difficult to assess. The most frequent personality change is the "caricature" variety. The personality traits have not

https://doi.org/10.1192/bjp.90.380.710 Published online by Cambridge University Press

been altered, but have become " more so," to the extent of a caricature; characteristics which were previously largely latent now become overt. In others the change is more fundamental—there may be an " inversion " of the personality, and the cheerful, sociable, alert person may become depressed, unsocial, and lacking in initiative.

In my experience personality change of severe degree and duration is almost always associated with intellectual loss, but I have no doubt that there are exceptional cases in which this is not so. After testing nearly 1,000 cases it is my experience that the two findings are closely associated, especially in those patients who show no obvious constitutional predisposition to affective disorders. Where such predisposition is present the personality change may be considered as a psychosomatic reaction which will clear up in the course of time, if no intellectual loss can be found on careful testing.

Discussion and Summary.

A differential test score method of detecting the presence of intellectual loss following head injury has been tried out and the results followed up in 520 consecutive cases. The test has been arranged so that, although it is simple and short enough to be carried out in 20–30 minutes, it provides a " mesh " fine enough to segregate most cases with definite intellectual impairment. About 10 per cent. of cases which on fuller testing with such tests as Test 33 (National Institute of Industrial Psychology), Kohs' Blocks, Cattell's Tests A and B, and the Raven Matrix Test, show evidence of loss, may fail to show a positive with the A and B series. In many of such cases which may give a history of severe head injury there will be clinical symptoms of euphoria, retardation, or personality change which indicate the desirability of more elaborate and time-consuming psychometric testing.

Intellectual abilities are of such variety and complexity that it is impossible to devise a battery of tests that will assess all of them, but for clinical use the tests must not be too time-consuming. Nevertheless, the A and B series—especially when supplemented by Kohs' Blocks, digit symbol, Raven's Matrix, and, if necessary, by Test 33 (N.I.I.P.) or Cattell's IIIA and B—do test a surprising number of faculties, e.g. memory, recent and remote, auditory and visual, verbal and non-verbal; synthetic and analytical capacities; reasoning; " relational thinking "; comprehension; and the four fundamentals of arithmetic (addition, subtraction, multiplication and division); visual imagery; constructive ability and speed—any or all of which may be impaired in post-traumatic states.

It is not to be assumed that the difference in the two test scores in the A and B series is a *measure* of intellectual loss, but such differential testing appears to give a fairly reliable index of the presence of deterioration—a conclusion which has been reached by a number of different investigators (Shipley (2), Brody (3), Wechsler (5), and others).

Psychometric tests do not indicate the presence of permanent intellectual loss, but the longer the period between head injury and testing the greater will be the significance of a positive finding, i.e. a difference of 10 or more in the two test scores. This figure of 10 or more is an arbitrary one, but has been found to be a reliable index of impairment in that 80 per cent. of 100 cases showing such a difference two months or more after head injury have been found on general clinical grounds to be unfit for further service in the Army or Air Force.

It should be emphasized that in making a diagnosis of the presence of intellectual loss the results of the tests as a whole should be taken into consideration; the A and B series usually gives an index of such loss when present, but this result should be confirmed by further testing with Kohs' Blocks, digit symbol, or other performance tests, and where necessary by such tests as No. 33 of the N.I.I.P., Cattell's Tests and Raven's Matrix.

The results of differential testing referred to above indicate that there is a high correlation between a *positive* result with the A and B series two months or more after head injury and *lowered efficiency* of a serious degree. The best index of a man's lowered efficiency is, of course, incapacity when returned to his usual work. This was found in a considerable number of cases, but in the majority this acid test of efficiency was not available. It was therefore necessary to judge the

https://doi.org/10.1192/bjp.90.380.710 Published online by Cambridge University Press

validity of a positive finding by correlating this with the next best available index of lowered efficiency—that is, his fitness or unfitness for further military service. Eighty per cent. of 100 positive cases were on general clinical grounds found by Medical Boards, who were uninfluenced by the result of the A and B tests, to be unfit for further service. Further, it was found that 80 per cent. of cases which were negative by the same differential test—although all were cases of moderate or severe head injury—were returned to duty.

The validity of any clinical test will be judged by its correlation, high or low, with the total clinical picture. The results of psychometric testing have, in my opinion, a sufficiently high correlation with the total assessment—to establish its value in assessing cases of chronic head injury.

Conclusions.

1. Psychometric testing of chronic head injury cases is of value in diagnosis, prognosis and treatment.

2. The presence of intellectual loss is the most significant indication of cerebral damage. The longer the period between the head injury and the testing the more significant are the findings.

3. The results of testing should be considered as a whole in arriving at a diagnosis of intellectual loss.

4. A deterioration in performance tests, in arithmetical reasoning, in digit retention—especially backwards in memory—and in "relational thinking" ("similarities" test) is characteristic of head injury cases.

5. A simple differential test—the A and B series—which can be carried out in 20–30 minutes by an examiner with some experience of psychometric testing will serve as an index of intellectual loss in the majority of cases with such deterioration.

I wish to thank Lieut.-Col. C. W. Greenway for permission to publish this paper; the officers of the hospital for their help in providing cases; and Brigadier G. Riddoch, Wing-Cmdr. Denis Williams, Dr. Earl and Dr. P. E. Vernon for their criticism and advice.

References.

(1) Babcock (1930), *Arch. of Psychol.*, No. 117.
(2) Shipley, W. C. (1941), "Measurement of Intellectual Impairment in Psychotics," *Amer. J. Psychol.*, **97**, 1313.
(3) Brody (1942), *Journ. Ment. Sci.*, **88**, 317 and 512.
(4) Clark Conkey (1938), *Arch. Psych.*, 232. New York, October.
(5) Wechsler, D. (1941), *Measurement of Adult Intelligence*, 2nd edition.
(6) Gilbert, J. D. (1935), *Arch. Psychol.*, No. 188.
(7) Symonds, C. P., and Russell, W. R. (1943), *Lancet*, January.

https://doi.org/10.1192/bjp.90.380.710 Published online by Cambridge University Press