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Cognitive Functioning in Multiple Sclerosis

By K. L. JAMBOR

Introduction

In previous studies* the estimation of the incidence of intellectual changes in multiple sclerosis has varied from as low as 2 per cent. (Cottrell and Wilson, 1926) to as high as 72 per cent. (Ombredane, 1929). In order to establish the incidence accurately, the most satisfactory method would clearly be a long-term follow-up (covering lifetime) of a sample of multiple sclerosis patients. Any cross-sectional study would include patients in varying degrees of advancement of the disease, and patients found to be free of intellectual deficits at the time of investigation would not necessarily remain so. Also, the indirect psychometric assessment of intellectual loss is notoriously difficult, and the direct method of follow-up would give much more accurate results. The only direct study up to date has been that of Canter (1951), who found a highly significant (i.e. 13·48 points) loss on re-testing multiple sclerosis patients on the Army General Classification Test after a four-year period. Even after such a short period as six months he found slight losses on most Wechsler-Bellevue subtests, in contrast to an average gain of six full IQ points of the control group.

The above facts seem to indicate that intellectual loss is perhaps a more frequent concomitant of the disease than is generally recognized; and if so, the recognition of this fact would be of obvious practical importance from the point of management of patients suffering from the disease. It could also contribute to a better understanding of the problems of multiple sclerosis patients, since they are frequently unpopular among nursing staff, and are regarded as "difficult" even by the patients' own relatives. It is perhaps the case that not only do they have to adapt to a progressive, but largely unpredictable, course of events as regards physical disability, but that they have to make this adaptation in spite of a progressively diminishing adaptive ability.

It was considered that a cross-sectional study, although not ideal, would still be informative if a sufficiently large sample of patients were seen, thus approximating to the results of a longitudinal study.

In the present study psychological testing of patients suffering from multiple sclerosis was undertaken in order to investigate whether:

(*a*) they show impairment of intellectual efficiency,
(*b*) if so, of what degree, and
(*c*) of what pattern.

The psychological investigation formed part of a wider study of the psychiatric aspects of multiple sclerosis, carried out by Dr. D. H. C. Surridge, at that time Senior Research Registrar, Littlemore Hospital, Oxford, the results of which have been reported separately(Surridge, 1969). The psychological investigation reported in the present article was planned and carried out by the author.

Method

In view of the nature of the disease, i.e. the occurrence of diffuse cerebral lesions, a test battery was selected to cover as wide a range of cognitive functions as possible. At the same time it had to be ensured that the tests could be administered in one session without adverse effects. The battery consisted of tests to assess:

i. Verbal intelligence on a shortened form of the Wechsler Verbal Scale. This "Short Verbal IQ" test had been prepared by M. Williams and G. Rochford (personal communication), and was found, on a small sample of psychiatric patients, to yield scores highly correlated with the full WAIS Verbal Scale IQ.

ii. Conceptual thinking on the WAIS Similarities subtest, and on the Weigl Sorting Test.

iii. Spatial ability on the WAIS Block Design subtest, and on a simple map reading task. The latter test consists of finding and tracing the shortest routes between points on a simple town plan (Williams and Jambor, 1964).

iv. Memory functions on the following tests: (*a*) the Digit Span Subtest from the WAIS; (*b*) the Babcock Sentence Learning Test (which was discontinued if the subject failed to learn the sentence in six trials and counted

* A short summary of previous investigations on intellectual changes in multiple sclerosis is given by Pratt (1951).

as failure); (*c*) the Modified Walton-Black Word Learning Test, and (*d*) a test of delayed recall.

The word learning test is a modification of the original in that instead of using ten words failed by the subject on a vocabulary test, eight rare words, usually unknown even to subjects with above average vocabulary, are presented verbally, and the subject has to learn their meaning. All eight words are nouns (the words fribble, kermes, gibus, vervaine, stanhope, gaby, burin and rebeck were given to the majority of subjects, but a longer list was available for substitution if any of these were familiar to the subject). At each presentation the words were given in the same order, thus the subject might learn either the correct association or the correct order. In a pilot study it was found best practice to discontinue the test and to count it as failed if not completed successfully within five trials (persisting after five trials seemed too distressing for the subjects, particularly for organic patients). In the instructions, subjects were told to try and learn the meaning of "as many words, and as quickly, as they possibly can," but it was not implied that they were expected to learn all the words, and thus the test could be discontinued without producing a sense of failure in the subjects.

In the delayed recall test the subject was told that he would be shown some pictures on a card, and that he should try and memorize them. On showing the card (which had nine pictures on it: moon, bird, bicycle, book, cart, drum, boots, cockerel and teapot) he was allowed to look at the pictures for as long as it took him to name them in sequence twice.

v. Speech functions on simple tests of the subjects' efficiency at reading, spelling, naming and comprehension. The reading and spelling tests were abbreviated forms of the Schonell Graded Reading and Spelling Tests. The naming test consisted of a consecutive presentation of eight cards with pictures which the subject had to name. The comprehension test consisted of the subject having to identify eight items from a larger selection on a card. These speech tests were prepared by M. Williams and G. Rochford (personal communication) and had been found useful in the assessment of dysphasia in intracranial damage.

vi. General intellectual efficiency on Brody's Test for Intellectual Deterioration (Brody, 1942). The test is a shortened form of the Babcock Scale. The score (or "deterioration quotient") the subject obtains is the measure of the discrepancy between his vocabulary, on the one hand, and his speed, knowledge of current events, short term verbal and non-verbal memory on the other. (The fifth subtest used by Brody, digit symbol, was omitted.) Brody's recommended cut-off points in DQs for indicating the absence, or presence of (mild, moderate and severe) dementia, however, were not applicable, as Brody's own standardization was done on a much older age group; and

vii. An assessment of the qualitative aspects of the subjects' performance was made, with particular reference to those "signs" which are thought to be indicative of organic involvement. "*Qualitative organic signs*" were considered to be present if any of the following were in evidence during testing:

Perseveration, i.e. an inappropriate continuation of a previous response;

Confabulation, i.e. a false response in the sense that phantasy clearly replaced memory, also "importations" on the delayed recall test;

Perplexity, i.e. a display of puzzlement and bewilderment with or without distress;

Concreteness, i.e. choice of concrete examples in preference to abstract responses;

Circumstantiality, i.e. roundabout expressions, lack of selectivity, lack of concise thinking and communication;

Need for reasssurance, i.e. constant expression of uncertainty and lack of confidence to a distressing degree, which could momentarily be alleviated by assurance and comforting;

Outdated information, i.e. the giving of outdated information with or without conviction;

Overconfidence, i.e. verbal or behavioural expression of confidence before commencing a task, without being able to live up to it;

Differences or Definitions, i.e. the giving of differences or definitions instead of similarities, and the giving of synonyms instead of the required opposites (on Brody's test)—that is, reverting to an easier task;

Variability, i.e. unusual inter-test or inter-item variability of functioning.

Testing procedure

Tests were normally given in the following order: short verbal IQ, block design, map reading, similarities, Weigl, delayed recall, Brody, sentence learning, digit span, word learning, speech tests. This order was not strictly adhered to, e.g. in those cases where speech defect was obvious from preliminary conversation, testing was introduced by a non-verbal task. However, of all tests containing pictorial material, the delayed recall test was always given first in order to avoid confusion with other pictures. The ten minutes interval between presentation of the card and recall was always filled by chatting with the patient about the following topics: their first school, their first job, how they spent their first earnings, how they celebrated their 21st birthday. The primary purpose of this was to spend the delay-interval uniformly with all subjects on a non-taxing task, but this conversation also proved a useful booster of morale, since subjects assumed that these questions were part of the battery, and most of them were able to "perform" to their satisfaction.

The average time for administering the test battery was one hour.

As the normal controls were tested during their working hours, the WAIS subtests were omitted from their battery. This was to cut down testing time, and also because sufficient information was already available.

Subjects

Selected patients with confirmed diagnosis of multiple sclerosis on the register of the Department of Neurology,

United Oxford Hospitals, were approached by letter and asked to assent to participate in a research project dealing with the problems of adaptation to their illness. Permission from their consultants and general practitioners was previously obtained. Of those originally approached, 105 agreed to co-operate and were subsequently visited and tested in their homes in the period from November, 1963, to July, 1964. In order to avoid possible complications due to the natural decline with age in some aspects of cognitive functioning, all patients included in the series were under 40 years of age. Although not all the patients were found to be completely testable (bedridden, aphasic), the complete battery was administered to the majority of the patients. However, some tests had to be omitted in certain cases on account of the patient's physical disability, i.e. where visual acuity was inadequate, tests involving the use of vision were omitted, or, where the use of the preferred hand was impaired, tests requiring writing and drawing were omitted. However, tests requiring the manipulation of test material (Weigl, block design) were omitted only if the use of both hands was impaired, as it had been shown that using one hand only, even if not the preferred hand, did not significantly alter the scores (Briggs, 1960).

Psychiatric examination of the patients took place on the same day as testing. For the purpose of the psychological investigation, the psychiatric examination in effect divided the patients into two groups: (*a*) those who had symptoms of depression and/or anxiety (henceforward referred to in short as "depressed MS" group and abbreviated as "MS (D/A)") and (*b*) those who did not have such symptoms (henceforward "MS" group). Groups (*a*) and (*b*) together form the "MS combined" group.

Since the experimental group was found to be psychiatrically heterogeneous, clearly more than one control group was needed to make the interpretation of test results possible. Although all had the confirmed diagnosis of an organic disease, anomalies in the MS patients' test performance might not have been directly due to CNS lesions, but possibly to mood disturbance. Normal controls were therefore tested to match the MS group and psychiatric controls to match the MS (D/A) group. Furthermore, it was conceivable that the presence itself of a chronic progressively disabling disease, even without CNS involvement, might affect intellectual functioning through, for example, an unusual mode of life or consistent disuse of certain skills, and therefore a further control group was needed. However, it proved impossible to find an entirely suitable clinical control group. Eventually, patients suffering from muscular dystrophy, which is a chronic and progressively disabling disease but in which the CNS is intact, were considered to be, from this aspect, the best choice.

The numerical distribution of the experimental and various control groups are given in Table I. The normal controls were matched to the MS group on age, sex and educational level. (With the Management's kind permission, employees from Morris Motors (Oxford) were selected on the above criteria to match the MS group, approached and, if willing to co-operate, tested.) The psychiatric controls were matched to the MS (D/A) group on age, sex, educational level and severity of psychiatric symptoms. They were drawn from patients in charge of Dr. F. J. J. Letemendia, Consultant Psychiatrist, Littlemore Hospital, Oxford.

The group of muscular dystrophy patients, whose co-operation was obtained through various Cheshire Homes and also the Norfolk Branch of the Muscular Dystrophy Association, was entirely unmatched owing to the comparative rarity of the condition in middle-aged adults. Statistical checking showed this group to be significantly different from the experimental group in that it contained a higher proportion of male patients ($\chi^2 = 15{\cdot}29$, $p < 0{\cdot}001$) and had a lower educational level ($\chi^2 = 11{\cdot}72$, $p < 0{\cdot}01$). Furthermore, the majority of multiple sclerotics lived at home, whereas all the muscular dystrophy patients had lived in institutions for considerable periods. These differences introduce complications in the interpretation of data.

Results and Discussion

Table II summarizes the main numerical results and the reader should refer to the appropriate test headings.

I. Verbal intelligence

Shortened form of the WAIS Verbal Scale. All groups yielded mean IQ scores in the average range. T-testing showed no significant difference between experimental and control groups.

Table I
The numerical distribution and mean age of experimental and control groups

Group	Male	Female	Total N	Mean age
Multiple sclerosis	34	43	77	35·9
Multiple sclerosis (depression/anxiety)	9	17	26	32·8
Total ("combined") multiple sclerosis	43	60	103	32·9
Controls, normal	36	43	79	31·6
Controls, psychiatric	8	27	35	34·8
Muscular dystrophy	29	8	37	33·9

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TABLE II

Mean results of experimental and control groups on various tests

Test	Group	N	Mean	SD	Significance[1]
Short verbal IQ	MS	78	102·79	21·15	N.S.
	Control (normal)	79	107·32	21·14	
	MS (D/A)	26	101·92	19·57	N.S.
	Psychiatric controls	35	105·63	17·69	
	MS combined	103	102·58	19·13	N.S.
	Muscular dystrophy	37	103·14	16·85	
WAIS similarities	MS	78	10·00	3·09	N.S.
	Control[2]	300	10·00	3·00	
	MS (D/A)	26	10·02	3·00	N.S.
	Psychiatric controls	35	11·30	1·85	
	MS combined	104	10·009	3·10	†
	Muscular dystrophy	36	11·38	1·80	
Weigl test	MS	76	3·40	1·13	‡
	Controls	79	3·91	0·30	
	MS (D/A)	25	3·56	0·70	‡
	Psychiatric controls	35	4·00	0	
	MS combined	101	3·44	1·18	†
	Muscular dystrophy	37	3·67	0·80	
WAIS block design	MS	65	9·53	3·42	N.S.
	Controls[2]	300	10·00	3·10	
	MS (D/A)	23	10·82	2·80	N.S.
	Psychiatric controls	35	10·28	2·30	
	MS combined	88	9·87	2·50	N.S.
	Muscular dystrophy	35	10·60	3·28	
WAIS digit span	MS	74	9·42	3·23	N.S.
	Controls[2]	300	10·00	3·0	
	MS (D/A)	24	9·96	2·6	N.S.
	Psychiatric controls	35	10·31	2·8	
	MS combined	98	9·55	3·13	N.S.
	Muscular dystrophy	36	9·89	2·52	
Sentence learning	MS	73	2·23	2·08	‡
	Controls	79	3·12	1·84	
	MS (D/A)	25	2·52	1·94	†
	Psychiatric controls	34	3·29	1·78	
	MS combined	98	2·30	2·08	N.S.
	Muscular dystrophy	37	2·43	1·75	

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TABLE II—*continued*

Modified Walton-Black learning	MS	72	1·0	1·56	‡
	Controls	77	2·57	1·58	
	MS (D/A)	25	1·4	1·84	‡
	Psychiatric controls	35	2·17	1·47	
	MS combined	97	1·1	1·64	‡
	Muscular dystrophy	36	1·77	1·50	
Delayed recall	MS	75	5·56	1·737	‡
	Controls	79	7·40	1·097	
	MS (D/A)	25	6·29	1·737	*
	Psychiatric controls	35	7·03	0·972	
	MS combined	100	5·74	1·679	‡
	Muscular dystrophy	21	6·90	1·019	
Brody's test	MS	76	14·50	16·29	‡
	Controls	79	−6·70	9·07	
	MS (D/A)	26	10·19	12·22	‡
	Psychiatric controls	34	−1·05	7·72	
	MS combined	102	13·4	15·46	‡
	Muscular dystrophy	37	−0·59	10·18	

[1]N.S. not significant; * $p < 0.05$; † $p < 0.01$; ‡ $p < 0.00$.
[2]Data for normal controls taken from Wechsler: *The Measurement and Appraisal of Adult Intelligence*, Williams and Wilkins, Baltimore, 1958.

This makes direct comparison between experimental and control subjects on other items of the test battery possible without having to make allowances for differences in intelligence.

II. CONCEPTUAL THINKING

Similarities

T-testing showed no significant difference between the MS and MS (D/A) groups and their respective controls, but there is a significant difference between the combined MS group and the muscular dystrophies. This, however, is not due to an impaired performance of the MS patients (whose mean score and SD corresponds almost exactly to that of the Wechsler standardization population), but to the above average achievement of the muscular dystrophy patients.

It can therefore be concluded that in our sample of MS patients verbal conceptualization appeared intact.

Weigl Sorting Test

Analysis of the data on this test was carried out by an arbitrary scoring method of assigning scores of 0 for total failures, 1, 2 or 3 to those who successfully completed the task with 3, 2 or 1 cues respectively and 4 to unaided performers (see appropriate section of Table II). The performance of both MS and MS (D/A) groups is highly significantly worse than that of their respective controls. The MS combined group is still significantly worse than the muscular dystrophies, although not at the same high level. A plausible explanation to account for impaired performance on this task would be an acquired organic deficit. However, the fact is that muscular dystrophy patients also tend to perform worse on the Weigl than normal controls. From this it would seem that physical disability, if present to a degree which impairs mobility and ability to manipulate objects in everyday life, also plays an important role. This is understandable if it is remembered that in the course of everyday life simple sorting tasks are often performed, e.g. dishes, clothes put away into cupboards, washing loads sorted out according to kind, etc. Our

sample of institutionalized muscular dystrophy patients had little opportunity for developing and practising such skills. On the other hand our MS patients had normal opportunities for developing the skill, although at the time of investigation many made only limited use of it because of their illness. To account for the above test findings the explanation is therefore offered that the apparent deficit found in muscular dystrophy patients is due entirely to their unusual mode of life, whereas in patients suffering from multiple sclerosis where the deficit is over and above that found in muscular dystrophies, it is due mainly to organic impairment, possibly with recent disuse of the skill as a contributing factor.

III. Spatial ability

Block Design

T-testing shows no significant difference between experimental and control groups, although it may be noted that the MS group obtains a lower score with a larger scatter than any of the other groups.

Map Reading

Performance on this test was sorted into "no cue needed", "cues needed" and "cannot cope" categories. χ^2 analysis revealed a slight difference (d.f. $= 2$, $\chi^2 = 9{\cdot}10$, $p = 0{\cdot}02$) between the MS group and their controls, but no other significant difference was found.

It should be noted that a large proportion, indeed, the majority, of subjects in all groups needed help or failed altogether on this test. It seems therefore that the average subject is not sufficiently familiar with this sort of task, and for this reason the test cannot be regarded as a useful measure of impairment of spatial ability.

IV. Memory functions

Digit Span

Group means are not significantly different in experimental and control groups.

Babcock Sentence Learning Task

The mean score of those subjects who successfully completed this task is approximately three in each group, t-testing yielding no significant differences. However, each group contained a proportion of subjects who failed to learn the sentence in the allocated number of trials. χ^2 analysis of "copers" *v.* "non-copers" yields a very highly significant difference between the MS group and their controls (d.f. $= 1$, $\chi^2 = 10{\cdot}3836$, $p < 0{\cdot}001$), but the difference falls short of statistical significance between the other groups.

Adapting the arbitrary scoring system of assigning a score of 6 to those who learnt the sentence in one trial, a score of 5 to those taking two trials, and so on to giving a score of 0 to failures, differences between experimental and control groups show up better (see Table II). However, muscular dystrophy patients do not perform any better than patients suffering from multiple sclerosis.

Again, a possible interpretation of this finding would be that the muscular dystrophy patients had no practice in this skill. They were without exception institutionalized and cared for in special homes. Patients suffering from multiple sclerosis were living, with very few exceptions, in their own homes in family circles. Although many of them were leading restricted lives they still participated in everyday events to a greater extent than the muscular dystrophy patients, and by doing so they would be likely to have much more opportunity to exercise their rote learning ability (remembering shopping lists, telephone numbers, passing on messages, etc.). As before, similar quantitative test results may have different causes, and it may well be significant that in spite of more opportunity to exercise their faculty of remembering, patients suffering from multiple sclerosis perform no better than the institutionalized muscular dystrophy patients. The lower educational level of the muscular dystrophy patients may also be relevant at this point.

Modified Walton-Black Word Learning

The percentages of total failures (i.e. failing to learn the meanings of the eight words in five trials) were very much higher here than on sentence learning in all MS groups, but only slightly higher or roughly at the same level in all the control groups. χ^2 analysis of "copers" *v.* "non-copers" yields very highly significant ($p < 0{\cdot}001$) differences between experimental and control groups. As expected, the word learning task seems to be generally more difficult,

but particularly so for the organic patients. The two tasks, although both learning, are of a rather different nature: one requires the verbatim immediate repetition of a sentence; the other is more complex in that it requires associate learning and retention (even if only for a short period of time), and retroactive inhibition also comes into play (the list consisting of eight words).

By the scoring system of assigning scores from 5 to 0 (from single trial learners to failures), group means were calculated and t-testing carried out (see "modified Walton-Black word learning" in Table II). This confirmed that the means of experimental and control groups were very highly significantly different. Learning ability, therefore, appears a very vulnerable mental function in patients suffering from multiple sclerosis.

Delayed Recall

The scores in this test were the number of pictures recalled unaided (i.e. without cues). T-testing yields significant differences between the means of all experimental and control groups. This again indicates a vulnerable aspect of mental functioning in multiple sclerosis.

V. Speech functions

The MS group performed slightly worse than their controls ($p = 0{\cdot}05$) on naming and reading. There was no significant difference on naming and reading between the other groups, and there was no significant difference on spelling and comprehension in any of the groups.

Apart from the above slight difficulties at naming and reading in the MS group, speech functions, as measured by the tests used, do not appear impaired in patients suffering from multiple sclerosis.

VI. General intellectual efficiency

All experimental groups obtain positive deterioration quotients, i.e. there is a discrepancy between performance on vocabulary, on the one hand, and speed, knowledge of current events, short term verbal and visual memory on the other, in favour of vocabulary. All control groups obtain negative scores indicating the absence, or the presence in the opposite direction, of such a discrepancy. T-testing yields very highly significant differences for experimental and control group means.

There is, therefore, strong evidence that general intellectual efficiency, as measured by this test, is markedly lowered in patients suffering from multiple sclerosis.

It is to be noted that the MS group mean is higher than the MS (D/A) mean, (although the difference is not significant statistically).

VII. Qualitative aspects of performance

The presence or absence of "organic signs" (e.g. perseveration, confabulation, etc.) during testing procedure was determined and noted. Findings of a simple analysis of organic signs present *v.* organic signs absent are summarized in Table III. All MS groups displayed organic signs more frequently than their respective controls although the χ^2 for the MS (D/A)–psychiatric controls pair falls short of statistical significance. This analysis does not take into account the number of organic signs that were present in any individual case (or group), nor the degree (slight or marked) to which these signs were in evidence. In actual fact, patients suffering from multiple sclerosis tended to display more than one sign and often to a moderate to marked degree, whereas in the control groups in no instance was more than one sign shown, and never to more than a slight degree, by any individual subject. A more involved analysis taking these facts into account would show up the differences between experimental and control groups even more. However, it is important to note that although these signs are generally thought to be indicative of organic involvement, they are occasionally, even if not frequently or to a marked degree, shown by subjects where no organic CNS involvement can be demonstrated.

Conclusions

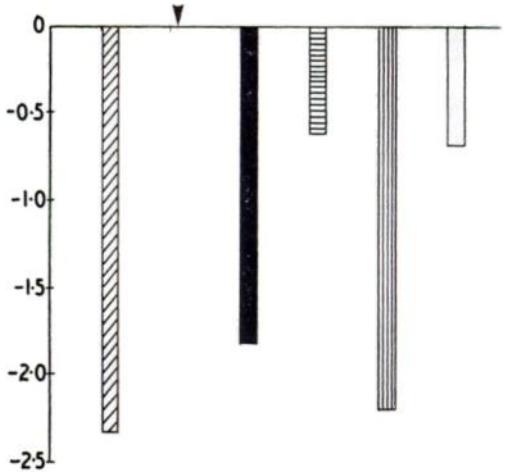
As stated in the introduction, the purpose of the study was to investigate whether patients suffering from multiple sclerosis, show (*a*) any impairment of intellectual efficiency, and if so, (*b*) of what degree, and (*c*) of what pattern.

(*a*) As measured by Brody's test for intellectual deterioration, intellectual efficiency of patients suffering from multiple sclerosis is shown to be definitely impaired.

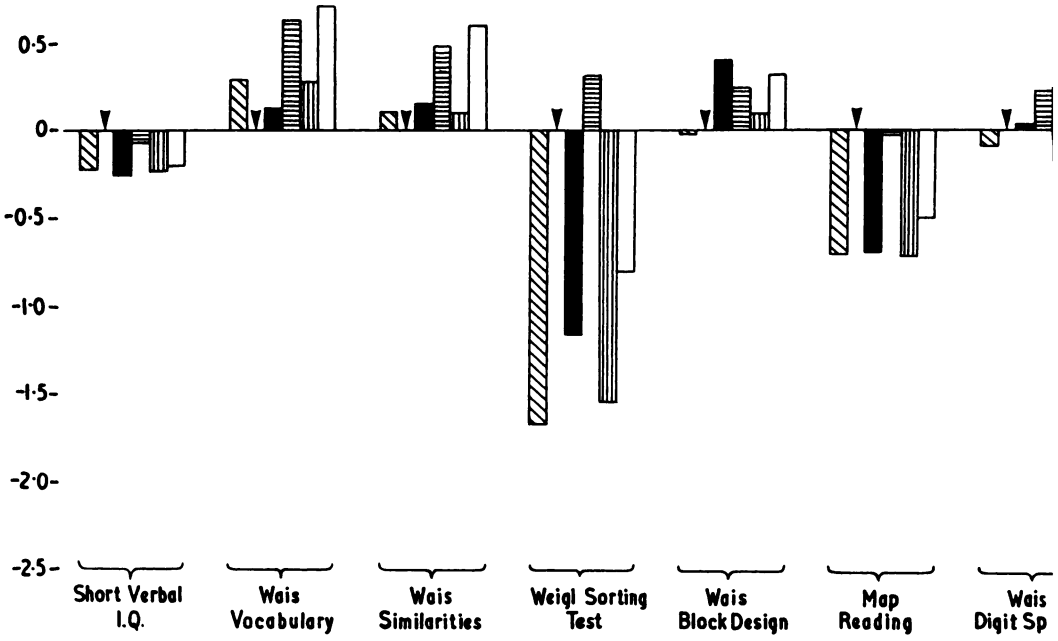
(*b*) Expressed in standard scores, i.e. as the deviation from the normal control group mean in the Brody test, the whole sample of MS patients (MS combined) obtains a group mean of minus 2·33, (see Graph 1). It is both conventional and legitimate to regard on statistical grounds a deviation as large as this as definite and of considerable degree.

(*c*) In order to find the answer to the question whether or not any consistent pattern of intellectual deficits emerged, all test scores were converted into standard scores by using the means and standard deviations of the normal control group as basis, and the standard score group means were calculated in order to make inter-test comparisons possible. As can be seen from Table IV and the Summary Chart (Graph 2), the largest negative deviation from

GRAPH 1



Standard score means on Brody's Test of the following groups: multiple sclerosis ▨, normal controls ▼ z = 0, depressed multiple sclerosis ■, psychiatric controls ▤, combined multiple sclerosis ▥, and muscular dystrophy □, expressed as the deviations from the normal control group mean.



Standard score means, expressed as the deviation from the normal group mean, on all tests included in the battery, the experimental and control groups.

▨ multiple sclerosis ■ depressed multiple sclerosis ▥ combined multiple sclerosis

▼ normal controls (z = 0) ▤ psychiatric controls □ muscular dystrophy

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TABLE III
Qualitative signs

Group	Present	Absent	
MS	42	35	$\chi^2 = 38{\cdot}17$ ‡
Controls	6	73	
MS (D/A)	9	17	$\chi^2 = 2{\cdot}43$ N.S.
Psychiatric controls	5	30	
MS combined	51	52	$\chi^2 = 7{\cdot}57$ †
Muscular dystrophy	8	29	

N.S. not significant; * $p < 0{\cdot}05$; † $p < 0{\cdot}01$; ‡ $p < 0{\cdot}00$.

normal in patients suffering from multiple sclerosis was found in intellectual efficiency. Non-verbal conceptualization (Weigl) and memory functions are also impaired to a considerable degree. Spatial ability (in map reading) and speech functions also show negative deviations but to a lesser extent.

The MS group does worse on a number of tests, i.e. on the Weigl, block design, sentence learning, word learning, delayed recall, Brody, and speech tests, than the depressed MS group. This finding would be consistent with the explanation that patients suffering from multiple sclerosis tend to get symptoms of anxiety and depression in the initial stages of their lower intellectual efficiency, possibly because of greater initial insight. This finding together with the fact that the psychiatric control group does generally better than the depressed MS group also allows the conclusion that intellectual

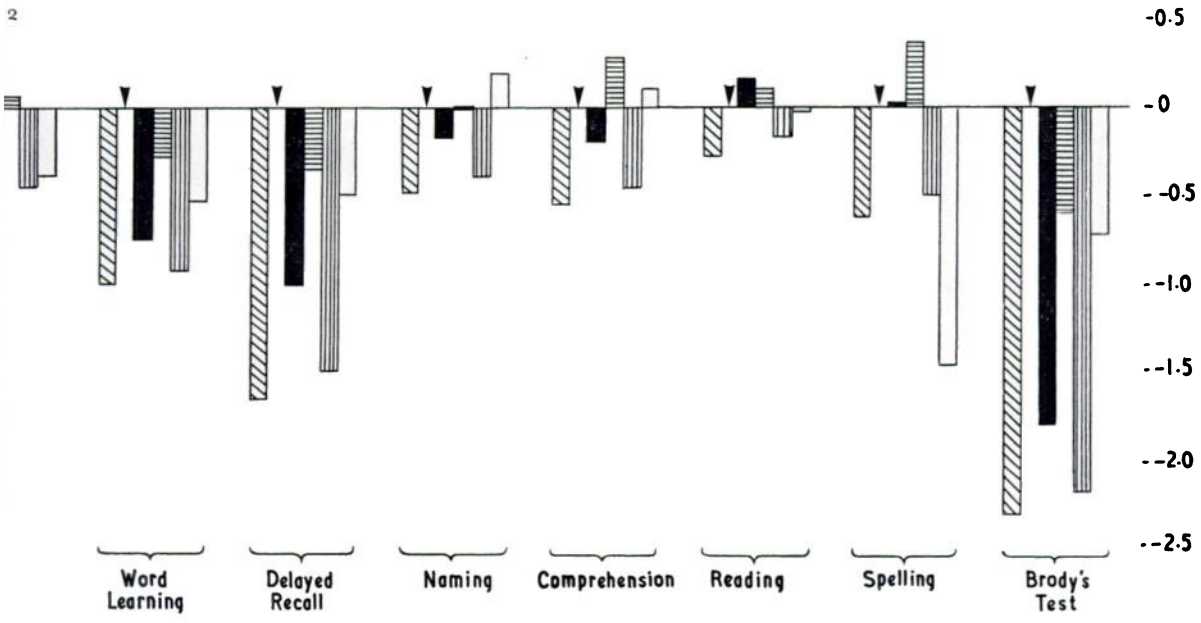

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TABLE IV

Standard score means of experimental and control groups on all tests

Test	Group	Standard score
Short verbal IQ	MS	−0·22
	Control (normal)	0·00
	MS (D/A)	−0·26
	Psychiatric control	−0·08
	MS combined	−0·23
	Muscular dystrophy	−0·2
WAIS vocabulary	MS	0·30
	Control (normal)	0·00
	MS (D/A)	0·14
	Psychiatric control	0·65
	MS combined	0·26
	Muscular dystrophy	0·73
WAIS similarities	MS	0·10
	Control (normal)	0·00
	MS (D/A)	0·15
	Psychiatric control	0·52
	MS combined	0·16
	Muscular dystrophy	0·64
Weigl sorting test	MS	−1·74
	Control (normal)	0·00
	MS (D/A)	−1·16
	Psychiatric control	0·30
	MS combined	−1·55
	Muscular dystrophy	−0·78
WAIS block design	MS	−0·00
	Control (normal)	0·00
	MS (D/A)	0·40
	Psychiatric control	0·23
	MS combined	0·10
	Muscular dystrophy	0·34
Map reading	MS	−0·73
	Control (normal)	0·00
	MS (D/A)	−0·69
	Psychiatric control	−0·03
	MS combined	−0·72
	Muscular dystrophy	−0·50
WAIS digit span	MS	−0·09
	Control (normal)	0·00
	MS (D/A)	0·04
	Psychiatric control	0·23
	MS combined	−0·06
	Muscular dystrophy	−0·13
Babcock sentence learning	MS	−0·48
	Control (normal)	0·00
	MS (D/A)	−0·32
	Psychiatric control	0·09
	MS combined	−0·44
	Muscular dystrophy	−0·37
Modified Walton-Black word learning	MS	−0·99
	Control (normal)	0·00
	MS (D/A)	−0·74
	Psychiatric control	−0·25
	MS combined	−0·93
	Muscular dystrophy	−0·50
Delayed recall	MS	−1·67
	Control (normal)	0·00
	MS (D/A)	−1·02
	Psychiatric control	−0·34
	MS combined	−1·50
	Muscular dystrophy	−0·46
Naming	MS	−0·48
	Control (normal)	0·00
	MS (D/A)	−0·15
	Psychiatric control	0·06
	MS combined	−0·40
	Muscular dystrophy	0·21
Comprehension (pointing)	MS	−0·56
	Control (normal)	0·00
	MS (D/A)	−0·20
	Psychiatric control	0·30
	MS combined	−0·47
	Muscular dystrophy	0·10
Reading	MS	−0·27
	Control (normal)	0·00
	MS (D/A)	0·16
	Psychiatric control	0·12
	MS combined	−0·16
	Muscular dystrophy	−0·06
Spelling	MS	−0·62
	Control (normal)	0·00
	MS (D/A)	0·004
	Psychiatric control	0·38
	MS combined	−0·46
	Muscular dystrophy	−1·47
Brody	MS	−2·33
	Control (normal)	0·00
	MS (D/A)	−1·80
	Psychiatric control	−0·61
	MS combined	−2·20
	Muscular dystrophy	−0·69

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impairment of patients suffering from multiple sclerosis, particularly if present to a marked degree, is unlikely to be due to concomitant mood disturbances.

It is not easy to say to what extent the intellectual deficits found in patients suffering from multiple sclerosis are due to central nervous system involvement and to what extent to progressive physical disability, since the muscular dystrophy group was an imperfect match to the combined MS group. However, in cases where comparison between the muscular dystrophy patients and patients suffering from multiple sclerosis is significantly unfavourable for the latter (in conceptualization, learning ability, delayed recall, and general intellectual efficiency), it can be concluded that the deficit is due to central nervous system impairment.

The comprehensive test battery used in the present study has served a useful purpose by showing that intellectual deficits in multiple sclerosis can be varied and may affect several functions. The evidence for memory impairment accords with the pathological finding that the periventricular region is a "territory of election" for plaque formation (McAlpine *et al.*, 1955).

A striking result of the study has been the evidence for the differentiation between verbal and non-verbal conceptualisation, which seems to warrant further inquiry.

Once it is recognized that mental deterioration is a real feature of the disease, important practical considerations follow for those who are concerned in the assessment and management of multiple sclerosis patients. The data collected have not yet been fully processed, and analysis may throw further light on the relationship between cognitive functioning on the one hand and the type of multiple sclerosis, duration of illness and physical disability on the other.

Yet another aspect of the study concerns the clinical psychologist who often faces the problem of assessing organic intellectual deterioration. In this task the contribution of the test results of a large confirmed organic group may prove useful. The Brody test, for example, which to the author's knowledge is not in general clinical use, may be particularly worth the clinical psychologist's attention. The present findings may not be relevant to all neurological conditions, but where the nature of the disease is similar to that of multiple sclerosis (diffuse lesions), patients might be expected to behave in a similar way.

The differences found between the organic and non-organic groups regarding qualitative signs were impressive. It would be interesting to see how other organic groups behaved in this respect, for psychometric tools to assess brain damage are as yet imperfect and the clinical psychologist may welcome information in addition to quantitative test results.

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Katalin Jambor, B.A., *Senior Psychologist, The Isis Group of Hospitals, Oxford; Littlemore Hospital, Oxford*

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