Clinically, our cases closely parallel Gillanders's description of nutritional heart disease, with the hypokinetic circulation, the poor movement of the heart as seen fluoroscopically, and the poor response to treatment. However, there was no evidence that malnutrition was a causal factor. Malignant malnutrition or kwashiorkor is a common condition amongst the African children admitted to this hospital, but in our cases the state of nutrition was much above the average, with no evidence of dermatosis, severe liver disturbance, oedema, or other stigmata of malnutrition. Thus until the aetiology of these cases is determined the term idiopathic cardiac hypertrophy seems appropriate.

The literature is briefly reviewed, with particular reference to the rarer forms of heart disease occurring in infancy and childhood.

We wish to thank Dr. E. Kahn and Dr. H. Grusin for their help in the preparation of this paper, and Dr. J. D. Allen, medical superintendent, for permission to publish the cases.

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MENTAL ABILITY AND SCHOOL ACHIEVEMENT OF PREMATURE CHILDREN AT 8 YEARS OF AGE*

BY

J. W. B. DOUGLAS, B.M.

Senior Lecturer in Public Health and Social Medicine, University of Edinburgh

This is the fourth in a series of papers describing the growth and development of a national sample of premature children who have been followed through from birth and compared with a closely matched group of children born at term. Previous papers have described their health (Douglas and Mogford, 1953a), their growth (Douglas and Mogford, 1953b), and their age at walking (Douglas, 1956). The present paper describes the results of reading, vocabulary, and picture intelligence tests given when they were 8 years old.

*This survey is being made by a joint committee of the Institute of Child Health (University of London), the Society of Medical Officers of Health, and the Population Investigation Committee. The chairman of the committee is Professor James Young, the vice-chairman Professor A. A. Moncrieff, and the secretary Professor D. V. Glass. The Nuffield Foundation has financed this inquiry during the pre-school years, and grants for continuing it in the primary school period have been made by the board of governors of the Hospital for Sick Children, Great Ormond Street, through the Institute of Child Health, and by the Ford Foundation. Fourteen regional hospital boards have also made grants to the inquiry from their free moneys.

During the last thirty years many studies have been made of the mental development of premature children, and excellent critical reviews have been given by Benton (1940) and Alm (1953). Most workers agree that premature children are restless, irritable, and lacking in concentration, and report a relatively high incidence of severe mental defect among them. These severe defects are usually associated with a history of birth injury, which is relatively common among premature children, or with developmental abnormalities, such as mongolism, which are themselves associated with low birth weight. But the important question of whether premature children are retarded in development after these abnormal groups have been excluded has not yet been satisfactorily answered. Some workers—for example, Hess *et al.* (1934)—find no evidence of mental handicap except when there is a history of cerebral damage, whereas others—for example, Lofthus (1930), Brander (1936), and Blegen (1953)—report handicaps of varying severity.

This lack of consistency is not surprising, since a large proportion of the premature children enrolled in these studies were not traced and those that were tested were by no means a random selection of those sought. A further source of bias lies in the fact that premature children are more common in poorer families, among firstborn infants, and among females; and this selection must be taken into account when assessing their mental development. If, as in so many of these studies, their scores are compared with those of a randomly chosen group of children born at term, there will always remain the possibility that any handicaps found are the result of environmental differences rather than of prematurity itself. More detailed criticisms of previous studies are given by Benton (1940), Alm (1953), and Douglas and Mogford (1953a, 1953b).

Nature of Present Inquiry

A unique opportunity to make a controlled study of a representative group of premature children was provided by the Maternity Survey of 1946 (R.C.O.G. Survey, 1948). All children born during the first week of March of that year were enrolled in the inquiry, and among them were 707 legitimate single-born babies weighing 5½ lb. (2.5 kg.) or less at birth, and therefore, by international definition, "premature." Information was lacking on the home conditions of 31 of these premature children, but we have been able to match each of the remaining 676 with a child (the control) weighing more than 5½ lb. at birth who was selected from the remaining legitimate singletons born during the survey week. The selection was made on the basis of sex, ordinal position in the family, mother's age, social group, and degree of crowding in the home; and wherever possible the premature child was matched with a control living in the area of the same local authority.

The majority of premature children were well matched for all these characteristics, and there is little doubt that in this way we have removed the major sources of bias in assessing their development. For further details of matching see Douglas and Mogford (1953a). The resulting sample is too small to allow us to make precise statements about severe mental defects but is well suited to a comparison of the general distribution of mental ability in premature children and their controls.

Available Information

In March, 1954, when the survey children were 8 years old, they were tested for their ability to read and understand a list of words of graded difficulty and to appreciate relationships shown in a series of picture strips. Three scores were given —one for reading, one for word comprehension (vocabulary),

and one for ability to appreciate relationships (picture intelligence). The tests were specially designed for this inquiry by the National Foundation for Educational Research in England and Wales and were approved by the Scottish Council for Research in Education.[1]

Our original intention was to test all children within a month of their eighth birthday, but, owing to unavoidable delays, some were tested later than this, and in the following tables all those tested after May 30, 1954, have been excluded.

Table I shows the state of the premature and control sample at the time of these tests, when the children were 8 years old. The loss of one member of a pair involves the exclusion of the other, since we are here interested only in comparing the performance of each premature child with his control. We are, of course, continuing to follow-up the remaining numbers.

TABLE I.—*Losses From the Matched Sample (Birth to 8 Years)*

Unavoidable loss	Death	177 pairs
	Emigration	49 ,,
Avoidable loss	Refusals	11 ,,
	Late tests and untraced	16 ,,
Inability to test	Educationally subnormal	8 ,,
	Ill or handicapped	8 ,,
Completed tests		407 ,,
Total in original sample		676 ,,

The excess of deaths among premature children that was noted in earlier papers has been maintained in recent years, although, of course, the number dying was small. Of the four children who died since 1950, three were prematurely born.

As already noted, the numbers in our sample are insufficient to assess the importance of prematurity as a cause of gross mental defect, but it is of interest that the premature child was the affected member in six of the eight pairs lost owing to educational subnormality. The premature children also predominated among those lost through illness or physical handicap. Five of the eight children affected were premature, three of them being blind or having poor sight. The other losses shown in Table I were evenly distributed between the premature children and their controls.

Results of Tests

The mean scores achieved in the three tests by the premature children are compared in Table II with those of their controls. Similar differences were found for each sex, and accordingly boys and girls have not been separated in the following Tables.

TABLE II.—*Test Scores of Premature Children and Their Matched Controls*

	Mean Test Score for		
	Mechanical Reading (407 Pairs)	Vocabulary (407 Pairs)	Picture Intelligence (406 Pairs)*
Premature children	13·65	14·47	36·82
Control ,,	16·55	15·47	39·83
Difference	−2·90	−1·00	−3·01
S.E. of difference	±0·48	±0·38	±0·67
Handicap of premature child	−17·5%	−6·5%	−7·6%

* One child completed the reading and vocabulary tests but not the picture intelligence test.

On each test premature children made scores slightly but significantly less than their controls. In absolute figures they appear to do worst in the picture intelligence test, but this is misleading because the mean scores of the controls for this test were more than twice as high as for the other tests. Therefore in line 5 Table II the differences in scores are expressed as a proportion of the mean score of the controls for each test. This proportion will be referred to as the "percentage handicap" of the premature child. It will be seen that the greatest percentage handicap is found for reading, in which the average premature child scored 17.5% less than the average control child. This compares with 6.5% less in vocabulary and 7.6% less in picture intelligence.

The frequency distribution of the differences between the scores achieved by premature and control pairs is shown in Figs. 1, 2, and 3. Each of these distributions shows a general shift to the left of the zero line.

It should be mentioned here that all tests of significance in this paper are based on the difference scores for the individual pairs and not on the actual scores of the premature children and their controls. As a matter of convenience the results of these tests are recorded only when P is 0.05 or less—that is to say, the usually accepted level of statistical significance.

TABLE III.—*Percentage Handicaps of Premature Children in Different Social Groups*

Father's Occupation	Percentage Handicap in			No. of Matched Pairs
	Mechanical Reading	Vocabulary	Picture Intelligence	
Non-manual	−17·3	−2·2	−0·5	79
Manual	−18·4	−7·6	−9·2	309*
Self-employed	−4·2	−8·7	−10·5	19

* One pair less for picture intelligence.
Comparing scores of non-manual and manual workers for the picture intelligence test, t=1·97, n=385, P=0·05.

TABLE IV.—*Percentage Handicaps of Premature Children Grouped by Weight at Birth*

Birth Weight of Premature Child	Percentage Handicap in			No. of Matched Pairs
	Mechanical Reading	Vocabulary	Picture Intelligence	
4½ lb. (2 kg.) or less	−14·13	−10·34	−13·05	80*
4½–5½ lb. (2–2·5 kg.)	−18·28	−5·57	−6·25	327

* One pair less for the picture intelligence test.
None of these differences is significant.

TABLE V.—*Percentage Handicaps of Premature Children Grouped by Length of Gestation*

Length of Gestation of Premature Child	Percentage Handicap in			No. of Matched Pairs
	Mechanical Reading	Vocabulary	Picture Intelligence	
At term or less than 4 weeks early	−20·0	−7·0	−8·3	246*
4 weeks before term or earlier	−11·8	−4·1	−5·6	107
Unknown	−5·5	10·2	−7·5	54

* One pair less for the picture intelligence test.
None of the differences between the figures in the first two lines is significant.

As already stated, it has been suggested in the past that the mental handicaps of premature children should be attributed to the poor environment in which they are reared rather than to their low birth weight or any obstetric or biological factors associated with it. The close matching of premature children and controls in the present study makes this explanation unlikely, but it may be argued that aspects of the environment other than the economic are important. Perhaps the handicaps would be reduced or eliminated among premature children whose parents were fully aware of their special needs and satisfied them. I have accordingly grouped the pairs in Table III by the occupation of the father. The majority of the parents with secondary and higher education are in the group of non-manual workers, and if an awareness of the special needs of premature children is an important factor in their later development we should expect to find the smallest handicaps in this group.[2] In addition

[1] Full details of these tests and their reliability will be published by the National Foundation. The reliability of the picture intelligence test is 0:92 (Kuder–Richardson Formula 20) calculated from a group administration of the test. The reliability of the reading and vocabulary test is not yet available.

[2] The educational background of the parents is described in a forthcoming book, *The Health, Growth, and Environment of the Pre-School Child.*

to having, on the average, a better education, the parents in the group of non-manual workers make fuller use of the available medical services.

In reading, there is no difference between the handicaps of the children in the two occupational groups, but in both vocabulary and picture intelligence the children of non-manual workers have smaller handicaps, though only for the latter are they significantly smaller.

Previous workers have been unable to reach agreement on the extent to which the mental handicaps of premature children are related to their birth weight. Brander (1936) found a steady fall in the intelligence of premature children with falling birth weight, but Lofthus (1930) and Blegen (1953) did not, although they both found that premature children as a group were mentally handicapped.

In Table IV the pairs are grouped according to the birth weight of the premature child. There is no consistent difference in the percentage handicaps of premature children in these two birth-weight groups. The lighter children are more handicapped in vocabulary and picture intelligence and the heavier ones in reading; but none of these differences is statistically significant. A division into finer weight groups shows no further tendency for the smaller children to be more handicapped.

In Table V the pairs have been regrouped according to the length of gestation of the premature child. Here again there are no statistically significant differences between the groups, but there is a consistent tendency for the greater handicaps to be found among the *least* premature children.

Lastly, I have grouped the pairs in Table VI into: (1) those where the premature child resulted from a pregnancy complicated by toxaemia or ante-partum haemorrhage, or terminated by induction; (2) those with no history of abnormality of pregnancy; and (3) those whose obstetric records were incomplete.

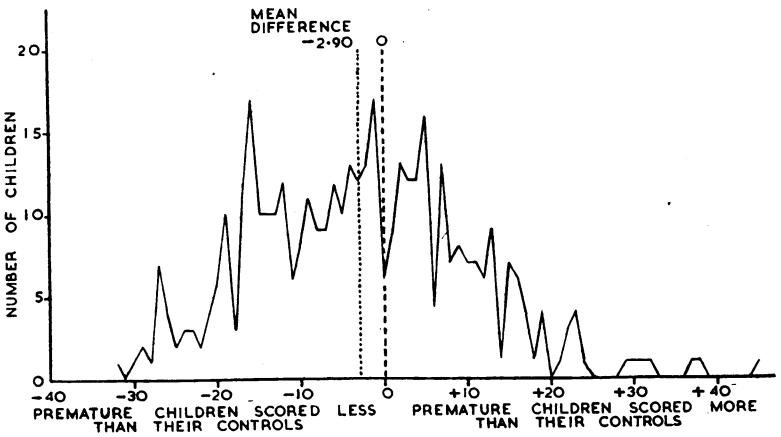

FIG. 1.—Difference scores in mechanical reading achieved by premature and control pairs.

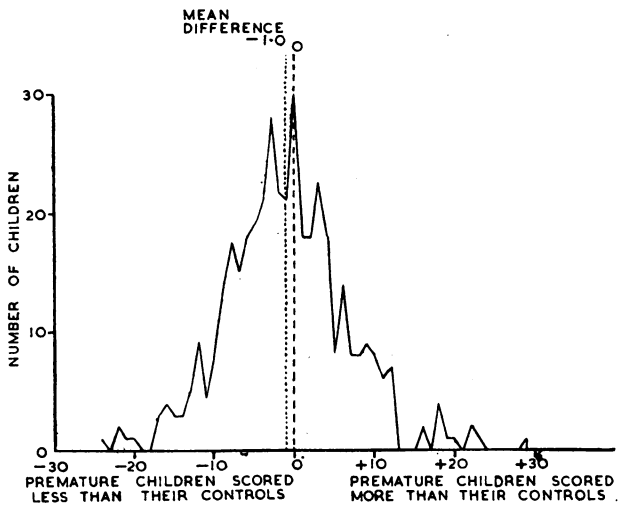

FIG. 2.—Difference scores in vocabulary achieved by premature and control pairs.

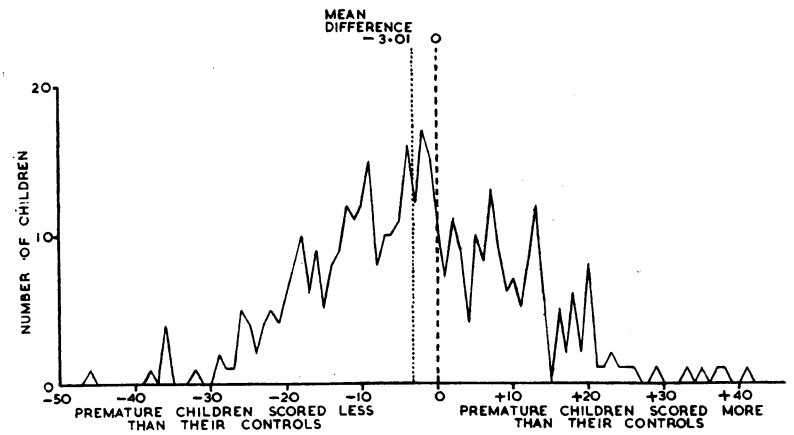

FIG. 3.—Difference scores in picture intelligence achieved by premature and control pairs.

Information about the course of pregnancy is based on the routine records of hospitals and midwives, which are sometimes far from satisfactory, as will be seen from the relatively large number of pairs with an incomplete obstetric history. In spite of these deficiencies, there is little doubt that group 1 contains the majority of premature children resulting from abnormal pregnancies and group 2 the majority resulting from uncomplicated ones.

Premature children resulting from uncomplicated pregnancies have consistently greater handicaps than those from pregnancies in which there was a history of toxaemia, antepartum haemorrhage, or induction. For reading and picture intelligence these differences are not significant, but for vocabulary they are highly significant. Moreover, they are constant for all tests when the data are further subdivided.

It is of considerable interest that the relationship between high handicap and uncomplicated pregnancy is as marked among the children of non-manual workers as among the children of manual workers. For the former the handicaps for reading, vocabulary, and picture intelligence are respectively −35.6%, −17.3%, and −5.5%; for the latter they are −20.2%, −10.5%, and −10.1%. Indeed, among the non-manual workers premature children suffer a significant handicap only if they have no history of toxaemia, antepartum haemorrhage, or induction.

A relatively large proportion of the premature children resulting from uncomplicated pregnancies had parents who were below average height and weight, and the question now arises whether these "genetically" small children are more or less handicapped than the rest in this group. It is an important question, because the finding of large handicaps among those with large parents—that is, among those whose prematurity was unexplained either by heredity or by obstetric abnormality—would suggest that there is an unidentified factor related both to low birth weight and to low intelligence. I have accordingly grouped the pairs with no obstetric reason for prematurity as follows in Table VII: A=The mother of the premature child is both *smaller* and

TABLE VI.—*Percentage Handicaps of Premature Children Grouped by Their History of Pregnancy*

Obstetric History	Percentage Handicap in			No. of Matched Pairs
	Mechanical Reading	Vocabulary	Picture Intelligence	
Toxaemia, A.P.H., etc.	−13·95	+4·09	−5·96	138*
No abnormality ..	−24·44	−12·70	−9·62	197
Incomplete obstetric history ..	−3·22	−8·91	−4·45	72

* One pair less for the picture intelligence test.
Comparing the scores of the vocabulary test of those with toxaemia, etc., and those without, t=3·013, n=333, P<0·01.

TABLE VII.—*Percentage Handicaps of Premature Children Grouped by the Size of Their Mothers (Group with no Abnormality of Pregnancy)*

Maternal Size Grouping	Percentage Handicap in			No. of Matched Pairs*
	Mechanical Reading	Vocabulary	Picture Intelligence	
A	−15·1	−7·7	−4·2	84
B	−21·0	−12·0	−7·4	47
C	−40·7	−28·3	−16·5	24

* 42 pairs excluded because height and/or weight of mother of one or both members was unknown.
Comparing Groups A and C: Mechanical reading, t=2·51, n=106, 0·02>P>0·01; vocabulary, t=2·64, n=106, P<0·01; picture intelligence, t=1·91, n=106, P approx. 0·06.

TABLE VIII.—*Percentage Handicaps of Premature Children Grouped by the Size of Their Mothers (Group with History of Toxaemia, A.P.H., Induction, etc.)*

Maternal Size Grouping	Percentage Handicap in			No. of Matched Pairs†
	Mechanical Reading	Vocabulary	Picture Intelligence	
A	−8·2	−0·6	−11·1	42
B	−5·5	+8·2*	−1·2	36
C	−19·4	+7·1	−3·6	21

* The mean score for the premature children was 8·2% higher than the mean score for the controls.
† 39 pairs excluded because height and/or weight of mother of one or both members was unknown.
None of these differences is significant.

lighter than the mother of the matched control. B=The mother of the premature child is *either* smaller *or* lighter than the mother of the matched control. C=The mother of the premature child is *both* taller *and* heavier than the mother of the matched control.

The assumption in this grouping is that A will contain the highest proportion of premature children whose birth weight is genetically determined, while C will contain the lowest proportion.[3]

In each test the handicaps of premature children are smallest in the group where there is the strongest evidence of a genetic element to account for their low birth weight (group A) and largest in the group where there is least evidence of a genetic element (group C). Group B occupies an intermediate position. When the handicaps in groups A and C are compared statistically, significant differences are found for mechanical reading and for vocabulary, whereas the difference for the picture intelligence test is just below the usually accepted level of significance.

I have carefully examined the available information on each child in group C, paying particular attention to the incidence of breech deliveries, other obstetric emergencies, a history of respiratory distress at birth, and the administration of oxygen. But these incidents are no more common in this group than in group A. Nor can the unfavourable position of group C be attributed to a poor environment; their homes are in every way similar to those of their controls and to those of the other premature children in the sample. It is worth noting, however, that a high proportion are firstborn (66% as compared with 44% of the surviving premature children) and that half of the remaining later-born children were born after an interval of six or more years from the birth of the immediately preceding sib.

As already mentioned, Table VII refers only to premature children resulting from uncomplicated pregnancies. If, as suggested above, the poor performance of premature children in group C is explained by an unidentified factor related both to low birth weight and to low intelligence, then an association between maternal size and mental handicap would not be expected for the rest of the pairs—that is to say, for those where prematurity was explained on obstetric grounds. Table VIII does in fact show that there is no consistent relationship between the size of the mother and the handicap of the premature child in these circumstances.

Comment

It is of interest that premature children are proportionately more handicapped in reading than in either vocabulary or picture intelligence.[4] This agrees with the observations of many research workers and schoolmasters that they lack concentration and that their performance lags behind their ability.

In general the mental handicaps of premature children are small if we exclude those with a history of birth injury or cerebral damage. A better idea of their importance is given if we relate their scores to those of all children of the same age in the population. (This we are able to do by using the test results for the main survey sample—see Douglas and Mogford, 1953b.) Among the children whose scores fell into the highest tenth of those taking these tests, 1 in 33 was prematurely born as compared with an expected ratio of 1 in 25. Among those whose scores fell into the lowest tenth, 1 in 17 was prematurely born (here again the expected proportion was 1 in 25). In other words, the premature children were slightly under-represented among the best scores and slightly over-represented among the worst.

The main interest in this study lies in the demonstration that there is a small but well-defined group of premature children who make outstandingly poor scores in all tests—namely, those whose prematurity is unexplained either by obstetric abnormality or by the small size of their parents. Even after this group has been excluded, however, premature children still show a slight but statistically significant handicap in reading and picture intelligence, though not in vocabulary.

Owing to the wide distribution of the sample, our information is necessarily incomplete and in some respects superficial, and a more intimate and detailed study is needed both to confirm the present observations and, if confirmed, to attempt to explain them.

Summary

This is the fourth of a series of papers describing the growth and development of a national sample of premature children—that is, weighing 5½ lb. (2.5 kg.) or less at birth—who, with a carefully matched group of controls, have been followed through from birth.

Tests of reading, vocabulary, and intelligence were given to these premature children and their controls when they were 8 years old.

Premature children scored less than their controls in each of these tests, being proportionately the most handicapped in reading.

The handicaps of premature children did not increase significantly with either falling birth weight or decreasing length of gestation.

In general the handicaps found were small, but there was a well-defined group with no obstetric or genetic

[3] I should like to have been able to include the height and weight of the fathers as well in this division, but the figures available were derived from wives' estimates and not from direct measurements.

[4] Difference between the handicaps in reading and vocabulary is −11.0 ±3.75% and between reading and picture intelligence −9.9 ±3.28%.

explanation of their low birth weight, who were heavily handicapped in all tests.

I wish to thank the chairman and members of the joint committee for their help and advice; the medical officers of health and the health visitors whose generous co-operation made the survey possible; and the mothers in all parts of the country who willingly answered numerous and detailed questions on their children's health.

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EPILEPSY OF LATE ONSET IN THE LIGHT OF MODERN DIAGNOSTIC PROCEDURES*

BY

HELEN DIMSDALE, M.D., F.R.C.P.

From the Maida Vale Hospital for Nervous Diseases, London

The number of diagnostic techniques available for the investigation of epilepsy of late onset raises the question how many are essential in the investigation of the individual patient. The accurate location of the causal lesion is obviously a different task from its detection, and is not dealt with here. This paper attempts only to assess which techniques are most likely to exclude the presence of a lesion and what are the clinical indications for their use.

The material consisted of 200 cases of epilepsy starting after the age of 20, excluding traumatic cases and those with papilloedema. Cerebrospinal fluid findings were not considered. The first group of 100 was investigated at the London Hospital Neurological Unit at the time of its evacuation in the second world war to Chase Farm E.M.S. Hospital, where facilities were limited. Pneumoencephalography by the lumbar route with partial replacement was the routine method of investigation. The second group consisted of 100 patients recently admitted to Maida Vale Hospital, where all the usual techniques were available. Little difference was apparent in the diagnoses when the two groups were compared (Table I). The term "idiopathic" was used, as formerly, to indicate that no significant macroscopic lesion was detected on radiological investigations, and was not restricted to central or genetic epilepsy.

The incidence of space-occupying lesions was about equal in the two groups, with a figure of 23 if angiomas are included.

Cerebral atrophy presenting as epilepsy provided just under a fifth of the cases. This condition was a definite clinical entity characterized by minor neurological signs, including some degree of mental deterioration in most patients. The radiological appearances of atrophy were present on pneumoencephalography. Occasionally the condition masks a tumour, but this combination was not observed in this series.

Epilepsy due to arteriopathy or arteriosclerosis, though not uncommonly seen in out-patient clinics, did not usually present a sufficiently difficult diagnostic problem for full neuroradiological investigation to be necessary. Epilepsy was attributed to this cause in 4% and 3% of cases respectively. Cerebral infarction from other forms of cardiovascular disease producing an epileptic focus was not represented in this series.

Clinical Features

Certain clinical features in both groups—that is, the age of onset of the attacks, the length of history, and the presence of abnormal physical signs—were associated with an increased likelihood that structural abnormalities would be found on investigation.

Age of Onset.—The cases are divided in Table I into those under 40 and those 40 and over, and show the age distribution of onset of attacks and diagnosis. Abnormalities were

TABLE I.—*Age of Onset and Diagnosis*

	Under 40		40 and Over		Total	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Idiopathic epilepsy ..	36	43	16	15	52*	58†
Cerebral tumour ..	7	9	13	9	20	18
Angioma	3	4		1	3	5
Cerebral atrophy ..	11	6	10	9	21	15
Cerebral arteriopathy ..			4	3	4	3
Aneurysm				1	0	1
Lesion present	37%	33%	63%	61%	48%	42%

* Including 1 temporal lobe epilepsy.
† Including 15 temporal lobe epilepsy.

detected in 37% and 33% of patients under the age of 40, and 63% and 61% in the later age groups. Tumours and cerebral atrophy show a relatively increased incidence in those aged 40 and over. The angiomas differed, and in seven out of eight patients produced fits in the third and fourth decades.

Duration of Symptoms.—If the attacks had occurred for more than five years the probability of a tumour being present was much reduced. Of the 38 patients with tumours in the two groups, 35 had a history of attacks for five years or less, and in only three did the history exceed five years. Three-quarters of the cases with cerebral atrophy had a history of five years or less, but five out of the eight cases of angioma had a history exceeding five years (Table II).

TABLE II.—*Duration of Symptoms*

	5 Years or Less		Over 5 Years	
	Group 1	Group 2	Group 1	Group 2
Idiopathic epilepsy ..	40	46	12	12
Cerebral tumour	20	15		3
Angioma		3	3	2
Cerebral atrophy	18	9	3	6
,, arteriopathy ..	4	3		
Aneurysm		1		

Physical Signs.—A causal lesion was detected in four out of every five patients with abnormal physical signs, and in one out of five without abnormalities on clinical examination.

Focal Attacks.—The diagnostic significance of focal attacks was modified by the recent interest in temporal lobe epilepsy. The number of patients investigated for focal attacks increased from 30% in group 1 to 58% in group 2, but the incidence of macroscopic causal lesions fell from the high figure of 63% in group 1 to 45% in group 2, because radiological investigations were more commonly negative in temporal lobe epilepsy than in focal attacks originating in other sites.

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